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The Association of Beef Carcass Conformation and the Yield of Thick and Thin Meat

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Many have believed for some time that beef cattle and beef carcasses described as more "desirable" in conformation actually yield more lean meat and have a higher ratio of lean to bone than those described as "inferior" in conformation. The "ideal beef carcass" has often been described as blocky, compact, straight-sided, smooth and yielding a high percentage of the higher value wholesale cuts (loin, rib and round).

Beef carcass composition studies have traditionally used such measures as total carcass fat, lean and bone; edible portion and the yield of trimmed, boneless retail cuts from the round, loin, rib and chuck as "end points" for use in characterizing the product. Research to date has failed to demonstrate a significant positive association between desirable conformation, as described above, and the yield of separable lean. Moreover, numerous studies have pointed to the rather marked influence of fat in confounding visual appraisals for "desirable" conformation in slaughter cattle as well as in carcass beef. The need to consider more fully a comparison of the yield of thick, high value muscle from carcasses differing in conformation formed the basis for this study.

Procedure

These preliminary trials were conducted in an effort to study beef carcass conformation by a new method developed at this station during the past year. The method involves determination of the yield of closely trimmed, boneless "thick" and "thin" muscles, expressed as a percent of the streamlined carcass weight, defined later in this report.

In general, "thick" muscles consist of muscles and/or muscle systems from the carcass considered to be suitable for steaks and roasts (high value cuts). The remaining muscles are classified as "thin" muscles (lower value cuts). The thick muscles of the hind-quarter include closely trimmed, boneless muscles and/or muscle systems that were two inches or more in thickness. They are as follows: strip loin, tenderloin, top-butt, knuckle, top round, bottom round and eye of the round. Fore-quarter thick meats include closely trimmed, boneless muscles and/or muscle systems (free of excessive seam fat) that are three inches or more in thickness. These are classified as chuck and rib roasts.

Thin meats include all the lean tissues that do not meet the requirements for thick meats. Muscles and/or muscle systems are trimmed to the specified thickness requirements using a modified swine back-fat probe as a measure of muscle thickness.

From Oklahoma Agricultural Experiment Station Project contributing to Southern Regional Research Project, SM-19.

Ten pairs of high standard and low choice conformation steer carcasses, *carefully paired* for similar ribeye area, marbling score, fat thickness at 12th rib, maturity group, carcass weight and estimated percentage kidney, heart and pelvic fat were purchased from a meat packer for use in the study. A comparison of carcass characteristics by conformation grade is presented in Table 1.

A visual comparison of the differences in choice and standard conformation in the hind quarters is presented in Figure 1.

Results and Discussion: Table 2 presents the means of average percentage yields of thick and thin meats and total lean, fat and bone on an unadjusted and an adjusted basis.

The unadjusted mean difference (unadjusted for difference in separable fat between the two conformation groups) of 0.93 percent in yields of thick meat, 31.50 and 30.57 percent for choice and standard conforma-

Table 1. Comparison of Average Carcass Characteristics

	Conformation	
	Low Choice	High Standard
Carcass (no.)	10	10
Marbling score[1]	6.1	6.6
Fat thickness—12th rib (in.)	0.35	0.29
Ribeye area (sq. in.)	12.79	11.26
Carcass weight (lb.)	599.78	600.34
Kidney, pelvic and heart fat (lb.)	24.40	33.01

[1] Marbling was scored on a 1-12 number scale, 1=devoid and 12=extremely abundant.

Table 2. Means of Average Percentage Yields of "Thick and Thin Meats" and of Total Lean, Fat and Bone.

	Carcass Conformation			Carcass Conformation		
Trait[1]	Choice % Unadj.[2]	Standard % Unadj.[2]	Mean Diff.[2]	Choice % Adj.[3]	Standard % Adj.[3]	Mean Diff.[3]
"Thick meat"	31.50	30.57	0.93	31.80	30.28	1.52
"Thin meat"	34.61	35.43	0.82	35.16	34.88	0.28
Total lean[4]	66.11	66.00	0.11	66.92	65.21	1.71
Total fat	19.48	16.88	2.60			
Total bone	14.39	17.11	2.72			

[1] All traits are expressed as a percentage of the streamlined carcass weight (carcass weight minus kidney, heart and pelvic fat).
[2] Means are unadjusted for differences in fat between the two conformation groups.
[3] Means adjusted for differences in fat between the two conformation groups.
[4] The sum total of thick and thin meat.

tion groups respectively was statistically significant. Thus there was a small, but an apparent real advantage for choice conformation in terms of the yield of high value steak and roast meat (thick meat). The adjusted mean difference, of 1.52 percent, pointed to a more meaningful advantage for choice in this regard.

Standard conformation carcasses were observed to have a slightly higher percentage of thin meat than choice conformation carcasses. Total lean yields were found to be almost identical between the two groups. Thus, the lean content of these beef carcasses, differing in conformation, but of similar weights, was relatively constant and fat and bone were the major variables. The choice conformation carcasses had on the average 2.72 percent less bone than the standard carcasses.

Muscles and muscle system yield comparisons from the hind-quarters were made between the two groups, a summary of which is presented in Table 3.

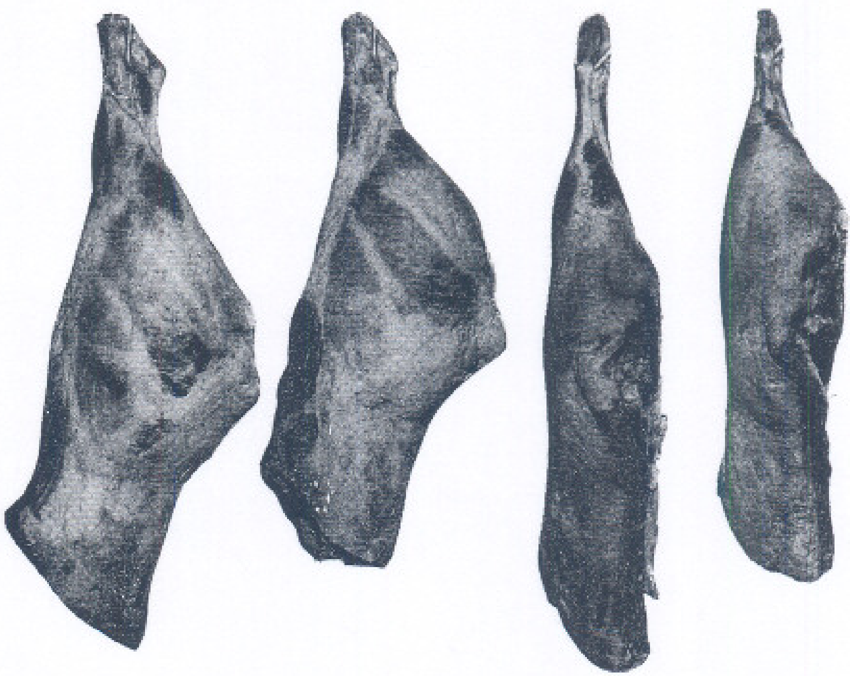

Figure 1. Lateral (left pair) and Dorsal (right pair) views showing a comparison of standard and choice hind-quarter conformation.

Table 3. Percentage Yield Mean Values and Mean Differences for Individual Hind-Quarter Muscles and Muscle Systems.

Muscle or Muscle System[1]	Carcass Conformation Choice (%)	Standard (%)	Mean Difference (%)
Tender loin	0.97	1.03	−0.06
Strip loin	2.68	2.56	0.12
Top-butt	2.69	2.49	0.20
Knuckle	3.16	3.19	−0.03
Top round	3.75	3.75	0.00
Bottom round	2.87	2.46	0.41
Eye round	1.33	1.31	0.02

[1] All muscle and muscle systems are expressed as a percentage of the streamlined carcass weight.

Choice conformation carcasses were found to have higher percentage yields of all muscles studied except two, the tenderloin and knuckle. Choice carcasses had significantly more top-butt and bottom round. This is of special interest since the top-butt (sirloin) and the bottom (outside) round are two muscle systems that are viewed directly when one makes a visual appraisal for conformation in the hind quarter. These results suggest that perhaps these two muscles have more influence on conformation appraisals than some of the other muscles in the hind quarter.

Differences in length, width and depth measurements of muscles and muscle systems were quite pronounced. In general, the standard conformation carcasses produced longer, wider, thinner muscles and muscle systems than the choice carcasses. However, most of the standard muscles lost the advantage of greater length and width when these were trimmed to meet the specifications for thick meat (high value cuts). Without exception, muscles of choice carcasses were thicker than those from standard conformation.

The ratio of lean to bone is a commonly used comparison, often employed by those engaged in the evaluation of beef carcasses to indicate carcass desirability with reference to these components. In this study, the choice conformation carcasses had an average ratio (fat adjusted) of thick meat to bone of 2.17:1 as compared to 1.83:1 for the standard carcasses. Similarly, adjusted ratio values of 4.55:1 and 3.90:1 were obtained for total lean to bone in choice and standard carcasses, respectively.

Thus, from these data, it appears that differences in total lean in carcasses of similar weight, but of different conformation may, indeed, be very small. Consistent and statistically significant advantages for choice conformation were observed in the yield of thick, high value meat. This advantage for choice, however, is not as great as many have believed. The most striking advantages for choice conformation were found to be in the ratio of total lean to bone and thick high value meat to bone. Standard conformation carcasses, on the other hand, were observed to have appreciably more bone and less fat.

Cobalt and Zinc Supplementation of "All-Barley" Rations for Fattening Steers

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Research work clearly demonstrates that steam rolled barley properly supplemented with soybean meal, calcium, vitamin A and certain trace minerals can constitute the entire feedlot ration. Previous investigations conducted at the Ft. Reno station[1] over the past several years substantiate this. These same investigations have been directed towards defining the trace mineral deficiencies of an "all-barley" fattening ration.

Results of the trial reported in 1964 demonstrated that supplemental cobalt, zinc and iron improved average daily gain and feed efficiency as much as a cobalt, zinc, iron, copper, manganese and iodine combination or a combination of dehydrated alfalfa and molasses, which are known to be rich sources of trace minerals.[2] These results, combined with the results of five earlier trials, indicated that barley is definitely deficient in cobalt, is probably marginal in zinc, but probably adequate in iron, copper, manganese and iodine.

The trial reported herein was conducted to determine the effects of cobalt, zinc and cobalt plus zinc supplementation of all-barley fattening rations.

Procedure

Sixty Hereford steers averaging fifteen months of age were equally allotted by weight and grade to twelve pens, with five steers per pen. There were four ration treatments, with three replications of each. Composition of the basal ration is given in Table 1. Experimental design and ration treatments are given in Table 2.

The steers were placed on feed May 5, and the trial continued for 136 days. Fifty percent cottonseed hulls were added to all rations initially, but were gradually withdrawn at weekly intervals until all hulls had been removed from the ration by the end of the fifth week. No supplemental minerals other than salt, free choice, were available to the cattle.

Table 1. Composition of the basal ration.

Soybean meal[1]	1.6 lb./head/day
Steam rolled barley	**ad lib**

[1] Composition: soybean meal—93.6 percent, calcium carbonate—6.2 percent, 21,000 IU vitamin A/lb.

Overnight shrunk weights were taken at the beginning and end of the trial as well as at twenty-eight day intervals throughout the course of the trial. During the final phase of the trial, rumen fluid samples were taken for volatile fatty acid analyses and blood samples for mineral and other routine analyses. At the completion of the trial, carcass data were obtained and liver samples were taken for mineral analyses.

Results

The results of this trial are presented in Table 3. The addition of cobalt alone, or cobalt plus zinc tended to increase weight gain and feed consumption. Noted responses obtained from cobalt approached significance ($P<.10$). However, zinc supplementation was apparently without effect on weight gain and feed intake.

Table 2. Experimental design[1]

	Basal	Basal + 3 mg cobalt	Basal + 300 mg zinc	Basal + 3 mg cobalt 300 mg zinc
Lots[2]	2, 6, 10	4, 8, 12	1, 5, 9	3, 7, 11[3]

[1] Supplemental cobalt and zinc as mg/head/day.
[2] Five animals per lot.
[3] Due to bloat, one steer in lot 11 was replaced on May 19 with another steer.

Table 3. Experimental results.

	Basal	Basal + 3 mg Co	Basal + 300 mg Zn	Basal + 3 mg Co 300 mg Zn
No. of steers	15	15	15	15
Av. weights, lb.				
Initial	718	719	723	726
Final	1015	1031	1022	1047
Av. daily gain, lb.	2.18	2.30	2.19	2.36
Av. daily feed intake, lb.	18.9	20.8	20.2	20.1
Feed/gain	8.68	9.06	9.20	8.57
Carcass grade[1]	8.9	9.5	8.9	9.5
Marbling score[2]	11.6	12.8	11.9	12.6
Dressing percent	60.7	60.2	60.6	60.8
Ribeye area, in.[2]	10.9	11.0	10.8	11.5
Fat thickness, in.	0.95	0.92	0.95	0.96
C_2/C_3[3]	1.27	1.25	1.24	1.44

[1] 8 = Av. Good, 9 = High Good, 10 = Low Choice.
[2] 11 = Slight, 12 = Slight +, 13 = Small −.
[3] C_2/C_3 = acetate/propionate ratio in rumen fluid.

While both cobalt and zinc supplementation decreased feed efficiency, no depression was noted with combined cobalt-zinc supplementation. Results showed, as expected, adding cobalt to a cobalt deficient diet would improve appetite and consequently gain. However, feed efficiency would not necessarily increase if another trace mineral or minerals were limiting. Under these conditions, it appears that zinc becomes the limiting trace mineral when cobalt level is made adequate.

Regarding carcass traits, cobalt supplementation significantly improved carcass grade ($P<.01$), marbling score ($P<.05$) and ribeye area ($P<.01$), but was without effect on dressing percent and fat thickness. Noted effect of cobalt should be interpreted as cobalt being a limiting growth and fattening factor, but not as a specific agent to improve carcass grade and ribeye area. Zinc supplementation did not affect the carcass traits. However, combined cobalt-zinc supplementation increased the ribeye area over cobalt alone ($P<.05$), which again suggests that zinc becomes the limiting trace mineral when the ration cobalt level is adequate.

Neither cobalt nor zinc nor combined cobalt-zinc supplementation had any effect on acetate-propionate ratios in rumen fluid.

Trace mineral analyses of barley used in this trial (Stillwater 1964) and the preceding trial (Ft. Reno 1963 and North Central Oklahoma 1963) are presented in Table 4. These data definitely indicated submarginal amounts of cobalt, if we consider the minimal requirement for cobalt to be 0.1 ppm. Regarding zinc, although some recent work suggests the zinc requirement to be in the neighborhood of 100 ppm, other work indicates the requirement to be somewhere between 15 and 30 ppm. Therefore, with a low calcium level as used in these trials (approximately 0.35 percent), this level of zinc is perhaps adequate or nearly adequate.

These indicated levels of cobalt and zinc lend explanation to the consistent response obtained from cobalt in all trials, and a somewhat more variable response obtained from zinc alone or in combination with other trace minerals. Determined levels of iron, copper, manganese and iodine are probably marginal to sub-marginal. Therefore, in an all-barley

Table 4. Trace Mineral Analyses of Various Barleys

	Ft. Reno 1963	North Central Okla. 1963	Stillwater 1964
		ppm	
Co	0.07	0.02	0.02
Zn	17.0	31.0	33.0
Fe	43.0	52.0	Not determined
Cu	5.0	5.0	Not determined
Mn	14.0	10.0	Not determined
I	0.10	0.04	Not determined

fattening type ration, it would probably be advisable to not only add cobalt and zinc, but supplemental iron, copper, manganese and iodine to supply adequate amounts with necessary safety margins.

Summary

In an "all-barley" ration supplemented with soybean meal, calcium and vitamin A, cobalt supplementation tended to increase weight gain and feed consumption, and improved carcass grade, marbling score and ribeye area. On the other hand zinc supplementation alone was without effect on growth performance and carcass traits. Combined cobalt-zinc supplementation interacted in such a way on feed/gain and ribeye area as to suggest that zinc becomes the limiting trace mineral when cobalt level is adequate.

These results indicate that an "all-barley" type fattening ration is deficient in cobalt and perhaps marginal in zinc.

The Performance of Western vs Dorset x Western Crossbred Ewes for Fall Lamb Production

Joe V. Whiteman, Mike B. Gould, Artemio A. Ovejera and Fred A. Thrift

In the production of fall born lambs the breed of ewe is of utmost importance. Ewes of many breeds do not exhibit estrus (heat) during the spring and, consequently, cannot be used in such an enterprise.

Oklahoma sheepmen have traditionally purchased replacement ewes from Texas and, to a lesser extent, other western states. Most of the Texas ewes have been of Rambouillet breeding, but many of the imported ewes have been of mixed breeding of Columbia, Panama or Corriedale with Rambouillet. These mixed ewes have not lambed as well during the fall as have straight Rambouillet ewes. Further, neither group has been consistently efficient producers in terms of percent lambing during a short period of time nor the number of lambs born per ewe lambing.

The question might logically be asked: can one raise better ewes than he can buy? Since ewe lambs that are raised are usually worth more as fat lambs at five months of age than Western (Rambouillet and the mixed types mentioned above) yearling ewes cost, it is obvious that the ewe that is raised must be more productive on a lifetime basis than the ewe that is purchased.

This report is a preliminary summary of several years data bearing on the question posed above: can one raise better ewes than he can buy?

Materials and Methods

During the spring of 1955 an experimental ewe flock was established at the Ft. Reno Experiment Station. The initial flock was composed of 100 grade Rambouillet and 100 ¼ Panama-¾ Rambouillet (RPR) yearling ewes. Purebred Dorset rams were mated to these ewes from 1955 through 1959. Dorset rams were used because a higher percentage of Dorset ewes will breed during May and June than will black faced ewes.

During each of the springs of 1957, 1958 and 1959, forty ewe lambs were raised and forty yearlings purchased. In each year the raised replacements were the first 20 ewe lambs to reach market weight from each group of ewes.

Purchased yearlings have included the following groups:

Designation	Breeding	Year Purchased
Panama	Panama	1957
N. Mex. Fine Wool	¾ Ramb.—¼ Merino	1957
Rambouillet	Rambouillet	1958
Market White Face	Mixed breeding[1]	1958
Columbia X	¾ Ramb.—¼ Columbia	1959
Flying H	Rambouillet	1959

[1] These ewes were part Columbia, Panama or Corriedale mixed with Rambouillet.

For purposes of simplicity in presenting results, all Dorset by Rambouillet and Dorset by RPR ewes were combined. Also, the Rambouillet, market white face, Columbia X and Flying H were combined as Western ewes and were considered to be typical of many of the ewes shipped into Oklahoma as replacements. The results relative to reproduction were keep separate for the Panama and the Rambouillet-Merino mixed ewes because it is obvious from their reproductive performance that they would not be recommended for fall lamb production.

The raised and purchased ewes for each year were placed together and were handled the same thereafter. During their first breeding season all replacement ewes were bred to small Hampshire rams. During later seasons, the rams may have been Hampshires, Dorsets, Suffolks, or Rambouillets but the raised and purchased groups to be compared were always mated to the same rams.

It should be noted that during 1957, the spring breeding season was for 32 days and cleanup breeding was attempted during 20 days in early

The breeding schedule used during the study was as follows:

Year	Breeding Dates	
	Spring	Cleanup
1957	June 3 — July 5	Aug. 3 — Aug. 23
1958	May 20 — June 29	Aug. 11 — Sept. 2
1959 and later	May 21 — June 30	Aug. 20 — Sept. 19

August. The poor spring breeding performance that resulted caused a change in management so that the breeding season was extended to 40 days during subsequent years. The cleanup breeding season was lengthened to 30 days after 1958 and moved toward the fall when most effective breeding is generally accomplished in sheep.

Other regular management practices were as follows:

1. Ewes were sheared from five to ten days before the beginning of the spring breeding season. Yearling ewes that were purchased had been sheared before purchase and were not resheared.

2. All ewes were fed about one-half pound of grain daily for the six weeks before lambing began.

3. All ewes were tagged (crutched) and had their faces sheared about two weeks before fall lambing began.

4. Ewes were fed one pound of grain daily for six to nine weeks while on wheat pasture. They also each received about one pound of grass hay each day.

5. Lambs were self fed in a creep from two to three weeks of age until reaching a market weight of 90-95 pounds. The creep feed was a mixture of one-third chopped alfalfa hay and two-thirds cracked kafir grain or the same hay grain ratio with 5 percent molasses.

6. All of the fall born lambs were marketed for slaughter except for a few ewe lambs that were kept for replacements. Some of the slower gaining winter born lambs did not reach slaughter weight by June 1 and were sold as feeders or fed out during the summer.

7. After 1960, the lambs were weaned at approximately 10 weeks of age at which time they weighed from 46 to 60 pounds. They were continued on pasture with the creep feed available until they reached market weight. The January-February born lambs were weaned about April 15th each year.

Results

In the evaluation of ewes for commercial production purposes, several factors must be measured. The factors considered in this study were as follows:

1. Percent of ewes lambing from matings made during the 40 day period following May 20.

2. Percent of ewes not conceiving during above period that conceived during the 30 day period starting August 20.[1]

3. Lambing rate (number of lambs born per 100 ewes lambing).

4. Percent lambs reared (number of lambs reared per 100 ewes in breeding flock).

5. Lamb birth weight.

6. Lamb 10-week weight—a good measure of the milk production of the ewe.

7. Lamb rate of gain from 10 weeks of age to market weight.

8. Wool production.

The first four factors are measures of reproductive efficiency and are of greatest importance when fall born lambs are desired because inefficient reproduction is the principal problem facing sheep producers who try to produce fall born lambs.

