PROGRESS REPORT
1959-1960
FEEDING AND BREEDING TESTS
CARCASS STUDIES WITH
BEEF CATTLE, SHEEP AND SWINE

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Contents

Winter calves marketed at eleven months of age.

Production of Slaughter Cattle to be Marketed Shortly After Weaning

J. E. Comfort, A. J. Dyer

Missouri has over a million beef cows. A great number of them produce feeder calves. Some produce slaughter calves marketed at weaning or shortly after weaning. Experiments have been in progress since 1954 dealing with methods of production that would yield a greater net return per cow.

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

Age and Method of Handling Calves in 1959.

Lot I: September-October, 1958 calves. Creep fed grain December 6 to June 4 (180 days). Fed grain in dry lot 121 days after weaning. Marketed at 12 months of age.

Lot II: December-January-February, 1958-59 calves. Creep fed grain June 6 to September 14 (100 days). Grain fed September 14 to December 22, for 99 days after weaning. Marketed at 11 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, 1958, calves were wintered on 47 pounds of corn silage and 1½ pounds of soybean meal per day. They gained 110 pounds during the winter and weighed 1092 pounds April, 1959. They were fed 2½ tons of corn silage and 108 pounds of soybean meal during the winter. The dams of the winter calves grazed fescue pasture with some lespedeza and mixed grasses untill November 28. From November 28 to April 2 they were fed 1.42 tons of low grade red clover and alfalfa hay and 108 pounds of soybean meal with winter pasture. In April, they weighed 932 pounds which was 125 pounds less than in November, 1958, before calving.

Results

1. The Lot I fall calves were creep fed grain during the winter, spring and early summer. They were weaned at nine months of age and grain fed in dry lot for 121 days. They ate a total of 28.5 bushels of corn. These calves ate less grain during the winter than fall calves in preceding years of this experiment. They ate some silage during the winter, but it was not possible to keep a separate record on the amount consumed by the calves as they were not separated from their mothers. A total gain of 570 pounds was made from December 6 to October 3. They were marketed at 12 months of age. Six calves graded choice and two were in the top good grade.

2. The winter calves in Lot II were creep fed grain 100 days before weaning, starting in June. This was earlier than in preceding years as the pastures were getting dry and their dams were all 10 years old. They were fed grain on mixed grass and legume pasture for 99 days after weaning and were marketed in December at 11 months of age. They ate 4.27 bushels of corn in the creeps before weaning and 15.3 bushels of corn after weaning, a total of 19.5 bushels of corn. The winter calves weighed about 100 pounds less than the fall calves when marketed. Two of the winter calves graded low choice, six top good and, one average good.

3. The fall calves weighing 801 pounds in October sold for $26.00 per cwt. The winter calves weighing 708 pounds in December sold for $23.75 per cwt. due to a decline in market price and grading about one-third grade lower.

	I Fall, 1958 Sept.-October Creep-Fed While Nursing	II Winter 1958-59 December-Jan.-Feb. Creep-Fed June-September
Nursing Period		
a. No. in each lot	8	9
b. Avg. initial weight	231 (Dec. 6)	200 (April 2)
c. Avg. final weight	515 (June 4)	504 (Sept. 14)
d. Avg. gain to weaning	284	304
e. Avg. daily gain	1.58	1.84
Average Daily Ration		
f. Cracked corn	.8 (180 days on creep)	2.39 (100 days on creep)
g. Soybean meal	.1	.3
Average Total Feed		
h. Cracked corn	144 (2.57 bu.)	239 (4.27 bu.)
i. Soybean meal	18	30
After Weaning Period		
j. Average final weight	801 (Oct. 3)	708 (Dec. 22)
k. Average gain after weaning	286	204
l. Average daily gain	2.36	2.06
Average Daily Ration		
m. Cracked corn	12.0	8.66
n. Soybean meal	1.5	1.1
o. Alfalfa hay	4.58	----
Average Total Feed		
p. Cracked corn	1452.0 (25.9 bu.)	857 (15.3 bu.)
q. Soybean meal	182	107
r. Alfalfa hay	554	----
Feed Required/100# gain		
s. Cracked corn	508	420
t. Soybean meal	64	52
u. Alfalfa hay	194	----
Market Graded	I	II
Choice	2	
Choice -	4	2
Good /	2	6
Good		1

4. In the 1959 test, the fall calves gave a higher return above all feed and pasture charges because of greater weight marketed and the one-third higher grade, even if you assume no decline occurred in market price from October to December. *(Project 78)*

Hexestrol Implant Levels in Wintering and Fattening Yearling Cattle

J. E. COMFORT, A. J. DYER, G. M. BOSWELL

The effects of implanting steers with Hexestrol at different levels were determined for steers that 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 mix-

ture of steamed bone meal and salt. The effects of "hormone" implants on the rate and economy of gain were studied.

Wintering Period Results

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

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

November 24, 1958, to April 18, 1959 - 145 Days
(All Figures Represent Averages in Pounds unless Otherwise Stated)

	Lot 1	Lot 2	Lot 3	Lot 4
No. Head Per Lot	9	9	9	8*
Hexestrol Implant Level	None	12 mg.	None	24 mg.
Average Initial Wt.	452.2	454.8	454.1	453.8
Average Final Wt.	679.4	705.7	687.2	716.2
Average Gain	227.2	250.9	233.1	262.4
Average Daily Gain	1.57	1.73	1.61	1.81
Feed Consumed/steer				
Corn Silage	4864.8	5275.9	4947.2	5203.4
Soybean Meal	281.4	281.4	281.4	281.4
Feed Per 100/gain				
Corn Silage	2141.2	2102.8	2122.4	1983.0
Soybean Meal	123.9	112.2	120.7	107.2

(*One steer developed enlarged glands on neck last 28 days - record not included.)

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

The 24 milliagram implant was more effective than the 12 milligram implant; the former increased rate of gain 14 percent and feed efficiency 7 percent over the controls.

The 12 milligram implant increased rate of gain 9 percent and feed efficiency 1.4 percent over the controls.

Intermediate Phase

Methods of management of the four lots in the intermediate phase were:

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

Lot 2—Reimplanted with additional 18 milligrams of Hexestrol. Continued on winter ration in dry lot.

Steers which were continued on winter ration of corn silage and soybean meal in dry lot and reimplanted were heavier and fatter than steers which grazed pasture without grain.

Implantation of steers in dry lot increased the gain by 10 percent and decreased the feed requirement by 2 percent.

Steers which were continued on winter ration in dry lot without implants gained 7 percent more than steers grazed on pasture without grain.

The winter implant of 24 milligrams did not decrease the gain on pasture in this experiment (Lot 4). (Gains in two previous experiments had been reduced by winter implants).

DRY LOT VS. PASTURE - INTERMEDIATE PHASE
April 19 to July 6, 1959 - 79 Days
(All Figures Represent Averages in Pounds unless Otherwise Stated)

	Lot 1 Dry Lot	Lot 2 Dry Lot	Lot 3 Pasture	Lot 4 Pasture
No. Head Per Lot	9	9	9	9
Hexestrol Implant	None	18 mg.	None	None
Average Initial Wt.	679.4	705.7	687.2	703.4
Average Final Wt.	778.8	814.7	778.6	796.3
Gain Per Steer	99.4	109.0	91.4	92.9
Gain Per Day	1.26	1.38	1.16	1.18
Feed Consumed Per Steer				
Corn Silage	3265.6	3513.0		
Soybean Meal	158	158		
Feed Per 100/gain				
Corn Silage	3285.3	3222.9		
Soybean Meal	159	145		

Fattening Phase

On July 6 all lots were started on a fattening ration of ground ear corn, full fed, and 1.5 pounds of soybean meal per head daily in dry lot. Alfalfa hay was limited. The original plan to grain-feed Lots 3 and 4 on pasture was changed due to a drouth. Steers in Lot 1 were implanted with 36 milligrams of Hexestrol, those in Lot 2 were reimplanted with 24 milligrams and those in Lot 4 were reimplanted with 36 milligrams of Hexestrol.

