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Fall creep-fed calves, one year old.

Production of Slaughter Cattle To Be Marketed Shortly After Weaning

J. E. Comfort, A. J. Dyer

Missouri is one of the leading states in the production of beef calves, having nearly a million beef cows. Many of the Missouri beef cow herds have less than 25 cows. Methods of production that would yield a greater net return per cow have been studied.

The calves used in this test were out of grade Shorthorn cows and were sired by a registered Shorthorn bull.

The age and method of handling calves in 1958 follows:

Lot I. September-October, 1957, calves. Creep-fed grain January 13 to June 13 (151 days). Fed grain in dry lot 112 days after weaning. Marketed at 12 months of age.

Lot II. November-December-January, 1957-58, calves (not creep fed). Weaned October 3, 1958. Grain fed October 3 to December 27—85 days. Marketed at 12 months of age.

Lot III. March-April, 1958, calves (not creep fed). Marketed at weaning—9 months of age.

The grain ration for the calves was a mixture of eight parts cracked corn and one part soybean meal (by weight). A mineral mixture of equal parts by weight of steamed bone meal and salt was available to the cows and calves.

The dams of the fall, 1957 calves were wintered on 69 pounds of corn silage and 1½ pounds of soybean meal per day. They gained 100 pounds in weight during the winter and weighed 1069 pounds April 21, 1958. They were fed 5 tons of silage and 225 pounds of soybean meal. The dams of the winter and spring calves grazed winter fescue and lespedeza supplemented with 0.9 ton oat hay and 180 pounds of soybean meal. They averaged 932 pounds April 21, 1958, and were 125 pounds lighter than in November, 1957, before calving. The cows with the spring calves weighed 953 pounds in April, 1958, two to four weeks after calving, and were 100 pounds lighter than in November, 1957.

Discussion:

1. The Lot I fall calves were creep-fed during the winter, spring, and early summer. They were weaned at nine months of age and grain-fed in dry lot for 112 days. They ate about 8 bushels of corn in the creep and 30 bushels of corn after weaning. These calves ate some silage during the winter with their mothers but it was not possible to keep a separate record on the amount consumed by the calves; the amount is included in the silage fed per cow. They made a total gain of 549 pounds from January 13 to October 3. They were marketed at 12 months of age and all were in the Choice grade.
2. The winter calves in Lot 2 were not creep fed before weaning. Attempts were made to get them to go to a creep eight weeks before weaning. The creep was located in shade close to the salt box and water. Grain was placed around the edge of the creep and in boxes just inside of the creep. They would stay around the creep shed with their

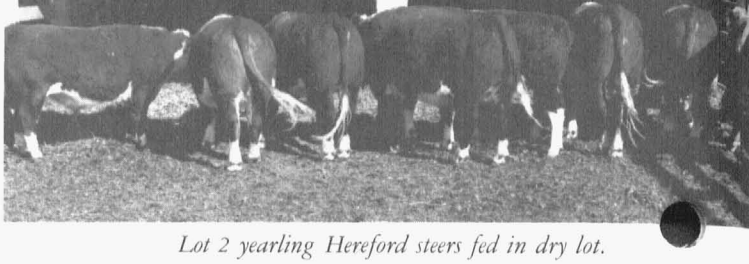
TABLE 1--PRODUCTION OF YOUNG BEEVES

	I Fall 1957 Sept.-Oct. Creep Fed While Nursing	II Winter 1957-58 Nov.-Dec.-Jan. Not Creep Fed	III Spring 1958 March-April Not Creep Fed
Nursing Period			
a. No. in each lot	10	10	6
b. Avg. initial weight	244 (Jan. 13)	201 (Mar. 25)	231 (June 13)
c. Avg. weaning weight	551 (June 13)	579 (Oct. 3)	587 (Dec. 27)
d. Avg. gain to weaning	307	378	356
e. Avg. daily gain	2.03	1.97	1.44
Avg. Daily Ration			
f. Cracked Corn	2.93 (151 days on creep)		
g. Soybeam Meal	.37		
Avg. Total Feed			
h. Cracked Corn	443 (7.91 bu.)		
i. Soybean meal	55		
Avter Weaning Period			
j. Avg. final weight	793	714	
k. Avg. gain after weaning	242	139	
l. Avg. daily gain	2.16	1.64	
Avg. Daily Ration			
m. Cracked Corn	15.1	11.19	
n. Soybean Meal	1.88	1.40	
o. Alfalfa hay	2.46	3.68	
Avg. Total Feed			
p. Cracked corn	1689 (30 bu.)	951 (17 bu.)	
q. Soybean Meal	211	119	
r. Alfalfa Hay	276	239	
Feed Required 100/Gain			
s. Cracked Corn	698	684	
t. Soybean Meal	87	86	
u. Alfalfa hay	112	172	
Market Grades			
Choice +		1	
Choice	4	3	
Choice -	6	1	
Good +		2	4
Good		2	2
Good -		1	

mothers, but could not be persuaded to eat grain in the creep. The cows were still milking well and there was plenty of good pasture. They ate 17 bushels of corn in 85 days after weaning. They were marketed at 11½ months of age weighing 714 pounds. Half of them graded Choice and half graded Good.

3. The Lot 3 spring calves were marketed without grain feeding when weaned at nine months of age. They weighed 587 pounds. They were good grade slaughter calves or fleshy good to choice grade feeder calves. They made a gain of about 2 pounds for each day of age without grain feeding.
4. The fall calves sold for $27.50 in October. The winter calves brought $27.00 and the Spring calves $26.50 in December.
5. In some of our previous experiments with calves we have made more efficient gains in dry-lot after weaning, but the calves in 1958 were in a fatter condition when weaned.
6. In the 1958 test, the winter calves gave a higher return above all feed and pasture charges because of the lower cost of wintering their dams. *(Project 78)*

Hexestrol Implant Levels During Winter, Pasture and Dry Lot



Lot 2 yearling Hereford steers fed in dry lot.

J. E. Comfort, A. J. Dyer, Myron Bennett

The effects of implanting steers with hexestrol at different levels were determined for steers which were wintered, grazed and finished.

The Wintering Period

Four lots of steer calves were wintered liberally on a ration of corn silage, soybean meal and a mineral mixture of steamed bone meal and salt. The effects of "hormone" implants on the rate and economy of gain were studied and are summarized in Table 2.

TABLE 2

	Lot 1	Lot 2	Lot 3	Lot 4
No. head per lot	10	10	10	10
Hexestrol implant level (mg.)	None	12	None	24
Avg. daily gain	1.57	1.68	1.61	1.88
Feed consumer per hundred pounds gain:				
Corn silage	2375	2300	2300	2164
Soybean oil meal	125	116	122	105

Results

Hexestrol implants resulted in larger gains and more efficient use of feed.

1. The 24 milligram implant was more effective than the 12 milligram implant; the former increased rate of gain by 18 percent and increased feed efficiency by 8 percent over the controls.

