Feeding and Breeding Tests

With Sheep, Swine, and Beef Cattle
Progress Report, 1965-66

Reported at 40th Annual
Livestock Feeders' Day
April 16, 1966

Misc. Pub.
M.P. 78
June, 1966

Oklahoma State University
Science Serving Agriculture
1891
Experiment Station
and USDA

CONTENTS

Factors to Take into Account When Adjusting Weaning Weights of Calves 5
L. V. Cundiff, R. L. Willham and Charles A. Pratt

Reproductive Performance of Sows Fed at Two Levels During Gestation 14
I. T. Omtvedt

Effect of Pre-Weaning Plane of Nutrition on Growth and Development of Beef Calves 18
John A. Steudeman, S. A. Ewing, J. J. Guenther and G. V. Odell

A Comparision of the Effects of Hand Mating and Lot Mating on the Reproductive Performance of Gilts 25
E. J. Turman, J. C. Hillier, Allen Sharp, Jerry Lawrence and James Tilton

Effect of Teasing on Mating and Lambing Performance of Spring-Bred Ewes 34
A. A. Ovejera, J. V. Whiteman, M. B. Gould and F. A. Thrift

Some Relationships Between Lamb Growth and Carcass Composition and Among Various Measures of Carcass Merit 40
Joe V. Whiteman, Lowell E. Walters and A. W. Munson

The Cumulative Influence of Level of Wintering on the Lifetime Performance of Beef Females Through Six Calf Crops 49
Larry Smithson, S. A. Ewing, L. S. Pope and D. F. Stephens

A Study of Some Factors Affecting Feed Intake and Performance of Finishing Steers 57
Joe Hughes, S. A. Ewing and L. S. Pope

Weight Loss Patterns of Beef Cows at Calving 64
S. A. Ewing, Larry Smithson, Dwight Stephens and Derald McNutt

Bermudagrass and Beef Cattle 67
Jack McCroskey

The Value of Cotton Seed Meal, Fish Meal and Urea in Milo Rations for Fattening Calves 72
Robert Totusek, Robert E. Renbarger, George A. B. Hall and Allen D. Tillman

Optimum Nutrition of the Young Lamb for Maximum Growth and Lean Production 79
Robert L. Noble, L. E. Walters, Allen D. Tillman and Eldon Nelson

Factors To Take Into Account When Adjusting Weaning Weights of Calves

L. V. Cundiff, R. L. Willham and Charles A. Pratt

There is opportunity for improving weaning weights of beef cattle by selection depending upon the degree to which differences observed among calves are genetic. Environmental differences among calves tend to reduce the effect of selection. Two methods of reducing environmental differences are available to the breeder. The best one is to physically control environment by standardizing feeding and management conditions. However, there are many factors over which breeders have very little or no managerial control. For some of these it is possible to use correction factors to adjust for nongenetic differences among individuals and thus improve the effectiveness of selection.

This study was conducted to determine the effect of seven environmental factors on weaning weight of calves raised in Oklahoma and to investigate the importance of two-way interactions among these factors. A second objective was to determine which type of correction, additive or multiplicative, is most appropriate in adjusting weaning weights for important sources of environmental variation.

Materials and Methods

The data used in this study were the adjusted 205 day weaning weights of 13,937 Hereford and Angus calves recorded in the Oklahoma Beef Cattle Improvement Program over a four year period from 1959 through 1962. Each calf was classified according to age of dam, sex, breed, type of pasture, area of the state, month of birth and type of management. The effects of these seven environmental factors were estimated by the method of least squares as outlined by Harvey (1960). The breakdown for age of dam is given in Table 2. Pastures were divided into three general classes (1) Native-ranches with predominately native grasses, (2) Improved-ranches with predominantly cultivated grasses such as Bermuda and Fescue, and (3) Mixed-ranches with a predominance of neither native or improved pastures. The state was divided into six areas: NE, SE, SC, NC, NW, SW. Type of management refers to whether the calves were creep-fed or not creep-fed.

To investigate all possible two-way interactions least squares analyses were computed separately for each sex, breed, type of pasture, type of management, and each of four seasons. Two-way interactions were examined by comparing least squares estimates computed for a given level of one factor within different levels of another factor. The interaction between age of dam and sex for example, was studied by comparing the least squares estimates for age of dam computed in the three separate sex analyses. The failure of the estimates to be the same was considered indicative of interaction. The criterion for assessing the significance of interaction was whether or not the 95 percent confidence intervals on the least squares constants overlapped.

The study of additive versus multiplicative correction factors was conducted by determining which method of adjustment would more nearly equalize averages between adjusted groups and variances within adjusted groups.

Results and Discussion

MAIN EFFECTS AND INTERACTIONS

The analysis of variance is given in Table 1. All factors were statistically significant sources of variation because of the large numbers. However, variance component estimates revealed that breed and pasture differences were of no practical importance. Together they accounted for less than one percent of the total variation in weaning weight. Age of dam, sex, area, month of birth, and type of management were important sources of variation each accounting for more than five percent of the total variance. All of these factors except areas will be considered in this report. Since a breeder is usually located in a given area there is no need of correction for areas.

Age of Dam. The results of the interaction analyses indicated that the effect of areas was essentially the same regardless of sex, breed, type of pasture, season, or type of management. Thus, the estimates of the effect of age of dam given in Table 2 were taken from the overall analysis. The estimates indicate that increases in age of dam of only 3-5 month increments have an important influence on weaning weights of calves out of 2- and 3-year-old cows. It appears that classifying cows into 3- to 5-month increments between 2 and 4 years of age would result in more accurate corrections than yearly increments. Productivity continued to increase at a diminishing rate until the cows were 8 years old. The average weaning weights were essentially the same for calves out of cows between 6 and 13 years of age. Productivity dropped off slightly in 14 and 15 year old cows. These results agree closely with previous reports from the Midwest and other areas of moderate to high rainfall.

Table 1. The Analysis of Variance.

Source of Variation	Degrees of Freedom	Mean Squares	Variance Components	% of Variance
Total	13,936		5,760	100
Direct Effects				
Age of dam	16	332,196*	410	7.1
Sex	2	4,274,254*	999	17.3
Breed	1	59,183*	8	0.1
Pasture	2	184,626*	41	0.7
Area	5	578,190*	303	5.3
Month of Birth	11	427,519*	376	6.5
Management	1	2,154,933*	314	5.4
Error	13,897	3,309*	3,309	57.4

*$P < .005$, i.e., if in reality there is no difference in weaning weights between age of dam groups, sexes, . . . , and types of management differences as large as those observed in this study would be expected to occur simply due to chance less than 5 times in 1000 such trials.

Table 2. Least Squares Estimates For Age of Dam

Age of Dam	Number of Calves	Constants[1]	Averages
— 27 mos.	843	— 49	369
28 — 30 mos.	690	— 36	381
31 — 33 mos.	454	— 28	389
34 — 39 mos.	1,059	— 20	398
40 — 45 mos.	1,005	— 4	413
4 yrs.	1,863	1	418
5 yrs.	1,538	7	425
6 yrs.	1,339	13	431
7 yrs.	1,122	16	434
8 yrs.	1,043	18	436
9 yrs.	984	18	436
10 yrs.	751	16	433
11 yrs.	538	16	434
12 yrs.	308	13	430
13 yrs.	218	15	432
14 yrs.	106	10	427
15 yrs.	76	— 5	413

[1] The average deviation of each age of dam group from the overall average.

They do not show the marked decline after 7 to 8 years that has been observed in the more arid regions of the West.

Sex of Calf. Interaction analyses indicated that sex x breed, sex x pasture, and sex x season interactions were small and unimportant. The interaction between sex and type of management was significant, however, and appeared to be important enough to be taken into account in adjusting weaning weights. The estimates for sex are given in Table 3 according to type of management. Bull calves that were creep-fed deviated significantly more from their mean than those that were not creep fed. These results suggest that bull calves possess greater growth potential than steers or heifers and that this potential is revealed even more when calves are creep-fed than when they are not creep-fed.

The differences observed in this study between bulls and steers and bulls and heifers are larger than those in previous reports. The differences between steers and heifers is smaller than expected. A tendency for producers to keep faster growing more thrifty male calves as bulls and to castrate the slower growing calves has apparently caused the differences between bulls and steers and bulls and heifers to be biased upward and the difference between steers and heifers to be biased downward. Thus, these estimates of the effect of sex are not considered appropriate for use in the field as correction factors.

Month of Birth. Month of birth had an important influence on weaning weight. However, the interaction analyses indicated that the effect of month of birth was dependent on type of management and type of pasture. The least squares constants obtained for month of birth in the separate analyses for creep-fed and noncreep-fed calves are given in Figure 1 and Table 4. These data indicate that creep feeding reduced

Table 3. Least Squares Estimates Within Type of Management for Sex of Calf.

Sex	No Creep		Creep	
	Constants[1]	Averages	Constants[2]	Averages
Bulls	32	423	38	475
Steers	—13	377	—15	421
Heifers	—20	371	—24	412

[1] The average deviation of each sex from the overall average of non-creep-fed calves.
[2] The average deviation from the overall average of creep-fed calves.

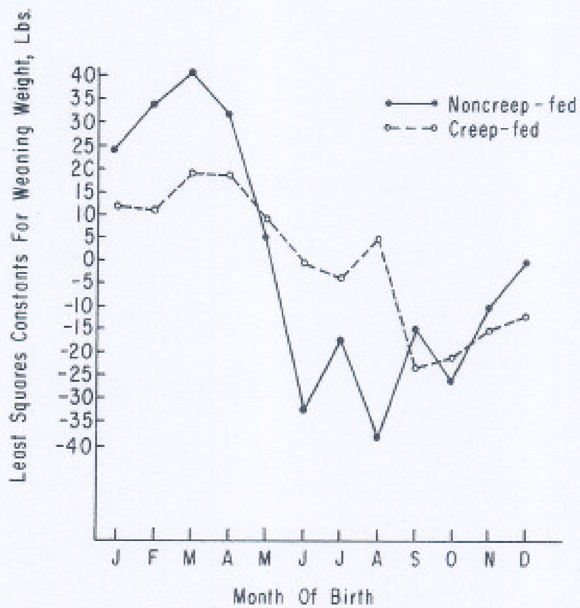

Figure 1. Month of birth by type of management.

the effect of season of birth on weaning weight. Calves born in the spring had an advantage over those born in the summer or fall in both types of management, but this advantage was much greater in calves that were not creep-fed than in those that were creep-fed.

The advantage of creep-feeding was greater for calves dropped in the fall than for those dropped in the spring, and calves dropped in the summer benefited even more from creep-feeding. These results suggest that calves born during the more adverse summer and fall seasons tend to compensate for the low milk production of their dams and reduced level of forage available to them by consuming more creep-feed. In this manner it appears that creep-feeding standardizes the preweaning environment and reduces the effect of season of birth on weaning weight. Thus, it appears that separate correction factors should be used for month or season of birth depending on whether calves are creep-fed or not.

The least squares constants obtained for month of birth in separate analyses for native and improved pasture are given in Figure 2 and Table 5. Calves raised on native pasture had a significant advantage over those raised on improved pasture when born in the spring or fall. Those raised on improved pasture had an advantage over those raised on native pasture when dropped during the summer months.

These data indicate that season of birth can have an important influence on weaning weight. The most effective method of reducing the source of nongenetic variation available to the breeder is to restrict the calving season to a two- or three-month period. However in herds where calves are born in more than one season of the year adjustments should be made for season of birth. It is evident from these data that no single set of correction factors are appropriate for season of birth. Separate

Table 4. Least Squares Estimates Within Type of Management For Month of Birth

Month	No Creep		Creep	
	Constants[1]	Averages	Constants[2]	Averages
Jan.	24	415	12	448
Feb.	34	425	11	448
Mar.	41	432	19	456
April	32	422	19	455
May	6	396	10	446
June	−33	357	0	436
July	−17	374	− 4	432
Aug.	−38	352	5	441
Sept.	−14	377	−24	413
Oct.	−27	364	−21	415
Nov.	−10	380	−15	421
Dec.	1	391	−12	424

[1] The average deviation for each month of birth from the overall average of non-creep-fed calves
[2] The average deviation from the overall average of creep-fed calves.

Table 5. Least Squares Estimates Within Type of Pasture For Month of Birth.

Month	Native Pasture		Improved Pasture	
	Constants[1]	Averages	Constants[2]	Averages
Jan.	16	440	4	419
Feb.	20	445	20	435
Mar.	36	460	25	439
April	27	451	18	433
May	− 1	424	10	425
June	− 4	420	9	424
July	−30	394	18	432
Aug.	−32	392	− 9	405
Sept.	−17	407	−11	404
Oct.	− 5	420	−35	380
Nov.	− 3	422	−26	388
Dec.	− 6	418	−24	391

[1] The average deviation of each month of birth from the overall average of calves raised on native pasture.
[2] The average deviation from the overall average of calves raised on improved pasture.

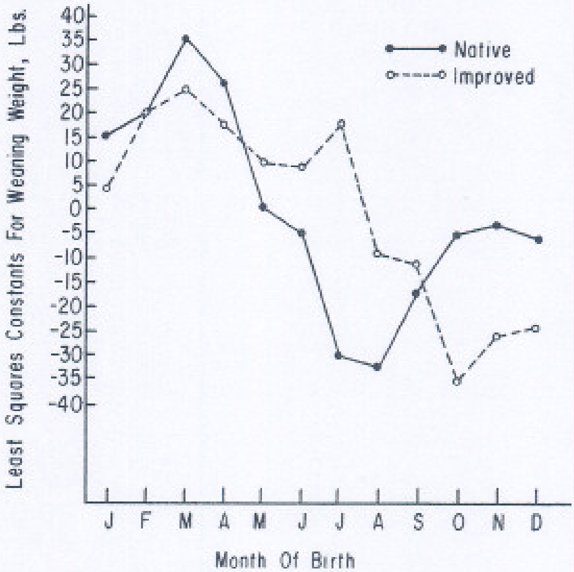

Figure 2. Month of birth by type of pasture.

corrections should be used depending on whether calves are creep-fed or not creep-fed and whether they are raised on native or improved pastures. Ranches that wean a large number of calves born throughout the year use corrections for their own particular situation based on their own records possibly within each year.

METHOD OF ADJUSTMENT

Both additive and multiplicative adjustments are used to adjust weaning weights for differences between calves due to nongenetic factors such as age of dam and sex. With additive adjustments the average difference between the sub-class chosen as standard and the sub-class represented by particular calf is added to the calf's weaning weight.

With multiplicative adjustments, the calf's weaning weight is multiplied times the ratio of the respective subclass averages. Multiplicative factors increase or decrease the weight relative to the existing weight of the calf while additive factors are the same regardless of existing weight. Both methods make about the same correction for calves of average or near average weight but they are different for animals at extreme light or heavy weights.

Thus, the two methods differ in their effect on variation within adjusted groups. Additive corrections do not alter the variance within adjusted groups while multiplicative factors raise or lower the variation depending on whether the correction factors are larger or smaller than 1.00. In order for correction factors to be most satisfactory they should equalize both averages between adjusted groups and variation within adjusted groups.

Age of Dam. The additive and multiplicative corrections derived in this study for age of dam are given in Table 6 along with the means and standard deviations that would result from their use. No corrections were made for cows ranging in age from 6 through 13 years since their average weaning weights had a range of only six pounds. The means were equalized fairly well by both methods. The standard deviations are measures of variation in weaning weight among calves of the various age of dam groups.

The method of correction in which the standard deviations are more nearly equal for all age groups is most appropriate for use in adjusting weaning weights. The additively adjusted standard deviations had a range of 12.8 pounds (62.2-49.4) and themselves a standard deviation of 3.2 pounds. The multiplicatively adjusted standard deviations had a greater range of 22.9 pounds (72.-49.9) and a standard deviation of 5.7 pounds. These results indicate that additive adjustments are more appropriate than multiplicative corrections in adjusting weaning weight for the effect of age of dam. Although additive adjustments would not equalize the variances in adjusted groups, they at least would not cause further divergence as would multiplicative corrections.

Sex of Calf. The results for sex are given in Table 7 according to type of management. These data indicate that multiplicative corrections are more appropriate than additive corrections in adjusting for the effect of sex. The multiplicatively adjusted standard deviations are more

Table 6. Additive Versus Multiplicative Adjustment for Age of Dam.

Age of Dam	Correction Factor	Additive Adjusted Average	Standard Deviation	Correction Factor	Multiplicative Adjusted Average	Standard Deviation
— 27 mos.	+64	433	62	1.17	431	73
28 — 30 mos.	+52	433	56	1.13	431	63
31 — 33 mos.	+44	433	57	1.11	432	63
34 — 39 mos.	+35	433	59	1.09	434	65
40 — 45 mos.	+20	433	55	1.05	434	58
4 yrs.	+15	433	56	1.04	435	59
5 yrs.	+ 8	433	54	1.02	433	55
6 yrs.	0	431	55	1.00	431	55
7 yrs.	0	433	59	1.00	433	59
8 yrs.	0	436	59	1.00	436	59
9 yrs.	0	436	58	1.00	436	59
10 yrs.	0	433	54	1.00	433	54
11 yrs.	0	434	53	1.00	434	54
12 yrs.	0	430	54	1.00	430	55
13 yrs.	0	432	50	1.00	432	50
14 yrs.	+ 6	433	49	1.01	432	50
15 yrs.	+20	433	58	1.05	433	60
Avg. Adjusted S.D.			56			58
Range			13			23
Standard deviation			3			6

nearly equal for the three sexes in both types of management than the observed standard deviations. This study suggests further that multiplicative adjustments have an advantage over additive corrections by accounting for the interactions between sex and type of managements. The multiplicative correction factors came out the same for both types of management while additive corrections differed.

Season of Birth. The results for season of birth given in Table 8 show that variation within adjusted groups is more nearly equal after additive adjustment than after multiplicative adjustment. Consequently, it appears that additive corrections would be more appropriate than multiplicative corrections in adjusting for season of birth.

Type of Management. Table 8 also gives the results for type of management. The observed standard deviations were essentially the same in creep-fed and non-creep-fed calves indicating that where adjustment is needed for type of management an additive adjustment is more appropriate than a multiplicative adjustment.

Regarding the effect of type of management, it is unsound from the standpoint of an ideal breeding program to creep-feed some calves and not others. Inasmuch as all calves are handled alike no correction

Table 7. Additive Versus Multiplicative Adjustments for Sex to Type of Management.

	Additive		Multiplicative	
Item	Correction Factor	Adjusted Standard Deviation	Correction Factor	Adjusted Standard Deviation
No Creep				
Bulls	−45	60	0.89	53
Steers	0	57	1.00	57
Heifers	+ 7	55	1.02	56
Creep				
Bulls	−53	62	0.89	55
Steers	0	54	1.00	54
Heifers	+ 9	52	1.02	53

Table 8. Additive Versus Multiplicative Adjustments for Season of Birth and Type of Management.

	Additive		Multiplicative	
Item	Correction Factor	Adjusted Standard Deviation	Correction Factor	Adjusted Standard Deviation
Season				
Feb.-Apr.	0	56	1.00	56
May-July	+26	62	1.06	66
Aug.-Oct.	+48	57	1.12	64
Nov.-Jan.	+28	55	1.07	59
Management				
No Creep	0	57	1.00	57
Creep	−28	57	0.93	53

is necessary. However, the practice of creep-feeding bull calves and not heifer calves may be sound from an economic point of view since bull calves apparently benefit more from creep-feeding than steers or heifers. The results of this study indicate that correction for sex and type of management would not be too difficult in instances where such a management scheme was allowed. By using a multiplicative correction to adjust to a common sex one could account for the effect of sex and sex by type of management interaction simultaneously. All that would remain is adding a correction factor for type of management appropriate for the specific conditions involved.

Summary and Conclusions

The data used in this study were the adjusted 205 day weaning weights of 13,937 Hereford and Angus calves recorded in the Oklahoma Beef Cattle Improvement Program over a four year period. It was determined that age of dam, sex, month of birth and type of management (creep versus no creep) are important sources of nongenetic variations that should be taken into account when adjusting weaning weights of values to improve the accuracy of selection.

The results for age of dam indicated that the effect of age of dam is essentially the same regardless of sex, breed, type of pasture, season of birth, or type of management. Weaning weights increased 46 pounds as cows increased in age from 2 to 4 years. It appears that classifying cows into 3 to 5 month increments between 2 and 4 years of age would result in more accurate corrections than yearly increments. This study has suggested that additive corrections are more appropriate than multiplicative corrections in adjusting weaning weights for the effect of age of dam.

The estimates of the effect of sex obtained in this study are not appropriate for use in the field as correction factors since the effect of sex was confounded with the effect of selection for size in the bulls of these data. This study has indicated, however, that the effect of sex is dependent on whether or not calves are creep-fed. It appears that bull calves benefit more from creep-feeding than steers or heifers. It was also determined that multiplicative adjustments are more appropriate than additive corrections in adjusting for the effect of sex since they more nearly equalize variation within sexes and it appears that they account for the interaction between sex and type of management.