Steers in dry lot during all three phases and then implanted with 36 milligrams of hexestrol at the beginning of the fattening period (Lot 1) made the largest and most efficient gains during the fattening period.

Steers in Lot 1 gained 8 percent more weight and 10 percent more efficiently than steers (Lot 2) implanted at three successive periods. The Lot 1 steers made 31 percent faster gains with 20 percent less concentrate per

FATTENING YEARLING STEERS IN DRY LOT WITH AND WITHOUT ADDITIVES
July 7 to October 31, 1959 - 117 Days

	Lot 1 Hexestrol Implant 36 mg.	Lot 2 Hexestrol Implant 24 mg.	Lot 3 No Implant	Lot 4 Hexestrol Implant 36 mg.
Ration:				
Ground Ear Corn				
Soybean Oil Mean				
1.5 lbs./daily				
Alfalfa Hay				
No. Steers to Lot	9	9	9	9
Avg. Initial Wt. (lbs.)	778.8	814.7	778.6	796.3
Avg. Final Wt. (lbs.)	1055.0	1070.0	988.5	1050.6
Total Gain (lbs.)	276.2	255.3	209.9	254.3
Avg. Daily Gain (lbs.)	2.36	2.18	1.79	2.17
Avg. Total Feed				
Ground Ear Corn (lbs.)	2095	2156	1998	2172
Ground Ear Corn (bu.)	29.9	30.8	28.5	31.0
Soybean Meal (lbs.)	170	170	170	170
Alfalfa Hay (lbs.)	284	288	215	251
Avg. Daily Ration				
Ground Ear Corn (lbs.)	17.91	18.43	17.07	18.56
Soybean Meal (lbs.)	1.45	1.45	1.45	1.45
Alfalfa Hay (lbs.)	2.43	2.46	1.84	2.15
Feed Consumed 100/gain				
Ground Ear Corn (lbs.)	759.06	844.49	951.88	854.11
Soybean Meal (lbs.)	61.59	66.59	80.99	66.85
Alfalfa Hay	102.89	112.81	102.43	98.70
Dressing Percentage	60.7	61.2	60.5	61.2
Carcass Grade	Good	Good	Good	Good

FATTENING YEARLINGS WITH AND WITHOUT ADDITIVES
Summary for Three Periods (Wintering, Intermediate, Fattening)

	Lot 1	Lot 2	Lot 3	Lot 4
Hexestrol Implant Level (mg.)				
Winter Period	None	12	None	24
Intermediate Period	None	18	None	None
Finishing Period	36	24	None	36
Average Total Feed (lbs.)				
Corn Silage	8150	8499	4947	5203
Ground Ear Corn	2095	2156	1998	2172
Soybean Meal	610	596	451	451
Alfalfa Hay	284	288	215	251
Pasture (intermediate phase)	None	None	Lespedeza Wheat	Lespedeza Wheat
Gain in Wt./Steer				
Winter	227.2	250.9	233.1	262.4
Early Summer	99.4	109.0	91.4	92.9
Finishing Period	276.2	255.3	209.9	254.3
Total Gain (lbs.)	602.8	615.2	534.4	609.6

unit gain than the control steers (Lot 3) without implants.

There was little difference in either rate or efficiency of gain during the fattening phase between steers that had three successive implants (Lot 2) and the steers having a 24-milligram implant in winter and 36-milligrams at the beginning of the fattening phase (Lot 4). However, the steers with three successive implants (Lot 2) were 16 pounds heavier at the end of the test. The additional gain was made in the intermediate phase.

Summary for the Three Periods

1. Implanting steers and reimplanting at three successive periods (Lot 2) produced slightly larger total gains than implanting only at the beginning of the fattening period (Lot 1) due to larger gains in winter and in the early summer period.

2. The steers implanted three successive periods also made slightly larger total gains than steers implanted in winter and fattening periods in this test (Lot 4).

3. The steers implanted with 24 milligrams of Hexestrol in winter, grazed in early summer, and reimplanted with 36 milligrams at beginning of finishing period (Lot 4) received 1½ tons less silage and 145 pounds less soybean meal and weighed only 5 pounds less at the end of the test than Lot 2 steers fed in dry lot the entire time and implanted at three successive periods.

Lot 1 yearling Hereford steers fed in dry lot.

4. The Lot 4 implanted steers made 14 percent greater total gain (75 pounds more) than steers that were not implanted (lot 3).

5. Implanting at the beginning of the finishing period increased gains and improved efficiency in gains, as indicated in Lots 1, 2 and 4.

6. Wintering steers liberally on corn silage supplemented with 2 pounds per day of soybean meal produced fleshy feeders, making it possible to fatten and market them by November 1.

7. All lots sold for the same price per cwt. and the carcasses in all lots were in the Good grade.

Lot 4 coming two-year-old Hereford steers fed Hexestrol 126 days and Tapazole the last 56 days.

Results of Feeding Yearling Steers at two Protein Levels With Feed Additives

G. B. Thompson, J. E. Comfort

The objective was to determine the effects of different protein levels, with and without a goitrogenic hormone-like compound (Tapazole) on the performance and carcass value of fattening steers.

Thirty-one grade yearling Hereford steers were used in this experiment. The steers were grazed during the summer and were brought into dry lot in October, 1958. The steers averaged approximately 750 pounds and carried only a moderate degree of finish. These steers were divided into four lots of cattle nearly equal in weight, condition, and general type. The cattle were fed twice daily. The daily ration was increased gradually until the cattle were on full feed after two weeks.

Treatments

All steers received 10 milligrams of an estrogenic hormone-like substance (Hexestrol) per head per day in the feed. The goitrogenic hormone-like substance (Tapazole) was fed as shown in the following table.

DESIGN OF THE EXPERIMENT

Lot	I	II	III	IV
Phase 1 - 56 days				
Digestible protein	7.5%	7.5%	8.5%	8.5%
Tapazole (mg./head daily)	None	125	None	None
Phase 2 - 28 days				
Digestible protein	7.5%	7.5%	7.5%	7.5%
Tapazole (mg.)				
First 14 days	None	125	None	None
Last 14 days	None	200	None	300
Phase 3 - 42 days				
Digestible protein	7.5%	7.5%	6.5%	6.5%
Tapazole (mg.)	None	200	None	300

Feedstuffs used:
Corn and cob meal
Soybean oil meal (44% C.P. solvent)
Cobaltized salt, 0.5% of ration (one ounce of cobalt chloride per 100 lbs. salt)
Red clover hay (brown, slightly moldy)
Salt and bone meal (equal parts) free choice