2. The 12 milligram implant increased rate of gain by 5 percent over controls but the increase in feed efficiency was negligible.

Intermediate Phase

On April 19, or at the beginning of the grazing season, two steers were removed from each of the four lots to make a fifth lot (lot 5). Certain groups were implanted for a 24 milligram level during the intermediate phase (73 days, April 19 to June 30).

Steers previously treated were retreated with the idea that 50% of the initial winter treatment had been utilized during the winter. This was purely assumption on the amount that was utilized during the winter period. Methods of management of the 5 groups in the intermediate phase were:

Lot 1—No implants. Winter ration continued in dry lot.

Lot 2—Reimplanted with additional 18 mg. to bring to 24 mg. level. Treated with 12 mg. during the winter. Continued on winter ration in dry lot.

Lot 3—No implants. Grazed wheat and lespedeza pasture.

Lot 4—No implants. Grazed wheat and lespedeza pasture.

Lot 5—Each steer was implanted or reimplanted for a 24 mg. level. Grazed wheat and lespedeza pasture.

Implantation for Lot 5 was as follows:

4 steers from Lots 1 and 3—24 mg. hexestrol implants. Received no implants during the winter.

2 steers from Lot 2—18 mg. of hexestrol implants. Treated with 12 mg. during the winter.

2 steers from Lot 4—12 mg. of hexestrol implants. Treated with 24 mg. during the winter.

By this procedure, the effects of implants for the period between the close of the winter trial and the beginning of the fattening period or the intermediate period (April 19—June 30) were determined. Two

TABLE 3--DRY LOT vs. PASTURE (APRIL 19-JUNE 30, 1958 - 73 DAYS)

	Lot 1 Dry Lot No Implants	Lot 2 Dry Lot 24 mg. Implants	Lot 3 Wheat & Lesp. Pasture No Imp.	Lot 4 Wheat & Lesp. Pasture No Imp.	Lot 5 Wheat & Lesp. Pasture 24 mg. Imp.
No. head per lot	8	8	8	8	8
Avg. daily gain	2.04	2.67	1.21	1.0	1.05
Feed consumer per hundred pounds gain:					
Corn silage	2126.9	1766.7	---	---	---
Soybean oil meal	94.8	72.4	---	---	---

lots (1 and 2) were in dry lot; 3 through 5 were on pasture to study a comparison of systems in developing steers to a finished grade.

Table 3 gives results.

Observations on Intermediate Phase:

1. Hexestrol implants had little effect on pasture gains. Implanted steers (Lot 5) produced only 0.05 pound per day more gain on wheat-lespedeza pasture than Lot 4 (no implants) which had a 24 milligram treatment during the winter.
2. Winter gains affected gains produced on pasture. Lot 4, which produced the largest gains in the winter (24 mg. implant group), produced 0.21 of a pound lower daily gain on pasture than Lot 3 (no implant in winter).
3. Steers which were continued on the winter ration in dry lot were heavier and fatter on June 30 than comparable steers which grazed pasture without grain.
4. The dry lot cattle fed corn silage gained nearly twice as fast as cattle which had only pasture during the April 19 to June 30 period.
5. Implantation of steers in dry lot increased the gain by 31 percent and decreased the feed requirement per unit of gain by approximately 18 percent.

Fattening Yearlings

Beginning July 1, all lots were started on a fattening ration of ground ear corn, full fed, and 1.5 pounds of soybean oil meal per head daily. All cattle which had previously been implanted, were reimplanted with enough additional implants to equal an initial implant of 36 milligrams. The amounts of implants, that were thought to be needed to equal a 36 milligram level, were an estimation. Table 4 lists treatments used at the beginning of the finishing period along with previous treatments.

Observations on Fattening Phase.

1. During the finishing period, cattle full-fed on pasture produced larger gains with less grain than steers full-fed in dry lot; however, prior to that time, cattle (Lots 1 and 2) had made faster gains and were heavier and fatter at the beginning of the finishing period. This probably contributed to slower rate of gain and lower feed conversion.
2. Steers fed in dry lot graded slightly higher which indicated that they had more finish. However there was not a great difference in final weight at marketing time.
3. A 36 milligram implant at the beginning of the finishing period in dry lot was more effective than an 18 milligram implant. The 18 milligram implant, however, had been preceded by implants of 12 milligrams at the beginning of the winter phase and 18 at the beginning of the intermediate phase.
4. Lot 1, which received the 36 milligram implant produced 23 percent larger daily gains with 20 percent less concentrates per unit of gain than Lot 2, which received an 18 milligram implant.
5. Steers in Lot 2 weighed slightly heavier at marketing time and graded one-third of a grade higher than steers in Lot 1. This was due to the greater gains produced during the winter and intermediate phase with implants. Therefore, the combined effects of repeated treatment on final grade and final weight must be considered.
6. Implanting steers with hexestrol at the beginning of the finishing period on pasture increased the rate of gain; that is, Lot 4 implanted at the beginning of the winter phase at the 24 milligram level gained 19 percent faster than the controls (Lot 3).
7. Implanting steers with hexestrol three different times—beginning of winter, start of the grazing season, and beginning of the finishing period (Lot 5)—produced faster gains than the controls.
8. Implanting at the high level once at the beginning of the winter phase and again at the beginning of the finishing phase was more effective than smaller implants given frequently. It was also more effective than a single 36 milligram im-

TABLE 4

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Winter Dec. 14, 1957 to April 18, 1958	None	12 mg.	None	24 mg.	4 steers-None 2 steers-12 mg. 2 steers-24 mg.
Intermediate April 19, to June 20, 1958	None	18 mg.	None	None	4 steers-24 mg. 2 steers-18 mg. 2 steers-12 mg.
Finishing July 1, 59 November 15, 1958	36 mg.	18 mg.	None	24 mg.	12 mg.

plant at the beginning of the finishing period.

9. Steers in dry lot showed indications of a vitamin A deficiency during the later part of the finishing period. The silage fed during the summer phase contained nitrates. Vitamin A supplement was added and feed consumption increased.