A breeder can eliminate the effect of season of birth on the weaning weights of calves most effectively by restricting calving to a two- to three-month period, but in herds where calves are born throughout the year adjustments should be made for season of birth. This study has indicated that additive corrections should be used for season of birth and that separate corrections should be used depending on whether calves are creep-fed or not creep-fed and on whether they are raised on native or improved pasture.

Literature Cited

Harvey, Walter R. 1960. Least-squares analysis of data with unequal numbers. Agricultural Research Service. U.S.D.A. ARS-20-8.

Reproductive Performance of Sows Fed at Two Levels During Gestation

*I. T. Omtvedt**

Level of feed intake at various stages of reproduction greatly influences sow productivity. Previous research with swine has shown that increasing the nutrient intake of the female prior to breeding increases the number of ova shed, but continued heavy feeding during gestation leads to high embryonic mortality. The recommended practice is to flush sows (increase their feed intake) about 10-12 days prior to breeding and then reduce their feed intake immediately after breeding. This limited intake is recommended for about the first 90 days of pregnancy, and then slightly higher levels are recommended during the last month of gestation since the unborn pig makes most of his growth during this period.

The requirements for sows will be affected by their size and growthness, environmental temperatures, and housing conditions. However, in view of the results obtained at this station and in other investigations, there may be a tendency to overfeed during gestation in many cases and this results in a waste of feed and lower productivity.

Since feed cost is one of the major items in swine production, the present study was initiated in the spring of 1965 to study the effects of reduced feed intake during gestation on reproductive performance of sows and gilts.

Materials and Methods

This study was conducted in the spring and summer of 1965 using 20 gilts and 20 sows from the OK 14 (Hampshire) breeding herd at Stillwater. All sows and gilts were managed in a similar manner prior to breeding. On April 1, the ration listed in Table 1 was increased from 5 lbs. per day to 7 lbs. per day for gilts and from 6½ lbs. per day to 8 lbs. per day for sows. The breeding period started on April 12 and continued for six weeks. Each female was hand mated twice daily while in heat and sows and gilts were each randomly assigned to one of the two feeding levels described in Table 2 at breeding.

*Conducted in cooperation with the Regional Swine Breeding Laboratory, AHRD, ARS, U.S.D.A. The assistance of Mr. W. E. Sharp, Swine Herdsman, in the care and supervision of the animals in this study is gratefully acknowledged.

Table 1. Sow Gestation and Lactation Ration.

Ingredient	TotalPounds
Milo-Western Yellow	1200.0
Oats	400.0
Soybean Meal (50 Percent)	224.0
Dehydrated Alfalfa Meal (17 Percent)	100.0
Tankage (60 Percent)	40.0
Dikal	12.8
Ground Limestone	8.0
Salt	10.0
Vitamin-Mineral-Antibiotic Premix	5.2
Total	2000.0

Table 2. Amounts of Feed Provided for Sows and Gilts During Various Periods of Production.

Feeding Level			Lbs. Feed Per Day Per:	
		Period	Gilt	Sow
Low	I	April 1, to breeding	7	8
	II	breeding to June 30	3½	4
	III	July 1, to farrowing	5	6
	IV	lactation (wn. at 6 wks.)	self-fed	self-fed
High	I	April 1, to breeding	7	8
	II	breeding to farrowing	7	7
	III	lactation (wn. at 6 wks.)	self-fed	self-fed

To insure adequate control over the daily intakes specified in Table 2, individual sow feeding stalls were used during gestation. Four outside lots that were essentially barren during the duration of this study were used and sows and gilts were kept in separate lots in groups of 10 females per lot.

All sows were brought to the farrowing barn 109 days after breeding. Approximately 3 days after farrowing, sows and their litters were moved to individual pasture lots and gilt litters remained in confinement until weaning in order to accurately measure consumption during lactation.

Each sow was weighed at breeding and at the 109th day of gestation. Weight of sow at farrowing was determined by subtracting litter birth weight from her 109-day weight. Sow and pig weights were also obtained 21 and 42 days after farrowing. All litters were given access to creep at 21 days.

Results and Discussion

The production records for sows and gilts maintained on the high and low intakes during gestation are summarized in Table 3, and feed records are presented in Table 4.

Breeding and Gestation Performance: Breeding performance appeared normal for both groups. Thirty-five females conceived at first service, and three of the five females that failed to settle at first heat conceived when exposed to the boar during their second heat period. Two sows on the high level failed to conceive when rebred at three consecutive heat periods.

Differences in weight gain during pregnancy between the high and low levels were similar (Table 3) for both sows and gilts (58 lbs. and 56 lbs. respectively). Sows were scored from 1 to 9 on the basis of their condition each time they were weighed. Notice in Table 3 that the condition score difference between high and low levels for sows (6.8 vs 5.4) was smaller than for gilts (8.1 vs 5.3).

Farrowing Performance: Level of feeding had no great influence on farrowing performance. The gilts on restricted intake farrowed larger litters of live pigs than those on the high level of feed intake (11.0 pigs vs 10.1 pigs), but no differences in litter size were noticed between the two levels for sows (Table 3).

Pig birth weights were heavier ($P<.01$) for sows than for gilts in this study. Although level of feeding did not significantly affect either litter size or pig birth weights, litter birth weight (total pounds of live pigs per litter at birth) tended to favor the low level of feeding ($P<.10$).

Birth-to-Weaning Performance: Although feeding level had only a minor influence on farrowing performance, sows and gilts on the re-

Table 3. Performance of Sows and Gilts Fed at Two Levels During Gestation.

	Sows		Gilts	
	High	Low	High	Low
No. of sows farrowing	8	10	10	10
Sow wt. at farrowing, lbs.	575.2	528.1	422.2	388.6[1,2]
Sow condition score at farrowing[4]	6.8	5.4	8.1	5.3[1]
Sow weight gains:				
Gestation, lbs.	159.0	101.1	167.1	111.0[1]
1st 21 days after farrowing, lbs.	—22.9	+ 3.6	—23.2	—10.5[1]
1st 42 days after weaning, lbs.	—34.4	—10.0	—42.8	—23.0[1]
Farrowing data: No. live pigs per litter	10.8	11.0	10.1	11.0
No. dead pigs per litter	0.8	0.4	0.4	0.2
Pig birth wt., lbs.	3.01	3.16	2.84	2.81[2]
Litter birth wt., lbs.	32.5	34.8	28.7	30.9[2,3]
21-day data: No. pigs per litter	7.1	8.6	7.7	8.9[3]
Av. pig wt., lbs.	11.2	11.8	9.7	9.1[2]
Litter wt., lbs.	79.8	101.0	74.9	80.6[2,3]
42-day data: No. pigs weaned per litter	7.0	8.6	7.6	8.6[3]
Avg. pig wt., lbs.	26.6	26.8	20.7	19.2[2]
Litter wt., lbs.	185.8	230.0	157.3	165.1[2]
Survival rate to weaning, percent	64.8	78.2	75.2	78.2[3]

[1] Difference between high and low significant at 5 percent level.
[2] Difference between sows and gilts significant at 5 percent level.
[3] Difference between high and low rate significant at 10 percent level, thus merely indicating a trend.
[4] Condition scores ranged from 1 to 9: 1=poor; 5=average; 9=fat.

stricted diets during gestation tended to have slightly more pigs at 21 days and at weaning than did females maintained at higher rates during pregnancy ($P<.10$). The fact that the high level sows were 47 pounds heavier than the low level sows at weaning (575 lbs. vs 528 lbs.) may be a factor contributing to the higher death losses among pigs in this group. The survival rate among low level sows was equal to that for low level gilts.

Litter weaning weights favored the low level sows and gilts, but these differences were not significant. However, sow litters were significantly ($P<.05$) heavier than gilt litters at birth, 21 days, and weaning.

Feed Consumption and Feed Costs: The feed records summarized in Table 4 revealed that the high level sows consumed 251 lbs. more feed than the low level sows during gestation, and the difference between the high and low group of gilts was 348 lbs. When sow ration cost was estimated at $55 per ton, these differences in feed consumption between high and low groups during pregnancy resulted in cost differences of $6.90 for sows and $9.57 for gilts. It is generally recognized that cost of feed is the largest single expense in producing pork; in most analyses it constitutes 70 to 80 percent of the total production cost. Table 4 illustrates how the two levels of feeding in this study affected efficiency. Since high level of feeding did not increase production, the additional feed consumed by those on the high level of intake merely increased production costs. The average cost of sow feed per live pig farrowed was $2.14 for the high level compared to $1.28 for the low level.

Since facilities were available to hold only 20 litters in confinement from farrowing to weaning, sows had to be moved to pasture after farrowing and the only feed consumption data available for the lactation period in this study was for the gilts maintained on concrete. Notice that low level gilts consumed an average of 56 lbs. more feed during the preweaning period (422 lbs. vs 366 lbs.), but the total consumption

Table 4. Feed Consumption and Sow Feed Costs for Two Levels of Feeding.

	Sows		Gilts	
	High	Low	High	Low
Sow Feed Consumption				
Gestation: Total feed per sow, lbs.	819.	568.	809.	461.
Sow feed per pig farrowed, lbs.	75.8	51.6	80.1	41.9
Lactation: First 3 wks. after farrowing, lbs.			160.	181.
Second 3 wks. after farrowing, lbs.			206.	241.
Total feed per gilt during lactation, lbs.			366.	422.
Breeding to weaning: Total feed per gilt, lbs.			1175.	883.
Sow fed per pig weaned, lbs.			154.6	102.6
Sow Feed Cost[1]				
Gestation: Feed cost per sow	$22.52	$15.62	$22.25	$12.68
Sow feed cost per pig farrowed	$ 2.08	$ 1.42	$ 2.20	$ 1.15
Breeding to Weaning: Fed cost per sow			$32.31	$24.28
Sow feed cost per pig weaned			$ 4.25	$ 2.82

[1] Sow ration cost estimated at $55 per ton.

from breeding to weaning was still 292 lbs. less for the low level gilts than for the high level gilts. The average feed cost from breeding to weaning for the high level gilts was $32.31 compared to $24.28 for the low level gilts. This difference of $8.03 per gilt in feed cost represents a difference of $1.43 in sow feed cost per pig weaned between the two groups ($4.25 vs $2.82). Creep feed consumed by each litter from 21 to 42 days after farrowing was essentially the same for each group.

Summary and Conclusions

Twenty sows and 20 gilts were fed at two levels of intake during pregnancy to study the influence of feeding level on productivity and production costs. Sows farrowed and weaned heavier pigs and heavier litters than gilts, but differences in litter size for sows and gilts were not significant.

The difference in performance between the two levels of feeding were not large, but tended to favor those on the restricted level of feeding. Sows were self-fed from farrowing to weaning and the gilts on the restricted diet during pregnancy consumed an average of 56 lbs. more feed during the six-week lactation period than did the gilts maintained at the higher level during gestation. However, the high level gilts consumed an average of 292 lbs. more feed than those on the low level during the entire period from breeding to weaning. The average sow feed cost from breeding to weaning for the high level gilts was $32.31 compared to $24.28 for the low level gilts. The cost of sow feed per pig weaned was $4.25 for the high level and $2.82 for the low level in this study.

Since sow nutrient requirements are influenced by growthiness and level of productivity of the sow plus season of the year and other environmental conditions, this study was not intended to determine specific optimum feeding-level recommendations. The present investigation was undertaken to study the influence of reduced level of intake during gestation on level of productivity under existing conditions. These data illustrate the poor economics of overfeeding sows during gestation and the importance of controlling feed intake in the sow herd. Gestating sows should be fed according to existing conditions, but care should be taken not to overfeed after breeding.

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

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

The ultimate goal of the beef industry is to produce a product which will continue to satisfy consumer demands. The industry is confronted with increasing competition from other protein foodstuffs as well as changing trends in consumer demands. In an attempt to reduce caloric intake, consumers are demanding tender, flavorful, juicy retail cuts which contain a minimum amount of fat. If beef is to maintain its enviable position as the major source of protein in the diets of consumers, the beef producer must continually strive to meet consumer demands, to attain more economical and efficient levels of production and to improve the quality of beef.

Fundamental information regarding the factors that can affect the performance and development of the beef calf is needed in order to attain a partial solution to the problems confronting the beef industry. Previous work at the Oklahoma Agricultural Experiment Station indicates that the nutritional level of the dam during the gestation period has a considerable effect on both the pre- and post-weaning feedlot performance of their calves. The results indicated that calves from the dams fed a high nutritional level were heavier at birth, at weaning and at the termination of the feedlot period than those calves from dams fed a low plane of nutrition.

Another experiment, involving the effect of pre-weaning performance of beef calves was conducted on a limited number of calves. Results of this experiment indicated that calves on a low plane of nutrition early in life tend to compensate for this inhibitory period by making rapid and efficient gains when placed in the feedlot. However, such calves require a longer feeding period to completely compensate for the initial advantage acquired by calves on a high plane of nutrition during early life. This work revealed that carcasses from creep fed calves weaned at 240 days of age were larger, had more ribeye area, less fat cover, and graded higher than those which were weaned at 140 days and maintained on limited feed until placed in the feedlot at 240 days of age.

The results presented herein, represent a continuation of research aimed at studying the factors affecting the growth and development of beef calves.

Experimental Procedure

The data reported were obtained from two experiments. The first experiment dealt with the influence of extreme (very high vs very low) nutritional levels, during the pre-weaning period, on post-weaning feedlot performance and carcass characteristics. Two groups of cows were selected prior to calving on the basis of their previous milk production. One group was considered to have an above average or "high milk" producing ability compared to the other group of cows which possessed a "low milk" producing ability. Calves selected were sired by five different sires. The calves produced by the high-milking dams were creep fed during the pre-weaning period, thus, the calves on the high plane of nutrition received high levels of milk plus a creep feed. The calves on the low-plane of pre-weaning nutrition were produced by low milking dams and were not creep fed. For this study, eight steer calves were randomly selected from the calves on the low plane of nutrition and seven steer calves were randomly selected from the calves on the high plane of nutrition.

In the second experiment, the effect of plane of nutrition in early life upon subsequent feedlot performance and carcass development in beef calves was investigated. For this experiment, twenty-two Angus and eighteen Hereford Steer calves were allotted as follows:

(1) Six Hereford calves were *weaned at 170 days,* then maintained on limited hay and pasture to restrict gains until 240 days of age.
(2) Six Angus calves were *weaned at 170 days,* then maintained on limited hay and pasture to restrict gains until 240 days of age.
(3) Six Hereford calves, *weaned at 240 days,* received no creep feed during the pre-weaning period.
(4) Eight Angus calves, *weaned at 240 days,* received no creep feed during the pre-weaning period.
(5) Six Hereford calves *were weaned at 240 days and creep fed* during the pre-weaning period.
(6) Eight Angus calves were *weaned at 240 days, and creep fed* during the pre-weaning period.

In both experiments, the post-weaning feedlot test was conducted at the Ft. Reno Livestock Research Station. All calves were self-fed a "finishing" ration containing approximately 75 percent concentrates until a slaughter weight of approximately 950 pounds was attained. Feedlot performance and carcass measurements were obtained. Carcass fat content was calculated from physical separation of the 9-10-11th rib section. The percent separable carcass fat was calculated by the following formula:

$$Y = 3.54 + .80x$$

In this formula, Y equals the percent separable carcass fat and x is the percent separable fat in the 9-10-11th rib section (Hankins and Howe, 1946). The percent of boneless, trimmed retail cuts from the round, loin, rib and chuck ("cutability") was calculated by the following formula:

$$\%\ RC = 52.66 - 5.33x_1 - .0065x_2 - .979x_3 + .665x_4$$

In this formula x_1 is the average fat thickness measured at the twelfth rib in inches, x_2 is carcass weight in pounds, x_3 is kidney fat as a percentage of carcass weight and x_4 is rib-eye area in square inches (Murphy *et. al.,* 1960). Statistical analyses of the data were conducted to aid in the interpretation of results.

Results and Discussion

Data revealing the influence of very high vs very low pre-weaning nutritional levels on pre- and post-weaning performance of beef calves are presented in Table 1. The apparent differences which existed between the two groups at the end of the pre-weaning period followed a pattern which was expected. In as much as calves on the high level of nutrition were, on the average, 94 pounds heavier than low level calves at weaning. Average daily gain favored the high level calves by .38 pounds per day.

In the post-weaning feedlot test, the low level calves tended to compensate for their restricted growth during the pre-weaning period. Aver-

Table 1. Comparison of Pre- and Post-weaning Performance of calves subjected to Very High vs Very Low Nutritional Levels During a 240 Day Pre-weaning period.

Pre-Weaning Treatment	Low Milk Non-Creep	High Milk + Creep
Pre-Weaning Performance		
Number of Calves	8	7
Birth Weight	80	75
Weaning Weight	479	573
Gain to Weaning	399	498
Daily Gain to Weaning	1.59	1.97
Post Weaning Feedlot Performance		
Initial Weight	460	559
Slaughter Weight	931	946
Feedlot Gain	471	387
Days on Feed	200	175
Daily Gain on Feed	2.36	2.21
Pounds Feed/100 pound Gain	910	992

age daily gain of the low level calves exceeded that of the high level calves by .15 pounds. Even though the high level calves had a lower average daily gain, they required an average of 25 days less to reach market weight. However, low level calves required less feed by 82 pounds per 100 pounds of gain than high level calves.

Data in Table 2 reveals the influence of very high vs very low pre-weaning nutritional levels on the carcass characteristics of calves fed to a slaughter weight of approximately 950 pounds. Carcass differences between the two groups were quite small. High level calves tended to have heavier carcasses which exhibited less physiological age, as indicated by the maturity score, than carcasses from the low level calves. Marbling scores tended to follow the same pattern as carcass grade in that carcasses from the low-level calves had higher carcass grades and marbling scores. The carcasses from the low level calves tended to have smaller scale, as indicated by carcass length and length of leg. On the average, carcasses from low level calves had 1.7 percent more carcass fat.

Statistical analyses of the data collected in the second experiment revealed no breed by treatment interactions. Thus, data from the two breeds were combined, within treatments, and are presented in Tables 3 and 4.

This experiment was designed to study the effects of a restricted level of nutrition during the pre-feedlot period. During this period, the calves were weaned at 170 days and maintained on limited hay and pasture before being placed in the feedlot at approximately 250 days of age. These calves were compared to calves weaned at 240 days of age with or without creep feed. Effects of these early life planes of nutrition on the pre- and post-weaning performance of beef calves are shown in Table 3.

At weaning or prior to being placed in the feedlot, the creep fed calves weighed, on the average, 63 pounds more than the normal weaned

Table 2. Effect of Very High vs. Very Low Pre-Weaning Nutritional Levels on Carcass Characteristics of 240 day Weaned Beef Calves Fed to Slaughter Weight.

Pre-Weaning Treatments	Low Milk Non-Creep	High Milk + Creep[1]
Carcass Quality Data		
Slaughter Weight	931	946
Carcass Weight[2]	582	590
Pressing Percent[3]	62.51	62.37
Conformation Score	Good +	Good +
Maturity Score	B —	A +
Marbling Score	Small +	Small —
Carcass Grade	Choice —	Good +
Carcass Development Data		
Ribeye Area	11.2	10.8
Fat Cover[4]	0.74	0.77
Length of Carcass	45.6	46.3
Length of Leg	29.5	29.8
Depth of Body	15.9	15.5
Thickness of Shoulder	8.8	8.9
Thickness of Round	9.4	9.8
Percent Kidney Fat	3.34	3.37
Pounds Carcass Fat	217.1	210.0
Percent Carcass Fat	37.3	35.6
Cutability	49.1	48.6

[1] The creep fed calves consumed an average of 427 pounds of creep feed during the pre-weaning period.
[2] The chilled carcass weight was calculated by subtracting two percent of the hot carcass weight.
[3] Dressing percent was calculated on the basis of the chilled carcass weight.
[4] Average fat cover over the 12th thoracic vertebra.