SUMMARY OF FEED LOT PERFORMANCE BY PERIOD AND TREATMENTS

LOTS	I	II	III	IV
Phase 1, 56 days - October 25 to December 19, 1958				
Treatments (1)				
Digestible protein	7.5%	7.5%	8.5%	8.5%
Tapazole (mg. daily)	---	125	---	---
Average gain per steer (lbs.)	206	205	196	193
Average daily gain (lbs.)	3.68	3.66	3.50	3.45
Average concentrates consumed (lbs.)	19.7	19.9	20.2	19.9
Phase 2, 28 days - December 20, 1958 to January 16, 1959				
Treatments				
Digestible protein	7.5	7.5	7.5%	7.5%
Tapazole (mg. daily)		125-200(2)		300(3)
Average gain per steer (lbs.)	90	76	93	100
Average daily gain (lbs.)	3.21	2.75	3.32	3.57
Average concentrates consumed (lbs.)	28.0	28.9	30.4	29.1
Phase 3, 42 days - January 17, to February 28, 1959				
Treatments				
Digestible Protein	7.5%	7.5%	6.5%	6.5%
Tapazole (mg. daily)		200		300
Average gain per steer (lbs.)	95	93	91	85
Average daily gain (lbs.)	2.26	2.21	2.18	2.02
Average concentrates consumed (lbs.)	24.9	24.0	28.6	23.8

(1) All cattle received 10 miligrams of Hexestrol per head daily in the feed.
(2) Changed from 125 to 200 miligrams per head daily on January 3, 1959.
(3) Started on Tapazole 300 miligram per head daily January 2, 1959.

Summary of Results

1. The daily gains, feed required per 100 pounds gain and dressing percentage were similar for all lots.

2. The greatest gains were made during the first 84 days of the 126-day feeding period.

3. Reducing the digestible protein from 8.5% to 6.5% during the fattening period did not improve feed lot performance or carcass value of yearling cattle above those receiving 7.5% digestible protein throughout the fattening period.

4. The carcass grades and selling price were highest for cattle receiving Tapazole throughout the feeding period. This difference was not significant

5. Feeding 300 milligrams of Tapazole the last half of the 126 day fattening period did not significantly improve gains, feed efficiency, selling price, or carcass grades. *(Project 237)*

SUMMARY OF FEED LOT, SALES AND CARCASS DATA FOR THE ENTIRE FATTENING PERIOD

Feeding period - October 25, 1958 to February 28, 1959 (126 days)

LOTS	I	II	III	IV
Number head per lot	8	8	7	8
Initial weight (lbs.)	762	761	762	759
Final weight (lbs.)	1153	1135	1142	1137
Average gain per steer	391	374	380	378
Average daily gain	3.10	2.97	3.02	3.00
Total feed consumed (lbs.)				
Concentrates				
Corn and cob meal	2,854	2,847	2,992	2,834
Soybean oil meal (44% C.P.)	156.8	156.5	173.9	168.1
Salt (cobalt 1 oz. per 100 lbs. salt)	15.1	14.5	16.0	15.2
Red Clover hay	582.5	599.8	583.4	591.0
Salt and bone meal	Free choice	Free choice	Free choice	Free choice
Feed Consumed per 100 lbs. gain				
Corn and cob meal	730.0	761.2	787.4	749.5
Soybean meal	40.1	41.8	45.8	44.4
Salt	3.9	3.9	4.2	4.0
Red Clover hay	149.0	160.4	153.5	156.3
Selling price / cwt.	$25.50	$26.00	$25.50	$25.50
Shrinkage (lbs.) (home weight-scale weight)	20	32	31	35
Dressing percent (based on warm carcass wt.)	60.8%	60.3%	60.0%	60.2%
Carcass Grades (USDA)				
Average choice		1		
low choice	1	1	1	2
high good	3	1	1	1
average good	1	3	3	
low good	2	2	1	4
high standard			1	
average standard				
low standard				
high commercial	1			1

Influence of Date of Birth and Other Factors on Weaning Weights of Beef Calves

J. F. LASLEY, J. E. COMFORT

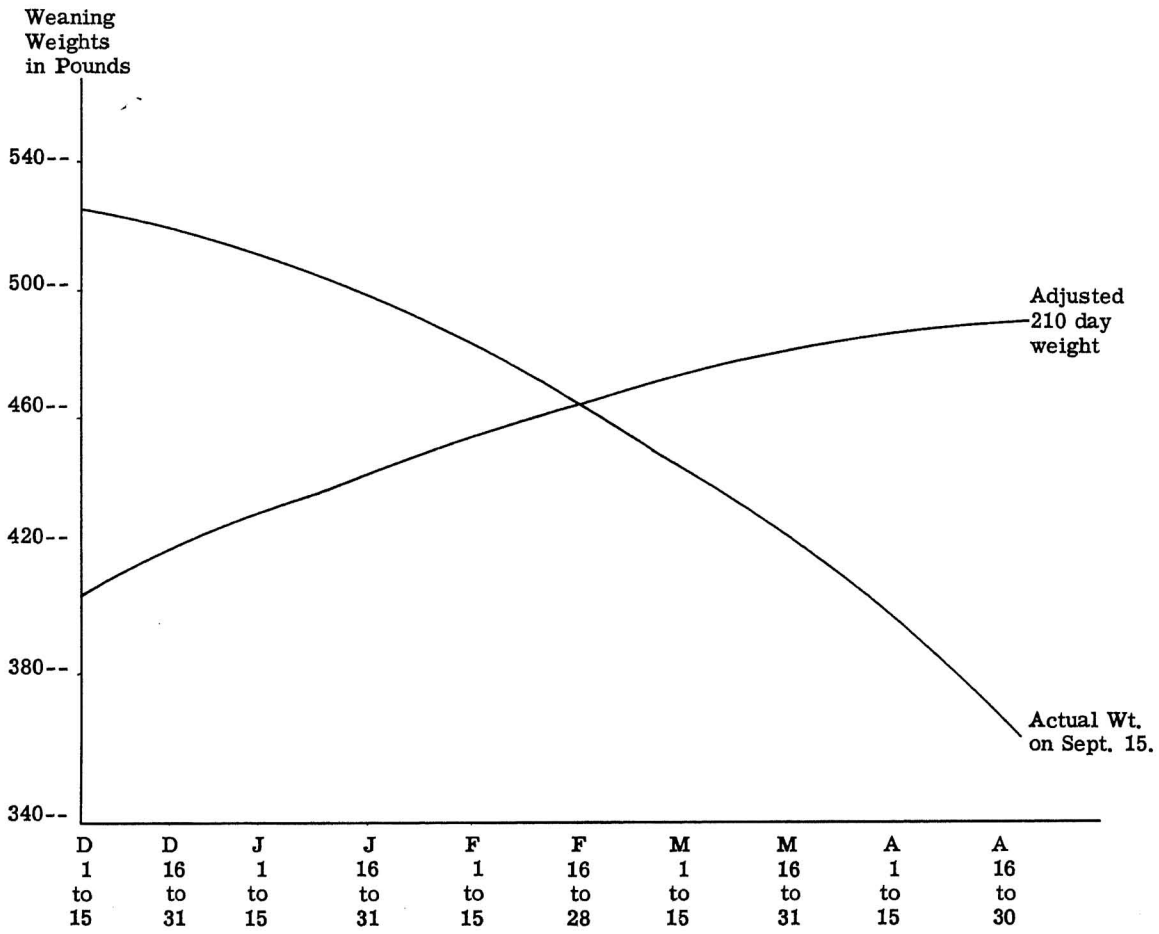
It is important to know something about the influence of certain factors on weaning weights in beef calves for two reasons. First, without this information, mathematical adjustments for certain factors can't be controlled. If these adjustments can be made, a larger proportion of the variations will be due to heredity and will thus make selection more effective. Second, if adverse effects of certain factors are known, they may be decreased or even eliminated by proper management.