Summary for the Three Periods

1. Implanting steers in the winter (Lot 4) with 24 milligrams of hexestrol and reimplanting in the finishing period with 24 milligrams produced highest gains. This gave 10 percent greater total gains than (Lot 5) implanting at beginning of each of the three phases and 13 percent more gain than no implants (Lot 3).
2. The use of hexestrol implants during the winter, intermediate and finishing phases in dry lot brought little improvement over an initial implant at the beginning of the finishing period. Lot 2 received implants at the beginning of each period but gained only 8 pounds more than Lot 1. Lot 1 produced a larger daily gain, more economically, than Lot 2 in the finishing period.
3. With the methods of management in this experiment there was no apparent advantage in implanting at the beginning of all three phases. *(Project 237)*

TABLE 5--FATTENING YEARLINGS ON PASTURE AND IN DRY LOT, WITH AND WITHOUT ADDITIVES JULY 1 TO NOVEMBER 15, 1958

	Lot 1 Dry Lot Hexestrol Implant 36 mg.	Lot 2 Dry Lot Hexestrol Implant 36 mg.	Lot 3 Lespedeza Pasture No Implant	Lot 4 Lespedeza Pasture Hexestrol Implant 36 mg.	Lot 5 Lespedeza-Red Clover Pasture Hexestrol Implant 36 mg.
Ration	Ground Ear Corn Soybean Oil Meal 1.5 lb. Daily Alfalfa Hay	Ground Ear Corn Soybean Oil Meal 1.5 lb. Daily Alfalfa Hay	Ground Ear Corn Soybean Oil Meal 1.5 lb. Daily Alfalfa Hay	Ground Ear Corn Soybean Oil Meal 1.5 lb. Daily Alfalfa Hay	Ground Ear Corn Soybean Oil Meal 1.5 lb. Daily Alfalfa Hay
Days on Feed	138	138	138	138	138
Avg. Initial Weight (lb.)	805.8	872.3	741.9	764.3	741.5
Avg. Final Weight (lb.)	1074.0	1088.5	1038.8	1117.0	1054.9
Total Gain (lb.)	268.2	216.2	296.9	352.7	313.4
Avg. Daily Gain (lb.)	1.94	1.57	2.15	2.56	2.27
Avg. Total Feed:					
Ground Ear Corn (lb.)	2711.6	2728.3	2385.5	2595.3	2545.8
Ground Ear Corn (bu.)	38.7	38.9	34.1	37.1	36.4
Soybean Oil Meal (lb.)	208.0	209.5	118.9	192.5	193.4
Alfalfa Hay (lb.)	356.8	362.0	164.4*	158.1*	76.9*
Avg. Daily Ration:					
Ground Ear Corn (lb.)	19.65	19.77	17.28	18.80	18.45
Soybean Oil Meal (lb.)	1.50	1.51	1.37	1.39	1.40
Alfalfa Hay (lb.)	2.6	2.6	4.7	4.5	2.20
Feed Consumer per 100 lb. Gain:					
Ground Ear Corn (lb.)	1010.8	1261.9	803.5	735.7	812.3
Soybean Oil Meal (lb.)	77.5	96.9	63.6	54.6	61.7
Alfalfa Hay (lb.)	133.0	167.4	55.3	44.8	24.5
Dressing Perdentage	61.8	60.5	62.1	61.9	62.1
Carcass Grade	Good	High Good	Low Good	Low Good	Good

* Alfalfa hay fed last 35 days.

TABLE 6--FATTENING YEARLINGS ON PASTURE AND IN DRY LOT, WITH AND WITHOUT ADDITIVES SUMMARY FOR THREE PERIODS (WINTERING, GRAZING AND FINISHING)

	Lot 1 Dry Lot	Lot 2 Dry Lot	Lot 3 Pasture	Lot 4 Pasture	Lot 5 Pasture
Hexestrol Implant Level (mg)					
Winter period	None	12	None	24	Mixed--0,12,24
Summer & finishing period	36	36	No implant	24	36
Avg. Total Feed:					
Corn silage	7673.1	8124.8	4468.7	4922.3	4646.42
Ground ear corn	2711.6	2728.3	2385.5	2595.3	2545.8
Soybean oil meal	586.0	587.0	425.3	429.5	430.2
Alfalfa hay	356.8	362.0	164.4	158.1	76.9
Pasture	None	None	Wheat & Lesp.	Wheat & Lesp.	Wheat-Lesp. Red Cl
Gain in weight per steer:					
Winter - Dec 14-Apr 18	189.9	204.7	194.3	227.5	203.9
Early Summer Apr 18-June 30	148.8	194.7	88.1	73.0	76.8
Fattening period July 1-Nov. 15	268.2	216.2	296.9	352.7	313.4
Total Gains (lb.)	606.9	614.6	579.3	653.2	594.1

Comparison of Hexestrol and Stilbestrol Implants

J. E. COMFORT, A. J. DYER, AND W. H. PFANDER

During the summer of 1958, a total of 129 yearling steers were used in two field studies comparing hexestrol (dihydro-stilbestrol) and stilbestrol (diethyl-stilbestrol) implants.

Ninety yearling steers were used at the Ted Anderson Farm near Montreal. Groups of 10 steers were implanted with 24, 18, or 12 milligrams of hexestrol or 24, 18, or 6 milligrams of stilbestrol. Three control groups of 10 steers each were used.

The steers were implanted March 4, 1957, and were fed silage until March 20. They then grazed either rye or wheat pasture until April 26. From April 26 to July 30, they grazed permanent pastures, containing an abundance of Lespedeza.

The average daily gains are in Table 7. The average daily gain of the groups implanted with hexestrol was larger than that of groups implanted with stilbestrol. There was one exception. The 10 steers implanted with 18 milligrams of stilbestrol made faster gains than the 18 milligram hexestrol group. The average daily gain of the hexestrol groups was 1.66 or 17.4 percent faster than that of the control groups. The stilbestrol groups averaged 1.61 pounds daily which was 13.6 percent faster than the control group.

In 1958 at the Agricultural Engineering Farm near Midway, 31 yearling steers fed ground ear corn, ground grain sorghum, and soybean meal on mixed grass and legume pasture were implanted with hexestrol or stilbestrol. Eight steers were in the control group. Implants were made and initial weights taken July 7. Final weights were recorded October 1. The steers were randomized for treatments using 36, 27, 24, and 18 milligram implants of hexestrol and stilbestrol. The 39 steers were fed together so feed efficiency of the different treatments could not be determined.

The average daily gain for all the hexestrol implant steers was 2.179 pounds per day or 11.86 per cent faster than the controls. Steers implanted with stilbestrol gained 2.044 pounds per day or 4.93 per cent faster than the controls. The average daily gains for the respective treatments are in Table 8.

Another group of yearling steers at the Agricultural Engineering Farm were implanted in 1957. Ten steers were implanted with 18 milligrams of stilbestrol May 1; 10 others were implanted with 24 milligrams of stilbestrol; 19 steers were in the control group. The steers were fed 165 days to October 12 on ground ear corn, and soybean meal and they

TABLE 7--HEXESTROL AND STILBESTROL IMPLANTS FOR STEERS ON PASTURE*
MARCH 4 TO JULY 30, 1958
(Ten Yearling Steers Used In Each Treatment)

	Control		Hexestrol		Stilbestrol	
Treatment	No Implant	Avg. Daily Gain	Implant	Avg. Daily Gain	Implant	Avg. Daily Gain
Group 1		.797 lbs.	18 mg.	1.278 lbs.	18 mg.	1.415 lbs.
Group 2		1.707 lbs.	24 mg.	1.969 lbs.	24 mg.	1.705 lbs.
Group 3		1.746 lbs.	12 mg.	1.712 lbs.	6 mg.	1.712 lbs.
Average		1.417 lbs.		1.664 lbs.		1.610 lbs.