Rate of Reproduction

In comparing ewe lambs that were raised to purchased yearling ewes one should remember that the purchased ewes were 7-8 months older at the time that each performance measure was taken. The difference in performance was particularly striking in relation to reproduction during the first years. Table 1 presents the reproductive performance during the first year for the Dorset crossbred ewe lambs and for the purchased yearling Western ewes.

These results are about as might be expected. The age advantage of the Western ewes made them much more productive than the crossbred ewe lambs under the breeding system used in 1957, 1958 and 1959. The Panama ewes and the Rambouillet-Merino ewes also gave disappointing performances.

The fact that the Dorset crossbred ewe lambs did not breed well for fall lambs when they were about 7 months old and that the mortality of the lambs that they produced was fairly high resulted in a change in management in 1960. Since that time 122 Dorset crossbred ewe lambs have been reared and exposed to rams August 20-September 19. Seventy-nine of these ewes produced 90 lambs and the livability of the lambs has been as good or better than the average of the whole flock.

Table 2 summarizes the second year's performance of the same ewes. This is presented separately because the crossbred ewes were about 19-20 months old at breeding time whereas the Western ewes were 26-27 months old. The results indicate that the Dorset crossbred ewes were much more

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[1] During 1957 and 1958 the period indicated in the Materials and Methods section was used.

Table 1. The Reproductive Performance During Their First Year of Dorset Crossbred, Western and Other Ewes.

	Dorset Crossbred	Western	Panama	Ramb.-Merino
No. of ewes	120	80	20	20
No. lambing (fall)	35	50	6	4
No. lambs	42	52	6	4
No. lambs reared	34	50	6	3
No. lambing (winter)	29	18	4	0
No. lambs	33	19	4	0
No. lambs reared	29	17	4	0
% Total lambs reared[1]	52	84	50	15

[1] Number of lambs raised per 100 ewes in the breeding flock.

Table 2. The Reproductive Performance During Their Second Year of Dorset Crossbred, Western and Other Ewes.

	Dorset Crossbred	Western	Panama	Ramb.-Merino
No. of ewes	115	79	20	19
No. lambing (fall)	104	57	16	16
No. lambs	138	71	19	17
No. lambs reared	125	65	17	17
No. lambing (winter)	9	14	1	2
No. lambs	13	21	2	2
No. lambs reared	9	18	2	2
% Total lambs reared[1]	117	105	95	100

[1] Number of lambs reared per 100 ewes in breeding flock.

productive of fall born lambs than were the Western ewes (109 percent reared vs 82 percent reared). (Any desired percentage figure can be obtained by making the appropriate calculation from the numbers given in the table.) This was due to a higher percent of the ewes lambing with a higher twinning rate of ewes lambing. It will be noted also that neither the Panama nor the Rambouillet-Merino ewes were very productive.

Not only did more of the Dorset crossbred ewes lamb during the fall than did any of the other breeding groups of ewes; but of those not lambing during the fall, a higher percentage of the Dorset crossbred ewes lambed during the winter. There were 2 of 115 Dorset crossbred, 8 of 79 Western, 3 of 20 Panama and 1 of 19 Rambouillet-Merino ewes that did not lamb during either period.

Table 3 presents the results to date for the same ewes relative to later reproductive performance. For the oldest ewes, their third through

Table 3. The Reproductive Performance During Their Third and Later Years of Dorset Crossbred, Western and Other Ewes.

	Dorset Crossbred	Western	Panama	Ramb.-Merino
No. of ewes	434	266	85	93
% lambing (fall)	92	82	62	86
Lambing rate[1]	153	131	138	114
% lambs reared (fall)[2]	129	98	84	78
No. lambing (winter)	17	29	24	6
Lambing rate[1]	159	155	158	133
% Total lambs reared[2]	134	114	126	87

[1] Number of lambs born per 100 ewes lambing.
[2] Number of lambs reared per 100 ewes in the breeding flock.

eighth years' performance is combined with the third through seventh years for the second group and the third through sixth years for the youngest age group. The results in the upper part of Table 3 were given in percentages so that comparisons would be easier to make.

The underlined values in the fourth row of Table 3 quickly typifies the ewes of the various breeding groups relative to producing and raising fall born lambs. The Dorset crossbred (Dorset x Western) ewes were far superior to any of the other breed groups. A higher percent of the ewes lambed during the fall; they produced more twins and, in spite of producing more twins, raised a higher percent of lambs born than the Western ewes. (The difference in lambs raised of lambs produced was small and probably due to chance. It is significant, however, because it is usually found that the death loss is much greater among twin lambs.)

Although represented by only a small number of ewes, the results obtained from the Panama ewes are worthy of note. The Panama breed was based on a crossbred foundation of Rambouillets and Lincolns. To the best of our knowledge, Lincolns are seasonal breeders. Consequently, we would not expect that the Panama ewes would breed for fall lambing as well as the other ewes. They did not. Only 87 percent of them mated during the spring compared to 95-99 percent for the other breed groups in this study. Only 62 percent of the Panama ewes lambed during the fall compared to 81-92 percent of the other groups. Consequently, it is felt that ewes with too much Lincoln breeding should be avoided for fall lambing purposes. (There is considerable other evidence at O.S.U. and elsewhere to support this recommendation.)

Likewise, the Rambouillet-Merino ewes did not compare well with either the Dorset crossbred or the Western ewes. They lambed during the fall as well as the Western ewes but only 14 percent of the ewes lambing produced twins—far fewer than any other group.

The winter lambing results in the lower rows of the table complete the results on a year-long basis. It should be noted that lambing rates were higher during the winter than the fall for all breed groups. This was as it should have been as many breeds have been found to be more productive when bred to lamb nearer the spring. The results presented in the bottom row of the table were those obtained when fall and winter lamb crops were combined. The Dorset crossbred ewes raised 134 percent lamb crop as compared to 114 percent for the Westerns. Their superiority was consistent throughout the study as far as reproductive performance was concerned.

Lamb Performance

Not only do the ewes produce the lambs but they also transmit one-half of their inheritance, and through their milk supply, govern the rate of growth and fattening up to about 70 days (10 weeks) of age more than any other single factor.

Table 4 summarizes the results that have been obtained over the years relative to birth weights, 70-day weights and rates of gain from 70 days of age to market weight (92-100 lb.) for the lambs produced by the Dorset crossbred ewes and the Western ewes. The Panama and Rambouillet-Merino ewe data were omitted because there were not many lamb records available and the values were similar to those presented. Each value presented in the table represents the average for over 125 lambs. Single and twin lamb data are presented separately because of the different growth pattern that is characteristic of each category. Single lambs are heavier at birth and at 70 days of age than twins. The values presented represent the average of all lambs falling in the particular class irregardless of the age of the ewe or whether the lamb was born during the fall or during the winter.

In comparing the lambs from Dorset crossbred ewes to lambs from the Western ewes, there were no birth weight differences of any great significance. At 70 days of age the single lambs from the Dorset crossbred ewes were 1.6 pounds heavier and the twin lambs 3.0 pounds heavier than the corresponding lambs from the Western ewes. The lambs from the crossbred ewes also gained .04 lb. per day faster after 70 days of age than did the lambs from the Western ewes.

Table 4. Lamb Birth Weights, 70-day Weights and Rates of Gain From 70 Days of Age to Market Weight as Related to Breed Group of Ewes.

	Dorset Crossbred		Western	
	Singles	Twins	Singles	Twins
Birth weight (lb.)	9.6	7.9	9.7	8.3
70-day weight (lb.)	54.8	46.9	53.2	43.9
Gain/da. after 70 da.	0.55	0.56	0.51	0.52
Av. age at 95 lb.	143.0	156.0	152.0	168.0

The heavier lambs from the Dorset crossbred ewes at 70 days of age were probably the result of greater milk production by these ewes as compared to the Westerns. The faster rate of gain of the lambs from the crossbred ewes after 70 days of age probably was not due to milk production because most of the lambs were weaned at about 70-75 days of age. Neither will transmitted gaining ability from their sires explain the increase because all lambs were sired by the same rams.

Although the differences in 70-day weight and rate of gain after 70 days of age were not great, the lambs from the crossbred ewes reached a market weight of 95 pounds about 10 days sooner than the lambs from the Western ewes.

Wool Production

The Western ewes used in this study were from 75 to 100 percent Rambouillet. Although variable in wool production, they sheared heavier fleeces of generally higher quality than the Dorset crossbreds. Dorset wool is very dry and more brittle than Rambouillet wool usually. The Dorset crossbred ewes in this study sheared drier, lighter weight fleeces.

Table 5 summarizes the wool production during the second and later years of the Dorset crossbred and Western ewes. The wool values are presented as grease wool (as it comes from the ewe) and clean wool (as estimated by the use of a Neale squeeze machine.) Although the Western ewes sheared 1.6 pounds more grease wool per head per year, the difference in the estimated pounds of clean wool was insignificant. The Dorset crossbred wool had a higher yield (percent of the grease weight that is actually wool). Wool buyers frequently pay more for the crossbred wool because of its higher yield although the amount of the difference varies from year to year due to marketing conditions.

Summary and Discussion

The results discussed herein were gathered from 120 Dorset crossbred, 80 Western, 20 Panama and 20 Rambouillet-Merino ewes during the period from 1957 to 1964. The crossbred ewes were sired by 20 different Dorset rams and their dams were similar in breeding and performance to the Western ewes in this study. The 80 Western ewes were from four different ranches in Texas and New Mexico and were thought to be as

Table 5. A Comparison of the Wool Production (Grease and Estimated Clean Weight) of Dorset Crossbred and Western Ewes.

	Dorset Crossbred	Western
Grease fleece wt.	8.8	10.4
Clean fleece wt.	4.7	4.5

good or better than the usual yearling ewes that are brought into Oklahoma for breeding purposes. The Panama ewes were purchased to determine how well ewes that were one-half Lincoln would breed for fall lambing. The Rambouillet-Merino ewes are similar in breeding to the fine wool Debouillet ewes of Texas and New Mexico.

These results clearly demonstrate that after the first year the Dorset X Western crossbred ewes (1) will lamb more readily during a lambing period from October 15 to November 25, (2) produce more twins, (3) raise at least as high a percentage of lambs born, (4) breed more readily from August 20 to September 19 if they do not conceive during late May and June and (5) produce lambs that are as heavy at birth, heavier at 70 days of age and that gain faster during the rest of the period to market than will the kind of Western ewes to which they were compared. They sheared less wool but it was usually worth more per pound as grease wool. The ewes are still being compared, therefore, a final conclusion as to expected years of production is not presently available.

The Effect of Sex on Feedlot and Carcass Traits in Swine*

*I. T. Omtvedt, C. M. Stanislaw, L. E. Walters, D. R. Rule and P. J. Cunningham***

Swine producers have observed that barrows grow faster and reach market weight at an earlier age than gilts, but gilts tend to yield more desirable carcasses. However, the size of these differences between the performance of barrows and gilts has not been thoroughly investigated.

Significant sex differences could greatly affect the accuracy of records used in swine improvement programs. Boars possessing the ability to sire pigs with superior carcasses are selected on the basis of their progeny's slaughter test. However, unequal numbers of barrows and gilts are often included in samples for evaluating potential herd boars. If sex differences exist, then the progeny test information may be biased depending on the sex ratio tested.

The present study was initiated to investigate the magnitude of the differences in performance between barrows and gilts and to study the possible existence of interactions between sire and sex. A sire-sex interaction means that the difference in performance between barrows and gilts is not the same for the progeny of all sires.

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*Conducted in cooperation with the Regional Swine Breeding Laboratory, AHRD, ARS, U.S.D.A.
**Grateful acknowledgement is made to D. F. Stephens, Superintendent, Ft. Reno Livestock Research Station, for his assistance and cooperation in making this trial possible.

Procedure

In the fall of 1964, 114 weanling barrow-gilt littermate pairs were allotted to a feeding test. The trial included 148 pigs at Ft. Reno and 80 pigs at Stillwater. Pigs were allotted to pens by sire and sex. An average of 4 pigs was fed in each pen with each sire having 2 pens of barrows and 2 pens of gilts. The lines of breeding and number of sire groups included in this trial are given in Table 1.

Pigs were self-fed, ground rations containing 16 percent protein from weaning to 120 lb. and 15 percent protein rations from 120 lb. to 200 lb. Equal parts of milo and wheat were used in the rations at Ft. Reno while milo served as the only grain in the Stillwater rations. Feed records were kept for each pen.

Pigs were removed from test at weekly intervals as they weighed 200 lb. At this time, all pigs were probed for backfat thickness and 2 pigs from each pen were randomly selected for the slaughter test. The pigs raised at Ft. Reno were slaughtered at Harris Meat Company, Oklahoma City, and those raised at Stillwater were slaughtered at the University Meat Laboratory.

The following carcass information was collected: length; backfat thickness; loin eye area at the 10th rib; weights of hams, loins and shoulders; and loin quality scores at the 10th rib. The cross section of the loin at the 10th rib was scored for marbling, color and firmness by a committe of 3 judges and the average of their scores was used in the analysis. The scoring system used for quality is given in Table 2.

Results and Discussion

Rate and Efficiency of Gain

The results for the 228 pigs evaluated are summarized in Table 3. Barrows gained 0.19 lb. per day faster and reached market weight of 200 lb. 12 days before their littermate gilts. In this trial, both sexes required approximately the same amount of feed per pound of gain, but the control of feed wastage was a problem at Stillwater and these records should be considered only as preliminary results.

Table 1. Lines of Breeding, Sire Groups, and Number of Pigs Evaluated

Line of Breeding	Description of Breeding	Location of Line	No. of Sires	No. of Pigs
OK14	Hamp. boars x Belts. No. 1—Duroc sows	Ft. Reno	8	148
OK32	Hampshire	Stillwater	4	64
14x8-9	Beltsville — Landrace — Poland cross	Stillwater	2	16

Line of breeding and sire differences were significant ($P<.01$) for both average daily gain and age at 200 lb. The 14x8-9 pigs at Ft. Reno made the most rapid gains and weighed 200 lb. at the youngest age. A sire-sex interaction was noted ($P<.025$) in the 14x8-9 line for average daily gain, but was not observed in the other 2 lines studied. The nature of this interaction is illustrated in Figure 1. In all sire groups the barrows outgained the gilts, but the differences between barrows and gilts ranged from 0.02 lb. per day to 0.25 lb. per day in the 8 sire groups included in the 14x8-9 line. The importance of this interaction will be more extensively studied in the next trial. However, the existence of this interaction would mean that both sexes need to be included to accurately evaluate the breeding value of a sire.

Probe Backfat Thickness

The backfat thickness is the only carcass trait that can be measured on the live animal. The probe is used in conjunction with visual appraisal to evaluate carcass merit of the live hog. The results summarized in Table 3 show that in this study gilts probed 0.13 in. less backfat than their littermate barrows. This difference was significant ($P<.01$) and was observed in all 3 lines of breeding studied. Sire differences were also noted, but the differences between barrows and gilts were relatively uniform within sire groups.

Table 2. Scoring System for Loin Quality.

	Description of Score		
Score	Marbling	Color	Firmness
1	Devoid	Extremely Pale	Very Soft
2	Scantily	Pale	Soft
3	Slightly	Slightly Pink	Slightly Soft
4	Average	Moderately Pink	Average
5	Moderately	Bright Pink	Slightly Firm
6	Well	Slightly Dark	Firm
7	Abundant	Dark	Very Firm

Table 3. Rate of Gain, Feed Efficiency and Probed Backfat.

	Line of Breeding			Average for all Pigs		
Item	14x8-9	OK14	OK32	Barrows	Gilts	Difference
No. Pigs	148	64	16	114	114	
Daily gain, lb.	1.72	1.44	1.45	1.72	1.53	0.19
Age at 200 lb., days	142	164	164	144	156	12
Feed per lb. gain, lb.	3.54	3.80	3.78	3.63	3.62	0.01
Probe backfat, in.	1.28	1.32	1.33	1.36	1.23	0.13

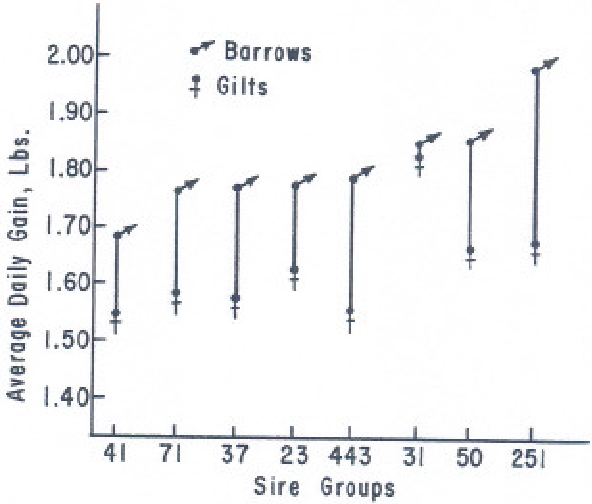

Figure 1 **Differences between daily gains of 14x8-9 barrows and gilts within the eight sire groups tested.**

Carcass Traits

The carcass measurements summarized in Table 4 show that gilt carcasses were 0.6 in. longer and had 0.10 in. less backfat, 0.44 sq. in. greater loin eye area, and 4.1 percent higher yield of lean cuts based on carcass weight.

Line of breeding and sire differences were noted for all measurements. In the OK 14 line, a significant ($P<.01$) sire-sex interaction was obtained for loin eye area. Gilts had larger loin eye areas than barrows for all sire groups, but the interaction resulted from the fact that differences between barrows and gilts ranged from 0.1 sq. in. to 0.9 sq. in. for the 4 sire groups evaluated in this line.

This is a small sample of sires and further investigations are needed before the significance of this interaction can be completely evaluated. However, if sire-sex interactions are important for loin eye area, both barrows and gilts will need to be included in the progeny test.

Loin Quality

Presently very little emphasis is placed on quality of meat in evaluating pork carcasses. However, increased incidences of soft, watery pork have been noted by various segments of the industry. The growing concern regarding this problem has recently stimulated research on possible causes of low quality pork, but the effect of sex on pork quality has not been investigated.

Table 4. Carcass Measurements and Quality Scores.

Item	Line of Breeding			Average of all Carcasses		
	14x8-9	OK14	OK32	Barrows	Gilts	Difference
No. Carcasses	60	32	8	50	50	
Length, in.	30.2	29.2	29.8	29.6	30.2	0.6
Backfat thickness, in.	1.36	1.30	1.20	1.38	1.28	0.10
Loin eye area, sq. in.	4.21	4.30	4.14	4.01	4.45	0.44
% lean cuts (carcass wt.)	53.3	54.7	53.8	51.7	55.8	4.1
% lean cuts (live wt.)	38.3	37.5	37.0	36.4	39.4	3.0
Quality Scores						
Marbling	4.6	3.1	3.4	4.4	3.6	0.8
Color	4.0	3.8	3.2	3.8	3.8	0.0
Firmness	4.8	3.8	3.2	4.8	3.8	1.0

The results of this preliminary trial reported in Table 4 indicate that sex may be an important factor in pork quality since the loins from barrow carcasses were scored higher than those from gilt carcasses for both marbling and firmness. Significant ($P<.01$) sire and line of breeding differences were also obtained indicating that heredity may also be a factor involved in loin quality.

In this preliminary trial, a significant ($P<.05$) sire-sex interaction was noted for marbling score in the OK 14 line. The 2 sire groups with the least amount of marbling among gilt carcasses had the most marbling among the barrow carcasses. The importance of these interactions are not clearly known, but these preliminary observations indicate the need for additional research in this area. Pork quality studies including other lines of breeding and more detailed measurements will be included in the next trial.

Summary

One-hundred fourteen barrow-gilt littermate pairs were evaluated for differences in performance and carcass merit. Barrows gained 0.19 lb. per day faster and reached 200 lb. 12 days earlier, but gilt carcasses were 0.6 in. longer and had 0.10 in. less backfat, 0.44 sq. in. larger loin eye area, and 4.1 percent higher yield of lean cuts. Feed efficiency records were essentially the same for both sexes in this trial.

Line of breeding and sire differences and interactions between sire and sex were also investigated. Sire-sex interactions were noted for average daily gain, loin eye area and marbling score, but these interactions were not noticed in all lines. Further studies are needed to determine the importance of these interactions.

A preliminary study of the influence of breeding and sex on pork quality was included. Significant ($P<.01$) differences were noted between lines of breeding, sire groups and sex for both marbling and firmness. Loins from barrows were firmer and had more marbling than loins from gilts.

Some Factors Associated with the Rebreeding of Two-Year-Old Hereford Heifers on High, Moderate and Low Levels of Winter Supplemental Feeding

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

Research conducted at the Ft. Reno Station demonstrated that beef heifers can safely be calved at two years of age and suffer no permanent deleterious effect on mature size, longevity or future producing ability. However, even when these heifers are maintained on a fairly liberal plane of nutrition they may be delayed in time of rebreeding following their first calf. When they are carried on low nutritional levels, this delay is quite prolonged and becomes a serious problem.

Probably the most serious criticism producers have leveled at the practice of two year old calving has been this delayed rebreeding. Therefore, it is important that more be learned about the factors associated with it. The purpose of this paper is to report a study of old records at the Ft. Reno Station which was concerned only with the rebreeding performance of two year old heifers maintained on three levels of winter feeding.

Materials and Methods

The data used in this study were taken from the records available on three repetitions of a project at Ft. Reno (projects 650-5, 650-6 and 650-8). Two of these repetitions (650-5 and 6) are described more in detail elsewhere in this Feeders Day bulletin. All of the trials used spring calved Hereford heifers started on trial as weaner calves in the falls of 1957 (650-5), 1958 (650-6), and 1960 (650-8). All heifers calved first at two years of age.