Records used in this study were obtained in the beef cattle herd maintained at Weldon Springs. The data were obtained from 651 purebred Hereford calves born in the years from 1951 to 1959 inclusive. An objective of this study was to formulate correction factors to be used in a breeding and selection program.

Age of Calf and Weaning Weight.

Since calves in a herd are born on different dates and they become heavier with increasing age, it is necessary to make weaning weight comparisons for selection purposes on the same age basis. The best way to do this is to weigh each calf as it reaches a certain age. From the practical standpoint, however, this is seldom, if ever, possible. Usually all calves in the herd are weighed on

Influence of time of birth on adjusted 210-day weaning weights and actual weights of calves on September 15.



the same day, or near the same day, and then their weaning weights are adjusted to the same age basis. Some experiment stations have prepared graphs and tables for this purpose whereas others have used the average daily gain of each calf from birth to weaning as a means of adjusting weaning weights to a standard age. This method of adjustment for age of calf seems to be as satisfactory for a particular herd as any other and may be more accurate than others under certain conditions.

The following formula was used for adjusting weaning weights of calves in this study to a 210-day basis:

$$\text{Adjusted 210 day weight} = \frac{\text{Birth weight minus Actual weaning weight}}{\text{Actual age}} \times 210 \text{ plus birth weight}$$

Since many beef cattle producers do not weigh calves at birth, average figures for birth weights of the different breeds gathered from several sources are summarized in an accompanying table. These may be used instead of actual birth weights.

AVERAGE BIRTH WEIGHTS OF CALVES OF THE VARIOUS BREEDS.

Breed	Birth Weights	
	Bulls	Heifers
Angus	66	59
Hereford	74	71
Shorthorn	67	62

Age of Dam and Weaning Weights.

The ages of cows that weaned calves in the Weldon Springs herd varied from two to 11 years. The table gives average 210-day weaning weights of the calves for cows of the different age groups. Weaning weights in this table were adjusted mathematically to show a smoother average trend for all age groups. On this basis, cows that were seven and eight years of age weaned the heaviest calves, whereas older and younger cows weaned lighter calves.

ADJUSTMENT FACTORS FOR AGE OF DAM

Age of Dam	Average* weaning weight (lbs.)	Difference** as compared to 7 yr. old cows	Factor to multiply** by to correct to 7 yr. old cow basis
2	360	83	1.2306
3	389	54	1.1388
4	411	32	1.0779
5	427	16	1.0375
6	438	5	1.0114
7	443	0	1.0000
8	442	1	1.0023
9	434	9	1.0207
10	421	22	1.0523
11	402	41	1.1020

*Weaning weights averaged and smoothed mathematically (corrected to 210 day bull calf basis).

**Weaning weights of calves may be adjusted to a seven-year dam basis by adding the appropriate figure in this column or by multiplying by the factor to the right of this figure.

Correction factors presented in Table 2 may be used to adjust the weights of calves to a seven-year-old dam basis. For instance, suppose a three-year-old cow weaned a calf that weighed 350 pounds at 210 days of age and one wanted to adjust this weight to a seven-year-old dam basis. This could be done by adding 54 pounds to the adjusted 210 day weight of the calf or by multiplying this weight by the factor 1.1388. In most cases, it would probably be more desirable to use the multiplicative factor rather than to add a certain amount, although the multiplication process requires more time unless a calculator is available.

Sex of the Calf and Weaning Weight.

In this study, bull calves averaged 39 pounds heavier at 210 days of age than heifer calves. No records on steer calves were available for this study. In comparing the records of different cows where some have bull calves and others have heifer calves, correcting the weaning weights of the heifers to a bull-calf basis makes a more valid comparison between cows. Such corrections should also be made when the lifetime records of two or more cows are compared.

Based on the results of this study, weaning weights of heifer calves could be adjusted to a bull-calf basis by adding 39 pounds to the adjusted 210-day weight of heifer calves or by multiplying by the factor, 1.0941.

Time of Birth During the Year and Weaning Weight.

These data (see table) show that, on the average, the earlier the calves were born in the calving season the lighter they were at 210 days of age. Undoubtedly, this trend was related to the amount of green feed available to both the cows and calves during the nursing period.

From this study it is apparent that the time of birth is a very important source of variation in the weaning weights of calves. For this reason it seems advisable to make adjustments for this factor when calves are compared for selection purposes. Adjustment factors are given in the table which may be used to adjust weaning weights to a birth date of from February 1 to 15. Corrections may

INFLUENCE OF TIME OF BIRTH ON WEANING WEIGHTS OF CALVES

	No. of calves	Average 210* day weaning weight	Difference compared to Feb. 1 to 15	Factor for correction to Feb. 1 to 15
Dec. 1 to 15	80	412	49	1.1189
Dec. 16 to 31	115	426	35	1.0822
Jan. 1 to 15	69	439	22	1.0501
Jan. 16 to 31	81	451	10	1.0222
Feb. 1 to 15	52	461	0	1.0000
Feb. 16 to 28	65	470	- 9	.9809
Mar. 1 to 15	56	478	-17	.9644
Mar. 16 to 31	70	485	-24	.9505
Apr. 1 to 15	42	491	-30	.9389
Apr. 16 to 30	21	496	-35	.9294

*Adjusted to 210 days, 7 year-old-dam, bull calf basis and averaged mathematically.

be made by either adding or subtracting a certain amount as shown in the table or by multiplying by the factor given for this same purpose.

From the standpoint of a breeding program in which an attempt is being made to select for heavier weaning weights, it would be desirable to shorten the breeding season so that the calves would be born within an 80 to 90 day period during January, February, March or April. Such a practice would result in calves being born in a shorter period of time and would make adjustments for time of birth of less importance. One objection to a shorter calving or breeding season, however, would be that some of the cows that calved late might fail to settle and might be open the following year. After the first year in which a shorter breeding season is followed, this disadvantage should be of less importance.

From the practical standpoint, early calves may be more desirable than late calves. The reason for this is that calves are usually weaned on a certain date rather than at a certain age. As illustrated in Figure 1, calves born in December would weigh from 120 to 150 pounds more on September 15, than calves born in April, even though the April calves made faster daily gains from birth to that date. *(Project 198)*

Summary

Records on 651 purebred Hereford calves were studied to determine the influence of various factors on weaning weight. The calves were produced in the purebred herd at the Weldon Spring Station during the years of 1951 to 1959, inclusive. Age of dam, sex of calf and time born during the calving season were found to have a definite influence on weaning weights of calves. Based on the data in this study, correction factors were calculated which could be used for adjusting weaning weights for these important sources of variation. Such adjustments are recommended for a herd where an attempt is being made to improve weaning weights of calves through breeding and selection methods.

Protein-Energy Interrelationships in Swine Rations

D. E. Boenker, L. F. Tribble

Protein is one of the most important nutrients in swine nutrition. It has been demonstrated by various investigators that the lack of adequate protein in the diet of swine can greatly reduce the growth rate, appetite and disease resistance. It has also been demonstrated that availability and utilization of protein can be affected by several factors. The quality of protein is important for if any one of the essential amino acids is lacking in the proper amount and ratio, it will limit the utilization of the other amino acids.

Since protein is the most expensive portion of swine rations, it is important to get as much as possible out of it. Investigators working with other domestic animals report that the increase in Caloric content of the ration has a "protein sparing" effect. Lofgreen, *et al,* 1951, studying the influence of energy intake on the nitrogen retention of growing calves observed there was a marked increase in the retention of nitrogen available for growth when calves were fed low protein intakes with an increased amount of energy of non-nitrogenous nutrients.