* These 90 steers were grazed in 3 groups on the Ted Anderson Farm near Montreal, Missouri.

TABLE 8--HEXESTROL AND STILBESTROL IMPLANTS FOR YEARLING STEERS FED GRAIN ON PASTURE*
(JULY 7 TO OCTOBER 1, 1958 - 86 DAYS)

	Control		Hexestrol			Stilbestrol		
	No. Steers per Treatment	Average Daily Gain	No. Steers per Treatment	Implant	Average Daily Gain	No. Steers per Treatment	Implant	Average Daily Gain
	8	1.948 lb.	4	36 mg.	2.625 lb.	5	36 mg.	2.139 lb.
			4	27 mg.	2.273 lb.	4	27 mg.	2.168 lb.
			2	24 mg.	1.767 lb.	2	24 mg.	1.988 lb.
			5	18 mg.	2.051 lb.	5	18 mg.	1.881 lb.
Average	8	1.948 lb.	15		2.179 lb.	16		2.044 lb.

* Agricultural Engineering Farm near Midway (Boone Co.)

grazed mixed grass and legume pastures.

Steers implanted with 24 milligrams of stilbestrol gained 2.64 pounds per day or 13.3 percent faster than the controls which gained 2.33 pounds per day. The steers implanted with 18 milligrams of stilbestrol gained 2.42 pounds per day or 3.86 percent faster than the controls. See Table 9.

TABLE 9--STILBESTROL IMPLANTS FOR YEARLING STEERS FED GRAIN ON PASTURE* MAY 1 TO OCTOBER 12, 1957, (165 DAYS)

Control			Stilbestrol		
No. Steers per Treatment	No Implant	Avg. Daily Gain	No. Steers per Treatment	Implant	Avg. Daily Gain
19		2.33	10	18 mg.	2.42 lbs.
			10	24 mg.	2.64 lbs.

* Agricultural Engineering Farm near Midway (Boone County)

Performance Testing of Bulls:

Type; Rate and Efficiency of Gain

J. F. LASLEY AND J. E. COMFORT

Bulls have been performance tested by feeding them individually for a period of from 140 to 166 days. This performance testing has been done in connection with the beef cattle breeding project at the Weldon Springs Station and one or two of the top testing bulls each year are kept for breeding purposes.

Bulls have been fed in individual stalls each year so that efficiency of gains as well as daily rate of gain could be determined for each bull. In this report, the efficiency of gains refers to the pounds of total digestible nutrients (T.D.N.) required for each 100 pounds of gain.

Beginning with the 1953 calves, a mixed ration of grain, protein and ground alfalfa has been fed, but before that time hay and grain were fed separately. All bull calves have been fed for a preliminary period of four to six weeks before being placed on the official test. Averages of two weights taken on successive days were used for the initial and final weights.

The U.S.D.A. scoring system (Form No. 522) in which bulls were scored for 11 different points was used in all years. The total score for this system when those for each trait are added ranges from a low of 30 to a high of 100.

Results

The average yearly records for the various traits measured are summarized in Table 10. Records for each of the traits have varied considerably from year to year with an overall average daily gain of 2.18 pounds for the 62 bulls fed, and an average of 508 pounds of T.D.N. required per 100 pounds of gain.

Table 11 shows the percentages of the 62 bulls which have been outstanding for the various traits. Thirteen (21 percent) have scored 80 points or higher at the end of the feeding trials, nine (12.9 percent) have gained more than 2.52 pounds per day and seven (11.3 percent) have required less than 421 pounds of T.D.N. for each hundred pounds of gain.

These data show rather clearly that a single bull may be outstanding for one trait but may be average

TABLE 10--AVERAGE YEARLY VALUES FOR VARIOUS TRAITS IN BULLS ON INDIVIDUAL FEEDING TESTS AT THE MISSOURI STATION

Year Calved	No. of Bulls Fed	Initial Weight (Lbs)	Initial Age (Days)	Final Weight (Lbs)	Initial Score (Points)	Final Score (Points)	Average Daily Gain (Lbs)	T.D.N. per 100 Lbs Gain (Lbs)
1951	9	433	263	810	75.22	73.89	2.27	453
1952	9	573	292	901	76.55	78.44	2.35	542
1953	9	603	270	893	73.66	72.22	2.07	495
1954	6	497	251	813	78.17	76.50	2.26	444
1955	6	514	244	834	75.66	76.50	2.29	469
1956	12	641	290	1002	73.75	68.83	2.18	481
1957	11	664	313	936	71.91	71.45	1.94	623
Total and weighted average	62	573.29	279.26	897.18	74.65	73.40	2.18	508

Hereford bulls on individual feeding test.

TABLE 11--THE PERCENTAGE OF BULLS PERFORMANCE-TESTED THAT WERE OUTSTANDING FOR CERTAIN PERFORMANCE TRAITS

Performance Trait	No. of Bulls	% of Bulls
Final score* above 80	13	21.0
Daily rate of gain above 2.52 lbs.	9	12.9
T.D.N.* less than 421 lbs./cwt.	7	11.3
Final score above 80 and rate of gain above 2.52 lbs. per day	3	4.8
Final score above 80, rate of gain above 2.52 lbs. per day and T.D.N./cwt. under 421 lbs.	1	1.1

* Bulls which exceeded the mean of the group by more than one standard deviation.

or lower in another. For this reason it becomes much more difficult to find individual bulls that are outstanding for all traits desired.

This point is emphasized by the fact that only three of the 62 bulls (4.8%) scored higher than 80 points at the end of the feeding trial and gained more than 2.52 pounds per day.

Only one bull in the entire group was able to meet all of the outstanding requirements for final score above 80 points, daily rate of gain above 2.52 pounds and feed requirements of less than 421 pounds of T.D.N. per hundredweight of gain.

The relationship between type, rate of gain and efficiency of gain and the influence of initial age, initial weight and initial score on these three factors is shown in Table 12. The age and weight of the bull calves when they were placed on feed did not have a significant influence on the rate of gains made during the feeding period. A slight trend was noted, however, for heavier and older calves to make slightly faster gains. The weight of the calves when they were placed on feed did not influence the efficiency of gains but gains were less efficient when calves were placed on feed at an older age ($P<.01$). For each day older when placed on feed, the calves required 0.807 pound more T.D.N. per 100 pounds of gain.