The heifers grazed native grass pastures at Ft. Reno the year-round. They were fed differing amounts of supplemental feed, cottonseed meal and milo, during the wintering period which, in most years, extended from November 15 to April 15. The levels used were based on the amount of supplemental feed necessary to produce certain weight changes in the heifers during the wintering period. For weaner heifer calves the weight changes for the different levels were as follows: *low,* no gain or loss of weight during the winter; *moderate,* an average daily gain of 0.5 lb. per day; and *high,* an average daily gain of 1.0 lb. per day. For bred heifers the weight changes were based on the heifers weight in the fall just preceding the wintering period as follows: *low,* a loss of 20 percent of the fall weight; *moderate,* a loss of 10 percent of the fall weight; and *high,* no loss of weight. In each case the loss included the loss of weight associated with calving (weight of calf, placental tissues, fluids, etc.).

The heifers were pasture mated to Hereford bulls from approximately May 1 to August 1 each year. Each bull was bred to an equal number of heifers from each level in an effort to minimize the effects of possible differences in fertility of the bulls. Breeding dates were not obtained.

The records utilized in this study were: body weights of the bred yearling heifers taken in the fall (November), and the following June after calving; date of birth of the first calf; date of birth of the second calf from which the approximate date of rebreeding was calculated using a gestation length of 285 days; and the calving difficulty score as determined by the herdsman at time of delivery of the first calf of each heifer. This score ranged from 1 to 5 with the lower score indicating less calving difficulty. Specifically the scoring system was as follows: 1—normal calving with no assistance required; 2—slightly difficult calving, some assistance required; 3—difficult calving, considerable assistance required; 4—a very difficult calving; and 5—caesarean section required.

The data for all trials were combined for this analysis. The objective was not to determine specific values, but rather to look for trends that might explain, in general, differences in the reproductive performance of young heifers.

Results and Discussion

The data in Table 1 is presented to show the numbers of heifers included in this study and the magnitude of the differences in average calving date of the first and second calves of heifers maintained on the three levels of winter feeding. The differences between the heifers on the various levels in the three trials reported here are remarkably consistent. They agree very closely with the differences observed in other studies involving these same levels at Ft. Reno.

As shown in Table 1, on the average, the high level heifers calved 2½ weeks earlier their first calf and 5 weeks earlier their second calf than did the low level heifers. When the performance of the high level heifers is compared to that of the heifers on the moderate level it is observed that the high level heifers calved approximately 1½ weeks and 3 weeks earlier their first and second calvings respectively.

Table 1. Average Dates of Calving of the First and Second Calves of Hereford Heifers on Three Levels of Winter Supplemental Feeding and Calving First at Two Years of Age.

		First Calf			Second Calf		
Project	Item	Low	Moderate	High	Low	Moderate	High
650-5	Avg. Calving Date	3-23	3-15	3-4	4-4	3-12	3-2
	No. of Heifers	14	15	14	11	14	12
650-6	Avg. Calving Date	3-16	3-10	2-26	4-4	3-16	3-1
	No. of Heifers	13	14	13	10	13	13
650-8	Avg. Calving Date	4-5	3-24	3-17	4-14	4-6	3-2
	No. of Heifers	11	15	13	11	12	9
All	Avg. Calving Date	3-24	3-17	3-6	4-7	3-21	3-1
Projects	No. of Heifers	38	44	40	32	39	34

Table 2 presents the rebreeding performance after calving first at two years of age of heifers on the three levels of winter feeding. In this table the heifers were grouped into rebreeding groups according to which 21 day period of the breeding season the calculated date of rebreeding occurred. Averages were then computed for the heifers within each group as follows: average weight the previous fall as they entered their winter as bred yearlings; average weight in June, which was approximately one month after the start of the breeding season; the average date of calving as two-year-olds; the average date of rebreeding; and the post-partum interval from calving to conception, which is merely the difference between the calving date and the rebreeding date.

The rebreeding pattern of the heifers on the three feed levels is clearly evident in Table 2. It is apparent that approximately the same number of heifers on each level failed to rebreed and were open. The differences in reproductive performance between the levels is in the time

Table 2. The Rebreeding Performance of Hereford Heifers After Their First Calving at Two Years of Age, With the Heifers Divided Into Groups on the Basis of the Time During the Breeding Season When Conception Occurred Within Each of Three Levels of Supplemental Winter Feeding.

Time of Rebreeding	No. of Heifers	Wt. of Heifers (lb.) Previous Fall	Wt. of Heifers (lb.) June	Avg. Calving Date	Avg. Date of Rebreeding	Post-Partum Interval, Calving to Conception (days)
			LOW LEVEL			
0- 21 days	1	830	800	2-27	5-18	80
22- 43	9	814	795	3-13	5-30	78
44- 65	10	791	741	3-30	6-23	85
66- 87	7	776	764	4-1	7-16	106
88-109	4	772	699	3-17	8-3	139
Open	6	755	703	4-13	---	---
			MODERATE LEVEL			
0- 21 days	12	868	871	3-7	5-15	69
22- 43	13	852	881	3-12	6-1	81
44- 65	7	829	860	3-24	6-22	90
66- 87	3	773	760	4-7	7-17	101
88-109	4	868	889	3-19	8-1	135
Open	4	819	855	4-18	---	---
			HIGH LEVEL			
0- 21 days	21	861	927	3-9	5-13	65
22- 43	8	874	908	2-27	5-27	89
44- 65	3	882	955	3-14	6-23	101
66- 87	0	---	---	---	---	---
88-109	0	---	---	---	---	---
Open	6	860	933	3-11	---	---

of rebreeding. Only one low level heifer out of the 31 rebred conceived in the first 21 days of the breeding season. This compares to 12 of 39 moderate level heifers (31 percent), and 21 of 32 high level heifers (66 percent) that conceived in the same period.

By the end of the second 21 day period there were still only 32 percent of the low level heifers settled. By the end of the same period, 64 percent of the heifers on the moderate level and 90 percent of the heifers on the high level had conceived. At the end of the third 21 day period all of the high level heifers that subsequently calved had settled, compared to 82 percent of those on the moderate level and 64 percent of the low level heifers.

One reason for the later rebreeding of the heifers on the low and moderate levels is simply the result of later calving. However, when one considers that the spread between the groups is greater for the second than the first calf, it is evident that some other factor is also involved. This other factor is the longer time that is required by the heifers on the lower levels to recover from calving and rebreed. The relationship between the post-partum interval from calving to conception and feed level that definitely appears to be a factor in this study has also been observed and reported by others.

Since heat dates were not obtained in this study it was not possible to calculate the length of the post-partum interval from calving to first heat. The only post-partum interval that can be calculated is from calving to conception. Thus, the post-partum intervals do not necessarily indicate how quickly heifers on a certain level returned to heat after calving. These data do not permit one to determine whether a heifer conceiving in the first 21 days of the breeding season has been in heat previously or not. Therefore, it is likely that some early calvers may have returned to heat prior to the start of the breeding season. Although this analysis may penalize the early calving groups it still provides a comparison of sorts and is worthy of consideration.

The heifers in this study that were fed at the high level required approximately 65 days to return to heat and rebreed. This is based on the observation that 66 percent of the heifers that settled did so in the first 21 days of the breeding season and as a group had an average post-partum interval of 65 days. It is likely that the post-partum interval of calving to first estrus was shorter than 65 days.

In contrast to the high level, the heifers on the low level required, at best, a minimum of 80 days after calving to rebreed. Approximately 64 percent of the heifers conceived in the first through third 21 day periods and had an average post-partum interval of 78-85 days. Since only one heifer bred during the first 21 days of the breeding season, and a 64 percent conception rate to first service is only slightly less than what should be expected, it might be speculated that these heifers settled on the first heat they had after calving. If this is true, and it seems reasonable, then 80-85 days appears to be the post-partum interval associated with the low level of wintering used in this study, and is probably the interval from calving to first estrus as well as to conception.

Heifers fed on the moderate level showed a more variable response. Approximately 64 percent rebred during the first and second 21 day periods. Of these heifers, half had a post-partum interval of approximately 70 days and the other half had an interval of approximately 80 days. Thus, although some of the heifers on the moderate level rebred nearly as quickly as the average heifer on the high level, the shortest average post-partum interval associated with the moderate level is approximately 75 days, some 10 days longer than that observed for the high level.

When all heifers rebreeding, regardless of how late, are included in the averages the post-partum intervals from calving to conception are: high, 74 days; moderate, 86 days; and low, 95 days. These differences mean that had all heifers calved on the same date as two-year-olds, the high level heifers would have dropped their second calves 3 weeks earlier than the low level heifers and nearly 2 weeks earlier than the moderate level heifers. It is interesting to note that the heifers on the low and moderate levels were delayed almost the same length of time when bred as yearlings. This suggests that feeding less than an optimum amount of feed is just as detrimental to the lactating two-year-old as it is to the yearling heifer.

What is the optimum feed level for young heifers? These studies do not provide the basis for answering this question. The data do indicate, however, that the high level is superior to either the low or moderate level if only reproductive performance is taken into account and no consideration is given to the economics involved.

Table 2 reveals an interesting relationship indicating the need for more extensive study. In the low level group two subgroups of heifers had an average weight of only 700 lbs. in June and both groups either rebred extremely late or were open. While it is true that the 6 open heifers had a very late average calving date, it is likewise important to note they were among the lightest weight heifers as a group. There is also a tendency for a longer post-partum interval to be associated with the groups of heifers lighter than 800 lbs. on the low level in the fall prior to their winter as bred yearlings.

It may be dangerous to speculate on the influence of body weight on rebreeding from the very limited data available in this study. It is true that it appears to be a factor only in the low level heifers. However, it should be recognized that, in most cases, the heifers on the other levels are all considerably heavier. It is tempting to believe that body weight may be an important factor in determining the magnitude of the effect of low levels of winter feeding on subsequent reproductive performance. Certainly, it indicates the need for further research to determine this relationship if it exists.

One difficulty invariably associated with calving heifers at two-years of age is the number of heifers requiring assistance. In nearly every Ft. Reno study approximately one-half of the heifers have had to be helped. This held true in this study for nearly 48 percent of the heifers required some degree of assistance (Table 3).

Approximately 27 percent of the heifers required considerable assistance. There was the chance an injury may have occurred or an infection introduced resulting in delayed rebreeding. To study this possibility the heifers were grouped according to the calving difficulty scores, and rebreeding dates and post-partum intervals were calculated for each group, Table 3. In no case was there any relationship between calving difficulty and any measure of rebreeding efficiency.

Summary

A study of the records of three repetitions of project 650 at the Ft. Reno Station was made to determine factors associated with the rebreed-

Table 3. The Rebreeding Performance of Hereford Heifers Fed Three Levels of Supplemental Winter Feed, Calving First at Two Years of Age, Divided Into Groups on the Basis of the Calving Difficulty Score at First Parturition

Level of Wintering	Calving Difficulty Score[1]	No. of Heifers	Avg. Calving Date	Avg. Rebreeding Date	Avg. Post-Partum Interval	No. Open Heifers
	1	21	3-18	7-4	108	4
	2	8	3-23	6-21	90	1
Low	3	4	3-13	5-21	69	1
	4-5	3	3-16	5-19	64	1
	1	15	3-19	6-12	85	2
	2	6	3-9	5-29	81	1
Moderate	3	5	3-19	7-6	109	0
	4-5	3	3-9	6-18	101	1
	1	19	3-13	5-22	70	5
	2	8	3-22	5-27	66	1
High	3	10	3-15	5-22	68	1
	4-5	3	3-15	5-18	64	0
	1	55	3-17	6-14	89	11
All	2	22	3-19	6-8	81	3
Levels	3	19	3-16	6-4	80	2
	4-5	9	3-13	5-27	75	2

[1] Calving Difficulty Scores
1—No assistance required, heifer calved normally
2—Heifer required some assistance to calve
3—Heifer required considerable assistance
4—Very difficult parturition
5—Caesearan section necessary

ing of two year old heifers on high, moderate and low levels of winter feeding. Although 47 percent of the heifers required some degree of assistance at calving there was no association between calving difficulty and rebreeding performance.

The average calving dates of the second calf of heifers on the low and moderate levels were, respectively, 5 weeks and 3 weeks later than the average date for heifers on the high level. Approximately one half of this difference was due to later breeding as yearlings as evidenced by later calving at two years of age (2½ weeks and 1½ weeks later for low and moderate respectively). The remainder of the delay in date of calving of the second calf is the result of a longer post-partum interval from calving to conception. The average intervals were: high, 74 days; moderate, 86 days; and low, 95 days.

These observations suggests adequate nutrition is just as critical in the lactating two-year-old as in the yearling heifer. Earliness of calving and promptness of rebreeding of two year old heifers depends, largely, on the level of nutrition provided during the critical wintering period.

The Cumulative Influence of Level of Wintering on the Lifetime Performance of Beef Females Through Five Calf Crops

S. A. Ewing, Larry Smithson, L. S. Pope and D. F. Stephens

The type of forage available to range beef cows in the winter months dictates that supplemental protein and often supplemental energy be provided to insure acceptable cow performance.

The amount of supplemental feed required is of great economic importance in terms of feed cost, reproductive performance and milk production of the dam.

Several experiments have been conducted at this station which relate to this subject and progress reports have been made periodically. This report summarizes performance of spring-calving cows wintered at different levels from weaning through five calf crops.

Experimental Procedure

One hundred twenty weaner heifer calves were selected from the Ft. Reno herd as experimental animals and started on test at an average age of approximately 8 months at weights of near 475 lbs. One-half of the above number was started as weaner calves in the fall of 1957 and the balance started as weaner calves in the fall of 1958. The heifers were allotted to four groups of 30 each on the basis of sire, dam's productivity, age, grade and weight. The winter feeding program was started each year in early November and was terminated when green grass was ample in the spring around April 15.

The experimental treatments employed were designed to result in selected winter weight change patterns as follows:

Lot 1 (Low). No gain the first winter as calves, with a loss of approximately 20 percent of fall weight during subsequent winters as bred females.

Lot 2 (Moderate). Gain of 0.5 lb. per head daily the first winter as calves, with a loss of 10 percent of fall weight during subsequent winters as bred females.

Lot 3 (High). Gain 1.0 lb. per head daily during the first winter as calves, then less than a 10 percent weight loss from fall weight during the subsequent winters as bred females.

Lot 4 (Very High). Self-fed a 50 percent concentrate mixture during the first winter as calves and during subsequent winters as bred females.

The above treatments have been followed to date with the exception that one half of the females in Lot 4 were reverted to the moderate level the fourth winter to study the effects of a very high level the first three winters followed by the moderate level during subsequent winters. This group from Lot 4 was designated Lot 5 and will be referred to as such in this report.

The daily level of winter supplemental feed consisting of cottonseed cake or cottonseed cake and ground milo was adjusted periodically to produce, as nearly as possible, the weight change patterns outlined above. The low level females were confined to dry lot during the early part of each winter and fed wheat straw to initiate the desired weight loss. After this initial period they were maintained on native tall grass pastures during the winter.

The females in all other treatments were maintained on native tall grass pastures during the entire winter and fed the appropriate levels of supplemental feeds. All animals had free-choice access to a mineral mixture consisting of two parts salt and one part steamed bone meal throughout the year. All groups were grazed on native pasture during the summer months.

The heifers were exposed to bulls as yearlings and calved first as 2 year olds. Detailed records have been collected on weight change patterns, skeletal development, reproductive performance, birth and weaning weights of calves and milk production has been estimated periodically during the summer by a standard procedure which involves weighing the calf before and after nursing.

Results

The results will be presented and discussed under separate headings designated by the general types of observations involved.

Weight Change Patterns

The periodic weights observed during the study to date are shown in Table 1 and designated as fall and spring weights. The spring weights in each instance were taken in early April, therefore these weights after the heifers were two years of age reflected weight changes from fall to spring and include weight losses incident to calving and early lactation. The rate of development of the heifers can be followed for each treatment by observing the progressive weights for a given time each year.

Using the successive spring weights taken at the beginning of the grazing season to reflect the development patterns, the weights for the first three respective seasons were: Low level, 462-571-667 lbs.; moderate level, 569-679-829 lbs.; high level, 620-789-889 lbs. The weight change patterns for the very high groups for this same period can be seen in Table 1, however, the gains produced by this level are excessive and may actually have a depressing influence on milk production.

The low level appears to be sub-optimum during the first four winters of the cow's life. Beyond this point of maturity, however, this

Table 1. Weight Change Patterns of Beef Females Wintered at Different Levels

Lot No.		1	2	3	4	5
Wintering Level		Low	Moderate	High	Very High	Very[5] High to Fourth Winter, Then Moderate
Calf Crop Number	Age in Months					
	7 Fall	473	472	475	488	457
	12 Spring	462	569	620	768	725
	18 Fall	783	829	859	892	892
1	24 Spring	571	679	789	1048	1095
	30 Fall	848	880	959	1084	1050
2	36 Spring	667	829	889	1182	1182
	42 Fall	968	1037	1066	1197	1171
3	48 Spring	807	934	991	1438	925
	54 Fall	1103	1137	1155	1328	1079
4	60 Spring	850	943	1025	1566	915
	66 Fall	1142	1186	1212	1430	1133
5	72 Spring	857	930	1043	1627	928
	78 Fall	1191	1240	1289	1480	1280

level has produced levels of productivity, expressed as pounds of calf weaned per cow, that are comparable to the moderate and high levels. A rate of development comparable to the moderate and high levels during the first four winters appears to be more desirable than either the low or very high levels practiced in this test.

The amounts of supplemental feed required for the various levels each winter are shown in Table 2. The supplemental feed provided the low level cows was fed typically from early January to mid-April. The other groups received supplemental feed from early November to mid-April each year.

Survival

The data in Table 3 indicates the number of cows remaining after five calf crops, the percentage remaining in the herd and the reasons for removal. Cows were culled from the herd on the basis of health or failure to conceive for the second successive year. From these data it appears that the cows on the high and very high levels are exhibiting lower survival rates than those on the low and moderate levels. With limited numbers of animals, however, strong conclusions at this point do not seem warrented.

Productivity

Productivity of the beef cow involves both percentage calf crop and weaning weight of the calves produced. Weaning weight, taken at a given time, is a reflection of birth date, milk production and the calves' ability to grow on the milk and other feeds consumed. Table 4 summarizes the long term performance of the cows in the different treatment groups. It is apparent that each higher level of wintering from low to high has tended to result in earlier calving dates by about one week. Levels above this do not appear to have improved this particular characteristic.

Table 2. Supplemental Feed Provided Per Cow For Each Level of Wintering During the Six Successive Wintering Periods

Treatment	Low[1]		Moderate[2]		High[2]		VH[2]	VHM[2]	
Winter	CSC	Milo	CSC	Milo	CSC	Milo	Mixed Ration	Mixed Ration	
1	52	39	275	259	389	732	3428	3428	
2	59	36	310	136	356	640	4990	4990	
3	55		238	81	396	753	5160	5160	
								CSC	Milo
4	38		225	29	389	643	6951	202	56
5	61		255	29	255	635	8254	249	---
6	80		258	34	242	569	6571	262	62

[1] Supplemental feeds provided during a period of approximately 100 days from early January.
[2] Supplemental feeds provided during a period of approximately 150 days from mid-November.

Table 3. Reasons for Removal of Beef Cows Wintered at Different Levels

Lot No. / Wintering Level	1 Low	2 Moderate	3 High	4 Very High	5 Very High to Fourth Winter Then Moderate
No. of Heifers started on test as weaner calves (1957-58)	30	30	30	15	15
No. of cows re-remaining — 1964	26	26	24	12	12
Percent of cows remaining	86.7	86.7	80.0	80.0	80.0
Cause for Removal:					
Death					
Calving Difficulty	1			2	
Impaction of Abomasum	1				
Brain Abcess		2			
Uterine infection		1			
Cause Unknown			2		
Culled					
Open 2 Successive Years	1		4		1
Hardware Disease		1			
Poor Condition	1				
Cancer Eye					1
Foundered					1
Uterine Prolapse				1	
Total	4	4	6	3	3

A graphic representation of the influence of level of wintering on calving dates for each calf crop is shown in Figure 1. The differences appear to be rather consistent for the low, moderate and high levels for all calf crops, however, the widest differences occur in the case of the second calf crop. The long term average birth weight for calves produced by the different groups does not vary widely. The greatest differences observed in birth weights were for the first calf produced by cows on the low level, which averaged about 10 lbs. less than calves produced by the other groups. After the first calf very slight differences appeared in birth weight among the various treatment groups.

The average weaning weights of calves for five calf crops (Table 4) increase progressively from the low to high level. Weaning weights of calves produced by heifers developed at the very high level is intermediate with respect to those observed for the other treatments. Figure 2 shows graphically the performance for all groups of cows in this regard with marked differences occurring in the first two calf crops. The difference narrows considerably beyond this point, however.

It is interesting to observe that the females developed at the low and moderate levels have improved steadily throughout the period.