The poultry industry has conducted many experiments in which the Caloric content of diets has been increased. Investigators recognized a Protein-Calorie ratio.

The objective of this research project is to study the Caloric influence on the utilization of protein in practical swine rations.

Ninety purebred Hampshire and Duroc pigs with an average initial weight of approximately 45.5 pounds were divided evenly according to weight, sex, and breed into nine lots. The pigs were confined on concrete and self-fed the rations in the table. The crude protein content of the ration was reduced by 3 percent when the pigs reached an average weight of 125 pounds.

Stabilized animal grease was added to rations 2, 5 and 8 to increase the Caloric content of the ration. Ground corn cobs were added to rations 3, 6 and 9 to decrease the useable energy in the ration. The assumption is made that the pig can digest little or none of the ground corn cob.

Pigs were weighed every two weeks. Feed consumption during this period was recorded. The pigs on experiment were fed to an average final weight of approximately 204 pounds. At this time the pigs were removed from the lot and live backfat probes were made.

RATIONS

Constituents	1	2	3	4	5	6	7	8	9	10	11	12
Corn, ground	76.5	67.9	64.2	68.5	59.7	56.0	84.9	76.2	72.5	93.2	84.5	80.8
SOBM, solvent	21.0	22.6	23.3	29.0	30.8	31.5	12.6	14.3	15.0	4.3	6.0	6.7
Fat		7.0			7.0			7.0			7.0	
Corn Cobs, ground			10.0			10.0			10.0			10.0
Salt[1]	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Bonemeal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Limestone	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7
Antibiotic[2]	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15
Vitamin B12[3]	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
B Vitamins[4]	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
Vitamins A&D[5]	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
Total, pounds	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04
% Protein, Calculated	16.1	16.08	16.08	19.01	19.06	19.05	13.06	13.07	13.06	10.06	10.05	10.05
% Calcium, Calculated	.64	.64	.64	.65	.66	.66	.62	.62	.62	.60	.60	.60
% Phosphorus, Calculated	.48	.47	.47	.45	.51	.50	.45	.45	.43	.41	.40	.40
Calculated Gross Energy, Calories/1#	1725.4	1906.3	1727.1	1741.5	1927.7	1743.5	1708.7	1889.7	1710.4	1692.0	1873.0	1693.8
Calculated Metabolizable Energy, Calorie/1#	1405.9	1568.8	1242.5	1371.4	1533.3	1207.7	1442.2	1604.6	1278.4	1478.0	1640.5	1314.2
MC/P ratio	87:1	98:1	77:1	72:1	81:1	63:1	110:1	123:1	98:1	145:1	156:1	125:1

1. Salt was supplemented with 1# of zinc oxide per 100# of salt.
2. Supplies 3.6 gm of chlortetracycline (Auromycin) per pound of supplement.
3. Supplies 10 mg of B12 per pound of supplement.
4. Supplies 2000 mg Riboflavin, 4000 mg Pantothenic acid, 9000 mg Niacin and 10,000 mg of choline chloride per pound of supplement.
5. Supplies 400 I.U. of vitamin D_3 and 2250 I.U. of vitamin A.

Results

See table. The addition of fat to the medium protein ration (16%) and the high protein rations (19%) resulted in increased daily gains of the pigs. However the addition of fat to the low protein ration (13%) did not result in increased daily gains. The addition of fat to the ration at all protein levels resulted in a reduction in the amount of feed required per 100 pounds of gain. This decrease

EFFECTS OF PROTEIN AND ENERGY LEVELS IN SWINE RATIONS

	Medium Protein			High Protein			Low Protein		
	1	2*	3**	4	5*	6**	7	8*	9**
% Protein, calculated	16.1	16.08	16.08	19.01	10.06	10.05	13.06	13.07	13.06
No. Pigs	10†	10	10	10	10	10	10	10	10
Avg. days on test	93.0	87.7	98.7	94.6	86.4	93.2	94.6	94.8	95.2
Avg. initial wt. lbs.	45.8	45.7	45.8	45.7	45.9	45.8	45.4	45.7	45.3
Avg. final wt. lbs.	204.8	203.5	205.0	201.5	207.6	202.2	203.0	205.1	204.7
Avg. daily gain, lbs.	1.63	1.80	1.61	1.65	1.87	1.68	1.67	1.68	1.67
Total feed consumed, pounds	5129.0	4617.0	6287.0	5349.0	4909.0	6248.0	5423.0	4911.0	6490.0
Feed consumed per 100 lbs. of gain	345.2	292.6	394.9	343.3	303.6	399.5	344.1	308.1	407.2
Avg. backfat probe corrected to 200 lbs., in inches	1.37	1.42	1.36	1.39	1.42	1.28	1.43	1.61	1.33
Avg. lbs. of feed consumed/day	5.62	5.27	6.37	5.65	5.68	6.70	5.73	5.18	6.82
Avg. lbs. protein consumed/day	.91	.85	1.02	1.07	1.08	1.28	.75	.68	.90
Avg. No. Metab. Cal. consumed/day	7901.2	8267.5	7914.7	7748.4	8709.1	8091.6	8263.8	8311.8	8718.7

*Stabilized animal fat added to diet to increase calorie content.
**Ground corn cobs added to reduce the amount of energy in the ration.
†One pig removed after on test for 76 days.

amounted to a 12 to 15 percent saving in feed required per 100 pounds of gain when compared to the medium energy rations at each protein level. When compared to the low energy rations at each protein level this savings amounted to as much as 25 percent less feed required per 100 pounds of gain.

Pigs fed the three levels of crude protein in this study had little difference in rate of daily gain or feed required per 100 pounds of gain.

There was little difference in thickness of backfat between the pigs in all lots, however those fed the high energy (fat) and low protein (13%) ration averaged the thickest backfat, 1.61 inches. Low energy rations at the three protein levels had a tendency to reduce backfat thickness; however, these differences were small. Addition of 7 percent fat at the medium and high protein levels did not have great effect in increasing backfat thickness of the pigs as one might expect.

Summary

Addition of 7 percent stabilized animal grease to medium and high protein rations resulted in increased daily gain of growing, fattening hogs. However, the increased energy at the low protein level did not result in increased rate of gain.

The increased calorie content of the ration resulted, at all protein levels, in a decrease in the amount of feed required per 100 pounds of gain. There was a 12 to 15 percent saving of feed when compared to medium energy rations and a 25 percent feed saving when compared to low energy rations. This result was obtained at all protein levels.

Protein levels used in this study seemed to have little or no effect on daily rate of gain or feed efficiency.

Addition of 7 percent fat to the medium and high protein rations had little affect on average backfat thickness. However, pigs fed low protein, high energy rations had the thickest backfat of all lots. *(Project 141)*

Amino Acid Supplementation of Practical Rations for Swine

E. E. BARTELS, D. E. BOENKER, L. F. TRIBBLE

Proteins are made up of amino acids and research has shown that hogs require proteins which contain certain amino acids. These amino acids are called essential amino acids as the pig must receive them in his diet. There are 10 of these essential amino acids.

ESSENTIAL AMINO ACID REQUIREMENT FOR WEANLING PIGS (Liveweight 25-70 pounds)*

Amino acid	Percentage of total diet	Amino Acid	Percentage of total diet
Arginine	0.20	Methionine	0.60
Histidine	0.40	Phenylalanine	0.46
Isoleucine	0.70	Threonine	0.40
Leucine	0.80	Tryptophan	0.20
Lysine	1.00	Valine	0.40

*Nutrient Requirements for Swine - National Research Council 1953.