TABLE 12--CORRELATION (r) AND REGRESSION COEFFICIENTS (b) FOR VARIOUS TRAITS IN PERFORMANCE-TESTED BULLS (ON A WITHIN SEASON BASIS - n = 55)

Traits Correlated	"r"	"b"
Initial weight and final weight	.812**	1.106
Initial weight and rate of gain	.125	.001
Initial weight and T.D.N./100 cwt gain	.041	.042
Initial age and rate of gain	-.086	- .001
Initial age and T.D.N./100 cwt gain	.388**	.807
Initial score and rate of gain	.079	.007
Initial score and T.D.N./100 cwt gain	-.071	- 1.250
Initial score and final score	.363**	.590
Final score and rate of gain	.451**	.024
Final score and T.D.N./100 cwt gain	-.514**	- 3.45
Rate of gain and T.D.N./100 cwt gain	-.576**	-18.14

** A correlation coefficient this large would be expected to occur due to chance alone only one time in a hundred. A perfect correlation coefficient would be either a +1 or a -1.

Calves which scored highest when placed on feed gained no faster and made no more efficient gains during the feeding period than those which scored lower for conformation or type. A highly significant correlation ($P<.01$) was found between initial score and final score. A score one point higher when the calves were placed on feed resulted in an average of 0.59 point higher score at the end of the feeding period.

The conformation score at the end of the feeding period was significantly correlated with the rate and efficiency of gains made during the feeding period. Thus, the calf which made the fastest and most efficient gains scored the highest. Although no attempt was made to determine the possible cause of this high relationship, it would seem that the amount of finish the bulls carried at the end of the feeding period could be largely responsible. Undoubtedly, the bulls making the most rapid and efficient gains

would be the fattest and score the highest at the end of the feeding period.

A highly significant correlation ($P<.01$) was found between rate of gain and efficiency of gains during the feeding period. Each increase of 0.1 pounds in daily gain was associated with an average of 11.81 pounds less feed (T.D.N.) required per pound of gain.

Summary

1. Bull calves from the beef cattle breeding project at Weldon Springs have been fed individually for a period of from 140 to 166 days each year since 1951. Considerable variation in average yearly values for type scores, daily gains and efficiency of gains has been observed. There has been no definite trend toward improvement in any of these characteristics over the years.
2. Although several individual bulls have been outstanding for either final type score, rate of gain or efficiency of gains only one bull could be classed as outstanding for all three characteristics. This illustrates clearly the principle that it is much more difficult to find individual bulls outstanding for several traits than it is to find those which are outstanding for one. This fact points out one of the advantages of using an index where a weight is given to each of the important traits and the merit of each individual determined by totaling all scores for the different traits.
3. The type score of calves when they were placed on feed was of no value in predicting the rate and efficiency of gain they would make during the feeding period. It did give some indication, however, of the type score of the calves at the end of the feeding period.
4. For each day older when placed on feed, calves required 0.807 pounds more T.D.N. per pound of gain. This points out the necessity of comparing calves on a feeding trial that are as near the same age as possible.
5. Calves which gained the fastest and made the most efficient gains during the feeding period scored the highest for type at the end of the feeding period, probably because they were fatter.
6. A highly significant correlation was found between rate and efficiency of gain, although this was not of sufficient magnitude for the conclusion that selection for rate of gain alone would also give the desired improvement in the efficiency of gains. More data should be gathered and other practical and economic factors should be studied before a definite conclusion is made on this point. *(Project 198)*

Heterosis and Selection for Heterosis in Swine

J. F. Lasley and L. F. Tribble

Two methods of breeding are available to the swine producer to increase the production in his herd. One is to keep only superior individuals in the herd for breeding purposes. This method is the most successful for traits which are highly heritable and where good records are used to find those animals which are outstanding. The second method is to cross lines or breeds in order to take advantage of hybrid vigor or heterosis.

Heterosis effects are usually greater for the traits which are not highly heritable. Heterosis is the extra performance above that obtained by mating the best to the best. It is usually measured by comparing the average of the offspring with the average of the two parent lines or breeds. To take advantage of heterosis in swine, inbred lines should be developed and tested as in hybrid corn production and the lines with the best combining ability should be kept for commercial production.

The data in this report are from a study in which an attempt was made to improve the "combining ability" of two different inbred lines by re-

producing each line from parents whose line cross progeny were superior to the average of all animals tested. Inbred Landrace and inbred Polands were used. The estimate of heterosis was obtained by comparing the average of crossbred Landrace x Poland sows and pigs with the average of the two parental lines when they produced inbred pigs. Heterosis values obtained here could be expected to be larger than when non-inbred pure breeds are crossed because the performance of the inbreds is usually below that of non-inbred swine.

Results

Crossbred Landrace x Poland pigs performed much better than the average of inbred Poland and inbred Landrace pigs at all ages between birth and 154 days of age (Tables 13 and 14 and Figure 1).

TABLE 13--INFLUENCE OF LINE CROSSING IN SOWS AND PIGS

	Inbred Sows*		L x P Sows
	Inbred Pigs	L x P Pigs	L x P x D Pigs
Number of litters	153	189	70
Litter size:			
Birth	8.04	8.51	9.87
56 days	5.23	6.60	8.41
154 days	4.69	6.32	8.06
Litter weight:			
Birth	27.50	28.85	32.47
56 days	196.90	260.30	321.35
154 days	767.10	1132.48	1540.00
Weight per pig:			
Birth	3.42	3.39	3.29
56 days	37.65	39.44	38.21
154 days	163.56	179.19	191.19

* Averages of inbred Landrace and inbred Poland sows.

TABLE 14--PERCENTAGE OF HETEROSIS FROM CROSSING INBRED LANDRACE AND INBRED POLANDS

	Per Cent Heterosis*		
	In Pigs	In Sows	In Both Sows and Pigs
Litter size:			
Birth	5.84	16.96	22.76
56 days	26.20	34.60	60.80
154 days	34.75	37.11	71.86
Litter weight:			
Birth	4.90	13.17	18.07
56 days	32.19	31.01	63.20
154 days	47.63	53.13	100.76
Weight per pig:			
Birth	-0.94	-2.95	-9.62
56 days	4.75	3.74	1.01
154 days	9.56	7.28	16.84

* Heterosis in the pigs represents the percentage advantage of crossbred Landrace x Poland pigs from inbred dams over the average inbred litters from inbred Poland and inbred Landrace sows. Heterosis in both sows and pigs was calculated by comparing the production of crossbred Landrace x Poland sows bred to Duroc boars with the average of inbred Poland and inbred Landrace sows when they produced inbred pigs. Heterosis in sows was estimated by subtracting that in the pigs from that in the pigs from that in both sows and pigs.