Table 4. Performance of Cows Wintered at Different Levels Through Five Calf Crops

Lot No.	1 Low	2 Moderate	3 High	4 Very High	5 Very High to Fourth Winter Then Moderate
No. of heifers started on test (1957-1958)	30	30	30	15	15
No. of cows remaining in 1964	26	26	24	12	12
Average calving date (month/day)	3/17	3/9	3/2	3/4	3/3
Average birth wt., lbs.	73	76	79	73	76
Average weaning wt., lbs. All calves	404	449	471	437	441
Percent Calf crop weaned based on cows exposed	84.6	85.3	87.0	82.1	83.1
Total pounds of calf Weaned per group, lbs. (sex corrected)	47757	56516	55161	24688	26824
Total pounds of calf Weaned lots 4&5, combined, lbs. (sex corrected)				51512	
Ave. milk production. (lbs. daily)	10.01	11.48	12.17	10.11	9.52
Total supplement cost For the six wintering Periods. ($ per cow)	15.30	73.80	160.52	671.72	288.86

Correspondingly, the curve for the females developed at the very high level has tended to turn down at the 5th calf. This may suggest that the cows developed at the very high level are physiologically older and the down turn normally expected to occur at 8-9 years of age is occurring at an earlier chronological age. Subsequent calf crops will provide additional information on this point. The performance of cows developed at the very high level (Lot 5) then switched to a moderate level the 4th winter are combined with Lot 4 in this graph since the same trend is noted for both groups.

It is also of interest to note that the females developed at the very high level produced calf weights as high in the case of the second calf as was noted for the same heifers for the 3rd and 4th calf, while all other females exhibited a rather steady improvement in weaning weight to the 4th calf. This may suggest that age of dam correction factors that are commonly used in selection programs may or may not be correct depending on the level of heifer development practiced.

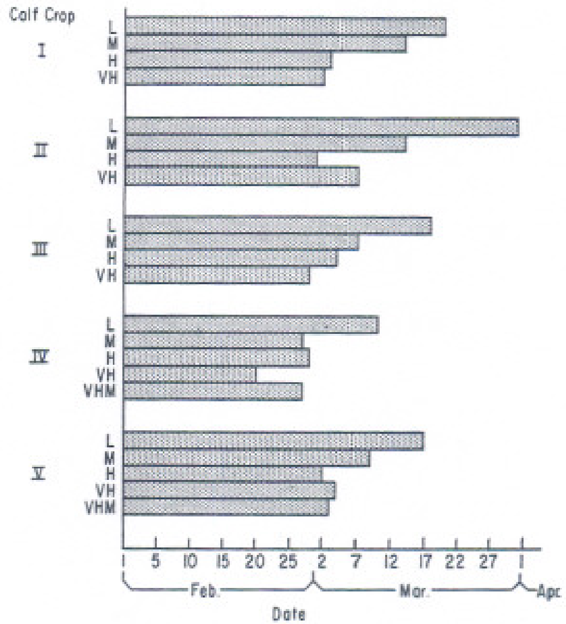

Figure 1. Influence of level of wintering on average birth date for successive calf crops.

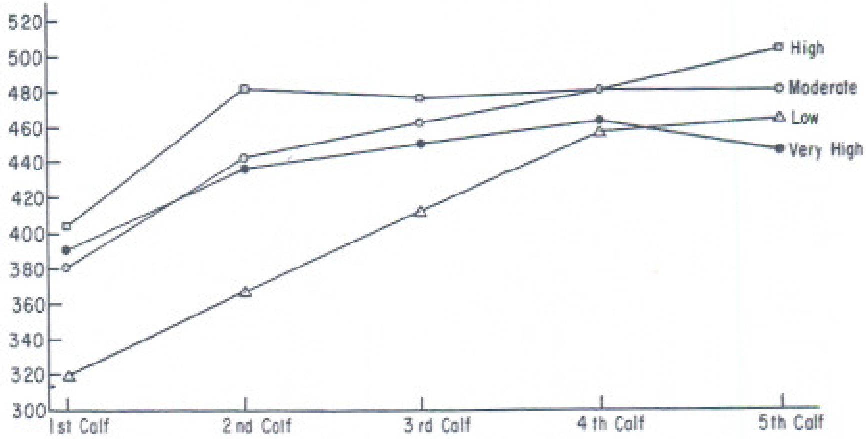

Figure 2. Average weaning weights of successive calf crops produced by cows wintered at different levels.

Figure 3 depicts the percentage calf crop observed for each of the five calf crops and Figure 4 shows the pounds of calf weaned per cow remaining in the herd at a given breeding season. This reflects both percentage calf crop and weaning weight of the calves produced. From this the low level has a most pronounced depressing influence through the first three calf crops after which time performance is comparable to the moderate and high levels. The higher productivity associated with the high level as compared with the moderate appears to diminish at a consistent rate through the first 4 calf crops, however, differences observed after the third calf are small.

The cost of supplementation for the various groups is also shown in Figure 4. Since the value of weaned weight is highly variable no attempt has been made to outline the single most profitable program, however, the feed costs reported or those that might be assigned by a producer and the comparative weaning weight and value per cow might be used to assess the value returned for increasing investments in feed. On this basis it would appear that returns for supplemental feed are most likely to favor the moderate level over the low level during the winters preceeding the second and third calf crops. It seems less likely that the increased supplement cost for the higher level will be offset by increased productivity unless the price of calves is extremely high relative to feed costs.

Summary

The influence of level of wintering on the performance of beef females through the first five calf crops is reported. The most marked sustained influence of the low level of wintering appears to be reflected in rebreeding performance as measured by average calving date. The weight change pattern exhibited by the moderate level appears to be consistent with both productivity and economy of wintering. The weight change characteristic of this level was a gain of 97 lbs. the first winter as weaner calves with subsequent winter weight losses of approximately 10-15 percent from fall weight including calving loss. Differences in

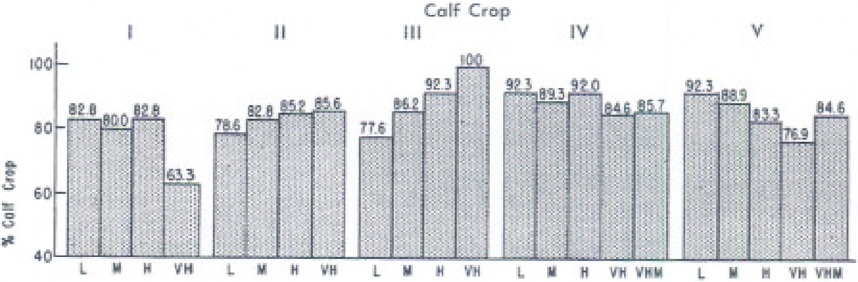

Figure 3. Influence of level of wintering on percentage calf crop weaned, based on cows exposed to bulls.

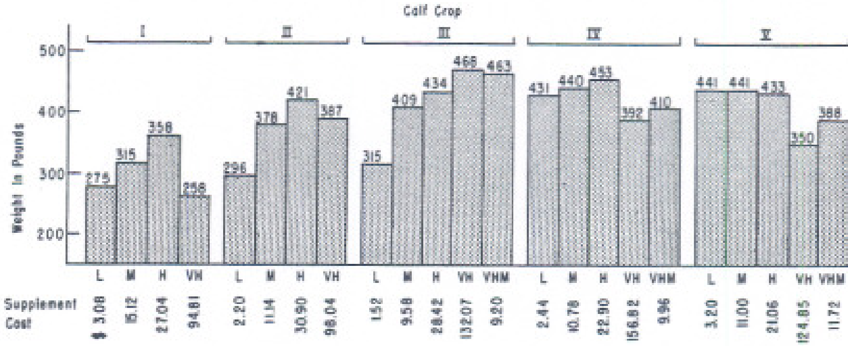

Figure 4. Influence of level of wintering on pounds of calf weaned per cow and supplemental feed cost prior to each calf crop.

cow survival resulting from level of wintering are not conclusive at this point. Development and maintenance of the beef females at very high levels reduced productivity below that observed for the moderate and high levels used in this study. Evidence also exists that this level of feeding may depress milk production below the more moderate levels. The results obtained by switching cows from a very high to moderate level indicates that the damage to productivity occurs early in life and is not corrected by lower levels after the third winter.

The data presented for the individual yearly calf crops indicate that rather than select a level of wintering for the life time of the cow, consideration should be given to the life cycle feeding approach in which higher levels are used during growth and development of the female followed by lower levels after the cow has reached maturity since the major influence of the various levels on cow productivity occurs during the first three calf crops.

Influence of Caloric Source and Bulk on Feed Intake and Performance of Finishing Steers

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

Southwestern feeders are continuing to show interest in high concentrate rations for finishing cattle. Involved in this interest are such things as relative cost of energy from roughages and concentrates and problems in preparing, storage, and handling of roughages.

Tests at this station have indicated that feed intake of high concentrate rations is considerably below that noted for rations containing 20 to 30 percent cottonseed hulls. In some cases calculated caloric intake has also been less for the high concentrate rations. Tests at other stations have shown similar results with respect to total feed intake. This work indicates that the animal possesses some mechanism which regulates energy consumption to very nearly the same level when rations ranging from 70 to 95 percent concentrate are fed.

There have been speculations that ration weight per unit of volume or density may be a limiting factor in consumption of high concentrate rations, however, previous work published from this station (MP 70, 1964) suggests that this is not a problem in that rations of varying density have been consumed in amounts to provide approximately equal energy intakes. The question then arises as to how energy intake might be improved when high concentrate rations are fed. To date there has been meager evidence that the mechanism controlling intake may be less sensitive to calories from fat than from carbohydrate. Further, the physical influence of bulk per se is of interest in studying rations for ruminants since for many years roughage or bulk has been considered important in maintaining normal rumen function.

The study reported here deals with the addition of fat to conventional and high concentrate rations as an alternative caloric source. Also reported is the influence of inert bulk when added to a high concentrate ration to provide an energy content per pound of ration comparable to that for a conventional finishing ration.

Experimental Procedure

Fifty yearling Hereford steers averaging approximately 700 lbs. were randomly allotted to ten pens of five steers each to provide replicate lots for five experimental treatments. The composition of the experimental rations is shown in Table 1. The rations were as follows:

A — Basal ration containing 20 percent hulls (75 percent concentrate)
B — High concentrate ration (95 percent concentrate)
C — Basal ration with 5 percent stabilized fat.
D — High concentrate ration with 5 percent stabilized fat
E — High concentrate ration with 5 percent fat plus 13 percent polyethylene fluff as a source of inert bulk.

Table 1. Composite of Experimental Rations

Ration Ration Type	A Conventional	B High Conc.	C Conventional +5% fat	D High Conc. + 5% fat	E High Concentrate + 5% fat + 13% polyethylene fluff[1]
Ingredients %:					
Steam rolled milo	62.15	84.55	56.95	79.55	Same as Ration D with 300 lbs. polyethylene fluff added to give calculated energy content per pound similar to Ration C.
Cottonseed meal	8.00	5.00	8.00	5.00	
Alfalfa meal	5.00	5.00	5.00	5.00	
Molasses	3.00	3.00	3.00	3.00	
Urea	1.00	1.50	1.20	1.50	
Stabilized animal tallow	----	----	5.00	5.00	
Cottonseed hulls	20.00	----	20.00	----	
Salt	.50	.50	.50	.50	
Limestone	.30	.40	.30	.40	
Vit. A premix	.03	.03	.03	.03	
Trace mineral premix	.02	.02	.02	.02	
Calculated Net Energy[2] (Megacalorie/lb.)	.630	.726	.690	.788	.685

[1] The polyethylene fluff used as a source of inert bulk was supplied gratis by El Du Pont De Nemours & Co. (Inc.) Wilmington, Delaware.
[2] Calculated from Morrison's *Feeds and Feeding*, 22nd Ed., Appendix Table 2.

The cattle were placed initially on Ration A diluted with approximately 30 percent additional cottonseed hulls in self feeders. The hull content was then reduced gradually during the first week. Following this the steers were placed on their respective experimental rations by blending these with Ration A which was then removed gradually during the second week, thus leaving the animals on the various treatments designated for the balance of the experimental period. All rations were self-fed throughout the total period. Initial, final and 28 day interim weights were taken after a 12 hour shrink period without feed and water.

Rumen fluid samples were collected periodically for determination of ratios of volatile fatty acids. Rectal temperatures were also determined at times as a measure of heat stress.

The cattle were slaughtered at a commercial packing plant and the carcass data collected was used to calculate the cutability estimate for the carcasses produced.

Results

A summary of results appears in Table 2. The summary values for each treatment represent an average for the replicate lots on each ration.

Daily Gain

The rate of gain was strikingly similar for all rations containing bulk whether the source was cottonseed hulls or inert bulk fed as poly-

Table 2. Summary of Results

Lot No. Ration Type of Ration	1 A Conventional	2 B High Concentrate	3 C Conventional + 5% fat	4 D High Concentrate + 5% Fat	5 E High Concentrate + 5% Fat with 13% polyethylene fluff
No. of steers	10	10	10	10	9[1]
Initial wt., lbs.	704	700	712	703	686
Final wt., lbs.	1043	992	1054	980	1028
132 day gain, lbs.	339	292	342	277	342
Daily gain, lbs.	2.57	2.21	2.59	2.10	2.59
Total daily feed intake, lbs.	27.4	22.3	25.7	19.4	22.5
Daily concentrate intake, lbs.	22.9	22.3	20.5	19.4	19.6
Daily net energy intake, megacalories	17.3	16.2	17.7	15.3	15.4
Total feed/100 lb. gain, lb.	1070	1005	990	922	871
Concentrate/100 lb. gain, lbs.	856	1005	792	922	758
Cost of gain, $/cwt.[2]	21.29	2241	22.08	22.40	[4]
Carcass observations:[3]					
Dressing %	61.0	61.1	61.2	61.4	60.6
Rib eye area, sq. in.	10.63	11.06	11.44	10.97	10.48
Ave. carcass wt.	636.2	606.1	645.0	601.7	622.8
Rib eye area per 100 lbs. carcass wt., sq. in.	1.67	1.82	1.77	1.82	1.68
Fat cover, in.	.59	.50	.59	.57	.57
Kidney knob wt., %	2.80	2.75	3.30	2.80	2.44
Cutability score, %	48.59	49.72	48.88	49.28	48.77
Carcass grade	Low Choice	Low Choice	Low Choice	Low Choice	Low Choice

[1] One steer died due to fibrous and abscessed kidney.

[2] Feed prices were as follows: milo $2.05/cwt, cottonseed meal $80/T, dehydrated alfalfa meal $40/T, molasses $30/T, urea $120/T, cottonseed hulls $15/T, salt $20/T, limestone $20/T and vitamin A premix $1.00/lb.

[3] Appreciation is extended to Wilson Packing Company, Oklahoma City and Mr. Raymond Fowler, Federal Grading Service, Oklahoma City for cooperation in obtaining carcass data.

[4] The cost per pound of gain for this lot, excluding the cost of the polyethylene addition was $18.42/100 lbs. The cost of the inert bulk used to gain information on the influence of bulk *per se* prohibits commercial use of it at the levels used in these studies.

ethylene fluff. The rate of gain produced by the high concentrate rations was approximately .4 lb. daily below that noted for steers on the bulk containing rations. The addition of 5 percent fat to either the conventional or high concentrate rations had little influence on rate of gain.

Feed and Energy Intake

The characteristic reduction in total feed intake was noted for the high concentrate rations as compared with rations containing 20 percent cottonseed hulls. The addition of 5 percent stabilized animal tallow depressed total feed intake when added to either the conventional or high concentrate rations with the greatest depression occurring when the addition was made to the high concentrate ration. The addition of inert bulk to the high concentrate ration (E) containing fat, increased total feed intake as compared to the same ration (D) without the bulk addition. The net result was complete compensation for the bulk addition in that essentially the same quantity of nutrient containing portion was consumed daily by steers on these two rations. The addition of inert bulk (E) to provide a similar calculated energy content per pound to that of the conventional fat containing ration (C) did not, however, result in equal intake of nutritive containing portion from these two rations.

The results with respect to daily concentrate intake for the various rations indicate that the conventional ration (A) containing 20 percent cottonseed hulls was consumed in an amount to provide almost identical concentrate intake noted for the high concentrate ration (B). The same trend was noted in comparing concentrate intake of rations C and D which were respectively conventional and high concentrate rations containing 5 percent fat additions. The addition of fat reduced daily concentrate intake in both types of rations, however, the greater reduction occurred in the case of the high concentrate ration.

In all cases it appears that steers will compensate for bulk additions to attain very similar levels of daily concentrate intake. The daily intake of calculated net energy from the total ration indicates greater energy intake for the conventional rations (A & C), however, these values may be misleading due to the inability to assess the proper useful energy value to all the feeds involved. Daily gains tend to follow the calculated net energy values closely in all cases except for ration E which contained the inert bulk. It is apparent in this case that the calculated value for net energy greatly under estimated the actual value of the ration since rate of gain was comparable to that noted for the conventional (bulk containing) rations A and C.

Since the addition of fat increased neither the calculated net energy intake nor the rate of gain produced, it does not appear that the mechanism controlling feed and energy intake is less sensitive to fat than carbohydrate.

Feed Efficiency

Feed efficiency tended to be higher for the high concentrate rations which has been characteristic of several studies of this type. The addition of fat reduced feed required per 100 lbs. of gain by 80 pounds (7 percent) when added to the conventional rations and by 83 (8 percent) pounds when the addition was made to the high concentrate ration. The improvement in efficiency resulting from fat additions is rather consistent with values from other work and may serve as a guide in evaluating whether fat may be an economical addition to rations as a replacement for milo.

The influence of bulk on the utilization of the concentrate portion of the ration is interesting. The concentrate required per 100 lbs. of gain also indicates the more efficient utilization of the fat containing rations. A most interesting comparison, however, is that between rations D and E. The addition of inert bulk greatly enhanced the utilization of the concentrate portion of the feed. Then a comparison between rations C and E indicates that some of the energy from the concentrate portion of the ration was required to utilize the cottonseed hulls which in reality points toward a negative net energy value for the hull additions.

The difference in concentrate efficiency of rations A and C may be explained by the fat addition to ration C. These results indicate that some bulk may be important for the most efficient use of concentrates and that even undigestible bulk may serve that purpose.

The explanation for the influence of bulk **per se** is not clear. Speculation may center around its influence on the rumen epithelium to maintain a more normal condition and function or on its influence on rate of passage of materials through the digestive tract. Rate of passage may be particularly important in milo utilization in high concentrate rations if the hardness of the grain particle or nature of the starch requires a longer time for efficient digestion than is characteristic of other grains. Ratios of volatile fatty acid production will be reported later since analyses are not complete at this time. The results with the inert bulk seem to point to the need of adding a bulky material that will not alter the level of propionic acid relative to acetic acid typically produced by high concentrate rations and yet exert the influence of inert bulk observed in this study.

The fact remains, however, that feed cost per pound of gain based on feed prices in the summer of 1964 did not differ widely among rations. These results are, of course, highly dependent on the relative cost of cottonseed hulls and the concentrate portion of the rations. It should be noted that the polyethylene fluff material used in these studies was used as a source of undigestible bulk for the purpose of studying the influence of bulk **per se**. Due to the high cost of the material, it is not a recommended ration addition for commercial purposes. It should be noted further that additional work is needed to verify the results noted in this trial as being due to the inert bulk addition.

No important differences were observed in rectal temperature of steers on the various rations, however, all steers were under rather severe heat stress as indicated by rectal temperatures as high as 105°F.

Summary

The influence of fat additions as an alternative energy source in conventional and high concentrate rations was studied. Also the influence of bulk **per se** added to a high concentrate ration was evaluated by using polyethylene fluff as a source of inert bulk.

Rate of gain was superior for all rations containing bulk whether in the form of cottonseed hulls or polyethylene.

Feed efficiency favored the high concentrate rations and fat additions to either high concentrate or conventional rations improved feed efficiency by 8 and 7 percent respectively. The addition of inert bulk to a high concentrate ration resulted in a marked improvement in efficiency with which the concentrate portion of the ration was utilized. Some possible reasons for this improvement are discussed, however, these results are considered preliminary at this time. The cost of the source of inert bulk used prohibits the commercial use of the material at the level reported.

The feed cost per pound of gain favored the conventional ration but these results are subject to relative prices of cottonseed hulls and concentrate ingredients in the ration. Fat additions did not reduce cost of gain at the prevailing price at the time the test was conducted.

Cutability score of carcasses tended to favor the high concentrate rations. Average carcass grade was the same for all treatments used in the study.

Genetic Relationships Between Growth and Carcass Traits

L. V. Cundiff, R. L. Willham, and D. F. Stephens

Numerous studies have shown that measures of growth rate in beef cattle are highly heritable. Thus, selection of breeding stock with superior gaining ability will result in genetic improvement in growth rate. When devising breeding programs which include selection for growth rate, it is important to consider the effect of genetic change resulting from this selection on other traits of economic importance.

Data were presented by Chambers *et al.* (1956) which indicated that selection for rapid growth on a five month post weaning feed would lead to genetic improvement in efficient use of feed. Further, no antagonism was indicated between growth and conformation appraisal at the end of the feeding period.

The purpose of this study was to investigate the genetic relationships between growth as measured by carcass weight per day of age and several carcass traits.

Materials and Methods

The data were 265 Hereford and Angus steers from 47 sires that were dropped in the spring of 1961 and 1962 and placed on a 5 month feed test after weaning. The calves were group self-fed a complete mixed ration containing approximately 9 percent digestible protein and 63 percent total digestible nutrients. Table 1 gives a description of the five groups. The data were studied on an intra-group basis to remove the effects of year, breed, herd and management differences. Table 1 also gives the average performance for the traits studied.