If the protein in a feed contains a balance of these essential amino acids it is referred to as a high quality protein. It has low quality protein when one or more of these essential amino acids are deficient. Grains in general contain proteins of low quality.

Most practical rations for swine are deficient in lysine, methionine and tryptophan. The objective of this research was to study the effects of adding one or more of these amino acids to rations for growing-fattening hogs.

Three trials have been completed. The lots and treatments were as follows:

Trial One					
Lot	1	2	3	4	5
Ration	1	7	7	8	9
Lysine %	--	--	0.2	0.2	0.2
Methionine %	--	--	0.1	0.1	0.1
Tryptophan %	--	--	0.03	0.03	0.03
Trial Two					
Lot	1	2	3	4	5
Ration	13	13	13	13	14
Lysine %	--	0.21	0.21	0.21	--
Methionine %	--	--	--	0.07	--
Tryptophan %	--	--	0.01	0.01	--
Trial Three					
Lot	1	2	3		
Ration	1	7	7		
Lysine %	--	0.2	0.2		
Methionine %	--	0.1	0.1		
Tryptophan %	--	0.03	--		

RATIONS FOR AMINO ACID EXPERIMENTS

Ration No.	1	7	8	9	13	14
Corn	76.5	84.9	76.2	72.5	97.5	89.5
Soybean oil meal	21.0	12.6	14.3	15.0	---	8.0
Animal fat			7.0	---	---	---
Ground corn cobs			---	10.0	---	---
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Bonemeal	1.0	1.0	1.0	1.0	1.25	1.25
Limestone	0.7	0.7	0.7	0.7	0.5	0.5
Antibiotic[1]	.15	.15	.15	.15	.15	.15
B Vitamins[2]	.07	.07	.07	.07	.07	.07
Vit. A & D[3]	.07	.07	.07	.07	.07	.07
Vit. B_{12}[4]	.05	.05	.05	.05	.025	.025
Percent protein	16	13	13	13	8.4	11.4

1. Contained 3.6 gm. chlortelracycline (aureomycin) per pound.
2. Contained 2 gm. riboflavin, 4 gm. pantothenic acid, 9 gm. nicotinic acid and 10 gm. choline chloride per pound.
3. Contained 2250 IU vitamin A and 400 IU vitamin D per gram.
4. Contained 10 milligrams vitamin B_{12} per pound.

Pigs in all trials were on concrete floored pens and were fed from a self-feeder. Purebred Hampshires and Durocs were used in trial 1. The same pigs were used in trial 2. Hampshire and Duroc crossbred pigs were used in trial 3. In trials 1 and 3 the pigs were fed from weaning to 125 pounds. While in trial 2 they were on feed from 125 to 200 pounds.

Pigs fed the 13 percent protein ration in trial 1 gained slowly, 0.99 pounds per head per day, and had a poor feed utilization, 406 pounds of feed per 100 pounds gain. Pigs fed the 16 percent protein ration gained 29 percent faster and required 16 percent less feed than those on the 13 percent protein ration. The addition of the three amino acids to the 13 percent protein ration greatly increased the rate and efficiency of gains of the pigs.

In trial 3, pigs fed the 16 percent protein ration made very good gains, 1.77 pounds per head per day, compared to approximately 1.5 pounds for pigs receiving 13 percent protein supplemented with amino acids.

The performance of the pigs in all lots in trial 2 was good. This performance is of interest because of the low level of protein in the corn, mineral, and vitamin rations. The addition of lysine to the ration improved the rate and efficiency of gains of the pigs while the addition of

TRIAL 1--VALUE OF AMINO ACID SUPPLEMENTATION OF GROWING-FATTENING SWINE RATIONS

Ration No.	1	7	7	8	9
% Protein	16	13	13	13	13
Lot	1	2	3	4	5
Energy Level	Med	Med	Med	High	Low
Amino Acids added*	--	--	+	+	+
No. of Pigs	5	5	5	5	5
Avg. Initial Wt.	43	40	41	41	40
Avg. Final Wt.	125	101	130	134	125
Avg. Daily Gain	1.32	0.99	1.45	1.51	1.37
Feed/100 lb. Gain	349	406	321	290	352

*Amino acids added - lysine 0.2%, methionine 0.1%, and tryptophan 0.03%.

TRIAL 2--AMINO ACID SUPPLEMENTATION OF CORN FOR FATTENING HOGS

Ration No.	13	13	13	13	14
Ration*	corn	corn - L	corn - LT	corn - LTM	corn - SBOM
Lot	1	2	3	4	5
No. of Pigs	5	5	5	5	5
Avg. Initial Wt.	125	124	123	121	122
Avg. Final Wt.	194	201	200	199	196
Avg. Daily Gain	1.50	1.66	1.68	1.70	2.05
Feed/100 lb. Gain	491	428	436	440	350

*L - Lysine .21% T - Tryptophan -01% M - Methionine .07%

TRIAL 3--AMINO ACID SUPPLEMENTATION OF PRACTICAL SWINE RATIONS

Ration No.	1	7	7
% Protein	16	13	13
Amino Acids*	--	LMT	LM
Lot	1	2	3
No. of Pigs	5	5	5
Avg. Initial Wt.	29	30.8	26.7
Avg. Final Wt.	124.7	113.5	108.3
Avg. Daily Gain	1.77	1.53	1.5
Feed/100 lb. Gain	269	286	284

*L - Lysine 0.2% M - Methionine 0.1% T -Tryptophan 0.03%.

methionine and trypophan resulted in little additional improvement. The corn-soybean oil meal ration was superior to any of the amino acid supplemented rations.

Further experimental work is needed on this matter. At present, a good feeding program to recommend for growing, fattening pigs from weaning to market weight would be to use ration 1 from weaning to 125 pounds, and ration 14 from 125 pounds to 200 pounds or market. *(Project 141)*

Effect of Level of Feeding During Gestation on Sow Performance

B. T. Dean, L. F. Tribble

Performance of the sow is one of the most important items affecting the swine producer's profits. The nutrition of the sow during various phases of the reproductive cycle has a great effect on her performance. It has been observed that sows which are fed too liberally during gestation do not perform well at farrowing and during lactation.

The objectives of this study are to observe the effects of level of feeding during gestation on sow performance. Fatness of the sows at various stages is being measured with a backfat probe.

Three trials have been conducted.

Trial 1

Ten Hampshire and six Duroc gilts were divided into two equal lots on the basis of litter mates and/or weight with each lot containing an equal number of Durocs and Hampshires. All gilts had been fed a well balanced ration prior to the beginning of the experiment and were in high condition at the time they were bred.

Treatments of both lots were the same from breeding to weaning except for the amount of corn received by each lot from the beginning of the experiment to the 109th day of gestation. During this part of the gestation period, lot 1 received 1¼ pounds of the protein supplement and 5 pounds of shelled corn per head; lot 2 received 1¼ pounds of the same protein supplement but only 3 pounds of shelled corn per head per day. The ration was considered to supply the minimum nutritional requirements of swine as per National Research Council recommendations for proteins, vitamins and minerals.

The gilts farrowed in a central farrowing house equipped with farrowing crates. When the pigs were two to three weeks old the gilts and litters were moved to bluegrass pasture where three and four gilts and litters occupied a single lot.

Backfat probes were taken at breeding, 109th day of gestation, and at weaning to evaluate the condition of the gilts.