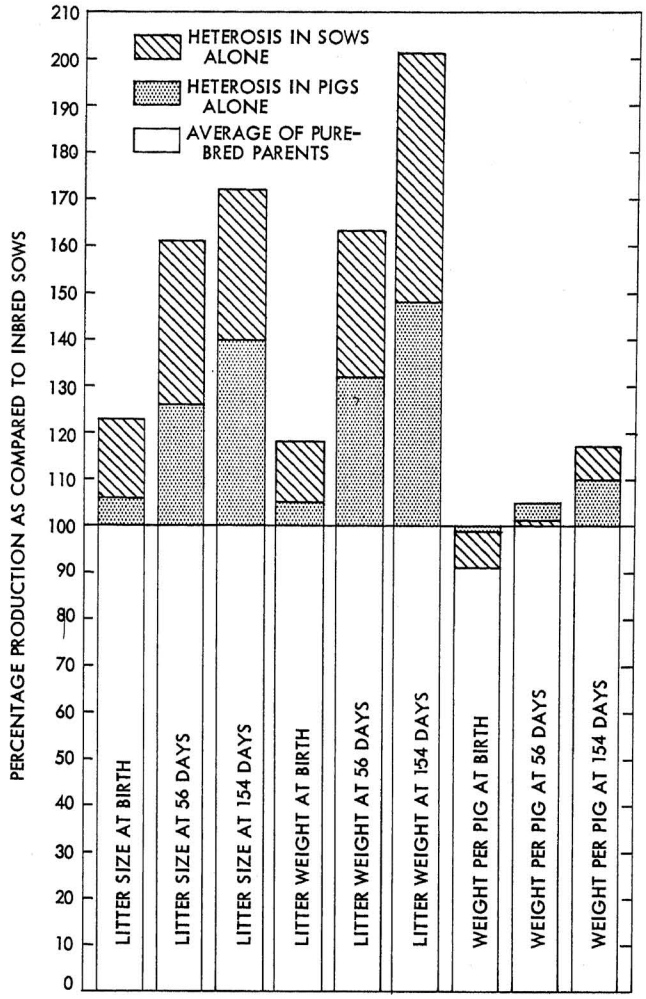


Figure 1—Percentage advantage of crossbred sows and crosbred pigs over the average of inbred pigs and sows.

Little advantage was noted in litter size or weight at birth, but the advantage increased greatly by the time the pigs were 154 days of age with an average of 47.63 percent heterosis in total litter weight at that time. The greatest heterosis effect was due to the vigor and livability of the pigs resulting in larger litters surviving. Heterosis effects were much less in average pig weight with crossbred pigs actually weighing less than inbred pigs at birth but weighing 9.56 percent heavier at 154 days of age.

Slightly greater heterosis values were obtained for crossbred Landrace x Poland sows than for the crossbred Landrace x Poland pigs. As was true in the pigs, the greatest improvement in sows from crossing was in litter size at the different ages. Most of this improvement was due to larger litters farrowed with the litters from the line cross sows maintaining some of this initial advantage up to 154 days.

Undoubtedly the line cross sows produced large litters at farrowing because they released more eggs during estrus and probably there was less embryonic and fetal death loss in their pigs. Pigs from crossbred sows actually weighed less than inbred pigs from inbred sows at farrowing, but they were about 4 percent heavier at weaning and 7 percent heavier at 154 days of age.

By using a three-line cross involving inbred Landrace, inbred Polands and inbred Durocs, advantage was taken of heterosis in both the sows and pigs. Such a breeding method resulted in over 100 percent heavier litters at 154 days of age than in inbred sows from the parent Landrace and Poland inbred lines when they produced inbred pigs.

Total litter size at 154 days in line cross Landrace x Poland sows mated to inbred Duroc boars was almost identical during three generations of selection for improved combining ability. There was some indication, however, of increased hybrid vigor through selection in line cross Landrace x Poland pigs as compared to inbred pigs from inbred parental lines. (Table 15) The advantage in the first generation of

TABLE 15--HETEROSIS SHOWN BY CROSSBRED PIGS DURING THREE GENERATIONS OF RECIPROCAL RECURRENT SELECTIONS

	Generation		
	No. 1	No. 2	No. 3
Litter size:			
Birth	2.76	-1.50	9.70
56 days	12.50	22.78	34.42
154 days	7.42	28.10	47.76
Litter weight:			
Birth	0.43	-1.22	11.64
56 days	19.83	39.99	41.32
154 days	1.91	46.09	63.60
Weight per pig:			
Birth	- 2.30	0	1.80
56 days	-17.50	14.00	5.10
154 days	- 6.57	14.01	10.76

selection was about 7 percent but increased to 28 percent in the second generation and 48 percent in the third (Figure 2). This was true even though there was a decline of only 0.16 pigs per litter in the inbred litters in the third generation as compared to the first.

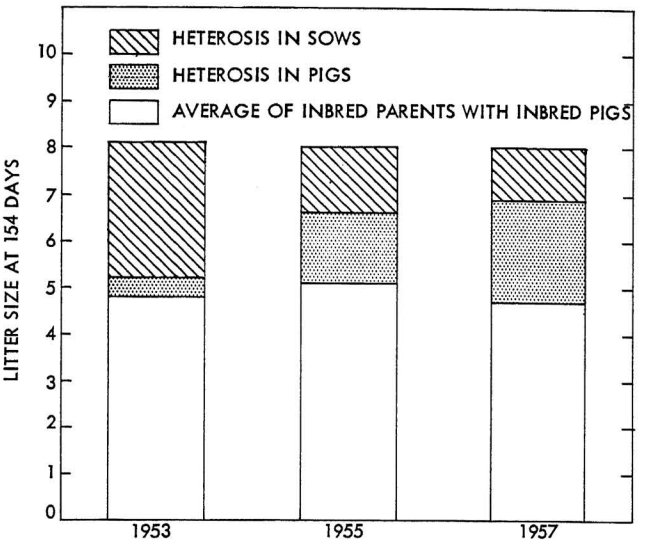


Figure 2—Advantage of crossbred sows and crossbred pigs in different years, compared with inbred sows and pigs.

Summary and Conclusions

1. A comparison of line cross pigs and sows with the average of the parental inbred lines showed larger heterosis values in the pigs and in the line cross sows. Most of this increased performance was due to larger litter size. This, in turn, was probably due largely to greater vigor in the line cross pigs and to an increased ovulation rate and less embryonic death loss in line cross sows. By taking advantage of heterosis in both sows and pigs by crossing three inbred lines, litter weight at 154 days of age was improved over 100 percent, compared to the average of the inbred parents.
2. Three generations of selection in which inbred lines were reproduced from parents having the best progeny test records based on line cross offspring did not improve litter size at 154 days of age in the three-line cross. The performance of line cross pigs from inbred Poland and inbred Landrace sows seemed to improve, however, with each generation of selection. This was true even though the performance of the inbred lines remained approximately the same during that period of time. *(Project 3)*

Hexestrol and High Moisture Corn for Fattening Lambs

C. V. Ross, John C. Rea

New types of farm machinery are making a number of operations possible which were hither-to thought impractical. With the advent of new air-tight silos and with better handling equipment many farmers are anxious to know the advantages of using high moisture corn in livestock fattening operations. Possible advantages are: (1) Corn may be stored even though the moisture is too high for cribbing. (2) Corn may be harvested at the convenience of the farmer. (3) Increased yields due to less shattering.