Carcass weight per day of age was the measure of growth rate used. Rib-eye area per hundred pounds of carcass was used as the measure of muscular development and average fat thickness was used as the measure of fatness. Federal carcass grade (⅓ of grades) was used as the measure of carcass quality and percent retail cuts the indicator of carcass cutability. Percentage retail cuts; the percent of boneless retail trimmed cuts from the round, loin, rib and chuck; was calculated by the following formula:

$$\%RC = 52.66 - 5.33X_1 - .979X_2 + .665X_3 - .0065X_4$$

Table 1. Performance of the Five Groups of Steers

Item	Groups				
	1	2	3	4	5
Number	63	60	74	32	36
Breed[1]	H	A	H	A	A
Age on test	211	211	254	210	211
Weight on test	478	501	477	484	450
Days on test	196	168	168	168	168
A.D.G. on test	2.48	2.38	2.69	2.48	2.45
Carcass wt./day of age	1.40	1.46	1.34	1.47	1.35
Carcass grade[2]	9.70	11.20	9.74	10.84	10.36
Rib eye/CWT	1.84	1.82	1.75	1.73	1.91
Fat thickness inches	0.79	0.86	0.70	0.86	0.72
% Retail cuts	48.05	47.00	48.61	46.83	48.08

[1] Hereford = H; Angus = A.
[2] High good = 9; Low choice = 10; Avg. choice = 11, etc.

In this formula X_1 is average fat thickness in inches, X_2 is kidney fat as a percentage of carcass weight, X_3 is rib-eye area in square inches and X_4 is carcass weight in pounds (Murphy *et al.*, 1960). Intra-group paternal half-rib analyses of variance and covariance were used to estimate the heritabilities and genetic correlations.

Results and Discussion

The relatively high heritabilities shown in Table 2 indicate that offspring from selected parents will have a higher average performance than those from unselected parents for any one of the traits. Measurement of these traits requires slaughter making it necessary to select individuals on the basis of their progeny or other close relatives. This increases the generation interval and reduces the progress by selection per unit of time. Other measures of growth rate exist such as live weight per day of age. Although not as accurate a measure of growth rate of the end product—beef, live animal growth rates compensate for this deficiency since they can be measured on the individual thus reducing the generation interval when compared with traits requiring slaughter. Carcass weight per day of age was used as the measure of growth rate since it was highly correlated with live measures of growth.

The primary purpose of this study was to study the expected genetic change in carcass traits if selection were based on some measure of growth rate only. The expected genetic change in one trait when selection is for another depends on several factors. However, the principle one is the genetic correlation between the two traits. Table 3 gives the gentic

Table 2. Heritabilities

Traits	Heritabilities (%)
Carcass wt./day of age	39
Rib-eye area/CWT	29
Fat thickness	43
Carcass grade	62
%Retail cuts	40

Table 3. Genetic Correlations Between Growth Rate and Several Carcass Traits.

Trait	Correlation
Rib-Eye Area/CWT	—.02
% Retail cuts	+.02
Fat thickness	+.15
Carcass grade	+.47

correlations between carcass weight per day of age and the various carcass traits. Both rib-eye area per hundred weight of carcass and percentage retail cuts have essentially no genetic relationship with growth rate. Although rib-eye area and retail cut percentage are not perfect indicators of proportion of lean, these results suggest that selection for growth rate would lead to no genetic change in percentage of lean meat. Selection for growth rate appears to lead to proportionate changes in fat, lean and bone, resulting in heavier carcasses leaving percentage of lean roughly the same.

The small gentic correlation between growth and fat thickness suggests that selection for increased growth rate would result in a slight increase in carcass fatness. Carcass grade, which in these data is primarily a measure of marbling or quality, and carcass weight per day of age had a moderate genetic correlation.

These data suggest that as growth rate is increased both outside fat deposition and intra-muscular fat deposition would be increased. The genetic correlation between outside fat thickness and marbling was high indicating that the genes responsible for fat deposition are probably general in their effect. That is, the same genes are responsible for fat deposition wherever it occurs. These particular results may not be applicable in other groups of cattle since there seem to be large differences between cattle in size at maturity. In this particular study the level of maturity at 12 to 13 months might have been such that this relationship between increased fatness and growth exists where in other data it might not. More work needs to be done in this area.

Ideally, cattle with rapid and efficient growth coupled with a high percentage of lean and enough marbling to grade choice would be most desirable. These data suggest that selection for increased growth rate is not antagonistic to the production of desirable carcasses since it would result in a slight increase in carcass grade and would have no effect on percentage of retail cuts. Consequently, some selection effort must be directed toward increased percentage of retail cuts for it to be improved.

One problem may arise with selection for percent retail cuts. In this study carcass grade or quality had a high negative genetic correlation with percentage of retail cuts, probably because of their high genetic relationship with fat thickness. Thus, there is an indication that carcass grade could be reduced by selection for increased percentage of retail cuts. With present marketing standards this is not good. Since the sampling errors of genetic correlations are quite high, the values found in this study really indicate the direction either positive or negative and either large or small in magnitude. Therefore, selection for growth rate and percent retail cuts is probably possible while maintaining carcass grade or quality.

Summary

Data from 265 Hereford and Angus steers representing 47 sire groups were studied. The heritabilities obtained for carcass weight per day of age, rib-eye area per hundred weight, fat thickness, carcass grade and percentage retail cuts indicated that selection for any one would be effective. The genetic correlations between the traits suggested that selecion for growth rate is compatable with the production of desirable carcasses.

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Preliminary Studies on the Performance of Lambs Weaned at 30 - 45 Days of Age

Hudson A. Glimp, Allen D. Tillman and Joe V. Whiteman

There is currently a lot of interest in management programs for sheep that involve weaning lambs at 30-45 days of age and carrying them to market weight under confinement conditions. Such a program might allow earlier rebreeding of the ewe, require less pasture per animal unit, and virtually eliminate internal parasites and adverse weather as problems in finishing lambs.

Studies are currently being conducted at this station to determine the feasibility of this type of program with ewes under Oklahoma conditions. However, before any program of this nature is successful, much information is needed on the nutrient requirements of this very young lamb. Morrison (1956) and N. R. C. (1957) do not list the nutrient requirements for lambs lighter than 50 lb. The purpose of these preliminary studies was to determine the response of lambs when weaned at 30-45 days of age.

Trial I—Procedure

Twenty-eight Rambouillet X Dorset wether lambs were weaned at a minimum weight of 30 lb. and a minimum age of 30 days and group-fed one of the two rations shown in Table 1. These lambs were already eating a small daily amount of a creep feed mixture of 28 percent alfalfa hay, 57 percent kafir grain, 10 percent soybean oil meal and 5 percent molasses. The lambs were weaned at two week intervals in groups of 8, 16 and 4, respectively, and alloted on the basis of weight per day of age to one of the two rations. Due to a lack of facilities and problems with urinary calculi, accurate feed consumption data were obtained only on the second group (16 lambs) weaned; thus the data in Table 2 represents those lambs.

At the end of 12 weeks, six of the lambs on each ration were placed in individual, slotted-floored pens and fed the same ration to a slaughter weight of 95-100 lb. The lambs were allowed to shrink 18 hours before slaughter and the carcasses were chilled 48 hours before the carcass measurements were taken. Loin-eye area was measured as an average of the urea in the right and left loins between the 12th and 13th rib. Average backfat thickness was taken as an average of three measurements over each loin-eye at the center of each loin-eye and one-half of the way from the center to each edge.

Results and Discussion

Five lambs, three on ration 1 and two on ration 2, developed urinary calculi before the sixth week on feed. Changing the calcium : phosphorus ratio and adding 0.25 percent ammonium chloride, as shown in Table 1, was effective in preventing further incidence of urinary calculi.

Table 1. Percentage Composition of Rations (Trial 1)

Ration	1		2	
Period	Initial	After 6 Weeks	Initial	After 6 Weeks
Ingredient				
Alfalfa meal			25.0	25.0
Ground milo	70.5	69.0	35.5	34.5
Crimped oats			15.0	15.0
Soybean meal (50%)	15.0	15.0	10.0	10.0
Wheat bran	10.0	10.0	10.0	10.0
Molasses	3.0	3.0	3.0	3.0
Trace mineralized Salt	0.5	0.75	0.5	0.75
Dicalcium phosphate	0.5	0.5	1.0	0.5
Calcium carbonate	0.5	1.5		1.0
Ammonium chloride		0.25		0.25
Nutrient Analyses				
Crude protein	16.9	16.8	16.5	16.4
TDN	75.1	74.6	67.5	67.2
Crude fiber	3.1	3.1	8.2	8.2
Calcium	0.52	0.78	0.67	0.93
Phosphorus	0.50	0.50	0.58	0.49

The average daily gains and feed efficiencies of 16 of the lambs fed during the first 12 weeks are shown in Table 2. The rate and efficiency of gain on the two rations were quite similar for the 12 week period. Analysis of the biweekly data, however, indicates that the lambs fed ration 2 went on feed better and gained faster during the early stages than those on ration 1, but those on ration 1 were gaining faster and requiring less feed per lb. of gain during the last six weeks of the 12 week period.

It should be noted that these lambs did not gain as rapid as normal for this age of lamb, due primarily to the poor gains during the first two weeks postweaning. The feed efficiencies, however, were quite satisfactory and suggest that efficient weight gains can be obtained with early-weaned lambs. Handling of the lambs at the 76 lb. weight at 12 weeks indicated that many of the lambs had already reached choice grade finish. This suggests that feeding high energy rations may cause an early onset of fattening in young lambs. Whether this would have occurred with other breed crosses is not known, but it is well established that the Dorset is a relatively early maturing breed.

The data on the lambs fed from 12 weeks to slaughter are shown in Table 3. Both rate of gain and feed efficiency decreased during this period, in comparison to the first 12 weeks. This would be expected since much of the weight gain during this period was probably fat, and fattening requires more feed per lb. of gain than does any other tissue.

Table 2. Average Daily Gains and Feed Efficiencies of Lambs, First 12 Weeks (Trial 1)

Ration	1	2
Number of lambs	8	8
Average weaning age	39.6	38.4
Average weaning wt., lb.	34.0	34.0
Wt. after 12 weeks, lb.	75.7	76.4
Average daily gain, lb.		
0-2 weeks	0.33	0.46
2-4 weeks	0.72	0.65
4-6 weeks	0.48	0.66
6-8 weeks	0.48	0.49
8-10 weeks	0.50	0.49
10-12 weeks	0.55	0.38
Total	0.51	0.52
Feed efficiency, lb. feed/lb. gain		
0.2 weeks	3.40	3.15
2-4 weeks	2.50	3.02
4-6 weeks	4.52	3.89
6-8 weeks	5.32	5.96
8-10 weeks	5.51	6.44
10-12 weeks	5.63	8.05
Total	4.34	4.83

The carcass information on these lambs is shown in Table 3. These data indicate that, by all criteria studied, ration 1 produced a more desirable carcass than ration 2. Lambs on ration 1 had a slightly higher dressing percent, significantly less shrink, and significantly larger loin-eye aras. The slightly lower backfat thickness and higher specific gravities also indicate that lambs on ration 1 had leaner carcasses than those on ration 2. The superior performance of ration 1 is surprising, but may be due to the higher TDN content in combination with a high protein content that would be considered as high-quality protein.

These factors may have been especially important during the early part of the trial. The carcass data indicate that the lambs on both rations were too fat at 95-100 lb., and that lambs raised under this regime may need to be marketed at a lighter weight, or from a later maturing breed or breed cross. Another significant observation was that three of the lambs on ration 1 and one on ration 2 had oily, soft carcass fat. This has also been observed at other stations when early-weaned lambs were fed in confinement.

Table 3. Average Daily Gain, Feed Efficiency, and Various Carcass Measurements, 12 Weeks to Slaughter (Trial 1)

Ration	1	2
Number of lambs	6	6
Wt. after 12 weeks, lb.	76.2	76.5
Slaughter wt., lb.	96.5	97.0
Average daily gain, lb.	0.41	0.40
Feed efficiency, lb. feed/lb. gain	6.66	6.78
Dressing percent	58.2	57.1
Percent shrink	4.8	9.8
Loin-eye area, sq. in.	2.37	1.95
Backfat thickness, in.	0.35	0.38
Carcass specific gravity	1.0271	1.0247

Trial II—Procedure

In another trial 16 of 32 January born lambs were weaned when they were within one to three days of 30 days of age and weighed about 30 pounds. Prior to weaning and during their feeding period the weaned lambs received the following rations:

	Ration up Until About 55 lb.	Ration From 55 to 70 lb.	Ration From 70 lb. – 85 lb.
Feeds			
Kafir grain %	57	63	45
Alfalfa hay (high qual.) %	28	32	50
Soybean meal %	10	--	--
Molasses %	5	5	5

The non-weaned lambs had the same feeds as a creep ration and were weaned at about 75 days of age after which time they were full fed the appropriate rations also.

The 30-day weaning of the young lambs was accomplished by removing the lambs from their mothers and placing them in a small pen with feed and water. The pen was located in an area where the lambs could neither see nor hear any other sheep. It is thought that this is an important factor in the management of very young weaned lambs.

The lambs (weaned and non-weaned) were weighed at frequent intervals to get a picture of the influence of early weaning on the growth pattern. Only the total feed eaten by the early weaned lambs could be measured.

Results

The results relative to the growth pattern are illustrated in Figure 1. The weaned lambs actually lost a little weight during the first eight days after weaning. After this adjustment period, they gained very well.

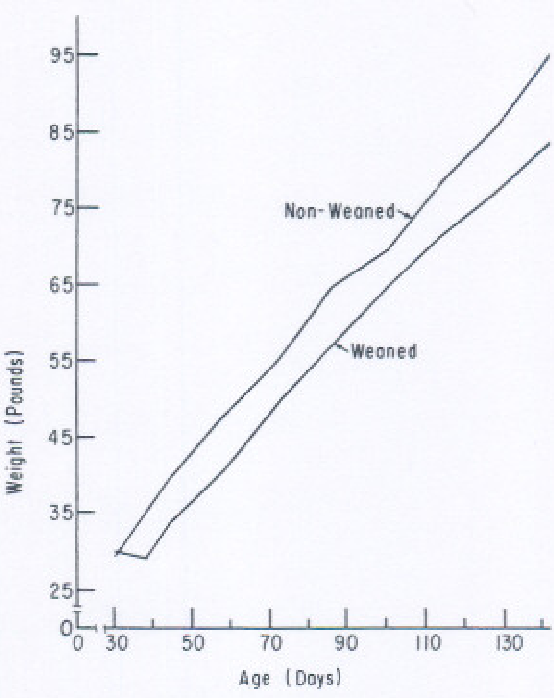

Figure 1. The average growth pattern of weaned and nonweaned lambs when weaning occurred at about 30 days of age.

At an average age of 142 days the weaned lambs averaged about 83 pounds compared to 95 pounds for the non-weaned lambs.

One of the early weaned lambs weighed only 20 pounds at weaning time and responded poorly. This and other experiences suggest that lambs weighing less than 25 pounds at 30 days of age may need better rations, care or something than these lambs received.

Other than the growth pattern, the data of interest from this trial concerned the feed efficiency of the weaned lambs. These 16 lambs gained 855 pounds and consumed 4,125 pounds of feed. Thus, they gained a pound for each 4.8 pounds of feed consumed.

Addenda

The results presented in this preliminary report are not presented as recommendations, but to indicate to anyone interested that on those occasions when it seems necessary to wean lambs at young ages it can be done. There is much that is not known about how to best feed and manage such lambs before, during and after weaning; but this record of some experiences may serve as a guide for those who wish to try such a management scheme. It is believed that either ration 2 of trial one or the ration used in trial two will give satisfactory results up until the lambs weigh 55-65 pounds after which time any good lamb fattening ration should be satisfactory.

The Effect of Pre-Weaning Plane of Nutrition on the Growth and Development of Beef Calves

J. J. Guenther, S. A. Ewing and G. V. Odell

Among the majority of modern consumers, beef is considered not only the king, but also the whole royal family of appetite appeal. Thus, from the standpoint of product demand the beef producer occupies an enviable position among his fellow food provisioners. Yet, if beef is to maintain its esteemed position in the market-place and if beef is to withstand growing competition from other protein foodstuffs, the beef producer must constantly strive to keep abreast of consumer demands, to increase his production efficiency and to improve the quality of his product.

To effectively cope with these problems, the need for fundamental information concerning the effect of various feeding and management practices on the growth and development of the beef calf is obvious. The following data represent a portion of the results from such a study currently in progress at the Oklahoma Agricultural Experiment Station.

Procedure

The research reported herein was derived from two separate experiments. In the first experiment, the influence of the nutritional level of the dam, during the gestation period, on subsequent growth and development of their calves from birth to slaughter weight was investigated. For this study, two groups of steer calves, each containing eight calves, were produced by three-year-old cows on low and high levels of wintering.

In the second experiment, the influence of pre-weaning plane of nutrition on the pre- and post-weaning performance of beef calves was studied. For this test, fifteen steer calves were obtained and allotted as follows:

(a) Four calves, *weaned at 140 days,* then maintained on limited creep feed on pasture to restrict gains until 240 days of age.
(b) Five calves, *weaned at 240 days.* No creep feed during the pre-weaning period.
(c) Six calves, *weaned at 240 days and creep fed* a high concentrate feed during the pre-weaning period.

The post-weaning feedlot test was conducted at the Ft. Reno Station. All calves were self-fed a finishing ration, containing approximately 65 percent concentrate, until removed for slaughter. The standard feed conversion, carcass quality and measurement data (including specific gravity) were obtained. Carcass fat content was calculated from the specific gravity determination.

Results and Discussion

Data in Table 1 show the influence of the nutritional level of the dam, during the gestation period, on the subsequent performance of their calves from birth to weaning and from weaning to slaughter weight. Calves from dams fed on a high plane of nutrition during gestation averaged 13 pounds heavier at birth than those from the low level dams. The "high" level calves also gained 17 pounds more than the "lows" during the pre-weaning period and by weaning time had increased this weight advantage to 30 pounds. Daily gain during this time favored the calves from the high levl dams by 0.13 pounds per day.

Results show that the calves from the high level dams continued to outperform the lows in the post-weaning feedlot test. These calves averaged 967 pounds when removed from test, 44 pounds more than those from the low level dams. Moreover, the high plane steers required 17 days less time in the feedlot. Originally, it was intended to slaughter

Table 1. Effect of Nutritional Level of Dam on Performance of Calves from Birth to Weaning and Weaning to Slaughter Weight.

Level of Nutrition of Dam	Low	High
Pre-weaning Performance		
Number of Calves	8	8
Birth Weight	63	76
Weaning Weight	378	408
Gain to Weaning	315	332
Weaning Age	204	199
Daily Gain to Weaning	1.55	1.68
Post-weaning Feedlot Performance		
Initial Weight	404	434
Slaughter Weight	923	967
Feedlot Gain	519	533
Days on Feed	224	207
Daily Gain on Feed	2.32	2.58
Pounds Feed/100 Pounds Gain	878	799

both groups at the same final live weight. However, the low level calves were removed from test at a lighter weight, when it became apparent from the daily gain records that they would have to be carried through the hot summer months to attain the necessary weight. Obviously, then, the differences in average daily gain and in feed efficiency, which favored the high plane calves by 0.26 pounds per day and 79 pounds feed, respectively, would have been much greater if the steers from the low level dams had been fed to the same final weight as the highs.

These results indicate that the level of nutrition of the dam, during gestation, has a considerable effect not only on birth weight and pre-weaning growth of the beef calf, but also on the subsequent post-weaning feedlot performance. Thus, dams which are well nourished during gestation appear to transmit to their calves a certain impetus which is maintained throughout its entire growing period. Conversely, calves from poorly nourished dams never seem to fully compensate for their poor start in life.

Data showing the influence of nutritional level of the dam on the carcass characteristics of calves fed to slaughter weight are presented in Table 2. Only small difefrences were noted between the two steer groups in the carcass quality results. The high level steers produced heavier carcasses which averaged slightly higher in conformation score and which exhibited a little less physiological age than the carcasses from the low level dams. The low plane calves yielded lighter carcasses, but showed a slightly higher dressing percent and marbling score than did the highs. No difference was obtained in carcass grade, however. Also, in overall carcass development, only minor treatment differences were noted. High plane carcasses tended to have larger ribeyes, a little more fat cover

Table 2. Effect of Nutritional Level of Dam on Carcass Characteristics of Calves Fed to Slaughter Weight.

Level of Nutrition of Dam	Low	High
Carcass Quality Data		
Slaughter Weight	923	967
Carcass Weight	583	605
Dressing Percent	63.2	62.6
Conformation Score	Good+	Choice−
Maturity Score	B−	A+
Marbling Score	Modest−	Small−
Carcass Grade	Choice−	Choice−
Carcass Development Data		
Ribeye Area[1]	10.9	11.6
Fat Cover[2]	0.76	0.83
Length of Carcass[2]	45.3	45.7
Length of Leg	27.6	28.6
Length of Loin	23.9	24.2
Depth of Body	14.8	14.8
Width of Shoulder	8.4	8.9
Width of Round	8.9	8.9
Specific Gravity	1.0498	1.0473
Pounds Fat	179	194
Percent Fat	30.7	32.1

[1] Square inches
[2] Inches

and to be larger scaled than the lows. In fat content, the high plane calves averaged 15 pounds or 1.4 percent more total carcass fat than did those from the low level dams.

Presented in Table 3 are the data showing the influence of pre-weaning nutritional level on the pre- and post-weaning performance of growing beef calves. Creep fed calves weighed, on the average, 70 pounds more at weaning than the normal weaned calves and 170 pounds more than the early weaners. Average daily gain to weaning favored the creep fed calves by 0.25 and 0.58 pounds per day, respectively, over the normal and early weaned calves. At the close of the post-weaning feedlot test, however, live weight differences between treatment groups had been greatly reduced. Thus, at slaughter, the creep fed steers outweighed the normal and early weaned steers by only 33 and 67 pounds, respectively. Both total and daily fedlot gain favored the calves which were restricted during the pre-weaning period.