All rations were hand fed until the gilts and litters were moved to pasture, where they were self fed.

An additional group of 15 Poland China and 15 Landrace gilts were probed at breeding, 109th day of gestation, and at weaning to obtain a larger number for correlation analysis of the effect of condition on the reproductive performance.

Trial 2

Sows used in trial 1 were held over for trial 2. Those that had been on limited feed in trial 1 were continued on limited feed.

A complete mixed feed was used during the gestation period (table). Lot 1 sows were fed 6 pounds of the gestation ration daily during the first month of gestation. This amount was reduced to 5 pounds for the remainder of the gestation period. The limited fed group, lot 2, was fed 4 pounds per head daily the first month. This was reduced to 3 pounds for the following three-week period—then reduced to 2 pounds for the following month. This amount was increased to 3 pounds per head per day during the last month of gestation. Both lots were on bluegrass pasture during the gestation period.

COMPOSITION OF RATIONS

Ingredients	Trial 1			Trial 2[1]	Trial 3		
	Protein Supplement	Lactation Ration	Creep Ration	Gestation Ration	Gestation Ration	Lactation Ration	Creep Ration
Corn		80.5	69.25	83.00	82.60	79.0	59.50
Rolled Oats							7.50
Soybean oil meal	62.2	12.0	23.0	10.78	10.75	15.0	23.20
Tankage	31.0	6.0	5.0	5.25			
Meat and bone					5.25	5.0	2.50
Alfalfa meal							2.50
Dried whey							2.50
Salt	2.0	0.5	0.50	0.35	0.35	0.5	
Salt trace minerals							0.50
Limestone	1.0	0.3	0.50	0.17	0.175	0.2	0.50
Bonemeal	2.0	0.4	0.50	0.35	0.35		0.50
Vit. A & D Supplement[2]	0.6	0.1	0.20		0.175	0.1	
Vitamin A[3]							.045
B vit. Supplement[4]	0.6	0.1	0.20		0.175	0.1	0.20
B12 supplement[5]	0.6	0.1	0.10	0.10	0.175	0.1	0.20
Antibiotics[6]			0.50				0.30
Hygromix[7]			0.25				
Zinc oxide							2.5 gms
TOTAL	100.00	100.00	100.00	100.00	100.000	100.0	100.005

1. Lactation and creep ration in trial 2 were the same as in trial 1.
2. Supplied 2250 units of vitamin A and 400 units of vitamin D per gram of supplement.
3. Supplied 10,000 units of vitamin A per gram of supplement.
4. Supplied 2 grams of riboflavin, 4 grams pantothenic acid, 9 grams niacin, 10 grams choline chloride, and .08 grams folic acid per pound of supplement.
5. Supplied 10 milligrams of B_{12} per pound of supplement.
6. Supplied 3.6 grams chlortetracycline (aureomycin) per lb. of supplement in trials 1 and 2. Supplied 10 grams oxytetracycline (Terramycin) per lb. of supplement in trial 3.
7. Supplied 12,000,000 units of Hygromycin B activity per ton of feed.

Trial 3

Purebred Hampshire and Duroc gilts were used in this trial. The gestation ration was a complete 15 percent protein mixture. Gilts in lot 1 were fed at the rate of 6 pounds per head per day during the gestation period whereas those in lot 2 were fed at the rate of only 4 pounds per head per day.

The treatment of the gilts in both lots was the same from the 109th day of gestation to weaning and was the same as trial 1 with the following exceptions: (1) The gilts and litters were not moved to pasture until the pigs were 4 to 5 weeks old, and (2) the pasture used during the lactation period was red clover.

A creep ration was placed before the pigs when they were 3 to 5 days old.

Results

In trial 1, limited fed gilts farrowed more pigs per litter than those fed normally. There was no difference in average weight at birth of the pigs between the two treatments. In trials 2 and 3, the normally fed sows farrowed more pigs which were slightly heavier at birth than those of limited fed gilts.

These differences might be due to the different feeding methods as in trial 1 a constant amount of protein supplement was fed while in trials 2 and 3 a complete mixed ration was fed. The limited fed sows in trials 2 and 3 received a smaller amount of protein, minerals, and vitamins during gestation than the normally fed sows; however, those in trial 2 received additional nutrients from pasture.

EFFECT OF LEVEL OF FEEDING DURING GESTATION ON FARROWING AND WEANING

Lots & Treatment	Trial 1[1]		Trial 2[2]		Trial 3[3]	
	Lot I Normal	Lot II Limited	Lot I Normal	Lot II Limited	Lot I Normal	Lot II Limited
No. in lot	8	8	7	8	8	8
Avg. No. pigs farrowed	8	9.87	10.1	9.5	8	6.87
Avg. birth wt. (lbs.)	2.6	2.6	2.93	2.84	2.95	2.72
Avg. No. pigs weaned	4.4	6.8	5.71	7.62	6.87	5.87
Avg. weaning weight (lbs.)	23.3	21.8	34.2	34.0	39.9	38.7
Percentage weaned	55.0	69.6	56.4	80.3	85.9	72.3

1 - Trial 1 and 3 were gilts.
2 - Trial 2 were sows held over from trial one.
3 - Weaning weights in trial I was corrected to 42-day weight, trial 2 and 3 weaning weights were corrected to 56-day weights.

AVERAGE FEED CONSUMPTION OF SOWS DURING GESTATION AND LACTATION AND CREEP CONSUMPTION OF PIGS

	Trial 1		Trial 2[1]		Trial 3	
	Lot I Normal	Lot II Limited	Lot I Normal	Lot II Limited	Lot I Normal	Lot II Limited
Sows (per head)						
a) Breeding to 109th day						
Shelled corn (lbs.)	545	327	---	---	---	---
Supplement (lbs.)	136	136	---	---	---	---
Gest'n ration (lbs.)	---	---	576	336	654	436
b) 109th day to weaning						
Bran (lbs.)	8	8	7	7	7	7
Lactation ration (lbs.)	490	559	542	576	605	651
Pigs (per pig)						
Creep (lbs.)[2]	7.1	4.9	13.4	12.6	20.5	17.4

1 - Trial 2 sows were pastured on bluegrass pasture during gestation period in summer, trial 1 and 3 gilts were in dry lot during gestation in the winter.
2 - Trial 1 pigs were weaned at 6 weeks whereas trial 2 and 3 pigs were weaned at 8 weeks.

In trials 1 and 2, the limited fed sows weaned more pigs per litter than did the normally fed sows. However, in trial 3 the reverse occurred. In trial 3, the pigs from the limited fed sows appeared weaker at birth than those from normally fed sows. This is probably an indication of a deficiency in the gestation ration of the limited fed gilts in trial 3. There was little difference in weaning weights of the pigs between the two treatments.

Sows fed a limited ration during gestation tended to eat more feed when self-fed during lactation than sows fed a normal level of feed. The difference in feed eaten during lactation was not enough to offset the smaller amount of feed consumed during gestation by the limited fed sows. The average results favored the limited fed sows by 209 pounds of feed for the gestation and lactation periods combined.

The consumption of creep feed varied greatly and the pigs in trial one ate very little creep feed. Although no direct comparison was made between the creep ration fed in trials 1 and 2 with the one fed in trial 3, the ration fed in trial 3 was consumed more readily and a much larger total amount was consumed than in trials 1 and 2.

Sows fed the normal level gained from 40 to 50 pounds more during gestation than the limited fed sows. The normally fed sows lost more weight during lactation, which might indicate that they gave more milk. However, total litter weights of the pigs in trials 1 and 2 were greater for the limited fed sows. With the exception of trial 3, the sows fed normally during gestation were heavier when they weaned their pigs than were the limited fed gilts.