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

Pre-weaning Performance	Restricted[1]	Normal Weaned (240 days)	Normal Weaned + Creep
Pre-weaning Performance			
Number of Calves	12	14	14
Birth Weight	69	68	70
240 Day Weight	440	511	574
240 Day Gain	371	443	504
240 Day Daily Gain	1.46	1.86	2.11
Post-weaning Feedlot Performance			
Initial Weight	412	500	557
Slaughter Weight	929	949	937
Feedlot Gain	517	449	380
Days on Feed	234	194	183
Daily Gain on Feed	2.21	2.31	2.08
Pounds Feed/100 lbs. Gain	928	935	991

[1] Calves on the restricted plane of nutrition were weaned at 170 days of age and maintained on limited hay and pasture to restrict gains until 240 days of age.

calves (without creep) and 134 pounds more than calves which were on the restricted nutritional level during the pre-feedlot period. Gains to weaning favored the creep fed calves by 0.25 and 0.65 pounds per day, respectively, over the normal weaned and restricted calves. All calves were removed from the post-weaning feedlot test at approximately 950

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

Pre-Weaning Treatment	Restricted	Normal Weaned (240 Days)	Normal Weaned + Creep
Carcass Quality Data			
Slaughter Weight	929	949	937
Carcass Weight[1]	590	596	591
Dressing Percent[2]	63.5	62.8	63.07
Conformation Score	choice	choice	choice
Maturity Score	A	A+	A+
Marbling Score	Modest	Modest	Modest
Carcass Grade	Choice	Choice	Choice
Carcass Development Data			
Ribeye Area	11.2	11.7	11.2
Fat Cover[3]	0.97	0.84	0.90
Length of Carcass	45.2	45.3	45.5
Length of Leg	29.0	29.3	28.8
Depth of Body	15.7	16.0	15.5
Thickness of Shoulder	8.9	8.9	8.9
Thickness of Round	9.4	9.5	9.6
Percent Kidney Fat	3.58	3.46	3.58
Pounds Carcass Fat	225.38	226.48	229.90
Percent Carcass Fat	38.2	38.0	38.9
Cutability	47.6	48.7	47.96

[1] The chilled carcass weight was calculated by subtracting two percent of the hot carcass weight.
[2] Dressing percent was calculated on the basis of the chilled carcass weight.
[3] Average fat cover over the 12th thoracic vertebra.

pounds. However, the restricted calves required 11 and 51 days longer to reach slaughter weight than normal weaned and creep fed calves, respectively. Normal weaned calves had the highest rate of gain in the feedlot with 2.31 pounds per day, followed by the restricted and creep fed calves with gains of 2.21 and 2.08 pounds per day, respectively.

Normally, rate of gain in beef calves is related to the feed efficiency in that as rate of gain increases, the pounds of feed required per pound of gain decreases. Therefore, as one might expect, creep fed calves required 56 and 63 pounds more feed per 100 pounds of gain than did the normal weaned and restricted calves, respectively.

These data indicate that calves limited in feed intake during the early growth period tend to compensate for this restricted period by making rapid and efficient gains when placed in the feedlot. However, they require a considerably longer feedlot period to fully compensate for the initial advantage obtained by calves that are creep fed during the pre-weaning period.

Data illustrating the effect of early life plane of nutrition on carcass characteristics of calves fed to slaughter weight is shown in Table 4. Only small differences were observed in the carcass quality data. Similarly, analyses of the carcass development data indicated that only small differences existed. A combination of factors resulted in the higher yield of trimmed boneless retail cuts ("cutability score") observed for the normal weaned calves as compared to the restricted or the creep fed calves.

Normal weaned calves had slightly larger ribeye areas, slightly less fat and a lower percentage of kidney fat than either of the other groups. Calves on the restricted level of nutrition had the highest amount of backfat (0.97 inches), followed by 0.90 inches for the creep fed calves compared to an average of 0.84 inches of backfat for normal weaned calves.

An estimate of total carcass fat suggested that the creep fed calves tended to have the largest amount of fat, however, these differences were small. Skeletal development appeared to be similar for all groups.

Summary

Experimental data presented in this paper were obtained from two individual experiments, both of which are segments of a more extensive project currently in progress at the Oklahoma Station. The entire experiment is designed to study the growth and development of beef calves during three phases of life; the pre-natal, pre-weaning or early life and post-weaning feedlot phase.

The effect of very high vs very low pre-weaning nutritional levels on post-weaning performance with regard to feedlot performance and carcass characteristics was studied in the first experiment. Results indicated that low level calves exhibited compensatory gain in the feedlot and were more efficient converters of feed. High level calves required less time to reach market weight than low level calves. Carcasses from low level calves tended to have a slightly higher percent of carcass fat.

In the second experiment, the effect of early life plane of nutrition on the pre- and post-weaning performance of beef calves was studied. As in the first experiment, calves limited in nutrient intake early in life tended to compensate for the restricted growth period by making rapid and efficient gains when put in the feedlot. However, they required a considerably longer feedlot period to completely compensate (with respect to body weight) for the initial restricted period early in life. Carcasses from the restricted calves tended to have more external fat and slightly lower cutability scores than those from the normal weaned and creep fed calves.

Literature Cited

Hankins, O. G. and Paul E. Howe. 1946. Estimation of the composition of beef carcasses and cuts. U.S.D.A. Tech. Bulletin No. 926.

Murphey, C. E., D. K. Hallett, W. E. Tyler and J. C. Pierce. 1960. Estimating yields of retail cuts from beef carcasses. J. Animal Sci. 19: 1240 (Abstr.).

A Comparison of the Effects of Hand Mating and Lot Mating on the Reproductive Performance of Gilts

E. J. Turman, J. C. Hillier, Allen Sharp, Jerry Lawrence and James Tilton

The most important single factor affecting the gross returns to a swine enterprise is number of pigs weaned per litter. This, in turn, is a function of: number of eggs ovulated; fertilization rate; embryo survival during gestation; and survival of pigs after farrowing. Any improvement in breeding, feeding or management that will result in an increase in any of these items will improve litter size at weaning.

It is well known that the number of eggs ovulated at a given heat period varies greatly among gilts. Among the factors that have been demonstrated to have a great influence on this item of reproductive performance are: (1) breed, (2) age of gilt, and (3) level of feeding. It has also been suggested, from results with laboratory animals, that the presence of the male, just prior to and during heat, may stimulate a higher ovulation rate.

The results reported in the past from other stations indicate that a low fertilization rate is not a major factor affecting litter size. Their results have shown that in the vast majority of the sows and gilts that settle to a particular mating, 95 percent or more of the eggs ovulated are fertilized. Almost all of the difference between numbers of eggs ovulated and numbers of pigs born is the result of embryonic mortality, that is death of the fertilized egg sometime during gestation, rather than being the result of an ovulated egg failing to be fertilized.

Embryonic death loss is probably the major factor reducing litter size in swine. It has been estimated that, even under the best of management, 25 percent to 40 percent of the fertilized eggs die during gestation. Under unfavorable conditions of management and/or environment this loss may be even larger. Two important factors that have been shown to increase the incidence of embryonic death loss are high levels of feeding after breeding, and exposure to high temperature. Undoubtedly, many other factors also affect embryo survival to the extent that one might make the general statement that any unfavorable condition that places some kind of a stress on the pregnant female will be detrimental to embryo survival. What still needs to be determined is the stage, or stages, of gestation when the pregnant female is most susceptible to stress.

The most common system of breeding practiced by swine producers is to pen mate sows and gilts by running one or more boars with a group of females. Certainly it reduces labor requirements and should result in all females being bred as early as possible in the breeding period in contrast to an occasional hand mated gilt being delayed for one cycle because of difficulty of heat detection. However, little is known of the effect, if any, that system of mating may have on the subsequent litter size. Certainly the frequent harrassment by the boar of a gilt during heat represents a form of stress occurring very early in gestation. This is a progress report of a research study now underway which was undertaken in an effort to determine the effect of hand mating vs. pen mating on ovulation rate, conception rate, and embryo survival of gilts.

Procedure

This study involved 60 gilts between the ages of 8 and 13 months. A total of three trials were conducted in the period from August, 1964, through April, 1965. With the exception of two Hampshire gilts used in Trial 2, all gilts were Yorkshires. All gilts on the same treatment in each trial ran together in the same lot, but were individually fed a 14 percent protein ration. The gilts were weighed at 14-day intervals and just prior to slaughter.

Two treatments were imposed in each trial. One group of 10 gilts was hand mated once each day they were observed to be in heat. The herdsman checked the lot each morning, and any gilt believed to be in heat was transferred to a breeding chute adjacent to the pen. The boar was allowed to serve the gilt and she was then returned to the lot. She was rechecked each morning thereafter until she refused to stand for service. The other group of gilts was lot mated, with boars rotated either twice or three times daily to insure that a fresh boar ran with the gilts at all times. No limit was placed on the number of services permitted each gilt. The lot was checked frequently to obtain breeding dates. A total of eight yearling Yorkshire boars were used. They were rotated daily in an effort to have each boar mated to an equal number of gilts on each treatment.

In allotment to treatment an effort was made to assign littermate gilts to different treatments. Otherwise allotment was on the basis of body weight. The two lots of gilts were not kept adjacent to each other but were separated by a lot in which no boars were kept. This precaution was taken to prevent close contact between the gilts in the hand mated lot with boars except at time of breeding.

The gilts were slaughtered in a local packing house and the entire reproductive tract recovered for study. In Trial 1 they were slaughtered as near to 35 days after breeding as possible, and in Trials 2 and 3 as close to 30 days post breeding as possible. Since slaughter was confined to one day per week the range in time of slaughter in Trial 1 was 34-41 days, and in Trials 2 and 3, 28-36 days post-breeding. The following observations were made 2 to 5 hours after slaughter on the reproductive tracts: (1) number of corpora lutea on each ovary; (2) number of apparently normal embryos in each uterine horn, and (3) number of dead or degenerating embryos in each horn. Each uterine horn was opened completely and all embryos were carefully examined. Any embryo that was grossly abnormal was classified as dead.

Trial 1: 20 Yorkshire gilts were allotted equally between the two treatment groups on August 10, 1964. The average age and weight of the gilts of the two lots were: hand mated, 249 days and 287 lbs., and lot mated, 252 days and 287 lbs. The first gilt was bred on September 2, 1964, and the last recorded mating was November 12, 1964. For the duration of this trial the daily feed allotment was 4½ lbs. per gilt. Fresh boars were rotated into the lot mated pen at 8:00 a.m. and 5:00 p.m. One gilt in the lot mated group died during the course of the experiment.

Trial 2: 18 Yorkshire and 2 Hampshire gilts were allotted equally between the two treatments on November 14, 1964. The average age and weight of the gilts of the two lots were: hand mated, 285 days and 293 lbs., and lot mated, 284 days and 284 lbs. The first recorded mating was on December 12, 1964, and the last on January 7, 1965. The gilts were started on 5 lbs. of the mixed ration per head per day, then "flushed" by raising the level to 7 lbs. per day 2 weeks before breeding was to start. As soon as a gilt was bred her feed level was dropped again to 5 lb. per day. Boars were rotated in the lot mated group three times daily, at 8:00 a.m., 1:00 p.m., and 5:00 p.m.

Trial 3: 20 Yorkshire gilts were allotted equally between the two treatments on December 22, 1964. The average age and weight of the gilts placed on each treatment were: hand mated, 306 days and 286 lbs., and lot mated, 302 days and 294 lbs. The first recorded mating was February 22, 1965, and the last mating occurred on March 13, 1965. The gilts were started on 5½ lbs. of feed per head per day, "flushed", starting 2 weeks before first expected breeding, by raising the feed level to 8 lbs. per head per day, then dropped on an individual basis, to 5½ lbs. per day at the time they were bred. Boars were rotated into the pen mated lot on the same schedule as in Trial 2. An additional stress was imposed on the gilts in the lot mated group. Beginning the day after the last day of heat each gilt was placed in the boar lot for 5 minutes on each of 5 consecutive days. During this 5-minute period the boars were permitted to run the gilt at will. One gilt in the lot mated group aborted, therefore, data was available on only 9 gilts in this lot.

Results and Discussion

Ovulation Rate:

In the interval between the twenty-fourth and fortieth hour after the start of heat the sow releases eggs from the ovary in the process of ovulation. The number of eggs released varies from a very few to as many as 30, with most gilts ovulating from 10-18. Obviously, ovulation rate, that is the number of eggs shed, is the first of several limiting factors affecting subsequent litter size.

At each place on the ovary where an egg is released, a structure called the corpus luteum forms. If the gilt is bred and conceives, these structures remain in the ovary for the duration of gestation. It is not the purpose of this paper to discuss their physiological function, but they are mentioned to point out the means available to determine the number of eggs ovulated at a heat period that occurred 30-40 days earlier. It is a simple matter to count the number of corpora lutea and know that they represent the number of potential embryos that could be in the uterus.

The gilts used in this study had an excellent ovulation rate. The data presented in Table 1 shows that 60 percent of the hand mated and 60.7 percent of the lot mated gilts ovulated 17 or more eggs. Just under 15 percent of each group ovulated 20 or more eggs, with one gilt ovulating 23. Only 3.3 percent of the hand mated and none of the lot mated gilts, ovulated 10 or fewer eggs. It is likely that the breed used and, as will be discussed later, the age of the gilts used and the system of feeding had much to do with obtaining this excellent prolificacy.

The data presented in Table 2 reveals that there was a small increase in ovulation rate in the gilts that were lot mated when compared to those hand mated. The average increase for all trials was 0.6 egg, with the range by trials being from no difference observed in Trial 2 to an increase of 1.0 egg in Trial 1. When analyzed statistically this difference was not significant.

There were marked differences between trials in ovulation rate. The average rate of all gilts in Trial 1 was 14.9 eggs, and the average weight and age of the gilts at time of breeding was 297 days and 310 lbs. The gilts used in Trial 2 were 24 days older, although weighing only 1 lb. more on the average than the gilts used in Trial 1. The average ovulation rate of the gilts in Trial 2 was 17.1 eggs, an increase of 2.2 eggs per gilt over Trial 1. The gilts in Trial 3 averaged 54 days older and 35 lbs. heavier than the gilts in Trial 2, and ovulated an average of 18.7 eggs per gilt, an increase of 1.6 eggs per gilt over the average for gilts of Trial 2.

It is likely that two factors account for most of the difference in ovulation rate between gilts of Trial 1 and Trial 2. One is the increased age of the gilts, and the second is the change that was made in feeding management. The gilts of Trial 1 were fed a constant level of feed throughout the trial. The gilts of Trial 2 were "flushed" by having their feed level increased from 5 to 7 lbs. per gilt for at least 2 weeks prior to breeding. The beneficial effect on ovulation rate of increasing the

Table 1. Ovulation Rate of the Gilts Used in this Study.

No. of Eggs	Treatment			
	Hand Mated		Lot Mated	
	Number	Percent	Number	Percent
20 or more	4	13.3	4	14.3
17 — 19	14	46.7	13	46.4
14 — 16	8	26.7	9	32.1
11 — 13	3	10.0	2	7.2
10 or less	1	3.3	0	0.0

Table 2. The Effect of Hand Mating vs. Lot Mating of Gilts on Ovulation Rate and Survival of Embryos 30-40 Days Post-Breeding.

Item	No. Gilts	Breeding Age	Breeding Weight	No. Eggs	No. Embryos	Percent Embryo Survival
		(days)	(lb.)			(Percent)
Trial 1.						
Hand Mated	10	307.8	320.0	14.4	11.5	79.9
Lot Mated	9	281.1	296.1	15.4	10.6	68.3
Trial 2.						
Hand Mated	10	320.2	317.8	17.1	14.0	81.9
Lot Mated	10	322.0	304.3	17.1	12.0	70.2
Trial 3.						
Hand Mated	10	378.4	348.9	18.4	15.4	83.7
Lot Mated	9	371.3	343.1	19.0	12.8	67.3
All Trials.						
Hand Mated	30	335.4	328.9	16.6	13.6	82.0
Lot Mated	28	328.1	315.5	17.2	11.8	68.6

feed level just prior to breeding has been demonstrated by other researchers. Although a comparison of flushed and non-flushed gilts was not made in the same trial in this study, the results indicated that flushing is a beneficial practice. It is also important to remember that since the gilts were individually fed, all gilts received the flushing level of feed. Had they been group fed it is likely that some would have eaten more than their share, thus depriving other gilts of the beneficial effects of flushing.

The data presented in Table 3 indicates that the age of the gilts had an important effect on ovulation rate. Data for all three trials were combined for all gilts on each treatment and divided into 3 groups according to the age of the gilts. The oldest one-third of the gilts in each treatment group averaged 44 days older than the middle one-third, which in turn, were approximately 42 days older than the youngest one-third of the gilts. The differences in ovulation rate were: for the hand mated group, an increase of 1.3 eggs between the youngest and middle age groups, and an increase of 1.0 egg between the middle and oldest groups; for the lot mated group, an increase of 0.9 egg between the youngest and middle group, and an increase of 1.4 eggs between the middle and oldest groups. For all practical purposes, each 6 weeks increase in age of the gilts used in this trial was accompanied by an increase of 1.0 egg in ovulation rate.

Other researchers have also reported that ovulation rate increases with increasing age in gilts. Most of their studies were based on observations made on younger gilts, comparing ovulation rates at the first, second and third heat periods of the gilt. The heat period after attainment of sexual maturity on which the gilts used in this study were bred was not known, but the results indicate there is a continuing increase in ovulation rate with increasing age of gilts at least to one year of age.

Table 4 presents the relationship between weight of the gilt and ovulation rate. While the differences are not as marked in the hand

Table 3. Effect of Age of Gilt at Time of Breding on Ovulation Rate and Survival of Embryos 30-40 Days Post-Breeding

Item	No. Gilts	Average Wt.	No. Eggs	No. Embryos	Percent Survival
Hand Mated					
Oldest 1/3	10	378.9	18.3	15.4	84.2
Middle 1/3	10	334.9	17.3	12.6	72.8
Youngest 1/3	10	293.6	16.0	13.8	86.3
Lot Mated					
Oldest 1/3	9	371.3	19.0	12.8	67.3
Middle 1/3	9	327.3	17.6	11.7	66.5
Youngest 1/3	9	285.7	15.7	11.6	73.8

mated group, the results in the lot mated group are very similar to those observed when grouping was based on age. This should be expected since the older gilts should be the heavier gilts. This was true to a large extent in the lot mated group since the fraction of the gilts that was in the same third, either top, middle or lowest, on both age and weight were: top one-third, 7 of 9; middle one-third, 6 of 9; and lowest one-third, 7 of 9. In the hand mated group the fraction in the same group on both age and weight was: top one-third, 5 of 10; middle one-third, 3 of 10; and bottom one-third, 7 of 10. This discrepancy between the allotments based on age and those based on weight in the hand mated group probably explains the relationship observed between weight and ovulation rate in the gilts on this treatment.

The results obtained in this study suggest that the producer could increase ovulation rate by breeding the older, heavier gilts of a group first. If ages are not known, selection based on weight of the gilts should also be effective. Certainly, it appears wise to delay breeding the younger, smaller gilts as long as possible.

The results of this study indicate that the presence of a boar in a pen of gilts has little, if any, stimulatory effect on ovulation rate. The most apparent advantage of this system of breeding is one of reduced labor requirements at breeding time, and eliminating human errors of heat detection.

Duration of Heat: An accurate measure of duration of heat was not obtained in this study since the hand mated gilts were checked only once daily. It was not determined just when heat ended in the period between the last acceptance and first refusal of the boar. The data based on days observed in heat is presented in Table 5. Of the 57 gilts for which heat dates were obtained in this study, 24 (42 percent) were in heat one day, 23 (40 percent) were in heat 2 days, and 10 (18 percent) were in heat 3 days. No gilts were in heat longer than 3 days. The average duration of heat in the gilts of the hand mated group was 1.8 days, with 67 percent in heat 2 days or longer. The average duration of heat in the lot mated group was 1.67 days, with 48 percent in heat 2 days or longer. The same number of gilts on each treatment (5) were in heat for 3 days.

Table 4. Effect of Weight of Gilt at Time of Breeding on Ovulation Rate and Survival of Embryos 30-40 Days Post-Breeding

Item	No. Gilts	Average Wt.	No. Eggs	No. Embryos	Percent Survival
Hand Mated					
Heaviest ⅓	10	363.6	18.0	15.0	83.3
Middle ⅓	10	326.9	16.7	11.6	69.5
Lightest ⅓	10	295.0	16.7	13.7	82.0
Lot Mated					
Heaviest ⅓	9	347.7	18.6	13.3	71.9
Middle ⅓	9	311.9	17.2	11.2	65.2
Lightest ⅓	9	288.8	16.0	11.7	72.9

Table 5. Duration of Heat in Hand Mated and Lot Mated Gilts.

Days Observed in Heat	Number of Gilts Observed in Heat							
	Hand Mated				Lot Mated			
	Trial 1	Trial 2	Trial 3	All Trials	Trial 1	Trial 2	Trial 3	All Trials
1	5	4	1	10	5	6	3	14
2	4	6	5	15	0	3	5	8
3	1	0	4	5	2	1	2	5

Conception Rate:

The conception rate obtained in this study was very good. Of the 57 gilts for which a mating was observed, 53 (93 percent) conceived at the first heat period they were bred. There were 2 gilts in each treatment group failing to conceive at first heat, but all conceived at the next heat period.