An experiment was run with the primary objective of comparing feeding value and yield of corn which was harvested when it contained 27.5 percent moisture versus corn in the same field allowed to stand until the moisture was 15.5 percent (#2). Another objective was to compare graded levels of Hexestrol to implants in wether and ewe lambs.

One hundred and twenty black faced Idaho lambs were divided at random into two pens of 32 ewe lambs and two pens of 28 wethers. One pen of ewes and one pen of wethers were fed a ration containing high moisture corn. The remaining pens of wethers and ewes received a ration containing No. 2 corn.

These four pens of lambs were subdivided into four uniform lots each. The lambs were implanted with graded levels of Hexestrol as follows: Wethers received 0, 5, 6, & 7 mgm implants and ewes 0, 7, 8, & 9 mgm implants. These lambs were self-fed on a complete ground and mixed ration as shown in Table 16.

After 41 days on feed all lambs were graded alive and marketed. Results of the comparison of lambs on rations containing high moisture corn versus rations containing No. 2 corn are shown in Table 17.

TABLE 16--RATIONS FED TO FATTENING LAMBS IN WHICH #2 CORN WAS COMPARED TO HIGH MOISTURE CORN

	Rations using Number 2 Corn			
	Ration I	Ration II	Ration III	Ration IV
Ground ear corn (%)*	44	58	60	65
SBOM (%)	6	7	5	7
Molasses (%)	5	5	5	5
Ground alfalfa hay (%)	45	30	30	23
Aureomycin (mgm/lb)	10	10	10	10
Days fed	7	10	12	12
	Rations using High Moisture Corn			
	Ration I	Ration II	Ration III	Ration IV
Ground ear corn (%)**	49.7	62.2	63.61	69.2
SBOM (%)	5.4	6.0	4.55	6.2
Molasses (%)	4.5	4.5	4.55	4.4
Ground alfalfa hay (%)	40.4	27.3	27.29	20.2
Aureomycin (mgm/lb)	10	10	10	10
Days fed	7	10	12	12

* Contained 14.6% moisture.
** Contained 27.5% moisture.

TABLE 17--COMPARISON OF RATIONS CONTAINING HIGH MOISTURE VERSUS NO. 2 YELLOW CORN[1] FOR EWE AND WETHER LAMBS

Treatment	No. 2 Corn	High Moisture Corn
Wethers		
No. of lambs	28	26
Avg. initial wt. (lbs.)	82.6	82.9
Avg. final wt. (lbs.)	108.7	111.0
Avg. gain (lbs.)	26.1	28.1
Avg. days of feed	41	41
Avg. daily gain (lbs.)	.636	.685
Feed/cwt. gain (lbs.)	739	707
Feed/cwt. gain dry matter basis (lbs.)	639	555
Avg. carcass yield (%)[2]	51.7	53.6
Avg. carcass grade[3]	5.4	5.3
Ewes		
No. of lambs	32	32
Avg. initial wt. (lbs.)	81.2	81.2
Avg. final wt. (lbs.)	108.3	105.3
Avg. gain (lbs.)	27.1	24.1
Avg. days on feed	41	41
Avg. daily gain (lbs.)	.661	.588
Feed/cwt. gain (lbs.)	635	770
Feed/cwt. gain dry matter basis (lbs.)	549	605
Avg. carcass yield (%)[2]	49.5	51.2
Avg. carcass grade[3]	5.23	5.03

[1] The high moisture corn ration contained an average of 21.44% moisture and the number 2 corn ration contained an average of 13.47% moisture.

[2] Carcass yield = $\frac{\text{Chilled carcass wt.}}{\text{wt. out of feed lot}}$ X 100.

[3] U.S. Grades were assigned numerical values as follows: high choice 9, medium choice 8, low choice 7, high good 6, medium good 5.

Observations on High Moisture Corn

(a) There were no statistical differences in gains of lambs fed high moisture or No. 2 corn in the ration. However, wether lambs on the high moisture corn ration consumed more feed and made slightly greater and more efficient gains than those receiving the ration containing No. 2 corn while ewe lambs made smaller and less efficient gains when fed the high moisture corn ration.

(b) When results of wethers and ewe lambs were pooled and figured on an equivalent moisture basis there was a saving in pounds of feed required per pound of gain in favor of lambs fed the high moisture corn ration.

(c) No significant differences were observed in grades or yields of lambs fed the rations containing high moisture or No. 2 corn.

(d) Plastic bags were satisfactory for storing the wet corn. Little spoilage was observed and the corn was palatable to the lambs.

(e) Picking the corn wet resulted in a higher yield per acre, figured on a dry matter basis, than when harvested later as No. 2 corn.

Results of the Hexestrol treatments are shown in Table 18.

Observations on Hexestrol Treatments

(a) All lambs implanted with Hexestrol made significantly faster gains than controls.

(b) There was no significant difference in gains made by the lambs on the various levels of Hexestrol implants. However, wethers implanted with 7 mgm. and ewes with 7 or 8 mgm. made slightly faster gains than other levels of implantations.

(c) Carcass grades and yields were not significantly affected by the Hexestrol treatment. There was less than one-third of a grade variation between controls and treated lambs.

(d) There was some udder development of ewe lambs implanted with Hexestrol but no serious side effects were noted. *(Project 356)*

TABLE 18--EFFECTS OF IMPLANTING HEXESTROL IN WETHERS AND EWE LAMBS

Treatment	Controls	5 mgm	6 mgm	7 mgm
Wethers				
No. of lambs	13[1]	14	14	13[1]
Avg. initial wt. (lbs)	83.8	82.5	82.1	82.7
Avg. Final wt. (lbs)	106.8	110.5	110.1	111.7
Avg. gain (lbs)	23.0	28.0	28.0	29.0
Avg. days on feed	41	41	41	41
Avg. daily gain (lbs)	.561	.683**	.683**	.720**
Avg. carcass yields[2]	54.4	52.9	51.2	52.1
Avg. carcass grade[3]	5.54	5.21	5.07	5.38

Treatment	Controls	7 mgm	8 mgm	9 mgm
Ewes				
No. of lambs	16	16	16	16
Avg. Initial wt. (lbs)	81.0	81.6	81.1	81.1
Avg. Final wt. (lbs)	100.5	110.1	109.6	106.9
Avg. Gain (lbs)	19.5	28.5	28.5	25.8
Avg. days on feed	41	41	41	41
Avg. daily gain (lbs)	.476	.695**	.695**	.629**
Avg. carcass yield	51.7	50.9	50.8	49.9
Avg. carcass grade	4.9	5.2	5.3	5.1

[1] One wether in the control lot died at the start of the test and one wether in the 7 mgm lot was not included in the results because of lung adheisions when slaughtered.

[2] Carcass yield = $\frac{\text{Chilled carcass weight}}{\text{weight out of feed lot}} \times 100.$

[3] U. S. Grades were assigned numerical values as follows: high choice 9, medium choice 8, low choice 7, high good 6, medium good 5.

