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

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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:

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

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.

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