Embryo Survival:

Research studies conducted in the past at other experiment stations have indicated that almost all of the embryonic mortality that occurs during the 114 days of gestation occurs within the first 30-35 days. If this is true, and it is based on good evidence, the number of live embryos present at 30-35 days gives a good estimate of what litter size would have been had the gilts been carried to term and farrowed. By using data obtained by slaughtering at 30-35 days rather than farrowing the gilts, research studies can be speeded up considerably and data can be obtained on a larger number of gilts. Perhaps the results and discussion that follows will be much more meaningful if they are regarded in terms of being an accurate measure of litter size had the gilts been allowed to farrow.

The most important difference observed in the gilts on the two treatments was in embryo survival. As shown in Table 2, there was an advantage in all trials in favor of the hand mated group. The average embryonic survival rate for each treatment, when all trials were combined, was 82.8 percent for the 30 hand mated gilts, and 68.6 percent for the 28 gilts that were lot mated, an average difference of 13.4 percent. The differences in favor of the hand mated gilts for each trial were; 11.6 percent in Trial 1, 11.7 percent in Trial 2 and 16.4 percent in Trial 3.

The economic value of this difference in embryo survival is best shown by comparing actual numbers of embryos. At the time of slaughter 30 to 40 days after breeding, there was an average of 1.8 more living embryos in the hand mated gilts. A similar difference was observed in every trial with the hand mated gilts exceeding the lot mated gilts by 0.9 embryos in Trial 1, 2.0 embryos in Trial 2 and 2.6 embryos in Trial 3. These differences were statistically highly significant.

It was not possible from the data obtained in this study to determine with certainty either when or why this difference occurred. Studies are now underway to attempt to determine whether it is the result of reduced fertilization rate or early embryonic death, or a combination of both. The best explanation as to the cause would appear to be the added stress of repeated harrassment of the gilts by the boars running with the lot mated gilts. This is given support by the results obtained in Trial 3 in which the gilts were placed in the boar lot for 5 minutes on each of the first 5 days after the last day of heat. The largest difference between treatments in both number of embryos and percent survival was observed in the gilts in this trial and they were the gilts that should have been under the greatest stress during and soon after heat.

Season apparently had no or little effect on embryo survival in this study since the average survival for all gilts in each trial varied very little among the three trials. These averages were: Trial 1, 74.2 percent; Trial 2, 76.0 percent; and Trial 3, 75.8 percent. It must be considered, however, that in no trial was breeding carried out during the summer. It is tempting to speculate that even wider differences would have occurred had this been done.

There was no consistent difference in embryo survival associated with age of the gilts at time of breeding (Table 3). In the hand mated group, survival is comparable in the oldest and youngest groups, but much lower in the middle one-third. In the lot mated group the best survival occurred in the youngest group, with the middle and oldest groups approximately the same.

When the embryo survival of gilts of different weights are compared (Table 4) there is a similar pattern in both treatments. The heaviest and the lightest groups have comparable survival, and both are definitely superior to the middle weight group.

The effect on embryo survival associated with age and weight of gilt at breeding is not clear cut. Just what importance to place on it, if any, is not known. The differences do not give any reason for changing the recommendation that if a producer plans to breed only a part of his gilts during a given season he should pick the older, heavier gilts. The advantage in favor of the oldest gilts over the youngest gilts in number of embryos was 1.6 embryos in the hand mated and 1.2 embryos in the lot mated group. This advantage was observed even though the youngest group had a slightly higher survival rate. The advantage in favor of the heaviest one-third compared to the lightest one-third of the gilts was 1.3 embryos in the hand mated and 1.6 embryos in the lot mated group.

The economic importance of level of embryonic death loss and its subsequent expression in litter size is very evident in the data presented in Table 3. The middle one-third of the hand mated group averaged ovulating 1.3 eggs more than did the youngest one-third, yet, because of a much higher rate of mortality, had 1.2 fewer embryos. In the lot mated group the middle group on age averaged 1.9 more eggs than did the youngest group, but lost almost all of this advantage because of a higher mortality rate resulting in an advantage of only 0.1 embryo at time of slaughter.

The results obtained in this study appear to justify reaching a rather general conclusion. The most logical reason for the poorer embryo survival in the lot mated gilts was the increased stress placed on these gilts at an apparently critical time. This suggests that the swine producer should critically examine his program to determine whether conditions of stress are being placed on gilts at, or near, time of breeding. It would appear that every effort should be made to eliminate all but the most necessary handling or disturbing of gilts during, and for several weeks following, breeding.

Summary

There were small differences in the performance of hand mated and lot mated gilts in ovulation rate, length of heat and conception rate. There were highly significant differences in each of 3 trials in favor of the hand mated gilts in embryo survival for 30-40 days after breeding. The average survival rate for all trials for 30 hand mated gilts was 82.8 percent compared to 68.6 percent for 28 lot mated gilts. On the average the hand mated gilts had 1.8 more live embryos than did the lot mated gilts.

There was a consistent increase in ovulation rate with increasing age of the gilts. In the gilts in this study, ranging in age from approximately 8 to 12 months of age, each increase of 6 weeks in age was accompanied by an increase of 1.0 egg in ovulation rate.

Effect of Teasing on Mating and Lambing Performance of Spring-Bred Ewes

A. A. Ovejera, J. V. Whiteman, M. B. Gould and F. A. Thrift

Introduction

By restricting the breeding period, and, consequently, the lambing period, the efficiency of the sheep operation can be increased. To accomplish this without the danger of a considerable number of ewes not being bred, it is necessary that the majority of the ewes in the flock, if not all, should come into heat at about the same time or within a relatively short period of time.

The breeding season for the experimental flock at the Fort Reno Livestock Research Station starts each year on or about the 21st of May and continues for 40 days. Figure 1 illustrates the pattern of the occurrence of the first estrus of the ewe flock. The figure shows that every day throughout the 40-day breeding season there are ewes exhibiting their first estrus. Most of the ewes exhibit heat and mate during the first four weeks of the breeding season. Some advantages could be gained if this breeding period could be reduced to three weeks or less which means that all ewes should come in heat within this period.

Various methods have been tried by other workers to control the time of sexual receptivity of ewes. This study was undertaken to determine the effect of teasing the ewes with vasectomized rams before breeding on their mating and subsequent lambing performance.

Materials and Methods

Before the 1965 breeding season, the flock of 315 ewes was equally divided into two groups according to breed, age, and previous year's lambing performance. The ewe flock was composed of 2 to 8 year-old Rambouillet[1], Dorset x Rambouillet, Rambouillet x Merino, and Panama. One group of 157 ewes was run with vasectomized rams for eight days beginning 16 days before the start of the breeding season. The other group of 158 ewes served as a control. If teasing the ewes with vasectomized rams before breeding had no influence on their mating pattern and subsequent lambing, then the two groups should have about the same performance.

At the start of the breeding season fertile rams were introduced into the teased and control groups. The fertile rams were equipped with marking harness. The ewes were observed once or twice daily and those with fresh marks were recorded as mated. Mating records obtained in this manner are not perfect: a few ewes are mated but not marked, and other ewes are marked but not mated.

---

[1]These ewes were of predominantly Rambouillet breeding but a few had as much as one-fourth Panama, Columbia or Corriedale breeding.

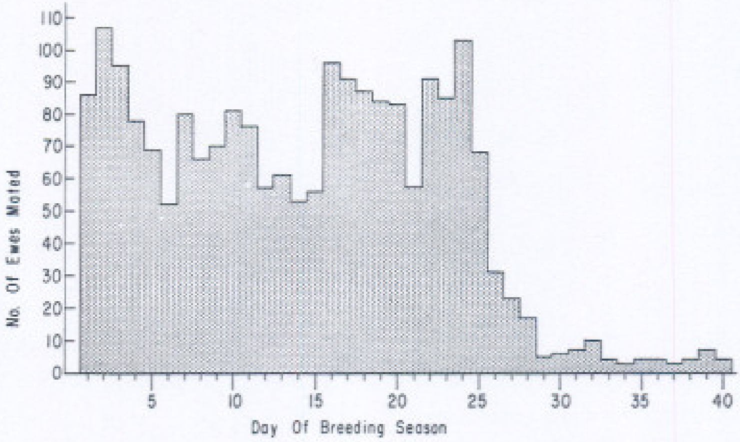

Figure 1. Pattern of the occurrence of first estrus of the ewes in the flock at the Fort Reno Livestock Research Station. Data include mating records of more than 2000 ewes over several years.

At lambing, lambing date and number born were recorded for each ewe. Lambing dates were checked back to mating dates to determine to which mating the ewes conceived. Mating dates of ewes that lambed with no recorded matings were estimated based on a 147-day gestation period.

Results and Discussion

The first estrus mating patterns for the teased group and control group are presented in Figures 2a and 2b. It appears from the histogram that a great majority of the ewes in the teased group mated during the first ten days of the breeding season, while in the control group most matings occurred during the first three and one-half weeks. Apparently the presence of teaser rams in the teased group before the breeding season caused some of the ewes to exhibit estrus earlier such that most of them mated within the first ten days of the breeding season.

In the control group some of the ewes exhibited their first estrus mating during the first two weeks of the breeding season but an even greater number mated first during the next ten days, especially during the 15th to 19th days of the breeding season. This indicates that there was probably a stimulating effect that occurred soon after the fertile rams were joined with the ewes, but most of the ewes did not exhibit estrus at that time. Nevertheless, they exhibited estrus one cycle later and were mated. This accounts for the great number of ewes mated during the 15th to 19th day period.

Figures 3a and 3b show the conception pattern of the two groups by day of breeding season. Comparing these to Figures 2a and 2b will indi-

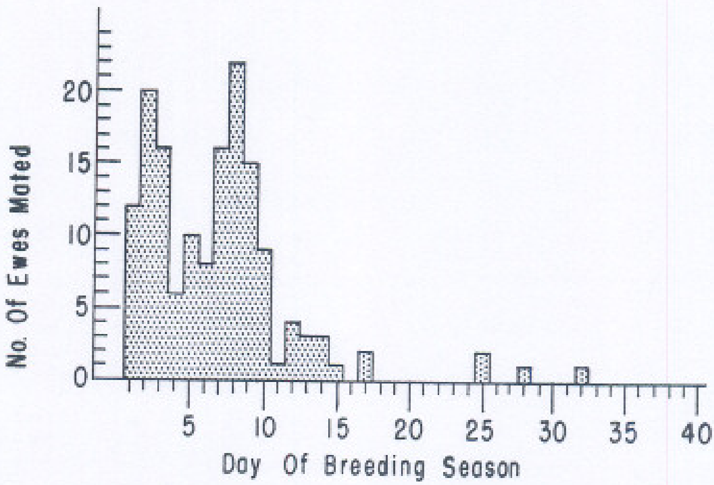

Figure 2a. Histogram illustrating the first estrus mating pattern of the teased ewes.

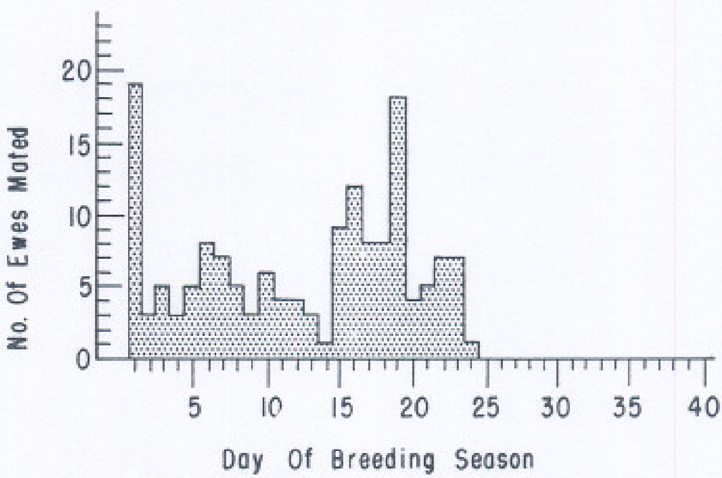

Figure 2b. Histogram illustrating the first estrus mating pattern of the control ewes.

cate that most of the matings during the first ten days of the breeding season for the teased group are relatively fertile or successful matings; that is, most of the ewes that mated during this period conceived to such matings. On the other hand, most of the control ewes that mated during

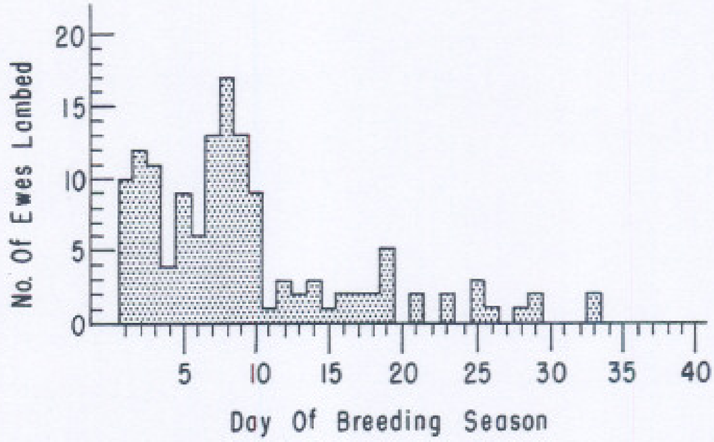

Figure 3a. Histogram illustrating conception pattern of the teased ewes.

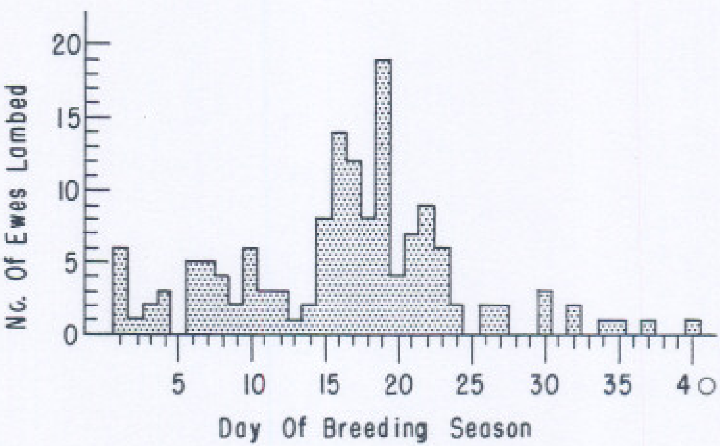

Figure 3b. Histogram illustrating conception pattern of the control ewes.

the first few days of the breeding season failed to conceive. Apparently, upon the introduction of the rams to the ewe flock some ewes were sexually receptive but their fertility was poor. Most of these ewes that did not conceive were bred during their next cycle and lambed, as indicated by the high number of ewes conceiving to matings that occurred during the third week.

The lambing performance of the two groups of ewes are summarized in Table 1. The 40-day breeding season was divided into four ten-day periods to see which period is most efficient or in which period the most conceptions out of the first estrus matings occurred and the most twins produced. In the teased group, 103 out of 134 ewes that mated first during the first ten days of the breeding season, or 76.9 percent, conceived to such matings. The corresponding figure for the control group is 34 out of 64 or 53.1 percent, which is considerably lower. During the next ten-day period 85.7 percent of the teased ewes that mated first during this period conceived to such matings while 84.5 percent of the control ewes that mated first during this period conceived to such matings. In the teased group only four ewes mated first during the last twenty days. In the control group 20 ewes mated first during the third ten days and 18 ewes or 90.0 percent conceived to such matings.

Lambing rate was measured as the average number of lambs born per hundred ewes lambing. In a given group of ewes, a higher figure indicates a higher incidence of twinning. The control group had consistently higher lambing rate than the teased group. This indicates that teasing before breeding had no beneficial effect on lambing rate and may have actually reduced it.

In both groups, the first estrus conception rate was higher for ewes that mated during the latter part of the breeding season than during the first ten days. Although the number of animals involved in some of the categories was too few to give conclusive evidence, it appeared that con-

Table 1. Lambing Performance of the Teased and Control Ewes.

	Teased Group	Control Group
No. of ewes	157	158
First 10 days[1]		
No. first estrus matings	134	64
No. conceptions	103	34
Lambing rate[2]	149.5	164.7
Second 10 days[1]		
No. first estrus matings	14	71
No. conceptions	12	60
Lambing rate[2]	141.7	158.3
Third 10 days[1]		
No. first estrus matings	3	20
No. conceptions	2	18
Lambing rate[2]	100.0	150.0
Last 10 days[1]		
No. first estrus matings	1	0
No. conceptions	0	0
Lambing rate[2]	0	0
Total first estrus conceptions	117	112
Lambing rate[2]	147.9	158.9
No. second estrus conceptions	20	29
Lambing rate[2]	130.0	131.0
Third estrus conceptions	1	1
Lambing rate[2]	100.0	100.0
No. not lambing	14	13
No. not mated	5	3

[1] Of the 40-day breeding season

[2] No. of lambs born per hundred ewes lambing

ception rate was low at the start of the breeding season when the ewes were coming out of anestrus and increased toward the latter part of the breeding season.

The most twins in both groups were produced from the matings that occurred during the first ten days of the breeding season as shown by the higher lambing rate. The lambing rate in the teased and control ewes that mated during the first ten-day period were 149.5 and 164.7 respectively. Lambing rate was lower for ewes that conceived to matings later in the season. This trend is typical of the ewe flock at the Fort Reno Livestock Research Station as shown by the following summary which includes more than 1800 mating and lambing records over several years:

Period of the breeding season	No. of ewes	Lambing rate
First 10 days	482	145.2
Second 10 days	670	139.3
Third 10 days	568	132.6
Last 10 days	103	135.9

Lambing rate was higher for ewes that conceived to first estrus matings than for ewes that conceived to return matings in both groups. Lambing rates were 147.9 and 158.9 for the teased and control ewes respectively that conceived to their first estrus matings. For the teased and control ewes that failed to conceive to their first estrus matings and had second estrus matings, lambing rates were 130.0 and 131.0 respectively.

Summary

About one-half of the flock of 315 ewes was teased with vasectomized rams for 8 days beginning 16 days before the 1965 breeding season (May 21-June 29) to determine the effect of teasing on mating and lambing performance. The other half served as a control.

Teasing before breeding brought about the occurrence of estrus in most of the ewes during the early part of the breeding season. As such, the teased ewes mated earlier and within a shorter period than the control ewes. Relatively more teased ewes had successful or fertile matings during the early part of the breeding season compared to control ewes. Lambing rate was higher for the control ewes which indicated that teasing had no beneficial effect on lambing rate and may have actually hurt it.

In both groups, conception rate was low at the early part of the breeding season and tended to increase toward the latter part. On the other hand, lambing rate was the opposite, that is, lambing rate was relatively high for ewes that conceived to matings that occurred during the early part of the breeding season and low for those that conceived to matings during the latter part. Lambing rate was higher for ewes that conceived to their first matings than for ewes that conceived to return matings.

Some Relationships Between Lamb Growth and Carcass Composition and Among Various Measures of Carcass Merit

Joe V. Whiteman, Lowell E. Walters, and A. W. Munson

There has been an ever increasing interest among stockmen in the real merit of their end product—the carcass. This is as it should be. Whatever changes are made either to improve animals through breeding or to improve efficiency of production through changes in feeding or management should not reduce the value of the carcass and, preferably, should increase it.

One of the principal difficulties encountered by stockmen and research men alike in relation to improving carcasses has been with regard to measurements of carcass value. There are many measurements that have been used. Some measure one characteristic of the carcass, others measure other characteristics. Some are good measures, others are not. Some are of interest to one segment of the industry, others to different segments. Some are very expensive to obtain, others are cheaper. In many instances the relationships among the measurements are not known or are different for different groups of carcasses.

Much of the criticism that has been directed toward the judging of our fat stock shows has arisen because the placing of the live animals did not agree with the carcass placing. Such critics have assumed that the carcass placing has been correct. It may not have been. While it is true that there are certain characteristics that can be best evaluated by an examination of the carcass, there are other characteristics that can be best evaluated in the live animal.

To solve this problem the cattle and sheep producers and research personnel should follow the example of the swine industry. Over twenty-five years ago it was discovered that a relatively simple measure on the swine carcass was a good predictor of carcass fatness. By associating live animal evaluations with this and other carcass measurements, research men, judges and producers changed their ideas of what constituted a good animal. Currently the industry is making rapid strides in really improving pork carcasses. The beef and sheep industries have been trying to follow their lead but have both encountered the same problem—a good carcass measurement.

With these ideas and problems in mind, the Animal Science Department started a study in 1962 to:

1. Develop easily obtained measures of lamb carcass merit.
2. Determine the relationships among the measures.
3. Associate the development of muscle, fat and bone in the carcass with growth and fattening patterns of the live lambs.
4. Determine detectable live lamb characteristics that are indicative of carcass excellence.

There were many reasons for selecting lambs as experimental animals.

1. To the best of our knowledge, lamb and beef carcasses develop similarly and are comparable in structure and composition. They differ principally in size.
2. To obtain the desired accuracy of certain measurements requires reducing the carcass to ground meat resulting in a per carcass loss of $10.00 for lambs or $100.00 for steers. Hundreds of carcasses are required to learn the desired answers.
3. Lambs of known origin and with complete records of growth were available.