In this regard, the early weaned calves gained 41 and 118 pounds more on test and average 0.10 and 0.25 pounds more per day, respectively, than did the normal and creep fed calves. Feed efficiency also favored the early weaned calves over the normal weaned and creep fed steers, even though the latter two groups were in the feedlot for shorter periods of time (8 and 28 days, respectively). Nevertheless, it is pointed out that

Table 3. Effect of Pre-weaning Plane of Nutrition on the Pre- and Post-weaning Performance of Beef Calves.

Pre-weaning Treatment	Early Weaned (140 days)	Normal Weaned (240 days)	Normal Weaned + Creep
Pre-weaning Performance			
Number of Calves	4	5	6
Birth Weight	73	75	75
Weaning Weight	328	430	500
Gain to Weaning	255	355	425
Daily Gain to Weaning	1.05	1.38	1.63
Post-weaning Feedlot Performance			
Initial Weight	302	377	487
Slaughter Weight	866	900	933
Feedlot Gain	564	523	446
Days on Feed	241	233	213
Daily Gain on Feed	2.34	2.24	2.09
Pounds Feed/100 Pounds Gain	757	807	861

all treatment lots were not slaughtered at the same final weight. Had the early and normal weaned calves been carried to the same live weight as the creep fed calves, their efficiency of feed conversion would have been reduced considerably. The converse would also be true for the creep fed calves, if they had been removed from test at a lighter live weight.

Data in Table 3 indicate that, while calves limited in nutrient intake early in life tend to compensate for this restriction by making rapid and efficient gains when put on full feed, they would require a considerably longer feedlot period to fully compensate for the initial advantage obtained by calves full fed early in life.

Results showing the influence of pre-weaning plane of nutrition on carcass characteristics of calves fed to slaughter weight appear in Table 4. Small, but important, differences were noted in the carcass quality data of the experimental steers. Creep fed calves yielded the heaviest carcasses, averaging 18 and 44 pounds more, respectively, than the normal and early weaned steers. Although little differences were observed in scores for conformation, maturity, and marbling, when these factors were considered simultaneously, they resulted in a ⅓ of a grade difference in carcass grade, favoring the creep fed and normal weaned steers. While this is but a small difference, it was critical with these cattle; for it resulted in the creep fed and normal weaned cattle being graded U.S. Choice and the early weaned cattle being rated U.S. Good by the federal grader.

Apparently, full feeding early in life is necessary for maximum ribeye development. In this regard, the creep fed calves averaged 1.0 square inches more ribeye than the normal weaned steers, while the latter were only 0.4 square inches larger in ribeye area than the early weaners. In addition, early weaned calves deposited more external fat than either the normal weaned or creep fed calves.

Table 4. Effect of Pre-weaning Plane of Nutrition on Carcass Characteristics of Calves Fed to Slaughter Weight.

Pre-weaning Treatment	Early Weaned (140 days)	Normal Weaned (240 days)	Normal Weaned + Creep
Carcass Quality Data			
Slaughter Weight	866	900	933
Carcass Weight	547	573	591
Dressing Percent	63.2	63.7	63.3
Conformation Score	Good+	Choice−	Choice−
Maturity Score	B−	A+	B−
Marbling Score	Small−	Small	Small
Carcass Grade	Good+	Choice−	Choice−
Carcass Development Data			
Ribeye Area[1]	10.1	10.5	11.5
Fat Cover[2]	0.87	0.76	0.78
Length of Carcass[2]	44.7	45.5	45.7
Length of Leg	27.9	28.1	28.1
Length of Loin	23.1	23.8	23.8
Depth of Body	15.0	15.3	15.3
Width of Shoulder	8.2	8.5	8.8
Width of Round	9.0	8.9	8.7
Specific Gravity	1.0474	1.0508	1.0448
Pounds Fat	175	173	197
Percent Fat	31.9	30.1	33.4

[1] Square inches
[2] Inches

Skeletal-wise, the full fed and normal weaned calves developed at about the same rate during the feedlot period; however, both groups produced larger scaled carcasses than did the early weaned steers. Finally, the creep fed calves produced about 1.5 percent more total carcass fat than the early weaners, yet the latter had 1.8 percent more carcass fat than the normal weaned steers.

Summary

The research data reported above was obtained from two separate experiments, both of which are segments of a larger experiment, currently in progress, designed to study the growth and development of beef calves during three phases of life; the pre-natal, pre-weaning, and post-weaning feedlot phase.

In the 1st experiment the influence of the nutritional level of the dam, during gestation, on subsequent growth and development of their calves was investigated. Results indicate that the nutritional level of the dam had a considerable effect on both the pre-weaning and post-weaning feedlot performance of their calves. Calves from the well-nourished dams were heavier at birth, at weaning and at the conclusions of the feedlot

period than those from the poorly-nourished dams. Calves from the high level dams produced heavier, larger scaled carcasses, required less time in the feedlot and were more efficient converters of feed than were the low level calves.

In the second experiment, the influence of pre-weaning plane of nutrition on the pre- and post-weaning performance of beef calves was studied. Results indicate that, while calves limited in nutrient intake early in life tend to compensate for this restriction by making rapid and efficient gains when returned to full feed, they would require a considerably longer feedlot period to fully compensate for the initial advantage obtained by calves full fed early in life. Carcasses from the creep fed calves were larger, had more ribeye area, less external fat cover, and graded higher than those from the early weaned calves.

Improving the Utilization of Milo for Fattening Calves: The Effect of Various Supplements[1]

Curtis W. Absher, Robert Totusek, Robert E. Renbarger and Eldon C. Nelson

Previous research at the Oklahoma Station has been directed toward improving the efficiency of milo (sorghum grain) for fattening calves, and a considerable amount of additional work is now in progress. Milo, on a chemical basis, appears to be equal in value to corn. However, feedlot comparisons in the Southwest have consistently shown milo to be 10 to 20 percent less efficient than corn. Even so, milo makes up a large portion of cattle fattening rations in Oklahoma and much of the Southwest because of its relative price advantage over other feeds. Therefore, any changes in milo rations that will improve milo utilization and feed efficiency will add considerably to the income derived from the feeding of milo to beef cattle.

Much of the previous work at the Oklahoma Station was concerned with the physical preparation of the milo grain. This appears a logical place to start to improve milo utilization because of the hard, flinty outer portion of the milo kernal. Although some improvement in milo utiilzation can be made through processing methods (see Feeders' Day Reports for 1964 and earlier years) milo is still inferior to corn in feed efficiency.

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[1] The urea used in this study was generously provided through the courtesy of Dr. L. E. Craig, John Deere Chemical Company, Tulsa, Oklahoma.

The two trials reported herein are of an exploratory nature and were designed to study the effect of various supplements and combinations of supplements on milo rations. Since the protein of milo is rather low in solubility (48 percent compared to 79 percent for corn in a recent comparison), it would seem logical to assume that a readily soluble protein might enhance milo utilization. Several protein supplements and a protein substitute which differ considerably in solubility were compared to cottonseed meal in these trials. Urea (a protein substitute) is very soluble, while soybean meal is more soluble, and fish meal is less soluble than cottonseed meal.

One of the consistent differences in chemical composition between corn and milo is in fat (ether extract) content, with corn averaging about 1 percent higher. The influence of 1 percent corn oil added to a milo ration was determined. The effect of adding a complex supplement containing 11 vitamins and 6 trace minerals to a milo ration which contained urea and corn oil, and of adding copper to a urea-containing milo ration, was also determined.

Trial 1 (Winter 1963-1964)

Materials and Methods

Eighty weanling Hereford steer calves with an average weight of 540 lbs. were obtained from the herds at the Fort Reno Livestock Research Station. The calves were divided on the basis of sire and weight into heavy and a light groups which averaged 582 and 498 lbs., respectively. Four calves by each of 10 sires in each weight group were randomly assigned to four treatment groups, making a total of 8 treatment groups or pens with 10 calves per pen.

The calves were all allowed access to the same ration for 28 days to allow them to adjust to the new environment and to become accustomed to self feeders. The starter ration contained 60 percent concentrates and 40 percent roughage. The feeding trial lasted 168 days, from November 6, 1963 to April 22, 1964. Two weights were taken of each steer after 16 hours without feed or water at the beginning and end of the experimental period and the average weights were used as the on-feed and off-feed weights.

The feeding trial was divided into three periods of 56 days each. Rations fed during the initial period contained 30 percent cottonseed hulls and 10 percent chopped alfalfa. The level of cottonseed hulls was reduced to 20 and 10 percent during the 2 subsequent periods, resulting in a 20 percent roughage ration during the finishing period. Milo was increased as cottonseed hulls were decreased, with adjustments in levels of cottonseed meal as necessary to keep the rations isonitrogenous (equal in crude protein). All other ration ingredients remained constant throughout the feeding trial. Salt was fed at a higher-than-usual level of 1 percent, and ammonium chloride was added at a level of 0.5 percent during the latter part of the feeding trial, in an attempt to minimize the incidence of urinary calculi. The rations were formulated to contain 12 percent crude protein and an analysis of samples of the rations indicated they contained approximately that amount.

Table 1 gives the composition of the four experimental rations for the final period. Ration A, the control ration, contained cottonseed meal as the supplemental protein source. Urea replaced cottonseed meal in Ration B, C, and D. Corn oil, at a level of 1 percent, was added to Rations C and D. All vitamins believed to be required by simple stomached animals, with the exception of vitamin A which was added to all rations, and 6 trace minerals were added to Ration D.

Three calves were lost from the trial, one due to urinary calculi, one due to chronic bloat, and one due to death from an unknown cause. This resulted in three incomplete sire groups. In order to maintain balance in the trial and to prevent biasing the results, the data from the remaining calves of the 3 incomplete sire groups were not included in the comparisons involving rate of gain and carcass traits. The feed efficiency comparisons necessarily included data from all calves. The experimental design, with numbers of calves involved in the rate of gain and carcass comparisons, is given in Table 2.

Table 1. Percentage Composition of Rations

Ration	A	B	C	D
Treatment	Cottonseed Meal	Urea	Urea Corn Oil	Urea Corn Oil Vitamins Trace Minerals
	%	%	%	%
Milo (finely ground)	65.5	72.5	71.25	70.25
Cottonseed meal	8.0	---	.25	.5
Cottonseed hulls	10.0	10.0	10.0	10.0
Alfalfa meal	10.0	10.0	10.0	10.0
Molasses	5.0	5.0	5.0	5.0
Bone meal	.5	.5	.5	.5
Salt (NaCl)	1.0	1.0	1.0	1.0
Urea	---	1.0	1.0	1.0
Corn oil	---	---	1.0	1.0
Vitamin mix[1]	---	---	---	.75
	100.0	100.0	100.0	100.0
Trace minerals[2]				½ #/ton
Vitamin A supplement[3]	+	+	+	+
Aureomycin[4]	+	+	+	+

[1] Vitamin mix (per lb. of ration): Vitamin D, 100 I.U.; Vitamin E, 3 mg.; Vitamin K, 0.2 mg.; thiamine, 0.8 mg.; riboflavin, 0.8 mg.; panthothenic acid, 4.0 mg.; niacin, 5.0 mg.; pyridoxine, 1.0 mg.; biotin, .04 mg.; choline, 600 mg.; folacin, .25 mg.; Vitamin B_{12}, .004 mg.

[2] Trace minerals (per lb. of ration): Manganese, 4 mg.; iodine, 10 mcg.; copper, 1.5 mg.; zinc, 20 mg.; cobalt, .04 mg.; iron, 5 mg.

[3] Vitamin A was added to all rations at a level of 1500 I.U. per lb. of feed.

[4] Aureomycin was added to all rations at a level to result in an intake of approximately 75 mg. per calf daily during the latter part of the fattening period.

Table 2. Experimental Design

Ration	A		B		C		D Urea Corn Oil Vitamin-Trace Mineral Mix	
Treatment	Cottonseed Meal		Urea		Urea Corn Oil			
Pen numbers	1	5	2	6	3	7	4	8
No. calves per pen[1]	7	7	7	7	7	7	7	7
Ave. initial wt., lbs.	509	588	500	568	497	591	486	584
No. calves per treatment[1]	14		14		14		14	
Ave. initial wt., lbs.	549		534		544		535	

[1] Indicates number of calves which completed test in complete sire groups and which were included in data obtained from individual steers. Since calves were group fed by pens, all calves (77 completed the feeding trial) are necessarily represented in the feed data.

At the conclusion of the feeding trial the cattle were shipped to Arkansas City, Kansas, and slaughtered. Carcass information was obtained after a 48 hour chill.

Results and Discussion

The results of the feedlot and carcass phases of the experiment are tabulated in Tables 3 and 4, respectively. The steers on the control ration gained significantly faster than those on all other treatments. It appears that the addition of 1 percent urea to the ration depressed gain and that the addition of 1 percent corn oil alone did not overcome the detrimental effect of the urea. However, the addition of the vitamin-trace mineral mix plus 1 percent corn oil did overcome much of the depressing effect of urea. The difference in gain in favor of the corn oil-vitamin-trace mineral addition compared to urea alone is statistically significant, which indicates the difference is a real one. These results suggest that the milo-urea ration used in this experiment was deficient in nutrients contained in corn oil and/or the vitamin-trace mineral mix, even though the ration contained alfalfa, molasses and bonemeal.

The efficiency of feed conversion follows much the same pattern as rate of gain. Essentially the same amounts of the control ration (Ration A) and the ration containing corn oil, vitamins and trace minerals (Ration D) were required to produce 100 lbs. of gain, while slightly more of the other two rations (B and C) was required. Although differences are small and not statistically significant, the urea containing ration (Ration B) was the least efficient of the four.

Differences are noticeably small in all comparisons of the slaughter and carcass information. The quality grades and back fat averages followed the same pattern as the average daily gains. As expected, the average quality grade was lowest for carcass from the slowest gaining cattle. Similarly, carcasses from the fastest gaining cattle (control group) had the most fat around the rib eye, which significantly reduced the trimmed retail cut yield for this group. Differences in average dressing percentage are small and fail to follow any logical pattern, although the advantage of cattle on Ration C compared to Rations A and B is statistically significant.

Table 3. Feedlot Performance

Ration Treatment	A Cottonseed Meal	B Urea	C Urea Corn Oil	D Urea Corn Oil Vitamin-Trace Mineral Mix
No. calves initially	20	20	20	20
No. calves completed trial	20	20	18	19
Ave. initial wt., lb.	549	534	544	535
Ave. final wt., lbs.	965	892	915	926
Ave. daily gain, lbs.[1]	2.48BCD[3]	2.14	2.21	2.32B[3]
Ave. daily feed intake[2]	21.2	19.5	19.9	20.0
Feed per cwt. gain, lbs.[2]	864	886	873	862

[1] Only data from calves which completed test in complete sire groups were included in gain average.
[2] Since calves were group fed by pens, all calves completing trial (77) are necessarily represented in feed data.
[3] Significantly greater than treatments indicated ($P < .05$) according to Duncan's New Multiple-range Test.

Table 4. Slaughter and Carcass Information

Ration Treatment	A Cottonseed Meal	B Urea	C Urea Corn Oil	D Urea Corn Oil Vitamin-Trace Mineral Mix
Dressing %[1]	61.7	61.6	62.6AB[2]	62.0
Quality grade[3]	8.6	7.9	8.4	8.6
Rib eye area, sq. in.[4]	10.2	10.1	10.2	10 5
Fat over rib eye, in.[5]	.75	.60	.66	.62
Trimmed retail cut yield (% carcass wt.)[6]	47.3BCD[2]	49.1ACD[2]	48.4ABD[2]	48.6ABC[2]
Trimmed retail cut yield (% live wt.)[7]	29.2	30.3A[2]	30.3A[2]	30.1A[2]

[1] Calculated on basis of shrunk Ft. Reno live weight and chilled carcass weight.
[2] Significantly different than treatments indicated ($P < .05$) according to Duncan's New Multiple-range Test.
[3] USDA 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.
[4] Determined by measurement of tracings of ribeye.
[5] Average of three measurements determined on tracings of the ribeye.
[6] 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) − .0098 (carcass weight
[7] Trimmed retail cut yield as determined in footnote 6 multiplied by dressing %.

Decisions as to the value of using urea, corn oil, and a vitamin-trace mineral mix must be based on reasonable cost-return estimates. Table 5 contains cost-return estimates based on current feed and beef carcass prices. The value of 100 lbs. of gain was derived by adjusting current carcass prices in accordance with the average quality grade observed on each ration and multiplying by the dressing percent. The difference between the feed cost and value of 100 lbs. of gain represents the feeding-margin for each ration in this experiment under present price conditions.

Cost-return estimates were calculated two ways for Rations C and D. In one case the actual cost of corn oil was used. Since the response from feeding corn oil was small and probably represents its energy value rather than any nutritional factors peculiar to corn oil, the market cost of feed grade animal fat was used in the second cost estimate of the corn oil-containing rations.

Although the differences are small the urea containing rations with or without corn oil (B and C) produced the most favorable feeding margins in this trial (using cost of animal fat). The difference in the costs of Rations A and B is essentially the difference between the price of eight pounds of cottonsed meal and the combined price of seven lbs. of milo and one lb. of urea. The additional energy from corn oil improved the feeding margin by only $0.27 per cwt., while the addition of the vitamin-trace mineral mix decreased the feeding margin considerably regardless of the price of fat used. The margins for both Rations C and D are noticeably reduced when the actual cost of corn oil is used.

The fact that the complex supplement apparently improved rate of gain of calves on a milo-urea ration points out the need for additional research to identify the responsible nutrients and/or find supplements (protein or otherwise) which are cheaper sources of the needed nutrients than the supplements used in this experiment.

Table 5. Cost—Return Estimates and Feeding Margins

Ration	A	B	C	D
Treatment	Cottonseed Meal	Urea	Urea Corn Oil	Urea Corn Oil Vitamin-Trace Mineral Mix
Cost/cwt. feed[1]	$ 2.22	$ 2.07	$ 2.34[3] 2.13[4]	$ 2.57[3] 2.35[4]
Value/cwt. gain[2]	21.20	20.91	21.43	21.30
Feed cost/cwt. gain	19.18	18.34	20.43[3] 18.59[4]	22.15[3] 20.26[4]
Feeding margin/cwt. gain	2.02	2.57	1.00[3] 2.84[4]	0.85[3] 1.04[4]

[1] Feed prices: Ground milo, $2.25/cwt.; cottonseed meal, $4.50/cwt.; alfalfa meal, $1.85/cwt.; molasses, $1.27/cwt.; urea, $5,20/cwt.; cottonseed hulls, $20.00/ton; salt, $1.30/cwt.; bonemeal $5.60/cwt.; feed grade animal fat, $6.50/cwt.; corn oil, $2.05/gal. or $28.00/cwt.; trace mineral mix, $11.00/cwt; vitamin mix, $34.00/cwt.

[2] Based on prices of $34.00 for U.S. Good and $36.00 per cwt. for U.S. Choice carcass. The carcass values by treatment were: A, $34.36/cwt.; B, $33.94/cwt.; D, $34.35/cwt.

[3] Based on actual cost of corn oil

[4] Based on cost of feed-grade animal fat.

Another factor that should be considered is the spread in beef prices between grades since some depression in carcass grade can be expected when urea is used. In a situation of wide price spread between grades, the savings made on feed cost could be lost with a lower selling price for the cattle.

Trial 2 (Summer 1964)

Materials and Methods

Twelve pairs of twin calves were used in a series of pilot studies during the summer and early fall of 1964. The twins were selected on the basis of visual appraisal for maximum similarity in size, structure, shape of head and legs, and color pattern. Note the similarity in initial weight within twin pairs (Table 8).

The rations used are given in Table 6. All of the rations contained high levels of milo. Experimental differences in the rations are in the supplemental fraction, with nitrogen from different sources, and in one case, supplemental copper in a urea ration. The composition and nitrogen solubility of protein supplements are given in Table 7. Three pairs of twins were assigned to each of the following comparisons: Cottonseed meal vs. cottonseed meal + urea (Rations 1 vs. 2), cottonseed meal vs. fish meal (Rations 1 vs. 3), cottonseed meal vs. soybean meal (Rations 1 vs. 4), and urea vs. urea + copper (Rations 5 vs. 6).

Table 6. Percent Composition of Rations (Identical Twin Pilot Trials)[1]

	1 Cottonseed Meal	2 Cottonseed Meal + Urea	3 Fish Meal	4 Soybean Meal	5 Urea[2]	6 Urea+ Copper[3]
Milo (finely ground)	68.5	67.5	73.5	70.5	76.75	
Cottonseed hulls	10.0	10.0	10.0	10.0	10.0	
alfalfa pellets (17%)	10.0	10.0	10.0	10.0	10.0	
Dehydrated						
Salt	1.0	1.0	1.0	1.0	1.0	
Dicalcium phosphate	----	----	----	----	.75	
Deflourinated phosphate	.5	.5	.1	.5	-----	
Monsodium phosphate	----	----	.1	.1	-----	
Cottonseed meal ("old process")	10.0	10.0	----	----	-----	
Urea	----	1.0	----	----	1.5	
Fish meal (70%)	----	----	5.3	----	-----	
Soybean meal (50%)	----	----	----	7.9	-----	
Total	100.0	100.0	100.0	100.0	100.0	

[1] All rations contained an antiodidant, santoquin, and supplemental vitamin A to furnish 1,020 I.U. per lb. of feed.
[2] Ration 5 calculated to contain 13 ppm. copper.
[3] Cupric carbonate added to ration 6 at rate of 27.5 gm./ton. Resulting copper level estimated to be 30 ppm.