** $P < .01$

Concentrate:Roughage Ratios; Pelleted Feed; Hexestrol for Fattening Lambs

C. V. Ross and R. L. Pavey

The primary objective of the experiment was to compare the effects of high, medium and low levels of concentrates in pelleted rations for fattening lambs. Other objectives were: To compare ground and mixed unpelleted rations with pelleted rations, and no Hexestrol versus three levels of implants for

wether and ewe lambs.

One hundred and twelve blackfaced Idaho lambs were divided into four uniform lots of wethers and four uniform lots of ewes and placed on experiment October 30. One lot each of wethers and ewes was self-fed each of the rations in Table 16. The lots were further divided into four equal sublots and implanted with Hexestrol as follows: Wethers control, 5 mgm, 6 mgm, and 7 mgm, Ewes control, 7 mgm, 8 mgm, and 9 mgm. Rations fed are shown in Table 19.

TABLE 19--CONCENTRATE: ROUGHAGE RATIOS, COMPOSITION AND FORM OF RATIONS FED TO FATTENING LAMBS[1]

Concentrate to Roughage	60/40 Meal	60/40 Pellets	50/50 Pellets	40/60 Pellets
Ground ear corn	62.75	62.75	52.00	41.00
Soybean meal	6.50	6.50	5.00	3.75
Molasses	5.00	5.00	5.00	5.00
Alfalfa Hay	25.75	25.75	38.00	50.25
Aureomycin[2]	+	+	+	+

[1] All rations contained 11% crude protein.

[2] Aureomycin added at the rate of 10 mg. per pound of feed.

The lambs were group self-fed for 69 days and were slaughtered. Results are shown in Table 20.

Observations

(a) Fastest and most efficient gains were made by lambs on the pelleted ration composed of 40 percent concentrates and 60 percent roughage.

(b) Poorest and least efficient gains were made by lambs on the ration containing 60 percent concentrates.

(c) Performance of lambs on the ration composed of equal concentrates and roughages was intermediate between the low concentrate and the high concentrate rations.

(d) There was little difference in performance of lambs on the high concentrate ration, either pelleted or unpelleted.

(e) Significantly lower carcass yields were obtained from lambs on the low concentrate ration.

(f) Highest grades were made by lambs fed the pelleted ration containing 50 percent roughage.

Results of the comparison of Hexestrol levels are shown in Table 21.

Observations

(a) All lambs implanted with Hexestrol made faster gains than controls. The composite amounted to 11.24 percent greater daily gains. However, there was so much variability within lots that only the 7 mgm implant level in ewes was significant. Wethers implanted with 6 mgm Hexestrol made fastest gains.

(b) Ewe lambs apparently responded more to hexestrol than wethers.

(c) Carcass yields were slightly lower on lambs on Hexestrol.

(d) Carcass grades were slightly higher for ewe lambs but somewhat lower for wethers on Hexestrol, compared with controls. *(Project 356)*

TABLE 20--THE EFFECT OF PELLETING AND VARIOUS CONCENTRATE: ROUGHAGE RATIOS FOR FATTENING LAMBS

Concentrate: Roughage Ratio	No. Finished	Avg. Initial Wt. (Lbs)	Avg. Final Wt. (Lbs)	Avg. Gain (Lbs)	Avg.[1] Daily Gain (Lbs)	Feed Eaten per Lamb Daily (Avg) (Lbs)	Feed per Pound Gain (Avg) (Lbs)	Carcass[2] Yield (Avg) (%)	Carcass[8] Grade (Avg)
Ewes									
60/40 Meal	16	68.75	102.63	33.88	.491	4.09	8.32	51.15	6.70
60/40 Pellets	16	68.91	104.50	35.59	.516	3.56	6.90	50.53	6.30
50/50 Pellets	15	69.27	110.80	41.53	.602[4]	4.28	7.12	51.30[5]	6.90
40/60 Pellets	16	69.22	110.75	41.53	.602[5]	4.05	6.73	50.44[5]	6.40
Wethers									
60/40 Meal	11	68.96	111.82	42.82	.621	3.93	6.47	50.48	6.20
60/40 Pellets	12	69.38	110.33	40.96	.594	4.98[3]	8.39[3]	53.18	6.25
50/50 Pellets	12	69.67	114.00	44.33	.642	4.56	7.10	51.97	7.20[4]
40/60 Pellets	12	69.54	120.50	50.69	.739[7]	4.43	5.99	49.31[7]	7.00[4]
Combined Ewes & Wethers									
60/40 Meal	27	68.84	106.37	37.53	.544	4.03	7.57	50.88	6.50
60/40 Pellets	28	69.11	107.00	37.89	.549	4.17	7.55	51.67	6.28
50/50 Pellets	27	69.46	112.22	42.76	.620[6]	4.40	7.11	51.71	7.03[7]
40/60 Pellets	28	69.36	114.93	45.57	.660[7]	4.21	6.41	49.96[7]	6.66

[1] Lambs were on feed 69 days.

[2] Carcass yield = $\frac{\text{Chilled carcass weight}}{\text{live weight out of feed lot}}$ X 100

[3] Feed wastage appeared to be greatest in this lot.

[4] Approaching significance at P .05.

[5] Approaching significance at P .01.

[6] Significant at P .05.

[7] Significant at P .01.

[8] U. S. Carcass Grades were converted to numerical values as follows: Medium choice 8, Low choice 7, High good 6.

TABLE 21--RESPONSE OF EWE AND WETHER LAMBS TO GRADED LEVELS OF HEXESTROL IMPLANTS

Hexestrol Implant Levels	No. Finished	Avg. Initial Wt. (Lbs)	Avg. Final Wt. (Lbs)	Avg.[1] Gain (Lbs)	Avg. Daily Gain (Lbs)	Carcass[2] Yield (Avg) (%)	Carcass[4] Grade (Avg)
Ewes							
Control	16	68.94	103.13	34.19	.496	51.75	6.44
7 mg	16	68.66	110.75	42.09	.610[3]	50.45	6.63
8 mg	16	69.47	107.06	37.59	.545	51.13	6.72
9 mg	15	69.07	107.53	38.46	.557	50.77	6.47
Wethers							
Control	12	69.38	110.92	41.54	.602	51.54	6.83
5 mg	11	69.67	115.36	45.41	.658	50.19	6.73
6 mg	12	69.63	116.83	47.21	.684	50.86	6.67
7 mg	12	68.88	113.83	45.13	.654	52.20	6.64

[1] For 69 days on feed

[2] Carcass yield = $\frac{\text{Chilled carcass weight}}{\text{live weight out of feedlot}} \times 100$

[3] Significant at P .05

[4] U. S. Carcass grades were converted to numerical values as follows: Medium choice, 8; Low choice, 7; High good, 6.

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