The results from the study can be checked with relatively few cattle carcasses to determine their applicability. This paper presents some results of this continuing study.

Materials and Methods

The 124 wether lambs used in this study were produced and raised at the Ft. Reno Livestock Research Station. The ewes that produced the lambs were of predominantly Rambouillet breeding or were crosses between these ewes and Dorset rams. The lambs selected for slaughter were one-half black faces (out of Hampshire or Suffolk rams) and one-half white faces (out of Dorset rams.) One-half of the lambs by each sire were singles and one-half were twins.

The lambs were born between October 15 and November 25. They were moved with their dams to wheat pasture when they were about 10 days old. Creep feed was available to them at all times thereafter. When the lambs were about 10 weeks old, they were weaned by the removal of their dams. From weaning until slaughter they were self-fed while grazing on wheat pasture.

As the lambs approached 100 pounds full weight, they were weighed weekly. When a lamb weighed 100 or more pounds, he was hauled to the meat laboratory at Oklahoma State University. He was slaughtered about 18 hours after his Ft. Reno full weight was taken and during which time he had no feed nor water, was hauled 100 miles and was sheared. Thus, the slaughter weight was a thoroughly shrunk weight of a fresh sheared lamb.

The carcasses were allowed to chill for about 48 hours before chilled weights were taken at which time the carcasses were processed and further measurements recorded. Although about 65 measurements were taken on each carcass, only those in Table 1 will be considered in this paper. These include many of the commonly used measurements plus some that in this study appeared to be better measurements of some characteristic of the carcasses.

Table 1. A Summary of the Measures of Growth and Carcass Merit of the Lambs Used in the Study.

Measure	Mean[1]
Birth weight (lb.)	9.3
Av. daily gain to 10 wks. (lb.)	0.63
Av. daily gain after 10 wks. (lb.)	0.57
Wt./da./age at slaughter (lb.)	0.66
Shrunk live weight (lb.)	90.6
Dressing percentage (Percent)	56.6
Ether extract (Percent)	28.9
Total carcass fat (lb.)	14.9
Loin fat trim (lb.)	2.6
Wholesale cut fat trim (lb.)	6.9
Fat at 12th rib (in.)	0.25
Quality score	11.4
Carcass Lean (Percent)	54.7
Total carcass lean (lb.)	28.0
Edible wholesale cut (lb.)	28.1
Ratio, lean to bone (lb.)	3.31
Conformation score	11.9
Specific gravity, hind	1.037
Loin eye area (sq. in.)	2.31
Trimmed wholesale cuts (Percent)	37.6
Carcass bone (percent)	16.4
Total bone (lb.)	8.4

[1] Mean = Average

The following measurements may need some explanation:

1. Ether extract—this is a measure of the percent fat in the carcass obtained by grinding the bone free portion, sampling the mixture and chemically determining the fat content.
2. Loin fat trim—this is the weight of fat trimmed from the loin. In this study it was the best measure of fat in the carcass other than ether extract which requires grinding the whole carcass.
3. Quality and conformation scores were given values prime + = 15; prime = 14; prime — = 13; choice + = 12; etc. These carcasses were scored by a highly qualified grader.
4. Carcass lean (Percent)—this measure was obtained by difference, that is, 100 percent minus percent ether extract minus percent bone = percent lean.
5. Edible wholesale cut—this was the pounds of shoulder, rack, loin and leg after all external fat was trimmed off and the bone was removed.
6. Ratio of lean to bone—pounds of lean per pound of bone. The idea here is that the amount of fat in a carcass is controllable by feeding methods or when the animal is removed from feed and marketed. The ratio of lean to bone is more likely to be bred into the animal.
7. Specific gravity, hind—this is a measure of the density of the hind saddle (the hind saddle of a lamb is essentially the same as the two hind quarters of a beef carcass.) Since fat is lighter than water, the fatter carcasses have lower specific gravities. This was

one of the best measures of either percent fat or percent lean in the carcasses.

Results

In reviewing these results, a very important consideration should be kept in mind. The lambs were killed at very similar live weights. Thus, carcass weights were very uniform. Herein these results are or may be different than those usually obtained with beef carcasses and frequently obtained with lamb carcasses. If animals are slaughtered such that live and carcass weights vary widely, there are automatic associations in the results that cause confusion. Larger carcasses will frequently have larger rib-eye areas, more fat, and more lean because they are larger. Thus, any measurement involving area, distance, or weight of some part is usually associated with carcass weight. Carcasses are sold by the pound and, consequently, percentages of the tissues (fat, lean and bone) may be more indicative of value per pound. Figure 1 illustrates schematically how the carcass develops from birth until about 30 percent fat is deposited.

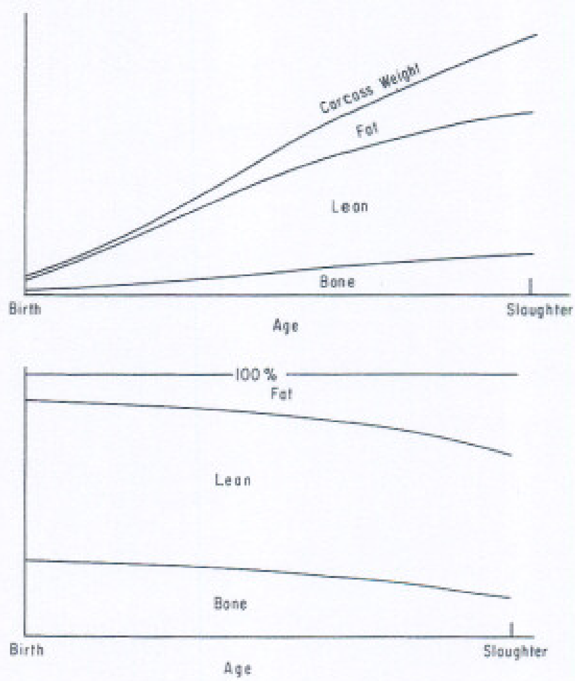

Figure 1. Schematic representation of carcass development in pounds (top) and in percentage (bottom).

In each case the carcass develops until it is about 16 percent bone, 54 percent lean and 30 percent fat. In the upper figure, normal carcass development is depicted where the upper curved line represents carcass weight and the space between the lines represents the principal tissue at different ages. Bone growth is relatively constant throughout. Lean development is rapid early but slows down toward the end. Fat deposition starts slowly but is increasing rapidly toward the end. All tissues are still increasing at the end so that if the animal is allowed to get bigger, the amounts of fat, lean, and bone will all increase.

In the lower figure where the top line represents 100 percent of the carcass, it can be seen that as the animal gets older and fat deposition increases, the percentages of both lean and bone must decrease.

The lamb carcasses used in this study are probably comparable in their relationships to what would be found in beef carcasses if calves were creep fed, weaned at about 175 days of age, put on a full feed and slaughtered at about 700 pounds.

Single vs twin lambs. One of the principal sources of variation in lamb growth rate is associated with whether a lamb is born and raised as a single or as one of a set of twins. On the average single lambs are genetically similar to twins and differences in growth rate are principally due to the fact that twin lambs usually get only about 65 percent as much milk as singles. Consequently, an analysis of the carcasses from singles as compared to twins should reflect the influence of milk during early life on carcass composition.

Table 2 shows the comparison of single and twin lambs for growth measures and certain carcass characteristics. The single lambs were 1.7 pounds heavier at birth, gained .14 pounds per day more up to 10 weeks of age (approximate weaning age), and gained only slightly faster after 10 weeks than the twin lambs. The average slaughter age was 148 days for singles and 171 days for twins.

The carcass measures indicate that the single lambs had less fat and more bone than the twins. The single and twin lambs had similar average values for lean tissue, percent trimmed wholesale cuts, loin eye area, and hind saddle specific gravity. The twin lambs had more fat trim from the loin and a higher ratio of lean to bone than the singles.

There were enough lambs involved in this study to critically evaluate the difference between single and twin wether lambs when they are slaughtered at similar and realistic weights. The differences observed are interpreted to be primarily a result of the differences in milk consumption by the lambs. Since none of the carcass differences are very great, it seems logical to assume that milk consumption during early life has relatively little influence on carcass composition when the lambs are slaughtered at similar weights.

Type of sire of lambs. It has been established that animals with a larger mature size exhibit a slightly different growth pattern than those with a smaller size. For this reason one-half of the lambs used in this

Table 2. Growth Rate and Carcass Composition of Single and Twin Lambs.

Characteristic	Singles	Twins
Number	62	62
Birth Weight (lbs.)	10.1	8.4
Av. Daily gain to 10 wks.	.70	.56
Av. Daily gain (10 wks. to sl.)	.58	.56
Dressing percentage	56.4	56.8
Ether Extract (Percent)[1]	28.5	29.2
Lean tissue (Percent)[1]	54.8	54.7
Bone and tendons (Percent)[1]	16.7	16.1
Trimmed wholesale cuts (Percent)[2]	37.6	37.6
Loin fat trim (lb.)	2.46	2.66
Fat at 12th rib (in.)	.24	.26
Loin eye area (sq. in.)	2.31	2.32
Specific gravity, hind	1.036	1.036
Ratio of lean to bone	3.25	3.36

[1] Based on chilled carcass weight.
[2] Based on shrunk, sheared live weight. Cuts are shoulder, rack, loin and leg.

experiment were sired by Hampshire and Suffolk rams (relatively large) and one-half were sired by Dorset rams (relatively small.) Although a few Dorset (whiteface) rams were larger than the smallest Hampshire and Suffolk (blackface) rams, the blackfaced rams averaged considerably larger than the whitefaced rams.

The results in Table 3 illustrate the influence that the type of sire can transmit to his offspring. Relative to the growth pattern, the type of sire had little influence on either birth weight or early growth rate. The size of the newborn is largely governed by the size of the dam and her nutritive state. The rate of early growth is mostly governed by the milk supply. The blackfaced lambs gained considerably faster from 10 weeks until slaughter. Since the lambs were weaned at about 10 weeks of age, their inherited capacity for gain came into play and could be exhibited. It should be remembered that both kinds of lambs had the same kind of mothers so that the differences shown in Table 3 are the influence of their sires.

A study of the carcass characteristics in Table 3 indicates that the whitefaced lambs had a higher dressing percentage, more ether extract (fat), more loin fat trim, and more fat at the 12th rib than the blackfaced lambs. All of the above measures are either measures of fat or are influenced by fat. Apparently, as is generally believed, the whitefaced lambs increase their fat deposition (Figure 1) at a lighter weight so that at 100 pounds live weight, they have deposited more fat than the blackfaced lambs.

The blackfaced lambs had more lean and bone which was also reflected in higher specific gravity values. It should be noted that neither percent trimmed wholesale cuts nor loin eye area showed a difference between the whiteface and blackfaced lambs. Their value in predicting carcass composition has been questioned before. They have some predictive value but, as this data indicates, they are not good indicators.

Table 3. Growth Rate and Carcass Composition of Whitefaced (Dorset Sired) and Blackfaced (Hampshire or Suffolk Sired) Lambs.

Characteristic	Whitefaced	Blackfaced
Number	62	62
Birth weight (lb.)	9.2	9.3
Average daily gain to 10 wks.	.63	.63
Average daily gain (10 wks. to sl.)	.54	.61
Dressing percentage	57.1	56.1
Ether extract (Percent)[1]	30.1	27.7
Lean tissue (Percent)[1]	54.0	55.5
Bone and Tendons (Percent)[1]	15.9	16.9
Trimmed wholesale cuts (Percent)[2]	37.6	37.6
Loin fat trim (lb.)	2.68	2.44
Fat at 12th rib (in.)	.27	.23
Loin eye area (sq. in.)	2.32	2.31
Specific gravity, hind	1.035	1.038
Ratio of lean to bone	3.37	3.25

[1] Based on chilled carcass weight.
[2] Based on shrunk, sheared live weight. Cuts are shoulder, rack, loin and leg.

This portion of the study indicates that sires may rather strongly influence the percentages of fat, lean, and bone of their progeny where such progeny are killed at about the same weight. This probably comes about through transmitted tendencies to start rapid fattening at different sizes as the lambs grow and also through transmitted ability to grow lean tissue at different rates. A lamb with great inherited ability to grow lean and bone tissue will probably reach 100 pounds before he has time to deposit much fat. On the other hand a lamb with poor lean and bone growth potential will have time to deposit more fat before reaching 100 pounds. Inherited ability to fatten and inherited ability to grow both influence growth rate and carcass composition. Consequently, the association between growth rate and carcass composition is not high as shown in Table 4.

The size of the correlation (whether + or —) between two measures is an indication of how precisely one may be predicted from the other. None of the correlations in Table 4 are high enough to have good predictive value.

Evaluation of measurements. As suggested in the introduction, there is a great need for measurements which will accurately tell something about a carcass. No single measurement will give good information about the several carcass characteristics that are of interest to different people. This study attempted to find good indicators of the percentages of fat, lean, and bone in the carcass. If a measure will give a good prediction of percent fat, the percent value multiplied times the carcass weight will give the amount of fat.

These data were analyzed to determine the association (correlation) between several measures and the composition of fat, lean and bone. The study was conducted in such a way that the values given in Table 5 represent the associations that one would expect to find among lamb car-

Table 4. Correlation[1] Between Measures of Rate of Gain and Measures of Carcass Composition.

Measures of composition	Birth Wt.	Measures of Rate of Gain A.D.G. to 10 weeks	A.D.G. after 10 weeks
Ether extract (Percent)	—.48	—.25	—.22
Lean tissue (Percent)	.44	.04	.18
Bone and tendons (Percent)	.49	.29	.33
Loin eye area (sq. in.)	.15	.18	.07
Loin fat trim (lb.)	—.40		—.38
Trimmed wholesale cuts (Percent)	.14		—.10
Fat at 12th rib	—.25		—.13

[1] These associations are what would be found among lambs of the same face color and rearing category.

casses from wether lambs of the same face color and the same birth and rearing category. If a measure is to be a good one, it must detect differences among carcasses that are reasonably uniform as would be found in these data handled as described.

An examination of the correlations in Table 5 indicates that the same measure does not show the same relation to the percentages of the three tissues. The percent ether extract was best estimated by the wholesale cut fat trim, loin fat trim, or specific gravity of the hind saddle. It should be noted that thickness of fat at the 12th rib (a standard measure) had only moderate predictive value. None of the other measures were of much value in predicting percent ether extract.

Percent lean was best estimated by the same measures as percent ether extract, that is, wholesale cut fat trim, loin fat trim, and the specific gravity of the hind saddle. (The fact that some of the correlations are negative does not influence the predictability of the measure). It should be noted that the size of the rib eye (another standard measure) has low predictive value. None of the other measures were good predictors.

Percent bone was best predicted by the weights of the four cannon bones. This has been reported by other workers and was not surprising. None of the other measures were nearly as good as the bone weight. Since these bones can be cut from a carcass for weighing without materially influencing the value of the carcass, it can be a valuable measure of bone where such is needed.

A few other relationships are worthy of note. Quality score, which is our best evaluation of marbling, was not highly associated with any of the carcass component percentages. It should be kept in mind, however, that these carcasses were from full-fed lambs and were all adequate in quality.

Conformation score, which is an evaluation of the shape of the carcass, was almost if not completely unrelated to the percentages of ether extract and lean. Trimmed wholesale cuts, as a percentage of live weight, was a poor indicator of carcass composition as was edible wholesale cut weight.

Table 5. Correlations of Several Measures with Carcass Composition, i.e., the Percentages of Fat, Lean, and Bone.

Measures	Carcass Composition Percent E.E.	Percent Lean	Percent Bone
Dressing percentage	.40	—.38	—.57
Wholesale cut fat trim (lbs.)	.75	—.69	—.62
Loin fat trim (lbs.)	.75	—.69	—.63
Fat 12th rib (in.)	.59	—.55	—.46
Quality score	.32	—.26	—.38
Edible wholesale cuts (lbs.)	—.14	.16	—.11
Ratio, lean to bone (lbs.)	—.04	.23	—.47
Specific gravity, hind	—.70	.69	.60
Loin eye area (sq. in.)	—.35	.37	.03
Conformation score	.07	.01	—.22
Trimmed wholesale cuts (Percent)[1]	—.26	.27	—.05
Wt. of cannon bones (gm.)			.81[2]
Total carcass lean (lbs.)[3]	—.70	.74	.21
Total carcass fat (lbs.)[3]	.92	—.91	—.70
Total carcass bone (lbs.)[3]	—.47	.32	.84

[1] Based on shrunk, sheared live weight.
[2] This correlation is based on only one year's data involving 64 carcasses.
[3] These should not be considered as predictors because they are as difficult and expensive to obtain as the percentages of ether extract, lean, and bone.

The ratio of lean to bone was essentially independent of percent ether extract. This means that muscular lambs can be lean or fat as can nonmuscular lambs and apparently the various combinations occur about equally often. The ratio of lean to bone was associated with the percentages of lean and bone, but it had to be, because it was calculated from the pounds of these tissues. The values were not high, however. The ratio of lean to bone was not intended to be a measure that one would use to estimate carcass composition. Rather, it was intended to be an index of carcass composition.

More lambs are being slaughtered each year in this continuing study. It is hoped that better measures than those reported herein will be found or that two or more of these measures can be combined to give even better estimates. The increased data will also permit a further evaluation to determine whether the measurements that appeared best in this study are still best when evaluated on separate independent carcasses.

Summary

The carcasses from 124 wether lambs were studied. One-half of the lambs were sired by growthy, blackfaced (Hampshire or Suffolk) rams and one-half by earlier maturing whitefaced (Dorset) rams. Further one-half of the lambs by each sire were single born and reared lambs and the other one-half were twins. The lambs were creep fed while nursing their mothers; weaned at about 10 weeks of age; and full-fed to slaughter weights of 100 pounds.

A comparison of the carcasses from the single and twin lambs indicated that the slower early growth of the twin lambs due to a smaller milk

supply was not associated with appreciable differences in carcass composition. The twins were slightly fatter and had less bone.

The growthier blackfaced rams sired lambs that grew faster after weaning and produced carcasses with more lean and bone than the lambs from the whitefaced rams. Since the carcass composition values used were percentages, the blackfaced lambs with more bone and lean automatically had less fat than the whiteface lambs.

A study of the association of measures of growth with carcass components (fat, lean, and bone) indicated low associations generally. Lambs that were heavier at birth had less fat and more lean and bone in the carcass when slaughtered than lambs with lighter birth weight.

The lambs that gained faster from birth to 10 weeks (those that got more milk and for other reasons) had less fat and more bone than slower gaining lambs. The lambs that gained faster from 10 weeks of age to slaughter weight tended to have less fat, more lean and more bone than the slower gaining lambs but the associations were all low.

Percent fat in the carcass was best estimated by wholesale cut fat trim, loin fat trim or specific gravity of the hind saddle. The same measures were the best predictors of percent lean. Percent bone was best predicted by the weight of the cannon bones. None of the measures were good enough as predictors to be classed as excellent but they were all substantially better than some that are traditionally used such as loin eye area, fat thickness at the 12th rib or wholesale cuts as a percent of the live weight.

The study is continuing and it is hoped that better measures or better combinations of measures will be found. Preliminary work with combinations of some of these measures show real promise of improved predictability.

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

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

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

The amount of supplemental feed required is of economic importance in terms of feed cost as well as the ultimate influence on 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 six calf crops.

Experimental Procedure

One hundred twenty weaner heifer calves were selected from the Ft. Reno herd as experimental animals and started on tests 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 lbs. 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 lbs. per head daily during the first winter as calves, then less than 10 percent loss of 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.

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 as 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 with supplemental feeds as necessary to produce the desired weight change.

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 which was estimated periodically during the lactation period 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 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 reveals the number of cows remaining after six calf crops, the percentage remaining in the herd and the reasons

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 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	738	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
6	84 Spring	874	981	1132	1374	976
	90 Fall	1146	1182	1262	1372	1172

Table 2. Supplemental Feed Provided Per Cow For Each Level of Wintering During the Seven 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	6154		249	—
6	80		258	34	242	569	6371		262	62
							CSC	Milo		
7	61		236	—	291	699	224	672[3]	252	--

[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.
[3] The cows on the very high level received 867 lb. of mixed ration during the first month of the seventh winter.

for removal. Cows were culled from the herd on the basis of health or failure to conceive for two successive years. Percentage of cows remaining in the herd suggests 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 warranted.

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

Table 3. Reasons for Removal of Beef Cows Wintered at Different Levels Through Six Calf Crops.

Lot No.	1	2	3	4	5
Winter Level	Low	Moderate	High	Very High	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 remaining	25	26	24	11	12
Percent of cows remaining—	83.4	86.7	80.0	73.3	80.0
Cause for Removal:					
Death					
Calving Difficulty	1			3	
Impaction of Abomasum	1				
Brain Abcess		2			
Uterine Infection		1			
Cause Unknown	1		2		
Culled					
Open 2 Successive Years	1		4		1
Hardware Disease		1			
Poor Condition	1				
Cancer Eye					1
Foundered					1
Uterine Prolapse				1	
Total	5	4	6	4	3

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. The very high level does not appear to have improved this particular characteristic.