Table 7. Chemical Composition of Protein Supplements (%)

Supplement	Dry Matter	Crude Protein	Crude Fiber	N-Free Extract	Ether Extract	Ash	Ca	P	Nitrogen Solubility
Fish meal	92.89	77.7	0.4	0.2	9.2	12.5	2.81	2.13	28.5
Cottonseed meal	92.06	43.9	10.3	35.2	3.6	7.0	0.24	1.02	42.8
Soybean meal	92.13	50.9	7.4	31.4	2.4	8.1	0.49	0.69	73.6

In the case of each comparison, one calf of each pair of twins was assigned to a control ration, the other calf of the same pair to the test ration. The twins were randomly assigned to treatments and the individuals were positively identified with flexible plastic ear tags. They were individually fed in stanchion-type feeders twice daily. Approximately one hour was allowed for the calves to eat their feed before they were turned together in a paved lot with free access to water. Each member of a pair received the same amount of feed.

The feed was weighed at each feeding with the amount being regulated by the calf with the less vigorous appetite. Refused feed was not weighed back, but was re-fed the following feeding and the amount of new feed given was adjusted accordingly. An effort was made to feed no more than would be consumed to prevent accumulation of spoiled feed. Initial and final weights were taken after 18 hours without feed or water.

Results and Discussion

Feedlot performance of the twins is shown in Table 8. It will be noted that the average daily gains are generally low. This can be attributed to some degree to the size of the cattle involved but is primarily due to individual feeding in stanchions.

The addition of 1 percent urea to a milo ration containing cottonseed meal did not significantly improve rate of gain and feed efficiency (Rations 1 vs. 2). Apparently a readily soluble source of nitrogen such as urea does not improve the utilization of milo, which contains a slowly soluble protein, when added to a ration containing adequate supplemental protein from cottonseed meal.

Fish meal as the source of supplemental protein resulted in an increase of 21 percent in rate of gain and an improvement in feed efficiency of 16 percent compared to the cottonseed meal ration (Rations 1 vs. 3). It is interesting to note that the protein in fish meal is of low solubility. Perhaps fish meal supplies nutrients which are deficient in milo. Additional research on fish meal in milo rations is now in progress.

There was very little difference in performance of calves fed soybean meal vs. cottonseed meal as the supplemental protein (Rations 1

Table 8. Feedlot Performance (Identical Twin Pilot Trials)

Ration	Item: Comparison	No. Pairs of Twins	Days on Feed	Ave. Initial Wt., Lb.	Ave. Daily Gain, Lb.	Feed Per Cwt. Gain
1	Cottonseed Meal			395	1.41	735
	vs.	3	90			
2	Cottonseed meal + Urea			403	1.40	770
1	Cottonseed Meal			314	1.49	625
	vs.	3	95			
3	Fish Meal			306	1.80	526[1]
1	Cottonseed Meal			409	1.46	682
	vs.	3	95			
4	Soybean Meal			417	1.42	702
5	Urea			313	.84	890
	vs.	3	130			
6	Urea + Copper			314	1.00	735

[1] Significantly more efficient ($P < .05$) by use of Student's "T" test.

vs. 4). Soybean meal is usually considered to be a superior supplement for fattening rations, and contains a protein which is very readily soluble.

The addition of 17 ppm copper to a ration containing 1.5 percent urea as supplemental nitrogen improved rate of gain 19 percent and improved feed efficiency 17 percent (Rations 5 vs. 6). It has been theorized that the enzyme urease breaks down urea so rapidly that the nitrogen escapes in the form of ammonia before it can be incorporated into protein. It has been postulated that copper might inhibit the action of urease and thus improve urea utilization. How added copper functioned to improve performance in this trial is not known. Although all calves were drenched with phenothiazine before the feeding trial started, it is possible that copper functioned as an anthelmintic and thereby improved performance by reducing infestation of internal parasites.

Use of high levels of copper in the ration cannot be recommended at this time. Copper stores in the liver are increased, and since high levels of copper can be toxic to humans, such livers could be unfit for human consumption.

Summary

Group feeding trials with milo rations for fattening calves showed that:

(1) Replacement of cottonseed meal with urea resulted in a decreased rate of gain but decreased the feed cost of gain and improved the feeding margin.

(2) The addition of corn oil to a milo-urea ration did not greatly improve performance, but a complex vitamin-trace mineral plus corn oil improved the rate of gain of calves on a milo-urea ration.

Pilot trials with individually-fed identical twin calves fed high milo rations indicated that:

(1) Neither the addition of urea to a cottonseed meal ration nor the replacement of cottonseed meal with soybean meal was of benefit.

(2) Either the replacement of cottonseed meal with fish meal or the addition of copper to a urea ration improved rate and efficiency of gain.

The Relationship Of Animal Age To Lean, Fat And Bone In The Beef Carcass

R. L. Henrickson and R. L. Monroe

Previous beef carcass investigations pertaining to body composition have used animals that include a variation in age, breed, sex, grade, etc. Carcass studies have demonstrated the wide variation in fat composition from animals on a fattening ration. However, age and breed also have caused marked differences in carcass composition.

In general, many beef carcasses today carry more fat, both external and internal, than is desired by the consuming public. Recognition by those in human nutrition and the medical profession that excessive amounts of fat may be harmful to the human body, has caused widespread interest in the fat problem. The role of animal fat in the diet has not been clearly delineated; however, it does appear that less fat is required than was formerly provided in good quality meat. Since removal of excess fat is one of the major problems confronting the beef industry, it is appropriate to determine tissue development during the growth period.

Procedure

Thirty-six Hereford heifers were used to investigate the effect of advancing age on the changes in carcass tissues. The heifers at six months of age were randomly assigned to six age groups. During the period from 6 months until the first group was slaughtered, the calves nursed their dams and had free access to a creep feeder.

The first group was slaughtered when the animals averaged 9 months of age. Carcass measurements and tissue quantities at this age were used as the basis for calculating subsequent changes. The remaining animals were group-fed a fattening ration consisting of shelled corn, cottonseed meal and hulls, alfalfa hay and molasses until the assigned slaughter age was reached (12, 15, 18, 21 and 24 months). Slaughtering and chilling were done in accordance with standard research procedures. The tissues were physically separated with a knife. The lean was analyzed for fat content so as to express the data as "fat free lean."

Results

While it has taken many years to develop beef cattle with the capability of storing large amounts of fat, it will be necessary to bring about more lean development in a short period.

While breed, blood line and level of nutrition are of fundamental importance, sex, exercise and other factors may also influence the quantity of fat or muscle in a carcass. The main factor considered in this investigation was animal age.

It is evident from information in Table 1 that the slaughter weight of the cattle at 9 months of age may be considered average. The calves were from cows that had been on a low level of nutrition. Consequently, the calves received little milk and growth was delayed until they learned to eat the creep fed ration. This would point up the fact that many lightweight calves may be 9 to 12 months of age because of a restricted diet. Since these animals were not on a forced diet during their early growth period, these data should be interpreted to be less than the maximum amount of muscle and fat which would occur.

Carcass weight, as reflected by the weight of one side, is also a poor indication of production or production efficiency (Table 1). The side

Table 1. Influence of Animal Age on the Quantity of Lean Based on a Complete Physical Separation of One Side[1]

Slaughter Age (mo.)	9	12	15	18	21	24
Slaughter wt. (lb.)	451.8	519.7	712.2	844.3	1083.3	1183.6
Side wt. (lb.)	127.9	150.5	220.2	273.0	332.8	389.4
Rib eye area (sq. in.)	5.9	6.5	8.4	9.2	10.7	12.3
Muscle wt. (lb.)[2]	70.6	80.5	103.7	122.1	125.9	143.5
Muscle %	55.7	53.1	47.3	45.9	41.0	42.1
Muscle-Bone ratio	2.9	3.0	2.5	2.7	2.2	2.5
Muscle fiber dia. (u)[3]	44.1	46.7	52.8	54.5	61.5	66.9
Muscle fiber area (sq. u)[4]	1533.1	1723.5	2202.7	2357.2	2940.9	3512.3

[1]The left side of each carcass was used.
[2]Muscle is reported as fat free.
[3]Rib eye muscle.
[4]Cross-sectional area.

weight increased threefold during the 15 month period from 9 to 24 months. However, the actual lean as measured by the rib area or total fat-free lean only doubled during this same growth period. Previous work has shown that age, up to 12 months, has a great effect upon muscle weight distribution. Considerable change in muscle weight associated with age accrued between birth and 9 months of age. It is interesting to note that rib eye area does closely parallel total muscle weight during the period from 9 to 24 months. This is as would be expected since the muscle groups surrounding the vertebra develop at a rate similar to muscle as a whole in the carcass. The remaining weight difference is that of fat and bone.

Percent lean in the side decreased by 13.6 percent during the growth period. It is readily obvious that percent lean in the side or carcass does not reflect a true measure of growth. This reduction in percent lean is the result of rapid fat deposition.

Muscle-bone relationships are of some use in interpreting the value of production. Previous work has shown that the muscle-to-bone ratio increases with age up to 12 months. The findings in this investigation further show a decrease in muscle-bone ratio as fat becomes a confounding factor.

Major changes in muscle fiber size occur with advances in age. At 9 months of age the cross-sectional fiber area was 1533.1 square microns, whereas at 24 months the area had increased to 3512.3 square microns (Table 1). Thus, more than a doubling of fiber area accrued during this 15 month period. Muscle weight also doubled during this period. The increase in cross-sectional fiber area may account for the change in total muscle weight.

Changes in fat and bone deposition during the fattening period are presented in Table 2. At 9 months of age, only a trace of marbling was observed. At 24 months the amount increased to "moderately abundant." There would appear to be some direct correlation between the quantity of marbling and outside fat cover. However, other work has shown that marbling may be present without excessive outside fat cover. These data reflect a five-fold increase in fat weight as the animal matures from 9 to 24 months. The percentage of fat increased from 25.0 to 43.1 Bone weight increased with animal age while the percentage of bone decreased. This was primarily influenced by the great quantities of fat which are deposited during the fattening period.

Specific gravity has been considered a measure which would reflect the level of fatness. It is evident from the data in Table 2 that the fatter carcass will have a lower specific gravity. Similar values were obtained when the specific gravity data from one side is compared with those from both sides. Thus it becomes obvious that only one side of the carcass would need to be subjected to the specific gravity treatment to gain a measure of carcass fat.

Table 2. Changes in Fat, Lean and Specific Gravity as Influenced by Animal Age

Slaughter Age (mo.)	9	12	15	18	21	24
Marbling	Traces	Traces	Sm.Amt.	Sm.Amt.	Modest	M.Abundant
Fat thickness (in.)	0.2	0.4	0.6	0.9	1.0	1.4
Fat wt. (lb.)	32.5	43.8	74.9	102.3	137.7	168.6
Fat (%)	25.0	28.9	33.8	37.3	41.4	43.1
Bone wt. (lb.)	24.5	26.9	41.3	45.8	58.7	58.1
Bone (%)	19.3	18.1	18.7	17.0	17.7	14.8
Specific gravity (side	1.0702	1.0667	1.0563	1.0462	1.0292	1.0258
Specific gravity (carcass)[1]	1.0686	1.0658	1.0567	1.0455	1.0296	1.0249

[1]Both sides of the carcass were used.

Summary

Hereford heifers were used to reflect the changes in major tissue development from 9 to 24 months of age. Muscle weight from one side increased from 70.6 to 143.5 pounds, similar growth change was reflected by rib eye area measurements which increased from 5.9 to 12.3 square inches. The percent muscle in the side did not appear to be a good measure of carcass value since percent lean is inversely related to the quantity of fat. The muscle-bone ratio appeared to increase up to 12 months but further advancements in age resulted in a reduction. This was considered to be caused by the rapid increase of fat. Cross-sectional muscle fiber area increased with animal age and tended to reflect a direct relationship to total fat-free lean.

This investigation indicates the need for additional work on the development of muscle as affected by age, breeding and/or nutrition. The production factors must be studied from the standpoint of their effect upon muscle systems as a distinct entity, rather than wholesale, or retail cuts.

Fat in a choice carcass is generally abundant. Fat thickness at the 12th rib area provided a rapid means for determining differences in carcass fat. Specific gravity of one side was nearly as good as when both sides were used to measure fat difference.

Improving Overall Feed Efficiency In Swine Production

J. C. Hillier

The cost of feed constitutes the largest single expense in producing pork, making up 70 to 80 percent of the total cost. Thus, improvements in overall feed efficiency can amount to very important savings. It is hoped that the information presented will serve two useful purposes. First to serve as a general guide in the organization of a modern swine production operation and second to bring attention to possible areas of improvement in existing swine operations.

To start the discussion one might ask, "How would you go about producing market hogs with an overall feed efficiency of 4.0:1?" That is 4.0 pounds of feed used in the entire operation for each pound of live hog marketed. This level of efficiency is possible today even though many herds are probably operating at an efficiency between 5.00 and 6.00:1.

In brief, these things would be required:

1. Nutritionally adequate rations for all stages of the life cycle.
2. Superior breeding stock—particularly from the standpoints of litter size and efficiency of gain.
3. Adequate housing and environmental control.
4. A sound herd health and sanitation program.
5. High reproductive efficiency in the sow herd.
6. The culling of non-productive sows as quickly as possible.
7. Minimum death loss at any age.
8. Marketing at weights not to exceed 220 pounds.
9. Eliminating feed wastage.

Feed efficiency during the growing-finishing stages has been emphasized for many years and considerable improvement has been made in this regard. However, there are many other areas, or segments, in the total pork production operation that have been given inadequate attention. For convenience in this discussion I have chosen to divide the complete production cycle into five periods, namely (1) pre-breeding, (2) breeding and gestation, (3) farrowing and lactation, (4) starting (5) growing and finishing. The possibilities for improving overall feed efficiency in each of these areas will be discussed.

Pre-breeding

It is common to select gilts at a weight of about 200 pounds as replacements for the breeding herd. Such gilts will average around 160-170 days of age. They are commonly bred at eight months or 240 days of age. This gives a pre-breeding period of 70-80 days. During this time the gilt will have consumed 350-385 pounds of feed (see Table 1, Feed Budget—Basic Considerations). She should gain 80-90 pounds during

Table 1. Swine Production—Feed Budget—Basic Considerations—Feed Allowances and Weight Changes (Estimated)

	Age in Days		Days in	Weight Changes			Feed Consumption	
	Start	Finish	Period	Start	Finish	Gain or Loss	Feed per Day	Total Feed
	Days	Days	Days	Pounds	Pounds	Pounds	Pounds	Pounds
Pre-breeding	170	240	70	200	290	90	5.5	385
Gestation No. 1	240	360	120	290	410	120	5.5	660
Lactation No. 1	360	402	42	410	360	—50	11.0	462
Recovery Period No. 1	402	427	25	360	390	30	7.0	175
Gestation No. 2	427	547	120	390	510	120	6.0	720
Lactation No. 2	547	589	42	510	470	—40	11.5	483
Recovery Period No. 2	589	614	25	470	520[1]	60	10.0	250
Summary	170	614	440	200	520	320		3135

[1]Sows smoothed up ready for market.
The above are estimates of the amounts of feed consumed by the breeding herd during each phase of a program in which sows are kept for two litters and then sold for slaughter.

this period. This is about as well as one can hope to do during this period. If daily feed intake is reduced, gain will be reduced sharply. Also, there is good evidence to indicate that ovulation rate would be reduced by reducing the feed intake, particularly just prior to breeding.

How important is it that gilts be eight months old when bred? Is this much time necessary for satisfactory sexual development? Good experimental evidence on the reproductive performance of gilts bred at various ages is not available. However, by drawing from research records, we find that most gilts are coming in heat regularly at 180-200 days of age. If bred when 240 days of age most of them will be in their third or fourth heat period.

Research data indicate that ovulations increase by about 2.5 ova from the first to the third heat. About 115 pounds of ration is required to carry a gilt from one heat period to the next. It appears that no great advantage is to be gained by breeding at second heat as compared to waiting to breed on the third heat. Under good management, breeding on second heat might tend to save a small amount of feed per pig raised as compared to breeding on third heat. However, allowing gilts to pass the third and subsequent heat periods unmated, could be an important factor influencing overall feed efficiency.

A sow or gilt will require about the same quantity of feed during gestation whether she farrows a litter of 5 or 12, therefore the use of highly productive breeding stock is very important to overall feed efficiency. However, having "good breeding stock" does not in itself insure high reproductive performance. Providing good management and satisfactory environmental conditions are equally as important in securing large litters of husky pigs.

The combined effect of litter size is shown in Table 2, columns 1 and 2. Column 1 indicates the number of pigs produced for each female maintained in the herd per year (two farrowings). A good average would be 14 or 15 pigs per sow kept in the herd per year. Figures in column 2 indicate that 215 to 230 pounds of feed consumed by the breeding herd would be invested in each weanling pig at this level of sow productivity. Many producers are inclined to give little concern to the loss of pigs at farrowing. The facts are that the loss of a pig at farrowing represents a loss of a minimum of 100 pounds and possibly as much as 200 pounds of feed for the breeding herd plus the housing, labor, etc., involved and the loss of an opportunity for profit on the pig itself. If only eight pigs are raised per sow per year the feed consumed by the breeding herd, per pig weaned, amounts to nearly 400 pounds.

Table 2. Estimated Feed Requirements per Head and Per Hundred Pounds Of Market Hog with Varying Sow Productivity and Feed Efficiency

Pigs per sow per two litters (annual) (1)	Feed Consumed Breeding Herd Pounds (2)	Feed Consumed per Head after Weaning at Efficiencies of: (3)				Total Feed Required Per CWT of market Hog at Efficiency of: (4)			
		3.0 lbs.	3.2 lbs.	3 4 lbs.	3.6 lbs.	3.0 lbs.	3.2 lbs.	3.4 lbs.	3.6 lbs.
5	640	1200	1234	1268	1302	558	574	590	607
6	530	1090	1124	1158	1192	507	523	539	558
7	455	1015	1049	1083	1117	472	389	503	520
8	399	959	993	1027	1061	446	462	478	493
9	355	915	949	983	1017	426	441	457	473
10	320	880	914	948	982	409	425	441	457
11	291	851	885	919	953	396	412	427	443
12	268	828	862	896	930	385	401	417	433
13	247	807	841	875	909	375	391	407	423
14	230	790	824	858	892	367	383	399	415
15	215	775	808	843	877	360	376	392	408
16	202	762	796	830	864	354	370	386	402
17	190	750	784	818	852	349	365	380	396
18	180	740	774	808	842	344	360	375	392
19	171	731	765	799	833	340	356	372	389
20	163	723	757	791	825	336	352	368	384

(1) The figures in this column are the numbers of pigs weaned per year per sow in the herd (2 litters), including infertile sows, death losses, etc. Under good management, this figure may range from 12 to 16.

(2) Figures in this column represent the amount of feed consumed by the breeding herd, both sexes, for each pig weaned. Figures show for level of sow productivity from 5 to 20 pigs per year per sow in the herd. The 3135 pounds of feed (Table 1) estimated to carry a gilt through two reproductive cycles and put her in shape to market is divided by the number of pigs shown on each line to obtain these figures. Feed for the boar has been added to this amount at the rate of six pounds per pig with a slight upward adjustment as pigs per sow decreased.

(3) The figures under the heading "Feed Consumed Per Head . . ." were calculated by multiplying the gain made by the pigs after weaning, 170 pounds (215 pounds market weight minus 45 pounds weaning weight = 170 pounds gain) by the proper feed efficiency figure, adding the 50 pounds of starter ration consumed before weaning and the share of the feed consumed by the breeding herd. Example: 170 pounds gain × 3.2 feed efficiency + 50 pounds of starter + 640 pounds of feed for breeding herd equals 1234 of feed required to produce a 215 market hog under these conditions.
Example: 1234 ÷ 215 = 574 pounds of feed per hundred weight of market hog.

(4) These figures are obtained by dividing the feed per head by the market weight of 215 pounds.

Reproductive efficiency is a very important factor in determining overall efficiency.

In rebreeding sows for the second and subsequent litters there is always the question of whether they should be allowed a three weeks "rest period". Again, research data precisely on this point is not available. However, observations and practices followed would indicate that sows weaned 35 days post farrowing, or later, and in strong condition, may be successfully rebred on the first heat following weaning. Here, much depends on the nturitional status of the sows at weaning.

One of the bonuses of adequate nutrition during lactation is early and successful rebreeding. On the other hand, "lactation fatigue" is common among females bred at an early age and rebred for successive litters as rapidly as possible. Such sows, if to be used further, require a rest period of at least three weeks and possibly more. However, in our experience, sows that have been self-fed well balanced rations during lactation, ovulate, breed, and carry subsequent litters satisfactorily when bred on the first heat following weaning at 35 or 42 days. To allow them additional recovery time may be inefficient use of feed. The use of individual sow feeding stalls may be very important at this time. With stalls sows can be fed on an individual basis and assisted materially in recovering from the previous lactation.

Flushing is the practice of increasing the nutrient intake of the female for a short time before breeding, in an effort to increase the number of ova shed. Research on this point indicates that flushing for a period of 10-12 days is as effective as a longer period. An increase from 5.0 to 7.5 pounds per day of a well balanced ration would be considered adequate flushing. This adds up to a total of 25-30 pounds of feed and would be expected to result in 1.5-2.0 more ova shed. This is a wise use of feed, particularly if gilts have been closely restricted during the pregestation period.

Breeding and Gestation

While flushing increases ovulation, continued heavy feeding leads to high embryonic mortality. Thus, the daily feed allowance should be reduced from the flushing level immediately after breeding.