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 the first four calf crops, however, the widest differences occur in the case of the second calf crop. Level of winter feed appeared to have no consistent effect upon calving date after the fourth calf crop. The long term average birth weight of 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 six 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 are intermediate with respect to those observed for the low and moderate treatments. Figure 2 shows graphically the performance for all groups of cows in this regard with marked difference occurring in the first two

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

Lot No.	1 Low	2 Moderate	3 High	4 Very High	5 VHM
No. of heifers started on test (1957-59)	30	30	30	15	15
No. of cow remaining after six calf crops	25	26	24	11	12
Average calving date (month/day)	3/16	3/9	3/2	3/4	3/4
Average birth wt., lbs.	74	77	79	74	77
Percent calf crop weaned per cow bred	86.3	87.0	86.4	81.0	83.3
Total lbs. calf weaned					
Non-corrected	57,765	66,675	64,145	28,280	31,060
Sex corrected	59,257	68,761	65,837	29,096	32,000
Age & sex corrected	60,171	67,601	64,077	28,497	31,436
Average lbs. of calf weaned					
Non-corrected	416	454	479	442	444
Sex corrected	426	468	491	455	458
Age & Sex corrected	433	460	478	445	449
Average milk production (lbs. daily)	10.4	12.0	12.2	10.3	10.3
Total supplement cost for the seven wintering periods ($ per cow)	17.74	83.24	186.14	710.59	298.94

calf crops. However, the difference narrows considerably beyond this point. It is interesting to observe that the females developed at the low and moderate levels have improved steadily throughout the period. However, heifers developed at the high and very high levels appear to reach a peak in pounds of calf weaned at the second calf crop and more or less maintain this level.

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 3 depicts the percentage calf crop observed for each of the six 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.

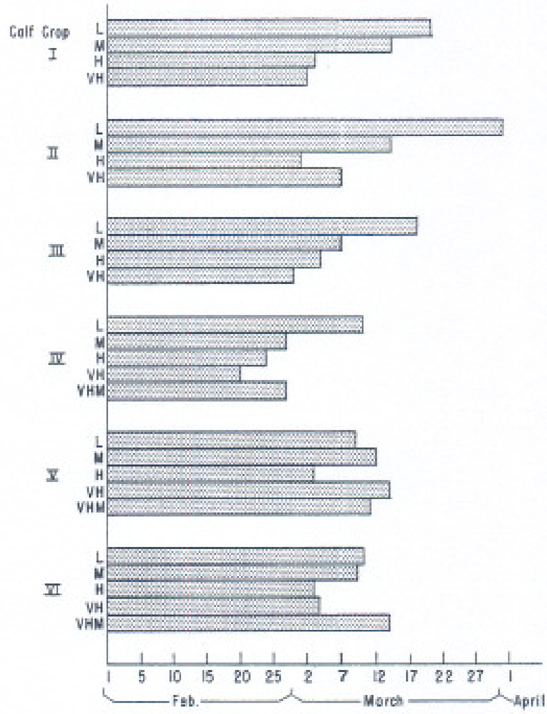

Figure 1. Influence of level of wintering on average birth date for successive calf crops.

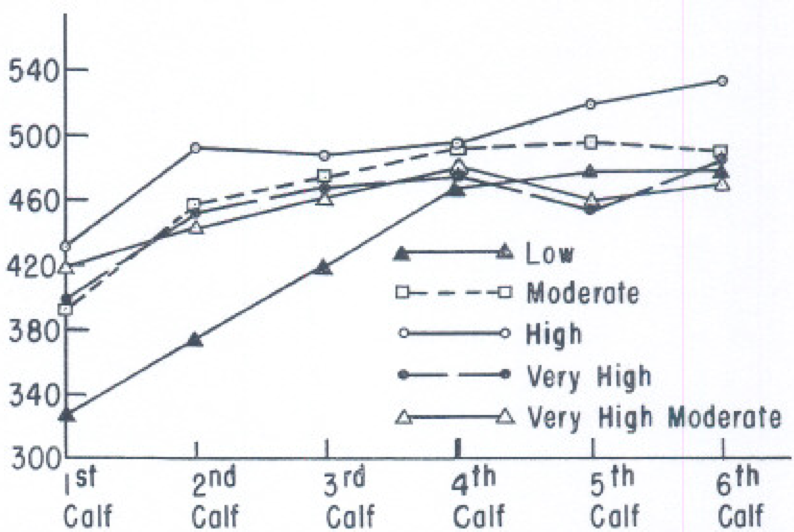

Figure 2. Average weaning weights (corrected for sex) of successive calf crops produced by cows wintered at different levels.

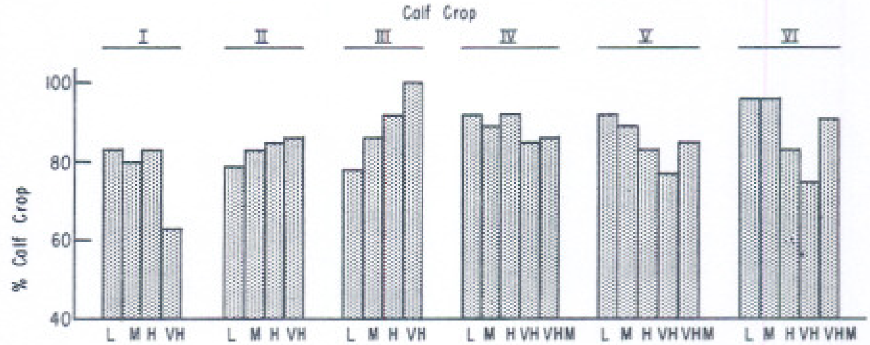

Figure 3. Influence of level of wintering on percentage calf crop weaned, based on cows exposed to bulls.

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 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 six 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 cow survival resulting from level of wintering are not conclusive at this point but the trend favors the moderate level. Development and maintenance of the beef females at a very high level reduced productivity below that observed for the more moderate levels. The results obtained by switching cows from a very high to moderate level indicates that the

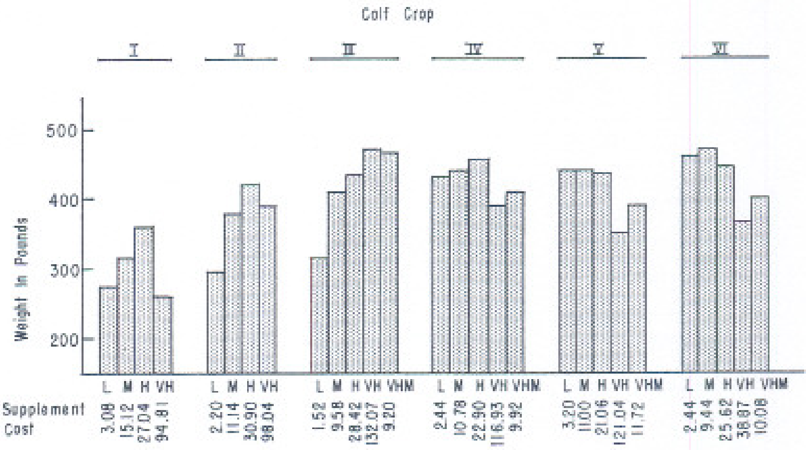

Figure 4. Influence of level of wintering on pounds of calf weaned per cow and supplemental feed cost prior to each calf crop.

damage to milk producing ability occurs early in life and is not corrected by lower levels after the third winter. Percentage calf crop was, however, improved by this treatment.

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.

A Study of Some Factors Affecting Feed Intake and Performance of Finishing Steers

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

High concentrate rations have been accepted by many Southwestern feeders as a suitable feeding program for finishing cattle. Associated with feeding a high concentrate ration is a characteristic reduction in total feed intake and in some cases a reduction in calculated caloric intake when compared with conventional rations. Since capacity of the digestive tract does not appear to be a reasonable explanation for this observed pattern of feed intake, interest is focused on more basic factors which may limit feed and energy intake.

Several theories concerning the regulation of feed intake have been proposed as a result of a series of studies. One of the main factors appears to be energy content or caloric density of the ration. Previous work indicates that the animal possesses mechanisms by which it can regulate energy intake when the fill or rumen load is not the limiting factor on intake. Other factors include bulkiness of the ration, end products of digestion and rate of passage.

A three-year study of some of the factors affecting feed intake of ruminants was initiated at this station in the fall of 1962. To date, five feeding trials have been conducted with steers to study the influence of ration density, bulk, and caloric source on feed intake. Trials 1, 2 and 3 were reported in the 1964 Feeder's Day Report[1], and the results of Trial 4 were reported in the 1965 Feeder's Day Report[2]. Results of the three-year study will be summarized in this report, and results of Trial 5 will be presented and discussed.

Three-Year Study

Milo served as the base grain for all rations used in the five feeding trials. The conventional rations contained 20-30 percent cottonseed hulls, while the high concentrate rations contained 95 percent concentrate with 5 percent alfalfa meal as the only source of roughage. These rations were modified by adding 5 percent stabilized animal tallow in order to study the effects of caloric source. Density and bulk effects were investigated by adding 16-20 percent sand and 13 percent inert polyethylene resin. All rations were fed free choice in self feeders.

The values presented in Tables 1 through 4 are averages of the number of comparisons indicated in the title of each table. Comparisons were drawn from five feeding trials. Estimated net energy values were calculated from published values.[3] Cutability scores are calculated estimates of the percent yield of boneless retail cuts[4].

HIGH CONCENTRATE vs. CONVENTIONAL RATIONS

Six comparisons of conventional and high concentrate rations are summarized in Table 1. Considering the average value, total feed intake was 21 percent greater with the conventional diet; however, daily concentrate intakes were similar for the two rations. Greater estimated net energy intake and higher average daily gain were obtained with the conventional ration. Feed efficiency expressed as total pounds of feed per 100 lbs. of gain favored the high concentrate ration, however, the

[1] Oklahoma Agricultural Exp. Station Misc. Pub. MP-74.
[2] Oklahoma Agricultural Exp. Station Misc. Pub. MP-76.
[3] Calculated from values in Morrison's *Feeds and Feeding*, 22nd Ed., Appendix Table 2.
[4] Calculated by the method of G.E. Murphey, D.K. Hallett, W.E. Tyler and J.C. Pierce. 1960. Estimating Yields of Retail Cuts from Beef Carcasses. J. Animal Sci. 19:1240. (Abstr.)

Table 1. Comparison of High Concentrate and Conventional Rations (Average of 3 comparisons)

	Type of Ration	
	Conventional	High Concentrate
No. of steers	16	16
Daily gain, lbs.	2.43	2.24
Daily feed intake, lbs.	27.87	21.99
Daily concentrate intake, lbs.	21.34	21.99
Est. daily net energy, megacal.	16.98	15.91
Total feed/100 lbs. gain, lbs.	1154	981
Concentrate/100 lbs. gain, lbs.	880	981
Carcass grade	choice—	choice—

amount of concentrates required per 100 pounds gain was 11 percent less when the conventional diet was fed. No important carcass differences were noted.

Data from this comparison indicates that some roughage in the diet may be necessary for maximum performance.

EFFECTS OF FAT ADDITIONS TO HIGH CONCENTRATE RATIONS

Results obtained when 5 percent stabilized animal tallow was added to high concentrate rations are summarized in Table 2. The addition of tallow reduced total feed intake and slightly increased estimated daily net energy intake. Average daily gain and feed efficiency favored the high concentrate ration without added fat. The feed efficiency patterns obtained in this comparison with high concentrate rations are opposed to results of fat additions to conventional rations. Most workers report an improved feed efficiency when 4-5 percent animal tallow is added to conventional finishing rations. Carcass grades and cutability scores were similar for both rations.

The data indicates that estimated daily net energy intake may be slightly increased by the addition of tallow to high concentrate rations; however, average daily gain did not parallel estimated net energy intake. Since rate of gain was not increased and since carcass cutability scores do not suggest important differences in composition it is doubtful if calculated net energy intake is a reliable measure of actual net energy consumption in this case.

EFFECTS OF SAND ADDITIONS TO CONVENTIONAL RATIONS

The results of four comparisons are summarized in Table 3. It appears that steers attempted to compensate for the sand additions by increasing total feed consumption; however, considering the average value, complete compensation for the nutrient dilution was not obtained. Daily concentrate intake and estimated net energy intake were slightly higher for the conventional ration without sand. Feed efficiency and daily gain also tended to favor the ration without sand.

Undoubtedly, sand acted as an energy diluent, and steers attempted to compensate for the dilution by increasing total feed intake. Improved

Table 2. Comparison of High Concentrate Rations With and Without 5 Percent Stabilized Animal Tallow (Average of 4 comparisons).

	Type of Ration	
	High Concentrate	High Concentrate + Tallow
No. of steers	19	20
Daily gain, lbs.	2.49	2.33
Daily Feed intake, lbs.	21.68	20.98
Est. daily net energy intake, megcal.	15.85	16.58
Total feed/100 lbs. gain, lbs.	884	904
Carcass grade	Good+	Choice−
Cutability score, percent	49.37	49.54

Table 3. Influence of Ration Density Increased by Sand Additions. (Average of 4 comparisons).

	Type of Ration	
	Conventional	Conventional + Sand
No. of steers	15	15
Daily gain, lbs.	2.53	2.39
Daily feed intake, lbs.	27.21	31.58
Daily concentrate intake, lbs.	21.05	20.17
Est. daily net energy intake, megcal.	16.51	15.92
Total feed/100 lbs. gain, lbs.	1086	1333
Concentrate/100 lbs. gain, lbs.	836	851
Carcass grade	Good+	Good+

feed efficiency due to physical stimulation of sand on the rumen lining is not evident in this data. In regard to the rations used in this comparison, it appears that density *per se* is not a limiting factor in feed intake of ruminants.

EFFECTS OF INERT BULK ADDITIONS

Data from inert bulk studies are presented in Table 4. Daily feed intake increased when 13 percent inert polyethylene resin was added to a high concentrate ration. Complete compensation for the nutrient dilution was not obtained since daily concentrate intake was higher for the ration without added polyethylene. Both daily gain and feed efficiency (pounds of concentrate per 100 lbs. gain) favored the ration with added inert bulk. The feed efficiency pattern obtained with inert bulk additions was very consistant throughout the three-year study. To illustrate this consistancy, the feed efficiency values for six comparisons are also shown in Table 4. In comparing the average values, added polyethylene improved feed efficiency (pounds of concentrate per 100 lbs. gain) by 13 percent. A possible explanation for this improvement is discussed in another section of this report. Carcass grades and cutability scores were almost identical for both rations.

Table 4. Influence of Inert Bulk Additions to a High Concentrate Ration (Average of Six Comparisons)

	Type of Ration	
	High Concentrate	High Concentrate + Polyethylene
No. of steers	29	29
Daily gain, lbs.	2.48	2.63
Daily feed intake, lbs.	21.03	22.40
Daily concentrate intake, lbs.	21.03	19.48
Calculated daily net energy intake megcal.	16.20	15.07
Feed/100 lbs. gain (including polyethylene)	857	852
Concentrate/100 lbs. gain, lbs.		
6 comparisons		
1	942	718
2	901	796
3	785	729
4	990	768
5	745	718
6	780	720
Average	857	742
Carcass grade	Choice—	Choice—
Cutability score, percent	49.52	49.40

Data from this comparison indicates that improved performance was obtained when a limited amount of bulky material was added to a high concentrate ration. It appears that some bulk may be necessary for the most efficient utilization of concentrates.

Trial 5 Experimental Procedure

The final trial of a three-year study of factors affecting feed intake of finishing steers was initiated in the spring of 1965. Forty yearling Hereford steers were fed a conventional ration for two weeks, after which time 12 hour shrunk weights were taken. The steers were then assigned on a basis of weight to eight groups of five animals each. Groups were then randomly assigned to treatment so as to provide 2 replicate lots for each of four experimental rations. The rations were

- B-High concentrate ration (95 percent concentrate)
- C-High concentrate plus 13 percent polyethylene fluff as a source of inert bulk.
- D-High concentrate with 5 percent stabilized animal fat
- E-High concentrate with 5 percent stabilized fat plus 13 percent polyethylene fluff.

Percent composition of the rations is presented in Table 5. These rations were fed free choice in self feeders for 113 days. Steers were kept in paved lots bedded with sand. Water and loose salt were available at all times. Interim weights were taken and total feed consumption for each lot was determined at 21-day intervals. Twelve-hour shrunk weights were taken at the end of the trial, and carcass data were obtained at a commercial packing plant.

Table 5. Composition of Rations Fed in Trial 5.

Ration Rati_n type	B High Concentrate	C High Concentrate + 13% poly- ethylene[1]	D High Concentrate + 5% fat	E High Concentrate + 5% fat + 13% poly- ethylene
Ingredients, percent				
Steam rolled milo	87.00	Same as	80.70	Same as
Cottonseed meal	3.00	B plus	4.00	D plus
Alfalfa meal	5.00	300 lbs.	5.00	300 lbs.
Urea	0.80	Polyethylene	1.10	Polyethylene
Molasses	3.00	Added to	3.00	Added to
Stabilized animal tallow	——	1 ton feed	5.00	1 ton feed
Salt	0.50		0.50	
Calcium carbonate	0.65		0.65	
Vitamin A premix	0.03		0.03	
Trace mineral premix	0.02		0.02	
Calculated net energy[2], megacalorie/lbs.	0.73	0.64	0.79	0.69

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

Results

A summary of the results appears in Table 6. Values represent an average for the replicate groups on each ration.

FEED INTAKE

Addition of inert bulk to high concentrate rations with or without added fat resulted in increased total feed intake. However, complete compensation for the bulk additions was not obtained since the quantity of nutrient intake by steers on rations C and E did not equal the nutrient intake of steers on rations B and D respectively. As a result, higher daily concentrate intakes were obtained with steers consuming rations without added inert bulk.

The addition of tallow to the rations resulted in an increase in total daily feed consumption and a corresponding increase in calculated energy intake. The added energy intake was apparently not utilized efficiently since feed conversion was depressed by the fat addition.

DAILY GAIN

The average daily gain obtained with the high concentrate ration (B) was exceptionally good. The depression in gain observed on the high concentrate ration plus fat (D) cannot be explained since no digestive disturbances were noted. The average daily gains for the two rations containing inert bulk (C&E) were essentially the same. Similarity of gains by steers consuming rations containing bulk was also noted in Trial 4.

Table 6. Summary of Results of Trial 5.

Ration Type of Ration	B High Concentrate	C High Concentrate + 13% poly-ethylene	D High Concentrate + 5% Fat	E High Concentrate + 5% Fat + 13% poly-ethylene
No. of steers	9[1]	10	10	10
Initial wt., lbs.	683	684	670	679
Final wt., lbs.	996	980	959	980
Ave. daily gain, lbs. (113 da.)	2.77	2.63	2.56	2.66
Total daily feed intake, lbs.	21.11	21.74	22.56	22.90
Daily concentrate intake, lbs.	21.11	18 92	22.56	19.92
Estimated daily net energy intake, megacalories	15.45	13.85	17.82	15.74
Total feed/100 lbs. gain, lbs.	763	826	880	861
Concentrate/100 lbs. gain, lbs.	763	719	880	749
Carcass data[2]:				
Ave. carcass wt., lbs.	618	598	596	596
Dressing percent	61.9	60.9	62.0	60.8
Rib eye area, sq. in./cwt. carcass	1.78	1.88	1.88	1.80
Fat cover, in./cwt. carcass	0.106	0.106	0.106	0.104
Cutability score percent	49.5	50.0	49.9	49.6
Carcass grade	High Good	Low Choice	Low Choice	High Good

[1] One steer was removed due to weight loss and chronic stiffness.
[2] Appreciation is extended to Maurer-Neurer, Arkansas City, Kansas, for cooperation in obtaining carcass data.

FEED EFFICIENCY

Most published data indicates that approximately 7-8 percent improvement in feed efficiency can be expected when 5 percent fat is added to conventional rations. The depression in feed efficiency obtained with rations containing fat (D&E) is not in agreement with results of Trial 4.

Addition of inert bulk greatly improved utilization of the concentrate portion of the rations. Improvements in feed efficiencies between rations B and C and between rations D and E were 6 and 14 percent respectively.

The specific action of bulk *per se* is not clear. Bulk may aid in maintaining a normal condition within the rumen and thus facilitate absorption of volatile fatty acids (VFA). When natural roughages such as cottonseed hulls and alfalfa hay are added to concentrate diets, the concentration of acetic acid in relation to the concentration of propionic acid increases in rumen fluid. Results of VFA analyses of rumen fluid samples from steers in this trial indicate an increase in the molar percent of propionic acid in steers consuming rations containing polyethylene. Since propionic acid is more efficiently utilized for body gain than acetic acid, this may be a partial explanation for improved feed efficiency with rations containing polyethylene. On the other hand, the polyethylene resin used is relatively inert, and the mode of action of the material is thus difficult to explain. Further studies are needed to elucidate the possible effects of inert bulk.

Summary — Trial 5

The effects of fat additions to high concentrate rations were studied. The influence of bulk *per se* was evaluated by using polyethylene fluff as an inert bulk.

The addition of fat to a high concentrate ration increased daily feed and estimated net energy intake. Average daily gain favored the high concentrate ration without fat; however, gain did not necessarily parallel estimated net energy intake. The addition of inert bulk to high concentrate rations resulted in improved utilization of the concentrate portion of the diet.

Three Year Study

The effects of ration density, caloric source and bulk on feed intake of ruminants were investigated. Conventional and high concentrate rations were modified by sand, tallow and inert bulk additions.

Both feed and energy intakes were reduced when a high concentrate ration was compared with a conventional ration. Data indicates that some roughage may be necessary for maximum performance.

Tallow additions to high concentrate rations reduced total feed intake and slightly increased estimated net energy intake. The addition of sand to conventional rations resulted in increased total feed consumption. Intake of nutrient material approached that of a similar ration without sand.

An increase in daily feed consumption was noticed when polyethylene resin (inert bulk) was added to high concentrate rations. Daily gain and feed efficiency favored rations with added polyethylene. It appears that limited bulk may be important in the most efficient utilization of the concentrate portion of rations used in this study. Cost of the inert bulk material prohibits commercial use at the levels reported.

Weight Loss Patterns of Beef Cows at Calving

S. A. Ewing, Larry Smithson, Dwight Stephens and Derald McNutt

It is becoming common practice to make feeding program recommendations for wintering beef cows on the basis of weight change patterns rather than a given quantity of feed. This approach has the advantage of making research results concerning the relationship between level of feeding and productivity, applicable to a wide variety of conditions. It is then the responsibility of the producer to evaluate his feeding or supplementation program under a particular set of conditions.

The recommendations arising from several years of research work at the Ft. Reno Station have been expressed in terms of winter weight change patterns for spring calving beef cows from fall through calving and up to the time that spring grass is ample. In a program of this type, it is important to anticipate weight loss at calving time in order to determine the level of gain that may be appropriate up to calving to prevent excessive total weight losses. Due to the wide differences in opinions as to the amount of weight loss at calving and the limited amount of data available, detailed records have been maintained on a group of cows to more clearly define this weight loss pattern at calving and evaluate the degree of variation encountered.

Procedure

Thirty-two, spring calving, mature Hereford cows were maintained on native tall grass pastures at the Ft. Reno Station for this study during the winter of 1964-65. The cows had ample native pasture available and were fed an amount of supplemental feed comparable to that of the moderate level practiced in project 650, described elsewhere in this publication. The level of supplement used in this particular winter trial averaged 1.56 lbs. of cottonseed caks daily in addition to free choice mineral consisting of two parts salt and one part steamed bone meal. The weights reported are those taken individually in the fall and at 14 day intervals until calving time approached. Weights were also obtained within 3 days before calving for each cow and then again within 1 day after calving. After this the cows were worked back into a 14 day weighing schedule which continued for 168 days after calving. At this time the cows had returned to the weight recorded the previous fall. All weights were taken after a 12 hour shrink period without feed and water.

The data were summarized as averages for cows having heifer calves and those having bull calves as well as averages for all cows, involved in this test. Standard deviations were determined for certain observations.

Results

The results of this study are summarized in Table 1 and Figure 1. The average weight loss at calving of all cows involved in the study, was 129 lbs. with a standard deviation of 29.6 lbs. The average birth weight of all calves was 75 lbs. and this weight made up 58.1 percent of the total weight loss at calving time.

The weight loss at calving expressed as a percentage of cow weight just prior to calving averaged 13 percent. This would indicate that a wintering program devised to result in an approximate 15 percent loss of fall weight through calving to spring would need to involve a level of feed to maintain fall weight with very little added weight loss after calving until spring grass is ample. In this particular study, the weight change pattern from fall through calving until 28 days post partum was approximately 17 percent loss of fall weight. This appears to be an ac-

Table 1. Weight Change Patterns of Range Beef Cows With Weight Loss At Calving And Birth Wt. of Calves.

Time of Weighing	Cows having Bull Calves	Cows having Heifer Calves	Average of All Cows
Fall Wt. (11-20-64)	1040	991	1014
Days before calving:			
56	1049	1021	1035
42	1028	1005	1016
28	1015	985	999
14	1016	970	991
3	1010	960	983
Days after calving:			
1	875	835	854
14	862	824	841
28	853	827	840
42	873	819	844
56	899	835	865
70	938	856	894
84	969	890	927
98	991	918	952
112	1002	944	971
126	1026	948	986
140	1032	968	998
154	1050	981	1013
168	1044	989	1014
Birth wt., lbs.	79	71	75
St. Dev., lbs.	---	---	9.5
Cow Wt. loss at Calving., lbs.	134	125	129
St. Dev., lbs.	---	---	29.6
Birth Wt. as a percent of Cow wt. loss	58.9	56.8	58.1
Cow Weight Loss at Calving as a persent of pre-calving wt.	13.2	13.0	13.1

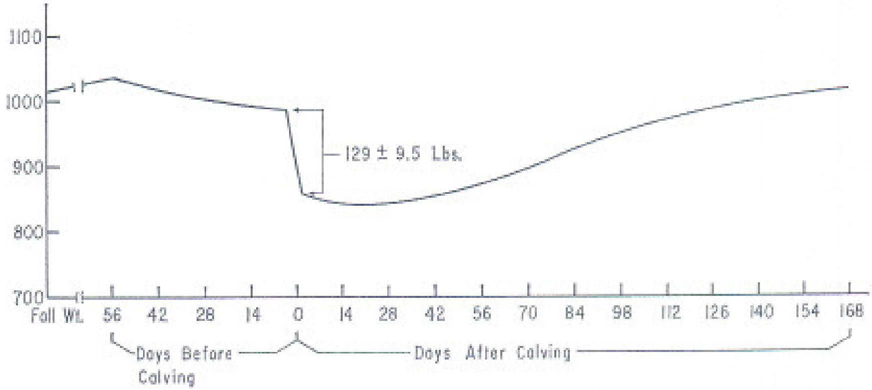

Figure 1. Weight change pattern of range beef cows through calving (line represents average cow weight).

Advantages of Bermudagrass

One real advantage is that with proper management it has an extremely high carrying capacity. With native pastures a year-round stocking rate of one cow unit for every eight to ten acres is recommended in the tall grass areas of Oklahoma. Bermudagrass on the other hand will carry a cow unit to every two to three acres if adequate moisture and fertility are available. Another definite advantage of bermudagrass is its ability to respond to fertilization. In fact, it must be fertilized or it will not produce satisfactorily. Due to the rapid growth rate it is possible to graze bermudagrass and harvest one or more hay crops during the same growing season without damaging the stand.

Problems Associated with Bermudagrass

One of the first problems observed concerning bermudagrass has been the lack of satisfactory gains during the last half of the growing season. This has been more pronounced with stocker steers than with nursing calves because of the ability of the cow to draw on her body reserves when feed is in short supply or poor in quality. The apparent drop in nutritive value around mid-summer is not clearly understood and is probably due to a number of things. First, we know that as the grass matures and summer progresses the percent of lignin increases. Furthermore, studies have shown that generally as the percent lignin increases the dry matter digestibility of the plant decreases (3). Secondly, there is evidence which indicates that cattle consume much less grass as it matures and as temperature increases.

In short, cattle probably gain poorly in middle and late summer simply because they don't eat enough grass. The apparent reduction in forage intake is probably due to a combination of factors. We know that a feed of low digestibility will remain in the digestive tract longer than one that is highly digestible, thereby reducing the total amount of feed that can be consumed. Low intake may also be due to reduction in palatability of the forage as a result of chemical or physical changes in the plant brought about by high temperatures and/or longer periods of daylight. Furthermore, an insufficient supply of grass will certainly cause an abnormally low consumption of forage.

Some cattle producers have observed a higher incidence of breeding problems with cows on bermudagrass than on native grass. Some feel that reproductive problems are associated with a nutrient deficiency in the grass or possibly a buildup of harmful compounds resulting from heavy fertilization. Although these are possibilities, it is much more likely that any breeding problems observed on bermudagrass are due primarily to lack of feed intake rather than harmful materials or nutrient deficiencies in the forage.

Many bermudagrass pastures in Oklahoma are inadequately fertilized or not fertilized at all resulting in low forage production. In addition, many livestock producers consistantly over-stock bermudagrass further agravating the problem of insufficient forage. Inadequate intake may also occur if forage quality is so low that it is low in palatability. Grass that has been allowed to make seed heads and rank growth will be less palatable as well as lower in digestibility and will therefore be low in productive value.

Internal parasites are a greater problem with cattle on bermudagrass than on native grass because of stocking rate and height of plant. As we increase stocking rate we also increase the buildup of internal parasite eggs in the soil and on the grass. Thus, if we increase stocking rate from one cow to ten acres up to one cow to two or three acres we should expect a significant increase in the parasite level of the pasture. In addition to a higher level of parasite eggs the problem is further complicated by the fact that bermudagrass is a shorter plant than native grasses and consequently cattle must graze closer to the soil, hence increasing the probability of picking up parasite eggs.

Management of Bermudagrass

Although bermudagrass is a hardy plant that can survive under severe abuse, it will not produce satisfactorily unless it is properly and carefully managed. One of the first requirements is that we must fertilize in order to achieve satisfactory performance. The amount and kind of fertilizer depends largely upon the fertility level of the soil. Since it is such a heavy user of nitrogen this is the element with which we should be most concerned. Assuming adequate levels of phosphorus and potassium are provided we should plan to add 100 to 200 pounds of nitrogen per year unless it is overseeded with a legume.

It has been estimated that a good stand of legumes will provide approximately the equivalent of 100 pounds of nitrogen. The form in which nitrogen is applied has no appreciable influence upon efficiency of utilization. Response to nitrogen fertilization may be achieved any time during the growing season that there is adequate moisture. In general, it is recommended that at least 50 pounds of nitrogen be applied per acre at the time the grass begins to "green up" in the spring. Thereafter, nitrogen should be applied according to soil moisture and the need for grass. If a hay crop is to be harvested and high yield is desired it is well to apply nitrogen about a month ahead of the planned cutting time. The entire summer allowance of nitrogen may be applied in one application if the grass is to be made into hay or divided into two or more applications when used for grazing in order to maintain forage quality and provide a uniform supply of grass throughout the growing season. When irrigation is available nitrogen should be applied just prior to irrigation.

Strict management of grass and cattle is absolutely necessary for satisfactory beef production on bermudagrass. It should be kept at a height of five to eight inches to maintain a high quality forage for grazing. If a hay crop is to be harvested it should be allowed to grow for a period of about four weeks or to a height of 15 to 18 inches (1,4). In order to maintain high quality forage throughout the growing season it is best to stock pastures heavily for a short period of time then rotate cattle to another pasture. One system which has been used satisfactorily is to graze five days and let the pasture rest for about 15 days to allow for regrowth. In order to encourage uniform grazing it is advisable to clip pastures to remove rank growth and use a drag to scatter manure piles after each grazing period. Any time a pasture gets too rank for good grazing it should be clipped or mowed for hay.

Wintering on Bermudagrass

Studies are currently being conducted at this station to determine the kind and amount of supplement to feed cows during the winter. Preliminary results indicate that cows wintered on bermudagrass pastures should receive about the same kind and amount of supplemental feed as on native grass. Although bermudagrass is generally higher in protein content throughout the growing season and even in the winter than native grasses, there is a definite need for protein and phosphorus supplements during the winter months.

Suggested Use of Bermudagrass

It appears that bermudagrass is better adapted to a cow-calf operation than a stocker-feeder program. Although stocker cattle gain well on bermudagrass early in the growing season their gains are normally poor after July 1. Cows on the other hand can maintain weight and continue to produce enough milk for adequate growth of calves (2). Preliminary work at Alabama indicates that creep-feeding calves on bermudagrass may be advisable during the latter part of the growing season.

It is not advisable to plow up good native grass and establish bermudagrass because of the high establishment and maintenance costs involved. A program of pasture management in which bermudagrass is used in connection with native grass as a part of the total pasture program seems advisable. Bermudagrass is at its peak in nutritive value during the months of April, May and June. These are the months when native grasses are restoring nutrient reserves in the roots and are harmed most by heavy grazing. Thus, if cattle were put on bermudagrass during this period and native pastures allowed to rest until about July 1, native pastures would have a chance to get ahead of the cattle, thereby increasing the carrying capacity of the native pastures. After cattle are turned in on native pastures the bermudagrass pastures then could be made into hay or used to carry dry cattle for the remainder of the growing season. Sufficient growth of bermudagrass could be retained late in the summer to provide winter grazing. If bermudagrass is the primary or only pasture grass it can be used effectively and profitably under proper fertilization, rotational grazing, parasite control and feed supplementation practices.

Summary

Presently Midland is the variety of bermudagrass best suited for most sections of Oklahoma. Bermudagrass has a much higher carrying capacity and a greater ability to respond to fertilization than native grasses but appears to be less palatable. Although individual animal performance is often 10 to 15 percent less for cattle grazing bermudagrass compared to native grass, the per acre weight gains may be four to five times greater on bermudagrass. Fertilization is absolutely necessary for satisfactory performance on bermudagrass. Although irrigation can increase forage and beef production significantly it is not necessary in most sections of the state for satisfactory production. Management of bermudagrass is the key to its successful use. If good native grass is available it appears that an integrated pasture system in which bermudagrass is used in conjunction with native grass is advisable.

References Cited

Decker, A. M. 1965. Midland Bermudagrass. Crops and soils 17:14.

Elder, W. C. and H. F. Murphy. 1961. Grazing characteristics and clipping responses of bermudagrass. Okla. Agr. Exp. Sta. Bul. B577.

Webster, J. E., J. W. Hogan and W. C. Elder. 1965. Effect of rate of ammonium nitrate fertilization and time of cutting upon selected chemical components and the *in vitro* rumen digestion of bermudagrass forage. Agronomy J. 57:323.

Wright, L. R., Jr. 1965. Midland Bermudagrass. Crops and Soils 17:12.

The Value of Cottonseed Meal, Fish Meal and Urea in Milo Rations for Fattening Calves*

*Robert Totusek, Robert E. Renbarger, George A. B. Hall and Allen D. Tillman***

Many cattle feeders are located in a "one grain area", due to availability and price of grains. This is true in much of Oklahoma and the Southwest, and the "one grain" in this area is milo. One of the serious weaknesses of milo is its poor feed efficiency, which is often 10-20 percent poorer than that of corn and barley. Attempts to improve the utilization of milo through supplementation are continuing at this station.

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

** The assistance and cooperation of D. F. Stephens in the conduct of the test, R. L. Willham and S. A. Ewing in making cattle available, and Paul Brackelsburg in providing carcass data are gratefully acknowledged.

Since the protein in milo is less readily soluble than the protein in corn, a readily soluble source of supplemental nitrogen (protein) might enhance the utilization of milo. Urea is a readily soluble source of nitrogen. It has been known for many years that fattening cattle utilize urea rather efficiently as a substitute for protein, and recent research at the Iowa and Indiana stations has demonstrated that almost all of the supplemental nitrogen in a corn ration can be in the form of urea. However, a previous trial at this station indicated that 100 percent replacement of cottonseed meal with urea resulted in lowered feed intake, rate of gain, and feed utilization[1]. The trial reported herein was conducted to determine the most optimum level of substituting urea for natural protein at levels lower than 100 percent.

Another objective of this trial was to compare fish meal with cottonseed meal as a source of supplemental protein in milo rations. In a previously reported pilot trial fish meal promoted greater daily gain and better feed efficiency than cottonseed meal. The protein of fish meal is of relatively low solubility. It is possible that a combination of fish meal and urea, with low and high nitrogen solubilities, might improve the utilization of milo. Furthermore, in the previously mentioned research a complex vitamin-trace mineral supplement improved performance of cattle receiving urea as the only source of supplemental nitrogen. Since fish meal is a richer source of certain vitamins and trace minerals than is cottonseed meal, fish meal might enhance the utilization of a high urea ration.

Procedure

Sixty-four Hereford steer calves with an average weight of approximately 525 lbs. and an average age of 8 months were obtained from the Experiment Station herds. They were divided into eight uniform lots primarily on the basis of sire and weight. The feeding period was 161 days long, from November 5, 1964 to April 15, 1965. Initial and final weights were based on an average of two weights taken after the calves were without feed and water for 16 hours. After the conclusion of the feeding trial the calves were shipped to Arkansas City, Kansas, for slaughter. Carcass data were obtained after a 48-hour chill.

The ingredient makeup of the rations is given in Table 1. Milo was finely ground through a hammer mill with a 3/16 inch screen. Rations 1-4 contained cottonseed meal, Rations 5-8 fish meal. Rations 1 and 5 contained no urea. In the remaining rations, the following percentages of natural protein supplement were replaced with urea: Rations 2 and 6, 25 percent; Rations 3 and 7, 50 percent; and Rations 4 and 8, 75 percent. The urea was added at a level to provide 25 percent more nitrogen than the amount in the natural protein which it replaced to compensate for its expected lower utilization. Milo was increased in each case as the level of natural protein was decreased. Levels of bonemeal and monosodium phosphate were varied in an attempt to equate

[1] See Okla. Agr. Exp. Sta. Mis. Pub. MP-76, P60.

Table 1. Ingredient Makeup of Rations

Lot and ration no.	1	2	3	4	5	6	7	8
Natural protein source	Cottonseed meal				Fish meal			
Level of urea, %[1]	0	25	50	75	0	25	50	75
Milo (finely ground)	63.6	65.5	67.4	69.3	67.7	68.6	69.5	70.4
Cottonseed meal[2]	10.0	7.5	5.0	2.5	----	----	----	----
Fish meal[3]	-----	----	----	----	6.4	4.8	3.2	1.6
Urea[4]	0	0.5	1.0	1.5	0	0.5	1.0	1.5
Alfalfa hay (ground)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Cottonseed hulls[5]	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Molasses, blackstrap	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Salt	.5	.5	.5	.5	.5	.5	.5	.5
Bonemeal	.5	.5	.5	.5	----	.2	.3	.4
Monosodium phosphate	-----	.1	.2	.3	----	----	.1	.2
Ammonium chloride	.4	.4	.4	.4	.4	.4	.4	.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Vitamin A[6]	+	—	+	+	+	+	+	+
Aureomycin[7]	+	+	+	+	+	+	+	+

[1] Indicates the percent of supplemental protein replaced with urea. The urea was added at a level to provide 25 percent more nitrogen than the amount in the natural protein which it replaced.
[2] 41 percent protein, "old process".
[3] 64 percent protein, herring meal from Nova Scotia.
[4] Feed grade urea containing 42 percent nitrogen.
[5] Cottonseed hulls fed initially at a level of 30 percent, then reduced to 20 percent and 10 percent over a four week period. Milo was increased as cottonseed hulls were decreased.
[6] Included at a level of 1,000 I.U./lb. of ration.
[7] Included at a level of 3.5 mg/lb. of ration.

calcium and phosphorus levels among rations. Ammonium chloride was included in all rations to miminize the occurrance of urinary calculi, and vitamin A and aureomycin were added to all rations. No hormones were used.

Proximate, calcium and phosphorus analyses of milo and the eight rations as fed are presented in Table 2. The basal cottonseed meal and fish meal rations (Rations 1 and 5) were formulated to contain 12 percent protein, on the assumption that the milo contained 8.5 percent protein. The feed analyses, available near the completion of the trial, showed that the milo contained an average of 10.4 percent protein. Consequently, all rations were higher in protein than anticipated.

All rations were self-fed throughout the feeding period. Each lot of calves had access to ample area in an open shed and an outside lot, and water (warmed in winter) was available at all times.