The degree of control of daily feed indicated above can best be accomplished by use of individual sow feeding stalls which permit the feeding of each sow according to her stage in the reproductive cycle and her condition. Such a practice has been followed by European producers for years and is now becoming more common among producers in this country. Table 1 indicates an average daily intake for this period of 5.5 pounds per day as an average on which to base a feed budget. This would allow around 5.0 pounds per day for the first 90 days and above 6.0 for the remainder of the gestation period. Size and growthiness of the females will be a factor to consider, with the larger, faster growing kind taking a little more feed. Conditions of housing and environmental temperature also influence the response obtained from a given feed allowance.

There may be a tendency for some to overfeed during gestation. Such a practice is not only a waste of feed but may actually result in lower productivity. This is particularly true of purebred producers whose customers expect to see herd boars and sows in show condition. If pasture can be used in any phase of a swine production program it would be most effective during the prebreeding and gestation periods.

Farrowing and Lactation

For the period from a few days before farrowing to about one week past farrowing many producers regulate the feed intake in accordance with what they consider to be the needs of the individual sows. For the remainder of the lactation period self-feeding a complete ration is common practice. For most sows with seven pigs or more this is probably the most economical way. They will require all of a well balanced ration they can eat to provide milk for the litter. Most good milking sows will lose weight during this period even when self-fed. Adjusting litter size at birth by transferring pigs among sows less than 12 hours post farrowing is a good practice where facilities make such a practice workable.

The age at weaning or length of the lactation period has a definite bearing on the amount of sow feed consumed during this period. A 56 day lactation period is no longer necessary. Forty-two or thirty-five days, that is 6 or 5 weeks seem to be adequate. Few commercial producers are successful with 3 or 4 weeks weaning. Dropping back from 8 to 6 weeks weaning will reduce the sow feed by about 165 pounds but cause increased consumption of starter ration by about 90 pounds per litter. This will result in a net saving of about 75 pounds of feed per litter. With exceptionally good buildings and equipment and skilled management five week weaning might lead to additional savings in feed.

Starting (up to 60 pounds)

Nutritionally adequate diets, sound herd health program and adequate environmental control are the big features leading to efficient conversion of feed to gain during this period. Palatable, nutritionally adequate diets leading to high daily intake and gain are most important in moving pigs through this critical period. Amino acid levels, antibiotic fortifications, mineral levels and energy values are of importance. Environmental temperature between 60 and 75°F promote maximum performance. The bacterial "load" present in the quarters will also be a factor in performance. Scours, pneumonia and disease problems generally cause more trouble during this period than later. Post weaning death losses from any cause must be avoided.

Self-feeding, completely mixed, well balanced, well fortified rations in a comfortable and clean environment provides greatest efficiency. Cutting corners during this period generally leads to trouble.

Growing-Finishing (60 pounds to market)

If the job has been well done to this point, the rest is simple. Simply supply adequate environmental control, good nutrition and reasonably clean quarters. Completely mixed rations may be slightly more efficient than free-choice feeding but not necessarily more profitable. Moderately fine grinding of grain is to be recommended in either case. Feed wastage during this period is a major problem in some operations. This should not be permitted. It is better that pigs have to "work" a little to get what they want to eat than to waste any. In many operations wastage amounts to 10-15 percent during this period.

Feed requirements per unit of gain increase as pigs become older and heavier. This is because a larger portion of the daily intake is used for maintenance in the heavier pig and each unit of gain represents more stored energy than the previous one. Considering the "overhead" cost of the pig at weaning and efficiency of gains on the individual pig, pork is produced at the lowest feed cost on pigs marketed at a weight between 200-220 pounds, by most producers. Holding pigs beyond this weight results in lowered overall feed efficiency for most producers.

The overall feed efficiency figure, that is the total feed required to produce a pound of live market weight hog, including the cost of feed consumed by the breeding herd, is probably the best single measure of the efficiency of a swine production unit. No portion of the total production program can be very far out of line if the overall feed efficiency is good. Producers using much over four pounds of total feed per pound of hog marketed should examine all phases of the operation to locate the "weak" areas.

In summary, there are many factors in addition to the nutritional adequacy of the rations being fed, which have a strong influence on the pounds of feed required to produce a pound of market hog. Productivity of the sow herd, herd health, death losses at any stage, and environmental factors such as temperature and moisture are all very important.

Injectable Vitamins For Range Beef Cows And Calves[1]

Robert Totusek

There has been much renewed interest in the vitamin A nutrition of beef cattle in recent years. One reason is that synthetically produced vitamin A is now very cheap. Another reason is that several experiments conducted at other experiment stations have indicated a beneficial effect from the addition of vitamin A to beef cattle rations which were considered to be adequate in carotene content.

A considerable amount of earlier research at the Oklahoma Agricultural Experiment Station indicated that vitamin A nutrition was not a serious problem for spring calving cows in normal years. The research showed that the addition of feeds rich in carotene, such as dehydrated alfalfa meal, to a wintering ration of dry range grass and cottonseed meal was without benefit. The beef cow is apparently able to store sufficient quantities of vitamin A while on summer pasture to carry her through the wintering period even when the ration is low in carotene. It is recognized, of course, that deficiencies are much more apt to occur after a summer drouth and in the case of the call calving cow that secretes vitamin A in milk and consequently depletes her body reserves.

Reports of symptoms typical of a vitamin A deficiency are heard quite frequently in the field. It is known that beef cattle are relatively poor convertors of carotene to vitamin A. Synthetic vitamin A is very cheap, as previously mentioned, and is also very easy to administer. It can be provided in the feed, or it can be injected directly into the cow with the assurance that each has received the intended dose of the vitamin. For these reasons it was considered desirable to investigate the value of injectable vitamin A for range beef cows.

The previous research at the Oklahoma Station demonstrated that a ration low in carotene did not produce serious consequences as far as the beef cow is concerned. However, it was observed that calves born to cows subsisting on a vitamin A deficient ration, although normal at birth, very quickly developed symptoms characteristic of a vitamin A deficiency, such as scouring and watering of the eyes. Consequently, it was also considered desirable to investigate the value of injecting a vitamin preparation into calves at birth.

Experiment 1. Injectable Vitamin A for Range Beef Cows

Procedure

A total of 155 Angus cows, 2, 3 and 4 years of age, were used in this study. Seventy-seven of the cows received no vitamin A and 78 received an intra-ruminal injection of vitamin A. The cows used in this experi-

[1] The vitamin A used in this study was generously provided through the courtesy of Dr. Jess N. Henson, Commercial Solvents Corp., Terre Haute, Indiana.

ment were also used to progeny test Angus bulls in the beef cattle breeding project. The cows were allotted to the vitamin A experiment in equal numbers by sires so that the vitamin A experiment would not confound the results of the progeny test. By the same token, since the sire of each expected calf was known, it was possible to inject one half of the cows bred to each bull and thereby reduce variation among the calves due to sire.

The cows were wintered on dry native range and were fed an average of 2½ lbs. of cottonseed cake from November 10 to April 20. An average of approximately 10 lbs. per head daily of prairie hay was fed from February 10 to April 10. All cows had access to a mineral mixture of equal parts of salt and dicalcium phosphate.

Vitamin A was injected on January 31 and the cows started calving in early February. Almost all of the cows calved within a 90 day period in February, March and April. Rebreeding of the cows was started on May 8. One million international units of vitamin A was administered per cow. The vitamin A was injected directly into the rumen at a point approximately midway between the last rib and the hip bone with a 4-inch 16-gauge needle. The cows were injected while crowded into a chute and were not restrained in a head gate or a squeeze chute. Information was obtained on weight of cows and calves and subsequent conception rate and rebreeding performance of the cows as measured by calving date the following year.

Results and Discussion

A summary of results showing the influence of injected vitamin A on beef cows and their calves in each of the three age groups is given in Table 1. An overall summary comparing all untreated cows with all

Table 1. Effects of Vitamin A Injected into Cows Before Calving, By Age and Treatment

	Age of cows, yrs.					
	2		3		4	
Vitamin A	No	Yes[1]	No	Yes[1]	No	Yes[1]
No. cows	21	21	23	24	33	33
Av. wt. cows 1-31-63, lb.	776	792	886	850	935	947
Av. wt. cows 5-7-63, lb.	708	724	822	805	847	847
Wt. change, lb.	—68	—68	—64	—45	—88	—100
No. calves born	20	21	23	23	30	31
No. calves at 112 days	17	20	21	21	28	30
Wt. calves at 112 days, lb.[2]	193	204	203	215	230	249
Date cows calved following year, March	19	21	9	10	1	1
No. cows open following year	6	4	2	0	7	5

[1] One million I.U. vitamin A injected into rumen 1-31-63.
[2] Average of steers and heifers

injected cows is shown in Table 2. Vitamin A apparently had no influence on the spring weight of the cows. The 3-year-old cows which were injected with vitamin A lost slightly less weight from the time of injection in late January to spring weighing but the reverse was true in the case of the 4-year-old cows, and the differences in weight changes were not large enough to be significant.

The number of calves born in each group of cows is shown but is not a reflection of winter treatments. All of the cows used in the experiment were pregnancy checked and believed pregnant when allotted to winter groups. The vitamin A was injected immediately before the cows started calving and, consequently, could not have influenced the number of calves born. The number of calves surviving to 112 days of age, slightly in favor of the cows injected with vitamin A, was not believed to be due to the vitamin treatment of the cows (see Footnotes 2 and 3 in Table 2) because some of the calf losses were of an accidental nature.

Calves out of the vitamin A treated cows were heavier at 112 days than those out of the untreated cows in all three comparisons. The advantages in weight were 11, 12 and 19 pounds for the 2, 3 and 4-year-old cows, respectively. The overall average advantage in weight of calves at 112 days was 14 pounds for vitamin A treated cows. The reason for this difference in weight is not apparent. The cows showed no symptoms of a vitamin A deficiency and were not themselves benefited by the vitamin A injection. Consequently, additional intakes of vitamin A would not be expected to increase milk production. Furthermore, calves in a subsequent trial (see Experiment 2) were not benefited by a vitamin injection which included vitamin A.

Table 2. Effects of Vitamin A Injected into Cows Before Calving, by Treatment

Treatment	No Vitamin A	Vitamin A[1]
No. cows	77	78
Avt. wt. cows 1-31-63, lb.	866	863
Av. wt. cows 5-7-63, lb.	792	792
Wt. change, lb.	—74	—71
No. calves born	73	75
No. calves at 112 days	66[2]	71[3]
Wt. calves at 112 days, lb.[4]	209	223
Date cows calved following year, March	10	11
No. cows open following year	15	9

[1] One million I.U. vitamin A injected into rumen 1-31-63.
[2] Calf losses in the untreated groups were due to the following causes: dead at birth—2, predatory animals—3, scours within one month after birth—2.
[3] Calf losses in the vitamin A group were due to the following causes: dead at birth—1, lack of milk—1, scours within one month after birth—2.
[4] Average of steers and heifers.

Vitamin A treatment did not influence the rebreeding performance of cows as measured by the date of calving the following year. However, fewer vitamin A treated cows were open the following year (9 vs. 15). It would seem that if reproductive performance were affected by vitamin A treatment it would also be manifested in the date of calving the following year. Numbers of cows in this comparison were not sufficiently large to allow a definite conclusion concerning reproductive performance as affected by vitamin A injections. More research is needed.

Results from a more extensive three year comparison now in progress should provide additional and meaningful information concerning both reproductive performance and weight of calves as influenced by vitamin A injection of cows.

Experiment 2. Injectable Vitamins A, D and E for Range Beef Calves

Procedure

The value of a preparation of vitamins A, D and E was investigated by injecting approximately ½ of a group of calves with the vitamins at birth. A total of 113 calves were used in the study, 59 of which received no vitamins and 54 of which received the vitamins A, D and E. Both Angus and Hereford calves were used. The procedure was to inject alternate calves within each group of the same breed, sex and sire. The vitamin preparation which was used had a potency of 500,000 international units vitamin A, 50,000 international units vitamin D and 50 international units of vitamin E per c.c. Two c.c. were injected making a total dosage of the vitamins of 1,000,000 international units of vitamin A, 100,000 international units of vitamin D and 100 international units of vitamin E. Information on the survival rate and weight of the calves at 210 days of age was obtained.

Results and Discussion

The influence of vitamins A, D and E injected into calves at birth is shown in Table 3. Neither survival to weaning at 210 days of age

Table 3. Effects of Vitamins A D E Injected into Calves at Birth

	Control (No vitamins)	Vitamins A D E[1] Injected
No. calves	59	54
No. calves survived to 210 days	58	53
Wt. of calves at 210 days[2]	459	460

[1] 1,000,000 I.U. vitamin A, 100,000 I.U. vitamin D and 100 I.U. vitamin E injected at birth.
[2] Average of steers and heifers.

nor weaning weights were influenced by the vitamin injections. As previously mentioned, the reason for heavier calves out of vitamin A injected cows as observed in Experiment I cannot be explained on the basis of the results of this trial.

Summary

1. The intra-ruminal injection of one million I.U. of vitamin A into range beef cows before calving had no apparent influence on:
   a. Spring weight of cows.
   b. Time of rebreeding of cows.
   c. Survival of calves to 112 days of age.
2. Fewer cows injected with vitamin A were open the following year than untreated cows. Additional research information is needed before general conclusions can be made on this point.
3. Calves from cows which had been injected with vitamin A tended to be heavier at 112 days of age than calves from untreated cows.

   Additional data concerning the observations reported above are now being obtained in a more extensive 3 year study concerning the value of injectable vitamin A for range beef cows.
4. Vitamins A, D and E injected into range beef calves at birth were without apparent affect on the survival and weight of calves at 210 days of age.

Winter Feeding Studies With Range Beef Cows: Value Of Zinc And Constant Vs. Increasing Level of Protein

Robert Totusek

The expense of winter supplement represents the biggest cash cost of maintaining a cow for a year and is a sizeable part of the total yearly cow cost, often accounting for 20 to 25 percent of the total. Any practice which will increase the productivity of the cow enough to more than pay the possible additional cost of the practice should be considered.

The practice of feeding supplemental protein falls into two categories. Either the supplement is fed at a constant level throughout the winter or it is fed in increasing amounts as the winter progresses. It would be theoretically more beneficial for the spring calving cow to increase the amount of supplemental protein as the winter progresses. This is because the protein value of grass decreases as winter progresses and the protein requirement of the cow increases with advancing pregnancy and actually almost doubles after calving and the cow begins to lactate.

Previous research at the Wilburton station (see 1957 Feeder's Day Report) failed to indicate any difference in cow performance between the two practices. The previous research was done with mature cows. It is logical to assume that younger cows, especially two or three-year-old heifers which are still growing, would be more sensitive to a protein deficiency in late winter and early spring than mature cows. Therefore, it was considered desirable to compare the two practices of feeding supplemental protein with younger cows.

Recent experimental work showed that the addition of supplemental zinc to certain feedlot rations often resulted in improved performance of fattening cattle. Although previous research at this station indicated little or no benefit from feeding trace minerals to range beef cows, the trace mineral mixtures previously fed either contained no zinc or very low levels of zinc. Consequently, the value of adding sizeable quantities of supplemental zinc to the winter ration of beef cows was determined in this experiment.

Procedure

The design of this experiment is indicated in Table 1. Note that it is possible to compare the practices of feeding constant versus increasing levels of protein supplement (lots 1, 4 and 7 vs. 2, 5 and 8), and to determine the value of supplemental zinc in the wintering ration of

Table 1. Design of Experiment

Treatment	Lot No.	No. Cows	Age at Calving, Yrs.
Constant protein supplement[1]	1	14	2
Increasing protein supplement[2]	2	14	2
Zinc, constant protein supplement[3]	3	14	2
Constant protein supplement	4	16	3
Increasing protein supplement	5	16	3
Zinc, constant protein supplement	6	15	3
Constant protein supplement	7	22	4
Increasing protein supplement	8	22	4
Zinc, constant protein supplement	9	22	4

[1] Cottonseed cake was fed at a level of 2.5 lb. per cow daily from Nov. 10 to April 20.
[2] Cottonseed cake was fed from Nov. 10 to April 20 at an increasing rate as follows (lb. per head daily): starting November 10–1.0, December 15–2.0, January 1–2.5, February 15–3.5.
[3] Zinc was included in the cottonseed cake at a level to provide an estimated intake of 75 ppm of the total feed intake (90% dry matter basis).

beef cows (lots 1, 4 and 7 vs. 3, 6 and 9). It is also possible to observe the relationship between the age of the cow and the feeding practices which were compared. This would be of particular interest in the comparison of the two methods of feeding the protein supplement.

The cows were wintered on native range and received in addition to the indicated supplements approximately 10 lbs. of prairie hay per head daily from February 10 to April 10. All cows had access to a mineral mixture composed of 50 percent salt and 50 percent dicalcium phosphate.

Observations were made concerning the weight changes of the cows, the weight of the calves produced and the ability of the cows to rebreed. All of the cows were grade Angus. They were also used to provide progeny test information on sires used in the beef cattle breeding project and, consequently, provided both genetic and nutritional information.

Results and Discussion

The weights of cows by age and treatment are shown in Table 2, while a summary of the weight of the cows by treatment is given in Table 3. There was not a large or consistent relationship between the feeding practice used and weight of the cows at intervals during the year. The most consistent trend noted was for cows receiving the increasing level of protein supplement to lose the most weight up to calving time. This would be expected since the cows on the increasing level of protein supplement would have received less supplemental protein up to that point than the cows receiving a constant level throughout the winter. These cows did tend to catch up in weight by spring since their protein supplement intake during the suckling period was greater than that of the cows on the constant level of protein. There was little difference in weight of the cows due to previous winter treatment by the end of the summer grazing season.

Table 2. Weights of the Cows, by Age and Treatment

Lot No.	Age of Cows Yrs.	No. Cows	Treatment	11-8-62	1-31-63	5-7-63	10-4-63
1	2	14	Constant protein	833	785	723	726
2	2	14	Increasing protein	845	758	736	769
3	2	14	Zinc	833	805	730	740
4	3	16	Constant protein	864	861	807	866
5	3	16	Increasing protein	870	852	840	869
6	3	15	Zinc	877	897	823	882
7	4	22	Constant protein	970	963	866	928
8	4	22	Increasing protein	956	892	842	916
9	4	22	Zinc	979	963	831	930

Table 3. Weights of the Cows, by Treatment

Lot No's	No. of Cows	Treatment	11-8-62	1-31-63	5-7-63	10-4-63
1-4-7	52	Constant protein	889	870	799	840
2-5-8	52	Increasing protein	890	834	806	851
3-6-9	51	Zinc	896	888	795	851

Data on calf production and the rebreeding performance of cows are presented in Tables 4 and 5. The fewer calves weaned by the cows on the increasing level of protein should not be considered a reflection of the winter feeding practice used. A study of the calf losses in the footnotes of Table 5 will reveal that the losses are probably not related to winter treatment. The winter treatments had very little influence on the birth weight of the calves or the weight of the calves at weaning at 210 days.

The cows which received supplemental zinc during the winter calved somewhat earlier than the non-zinc supplemented cows. However, it should be noted that practically all of the advantage in calving date was accounted for by the 2-year-old cows. Since there was no corresponding improvement in calving date in the 3 and 4-year-old groups it would be difficult to assume that the feeding of supplemental zinc was beneficial in terms of rebreeding performance. There was little difference in number of open cows the following year.

The results of this experiment substantiate those previously observed at the Wilburton station and further indicate that 2 and 3-year-old cows are no more susceptable to a short time deficiency of protein intake during the suckling period than more mature cows. It appears that the total amount of feed that is used during the wintering period is more important than its distribution. It is also apparent that there is not a critical deficiency of zinc in the winter forage and supplements as ordinarily consumed by range beef cows in this area.

Summary

1. The results of this experiment with 2, 3 and 4-year-old spring calving range beef cows indicate that it makes little difference whether the supplemental protein is fed at a constant level or gradually increased as the wintering period progresses.
2. There was no advantage in supplying supplemental zinc during the wintering period for range beef cows wintered on dry grass supplemented with cottonseed meal and a small quantity of prairie hay.

Table 4. Production Data, by Age and Treatment

Lot No.	Age of Cow Yrs.	No. Cows	Treatment	No. Calves Weaned[1]	Birth Wt.	Weaning Wt.	Calving Date Following Year	No. Open Cows Following Year
					lb.	lb.		
1	2	14	Constant protein	13	58	356	Mar. 29	4
2	2	14	Increasing protein	11	54	328	Mar. 31	3
3	2	14	Zinc	13	55	334	Mar. 1	1
4	3	16	Constant protein	16	61	378	Mar. 8	1
5	3	16	Increasing protein	12	62	390	Mar. 17	0
6	3	15	Zinc	14	62	388	Mar. 7	1
7	4	22	Constant protein	21	62	418	Feb. 29	4
8	4	22	Increasing protein	16	64	409	Mar. 1	4
9	4	22	Zinc	22	67	402	Mar. 2	4

[1] See Table 5 for summary of calf losses by treatment.

Table 5. Production Data, by Treatment

Lot No.	No. Cows	Treatment	No. Calves Weaned	Birth Wt.	Weaning Wt.	Calving Date Following Year	No. Open Cows Following Year
				Lb.	Lb.		
1-4-7	52	Constant protein	50[1]	60	384	Mar. 12	9
2-5-8	52	Increasing protein	39[2]	60	376	Mar. 16	7
3-6-9	51	Zinc	49[3]	61	375	Mar. 3	6

[1] Fifty-one calves born: 1 dead at birth.
[2] Forty-seven calves born: 2 dead at birth, 4 died of scours, 2 killed by predatory animals.
[3] Fifty-one calves born: 1 dead at birth, 1 killed by predatory animals.