Results and Discussion

Feedlot performance, for each of the eight lots, is shown in Table 3. The substitution of urea for 25 or 50 percent of the cottonseed meal resulted in the highest feed intake and fastest gains among the lots

Table 2. Chemical Composition of Feeds (Percent)

Feed	Dry matter	Ash	Crude protein	Ether extract	Crude fiber	N-free extract	Ca.	P.
Milo	91.56	1.7	10.4	3.5	2.6	73.4	0.37	0.31
Ration no. 1	92.07	4.2	15.0	3.3	9.7	59.9	0.39	0.44
Ration no. 2	91.64	4.3	15.2	3.3	9.9	58.9	0.33	0.40
Ration no. 3	91.28	4.5	15.5	3.3	13.1	54.9	0.35	0.46
Ration no. 4	91.81	4.2	16.0	3.5	10.9	57.2	0.48	0.44
Ration no. 5	92.10	4.0	15.0	3.3	10.6	59.2	0.41	0.38
Ration no. 6	91.66	4.3	15.4	3.5	13.0	55.5	0.46	0.39
Ration no. 7	92.19	4.5	15.8	3.9	10.8	57.2	0.46	0.42
Ration no. 8	90.98	4.1	16.4	4.5	9.2	56.8	0.45	0.40

Table 3. Feedlot Performance, by Lot (161 days, 8 steers per lot)

Lot and ration no.	1	2	3	4	5	6	7	8
Natural protein source	Cottonseed meal				Fish meal			
Level of urea, %	0	25	50	75	0	25	50	75
Av. initial wt., lb.	522	526	525	522	525	526	526	522
Av. final wt., lb.	894	930	933	888	923	909	922	844
Av. daily gain, lb.	2.32	2.52	2.55	2.28	2.48	2.39	2.47	2.25
Av. daily feed, lb.	19.3	20.6	21.2	18.7	20.5	19.3	19.8	17.5
Feed/cwt. gain, lb.	832	818	830	820	828	807	801	775

receiving cottonseed meal, while replacement of 75 percent of the cottonseed meal resulted in a small decrease in feed intake and a rate of gain comparable to the all cottonseed meal group (Ration 1). Differences in feed efficiency were small. The pattern among the fish meal lots was less clear, although substitution of urea for 75 percent of the fish meal resulted in a daily gain which was the poorest of the fish meal lots, and considerably lower than the all fish meal group (Ration 5). There was a tendency for feed intake to decrease and feed efficiency to improve as the level of urea substitution for fish meal increased.

Slaughter and carcass data for each of the eight lots are given in Table 4. Differences in all carcass traits which were measured were very small, although the calves fed the 75 percent levels of urea (Lots 4 and 8) tended to produce carcasses which had less fat cover and graded lower than calves fed lower levels of urea.

Feedlot performance and carcass data are summarized by treatment in Table 5. Cottonseed meal and fish meal (Comparison 1 in Table 5) produced almost identical results. Cattle which were fed fish meal were slightly more efficient, but all other comparisons were very similar if not identical. Comparison 2 in Table 5 combines cottonseed meal and fish meal lots according to level of urea replacement. The results indicate that rations containing urea at levels of 25 and 50 percent replacement were comparable to the natural protein rations. Rate of gain and feed efficiency were actually better at the 50 percent urea level than at the 0 and 25 percent levels, but differences were very small. The 75

Table 4. Slaughter and Carcass Information, by lot (8 steers per lot)

Lot and ration no.	1	2	3	4	5	6	7	8
Natural protein source	Cottonseed meal				Fish meal			
Level of urea, %	0	25	50	75	0	25	50	75
Dressing %[1]	61.0	61.0	60.6	60.8	60.7	61.6	61.6	60.2
Carcass grade[2]	9.5	10.5	9.9	8.8	10.0	10.0	9.6	8.9
Ribeye area, sq. in.[3]	10.4	10.9	10.8	10.8	10.7	10.8	10.3	10.8
Fat cover, in.[4]	.72	.68	.64	.63	.66	.68	.70	.58
Cutability, %								
Carcass basis[5]	49.1	49.6	50.0	50.4	50 0	50.0	49.1	50.8
Live basis[6]	30.0	30.3	30.3	30.6	30.3	30.8	30.2	30.6
Round yield,%								
Carcass basis[7]	21.8	21.4	21.8	22.4	21.8	21.9	21.4	22.0
Live basis[8]	13.3	13.1	13.2	13.7	13.3	13.5	13.1	13.2

[1] Calculated on basis of shrunk Ft. Reno live weight and chilled carcass weight.
[2] USDA carcass 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.
[3] Determined by measurement of tracings of ribeye.
[4] Average of three measurements determined on tracings of the ribeye.
[5] Calculated as follows: percent of carcass as boneless trimmed retail cuts from the four major wholesale cuts = 51.34 (fat thickness) — .462 (percent kidney fat) + .740 (ribeye area) — .0093 (carcass weight).
[6] Trimmed retail cut yield as determined in footnote 5 multiplied by dressing percent.
[7] Trimmed round expressed as percent of chilled carcass weight.
[8] Percent round as determined in footnote 7 multiplied by dressing percent.

Table 5. Feedlot Performance and Carcass Information, by Treatment

	Comparison 1		Comparison 2			
Lot and ration no.	1-2-3-4	5-6-7-8	1-5	2-6	3-7	4-8
			Level of urea, %			
Treatments compared	Cottonseed meal	Fish meal	0	25	50	75
No. steers	32	32	16	16	16	16
Av. daily gain, lb.	2.42	2.40	2.40	2.45	2.51	2.27
Av. daily feed, lb.	19.9	19 3	19.9	19.9	20.5	18.1
Feed/cwt. gain, lb.	825	803	830	832	816	798
Dressing %[1]	60.9	61.0	60.8	61.3	61.1	60.5
Carcass grade[1]	9.7	9.7	9.8	10.2	9.8	8.8
Ribeye area, sq. in.[1]	10.7	10.7	10.6	10.8	10.5	10.8
Fat cover[1]	.67	.66	.69	.68	.67	.60
Cutability,[1] %						
Carcass basis	49.8	50.0	49.6	49.8	49.6	50.6
Live basis	30.3	30.5	30.1	30.5	30.3	30.6
Round yield, %[1]						
Carcass basis	21.9	21.7	21.8	21.7	21.6	22.2
Live basis	13.3	13.3	13.3	13.3	13.2	13.4

[1] See footnotes in Table 4.

percent level of urea resulted in a lower rate of gain, decreased feed intake, less fat cover, lower carcass grade, but better feed efficiency than lower levels of urea.

Some cost and return estimates, based on certain assumed current prices, are presented in Table 6 (by lot) and Table 7 (by treatment). Although these estimates will obviously vary as prices change, they do provide a basis for current economic considerations. The calculations terminate with the return per steer above feed cost. This figure is determined by the actual cost of the ration, feed efficiency, total gain per steer, the value of the carcass based on grade, and dressing percentage, and represents the amount of money available to pay non-feed costs and return a profit. It should be emphasized that the final market value of the steers was determined by actual carcass weight and grade and not by live weight and appraised value.

As the level of urea increased, the cost per cwt. of feed decreased. Because of lower feed cost, the rations containing urea allowed a greater dollar return per steer above feed cost compared to the rations containing no urea, with one exception.

Table 6. Cost and Return Estimates by Lot (8 steers per lot)

Lot and ration no.	1	2	3	4	5	6	7	8
Natural protein source	Cottonseed meal				Fish meal			
Level of urea, %	0	25	50	75	0	25	50	75
Initial value/steer, $[1]	130.62	131.41	131.25	130.62	131.25	131.56	131.41	130.62
Final value/steer, $[2]	239.01	251.44	249.19	233.89	246.12	246.56	248.94	230.95
Increase in value/steer, $[3]	108.38	120.04	117.94	103.26	114.87	115.00	117.53	100.32
Total feed/steer, lb.	3094	3311	3397	2998	3292	3091	3172	2805
Cost/cwt. feed, $[4]	2.22	2.19	2.17	2.15	2.43	2.35	2.23	2.20
Feed cost/steer, $[5]	68.60	72.65	73.79	64.43	80.05	72.63	70.74	61.57
Return/steer above feed cost, $[6]	39.78	47.39	44.15	38.83	34.82	43.36	46.79	38.76

[1] Initial weight × $.25/lb.
[2] Av. carcass value/lb. × carcass weight. Carcass prices used were ($/lb.): High choice, .450; average choice, .445; low choice, .440; high good, .435; average good, .425; low good, .415.
[3] Final value − initial value.
[4] Feed prices: Ground milo, $2.15/cwt.; cottonseed meal, $78.00/ton; fish meal, $170.00/ton; urea, $95.00/ton; ground alfalfa hay, $30.00/ton, cottonseed hulls, $22.00/ton; molasses, $36.00/ton; salt, $1.20/cwt.; bonemeal, $5.60/cwt.; monosodium phosphate, $10.00/cwt.; ammonium chloride $11.75/cwt.; vitamin A, $.08/million I.U.; aureomycin, $.06/gm.
[5] Total feed/steer × cost/cwt. feed.
[6] Increase in value/steer − feed cost/steer.

Table 7. Cost and Return Estimates, by Treatment

	Comparison 1		Comparison 2			
Lot and ration no.	1-2-3-4	5-6-7-8	1-5	2-6	3-7	4-8
Treatments compared	Cottonseed meal	Fish meal	Level of urea, % 0	25	50	75
No. steers	32	32	16	16	16	16
Initial value/steer, $[1]	130.98	131.21	130.94	131.48	131.33	130.62
Final value/steer, $[1]	243.38	243.14	242.56	249.00	249.00	232.42
Increase in value/steer, $[1]	112.38	111.93	111.63	117.52	117.73	101.79
Total feed/steer, lb.	3200	3090	3193	3201	3285	2902
Cost/cwt. feed, $[1]	2.16	2.31	2.32	2.27	2.20	2.17
Feed cost/steer, $[1]	69.12	71.44	74.20	72.73	72.30	63.02
Return/steer above feed cost, $[1]	43.26	40.49	37.42	44.79	45.44	38.77

[1] See footnotes in Table 6.

The return per steer from the urea rations was especially favorable when carcass grade or rate of gain or feed efficiency was improved. The replacement of 25 or 50 percent of the natural protein resulted in the greatest profit per steer in both the cottonseed meal and fish meal groups. The replacement of 75 percent of the natural protein supplement with urea resulted in less profit than 25 or 50 percent replacement because of less gain and lower grade, in spite of a favorable feed efficiency. When all cottonseed meal lots were compared with all fish meal lots, cottonseed meal feeding was more profitable due to the high cost of fish meal ($170 vs. $78/ton).

This trial and previous research at this station indicate that feed intake, rate of gain and carcass grade decline when more than 50 percent of the natural protein supplement is replaced with urea. However, urea is a cheaper source of nitrogen than is natural protein, so a cattle feeder may be able to tolerate a reduced rate of gain and carcass grade in some cases in order to obtain a more economical gain. The price of urea is expected to decrease further.

Sizeable improvements in feed efficiency *per se* were not obtained through the use of various combinations of nitrogen sources, except when accompanied by a lowered rate of gain which was observed when urea replaced 75 percent of the fish meal. It appears that the greatest value of urea in the ration is in terms of decreasing the feed cost.

Summary

A group feeding trial with milo rations indicated that:

(1) The replacement of 25 or 50 percent of the natural protein with urea caused no decrease in feed intake, rate of gain or carcass grade. In the case of cottonseed meal, 25 or 50 percent replacement with urea actually resulted in some increase in feed intake and daily gain, but this tendency was not apparent in the fish meal lots.

(2) The replacement of 75 percent of the natural protein with urea resulted in decreased feed intake, rate of gain, and carcass grade.

(3) Feed efficiency tended to improve as the level of fish meal replaced by urea increased. The best feed efficiency was observed when 75 percent of the fish meal was replaced with urea.

(4) Little difference in the average feeding value of cottonseed meal and fish meal was noted, although feed efficiency slightly favored the fish meal rations.

(5) Current feed prices favor the use of urea, especially at a level of 50 percent replacement of natural protein.

Optimum Nutrition of the Young Lamb for Maximum Growth and Lean Production

Robert L. Noble, L. E. Walters, Allen D. Tillman and Eldon Nelson

If the sheep industry is to supply a greater percentage of red meat to the consuming public, more efficient systems of production of meatier lambs must be developed. Fortunately, sheep respond to very intensive methods of production and one means of intensifying lamb production in recent years is earlier weaning. For such a program to work, the young lamb must have optimum nutrition from birth to slaughter. It is imperative, if early weaning is to be successful, that lambs consume considerable creep feed and to attain near maximum growth during the pre-weaning period, as well as to continue this rapid growth during the post-weaning phase.

The purposes of this study were (1) to develop rations for the early, weaned lamb, during both the pre- and post-weaning periods, that will produce an efficient conversion of ration energy to an acceptable carcass and (2) to study the deposition of lean, fat, and bone tissue by lambs from approximately 60 pounds to 100 pounds when self-fed rations varying considerably in energy (T.D.N.) level.

Procedure

Forty lambs from ewes having singles were selected for the study; the ewes were either Rambouillet or Rambouillet x Dorset crosses. The lambs were sired by Hampshire, Suffolk, or Dorset rams and were born on October 21 ± 2 days.

When lambs were two weeks old, they were allotted on the basis of birth weight, weight at 2 weeks, type of birth, sex, and breed of sire to one of two rations; a *standard ration* which contained 55 percent concentrates, 45 percent roughage, and an estimated T.D.N. content of 63 percent (moderate energy level); and an *all-concentrate* ration which contained 95 percent concentrates, 5 percent roughage, and an estimated T.D.N. content of 78 percent. The compositions of these rations are shown in Table 1.

The study was divided into two phases, a 45-day creep-feeding and a post-weaning phase. During the first phase, ewes and lambs grazed wheat pasture during the day but at night the ewes and lambs were penned in dog-proof lots. The ewes were fed one pound of ground milo per head daily and the lambs had access to one of the self-fed creep rations. Milk production of the ewes was measured on the 35th and 60th days of lactation. Weights were taken every 14 days and feed consumption records were calculated at this time. Four lambs from each group were slaughtered at weaning. Carcasses were weighed, ribbed, cut into wholesale cuts, and then physically separated into fat, lean, and bone to establish initial carcass composition for subsequent growth and development studies.

TABLE 1. Percentage Composition of the Rations

Ingredients	"Standard"	"All Concentrate"
Ground alfalfa hay	45.0	5.0
Steamed rolled milo	39.5	69.0
Soybean oil meal	10.0	15.0
Molasses	5.0	5.0
Wheat bran	-	5.0
Sodium chloride	0.5	0.5
Calcium carbonate	--	0.5
Vitamins A and D[1]	+	+
Antibiotics[2]	+	+
Chemical composition		
Dry matter	88.7	88.7
Crude protein	15.8	15.2
Crude fiber	17.7	4.3
Est. T.D.N.	63	78
Calcium	.75	.70
Phosphorus	.24	.30

[1]Each pound of feed contained 400 I.U. of vitamin A and 50 I.U. of vitamin D.
[2]Each pound of feed supplied 10 mgs. of chlortetracycline.

During the post-weaning phase, the remaining 16 lambs per treatment were divided into four groups of four per group and continued on their respective rations. The group-fed lambs were weighed off the experiment as they reached a live weight 100 pounds. The lambs were shrunk for eight hours and re-weighed. During this period the lambs were shorn. Immediately following slaughter, weights were collected on the following: complete digestive tract, contents of the rumen, pelt, and head, heart and liver. The carcasses were then chilled for 48 hours, weighed, ribbed and measured using standard procedures.

The following carcass information was obtained: weight of the chilled carcass, rib eye area and fat thickness, 12th rib, yield of streamlined trimmed hind saddle (flank off), and yield of trimmed lean cuts (leg, loin, rib and shoulder). The streamlined hind saddle and the lean cuts were trimmed to 1/4 inch of finish. After these measurements were taken, physical separations of fat, lean, and bone were made. Samples of the lean tissue were then ground and analyzed for either extract and moisture using standard procedures.

Results

Creep Feeding Phase—The average daily gains of the lambs of both groups were very satisfactory during this period. Although the lambs fed the "All Concentrate" ration gained slightly faster, this is perhaps due partly to the greater milk yield of their dams during the middle of the lactation period. Creep-feed consumption was essentially the same for both groups.

The carcass information on the lambs slaughtered at the end of the creep-feeding phase is shown only to establish initial carcass information for subsequent growth and development comparisions. As the animals ate only an average of 36-38 pounds of feed per lamb, it is doubtful if ration had any major effect on carcass composition during the 45-day creep feeding period.

Post Weaning Phase—The average daily gains of the lambs of both groups was quite satisfactory, however, there was wide range (.35 to .79 lbs. per day) in average daily gains within both groups. Perhaps this indicates the potential for improvement in growth rate which can be made by selection.

The average pounds of lean, fat, and bone tissue produced by the lambs which were slaughtered at a constant weight of 100 pounds is shown in Table 2. Although the two rations varied 40 percent in roughage content and 15 percent in energy level, only small differences were noted in carcass composition and pounds of tissue (lean - fat - bone) produced. The data on individuals indicate that there was a rather small range in the amount of lean produced but considerably wider range in the amount of fat produced.

It is intersting to note (Figure 1) that as the lambs increased in weight from approximately 57 to 100 pounds, the lean produced increased only 42-52 percent whereas the fat product increased by over 150 percent.

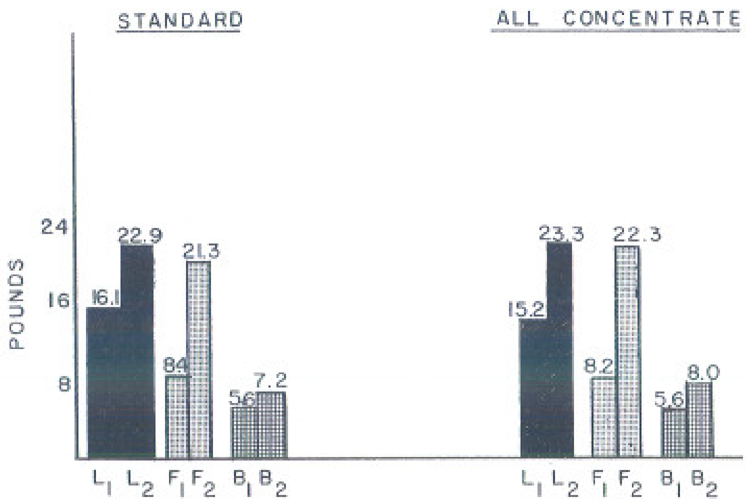

Figure 1. $L_1F_1B_1$ denotes pounds of lean, fat and bone respectively for lambs slaughtered at weaning time (approximately 57 pounds). $L_2F_2B_2$ denotes pounds of lean, fat and bone respectively for lambs slaughtered at the end of post-weaning phase (approximately 100 pounds).

TABLE 2. Summary of Results

	"Standard"	"All Concentrate"
Creep Feeding Phase		
Production Data		
Number of lambs	20	20
Birth weight (lbs.) 10/21 ± 2 days	10.3	10.4
Initial wt. (lbs.) creep feeding phase	21.0	21.5
Milk production of the dams		
35th day of lactation (lbs.)	2.8	3.2
60th day of lactation (lbs)	1.0	1.0
Weaning wt. (lbs.) 12/21—(60 days of age)	57.7	59.8
Gain per lamb (lbs.)	36.7	38.3
Average daily gain (lbs.)	.82	.85
Feed per lamb (lbs.)	36.0	37.6
Carcass Data (Averages for 4 lambs per treatment)		
Live wt.	57.00	58.60
Cold carcass wt.	30.40	29.20
Fat thickness, 12th rib (ins.)	.12	.08
Kidney knob (lbs.)	1.10	1.00
Rib eye area, 12th rib (sq. in.)	2.15	2.00
Streamlined trimmed hind saddle (lbs.)	11.40	10.70
Trimmed lean cuts (lbs.)	20.70	20.70
Pounds of tissue		
lean	16.13	15.23
Fat	8.38	8.18
Bone	5.58	5.58
Post Weaning Phase[1]		
Production Data		
Initial weight (lbs.)	55.8	56.5
Final weight (lbs.)	100.6	101.0
Average daily gain (lbs.)	.55	.59
Number of days on feed	83.0	80.0
Feed per day (lbs.)	3.27	3.16
Feed per wt. gain (lbs.)	606.0	543.0
Pounds of feed per pound of lean produced[2]	39.3	31.8
Pound of T.D.N. per pound of lean produced[2]	24.7	24.8
Ratio of acetic:Propionic acid	1:3.1	1.1.7
Carcass Data[3]		
Cold carcass wt. (lbs.)	52.00	54.40
Fat thickness, 12th rib (in.)	0.29	0.31
Kidney knob (lbs.)	2.41	2.93
Rib eye area, 12th rib (sq. ins.)	2.20	2.40
Streamlined trimmed hind saddle (lbs.)	17.30	17.50
Trimmed lean cuts (lb.)	29.90	30.60
Pounds of tissue		
Lean	22.92	23.30
Fat	21.30	22.33
Bone	14.07	14.95

[1]Four lambs died, all concentrate group, urinary calculi.
[2]During the post-weaning phase only (assuming 16 lbs. of lean per lamb at 57 lbs.)
[3]Averages for 16 lambs, standard ration; 12 lambs "all concentrate" ration.

Summary

Although the lambs fed the "all concentrate" ration, gained slightly faster, required less feed per wt. gain, had higher dressing percentages, and a more narrow ratio of acetic to propionic acid in the rumen fluid, the average pounds of lean produced and the pounds of energy (TDN) required to produce a pound of acceptable lean (all carcasses graded choice and above) were essentially the same for both groups.