The backfat probes indicated that on the average the normally fed sows increased in fatness during gestation while the limited fed sows decreased. In trials 1 and 2, the limited fed sows gained in fat during lactation and in all three trials the normally fed sows were fatter when their pigs were weaned than the limited fed sows.

In trial 1 where additional sows were probed, the analysis indicated a definite relationship between the change in backfat thickness during gestation and the number of pigs farrowed. The analysis showed that for each increase of one millimeter in backfat thickness there was a decrease of 0.15 pig per litter.

EFFECT OF LEVEL OF FEEDING DURING GESTATION ON AVERAGE GAINS AND BACKFAT CHANGES DURING GESTATION AND LACTATION

	Trial 1		Trial 2		Trial 3	
Lots and Treatment	Lot I Normal	Lot II Limited	Lot I Normal	Lot II Limited	Lot I Normal	Lot II Limited
Breeding to farrowing						
a) Gain in weight (lbs.)	113	67	108	69	127	74
b) Gain or loss backfat probe[1]	/10	-5	/3	-2	/1	-5
Farrowing to weaning						
a) Gain or loss in weight	-5	/22	-31	-18	-75	-5
b) Gain or loss in backfat probe[1]	-9	/2	00	/2	-6	-4

[1]Probes are given in millimeters (25.4 mm = 1 inch).

Conclusions

Work on this problem needs to continue before definite conclusions can be made. The protein, mineral and vitamin portion of the ration during gestation should receive the most attention.

We would suggest feeding 1 to 1¼ pounds per head per day of a protein supplement containing minerals and vitamins to sows during gestation in dry lot; ¾ to 1 pound if on good pasture and only enough grain (corn, oats, etc.) to maintain the desired condition. And don't get sows too fat during gestation. *(Project 335)*

Effect of Two Levels of Energy on Reproductive Performance of Gilts

B. N. DAY

The reproductive ability of farm animals is known to be influenced by many different factors. A measure of reproductive efficiency in the swine herd must consider both the male and female and also the different phases of the reproductive cycle such as puberty, estrus, and pregnancy. The physiological processes controlling the various stages of the reproductive cycle are widely different. In turn, the feeding and management practices required to obtain a high rate of reproductive efficiency will vary with changes in the reproductive state of the animal. An example of this is the amount and kind of feed fed at different stages of the reproductive cycle. Full-feeding gilts during a two to three week period prior to breeding has been demonstrated to be a sound practice, as full-fed gilts ovulate more eggs than those limited-fed. However, full-feeding during stages of reproduction may not be desirable. To obtain more information on effects of different feeding levels on reproductive efficiency, the influence of different levels of food energy on the reproductive performance of gilts was investigated.

Thirty-six gilts weighing an average of 150 pounds were randomly assigned within weight classes to six lots of six animals each. Three pens were full-fed a complete mixed ration and three pens were limited-fed a similar ration. Gilts allotted to the full-fed group had access to a self feeder throughout the experimental period which extended from an average weight of 150 pounds to the 25th day of gestation.

Previous to the second estrus, gilts assigned to the limited-fed group received approximately 75 percent as much corn, and the same amount of protein supplement as the full-fed group consumed. Following the second estrus the limited-fed gilts were full-fed until bred at the third estrus. The limited-fed gilts were then maintained on 3½ pounds of corn and 1 pound of protein supplement per head per day from the time of breeding to the 25th day of gestation.

Results

The average age that the gilts reached sexual maturity was decreased by restricting the energy level of the ration. Gilts receiving the low energy ration showed first estrus at an average age of 174 days; the average age at puberty for the full-fed group was 182 days. This difference of eight days was statistically significant, giving further evidence that the age of puberty of gilts is influenced by the amount of energy consumed during the growing-fattening period of development.

Gilts fed the low-energy ration weighed an average of 21 pounds less than the full-fed group of gilts at the time of puberty. The average weights at puberty for the limited-fed and the full-fed gilts were 192 and 213 pounds, respectively. This difference would be expected since age appears to exert a more pronounced influence on the time of sexual development than weight. In turn, the limited-fed gilts consumed considerably less feed prior to the onset of sexual maturity than the full-fed gilts.

Sexual receptivity at the time of breeding was more pronounced and more regular in the limited-fed gilts. Although no reproductive irregularities were noted in the limited-fed gilts, four full-fed gilts showed reproductive aberrations during the second estrous cycle. One gilt in the full-fed group failed to exhibit a third estrus, one had an estrous cycle of 55 days before breeding and two full-fed gilts exhibited weak signs of sexual receptivity at the third estrus which were less than one day in duration.

Nine full-fed gilts and eight limited-fed gilts were bred at the third estrus to furnish information on the ovulation rate and early embryonic mortality rate. Three of the full-fed gilts and two limited-fed gilts were not pregnant when slaughtered on the 25th day after mating.

The average ovulation rates recorded for the two treatment groups were approximately equal. As shown in the table, the average numbers of corpora lutea counted on the ovaries of the full-fed and limited-fed gilts were 10.3 and 11.7, respectively.

These data again point out the advantage of increasing the nutritional plane of gilts immediately prior to breeding. Other studies have shown that the ovluation rate decreases if gilts are limited-fed immediately prior to breeding. However, when limited-fed gilts are "flushed" for two to three weeks before breeding, little difference has been found between the ovulation rates of full-fed and limited-fed gilts.

The average number of living embryos present on the 25th day of gestation was essentially the same in the full-fed and limited-fed gilts. The average embryonic mortality rate during early pregnancy was slightly higher in the limited-fed gilts than in the full-fed gilts. This difference was 6 percent which is a rather small difference when the variation within each feeding group is considered. It has been shown rather consistently in other studies that limited-feeding during early pregnancy will decrease the early embryonic mortality rate. Therefore, it is felt that the small difference observed in favor of the full-fed gilts in the present study may be due to sampling variation rather than a real treatment effect. *(Project 276)*

SUMMARY OF REPRODUCTIVE PERFORMANCE OBSERVED IN GILTS ON FULL AND LIMITED FEEDING PROGRAMS

	Feeding Regimen					
	No. of Gilts	Full	No. of Gilts	Limited	Difference	Average
Age at puberty, days	18	182	18	174	8*	178
Wt. at puberty, lbs.	18	213	18	192	21*	202
Avg. no. of corpora lutea	6	10.3	6	11.7	1.4	11.0
Avg. no. of living embryos	6	8.3	6	8.2	0.1	8.2
Avg. embryonic death rate, %	6	24.0	6	30.0	6.0	27

*Probability of chance occurrence is less than 0.05.

Effects of Stilbestrol and a Combination of Progesterone and Estrogen on Growing-Fattening Swine

B. N. Day, L. F. Tribble, S. E. Zobrisky

Barrows have more backfat than gilts and gilts are fatter than boars. This sex difference in backfat thickness is presumably due to the different sex hormones produced by boars and gilts and, in the case of barrows, to the absence of the male sex hormone. An experiment was conducted to study the influence of stilbestrol and a progesterone-estrogen combination on the rate and efficiency of gain, and the carcass composition of barrows.

Forty-eight Poland China barrows were assigned to eight lots of six animals each at the beginning of the experiment. Two lots of barrows were designated as the controls (Group I) and two lots were subjected to each of the following hormonal treatments: Group II, 6 mg. of stilbestrol; Group III, 166.7 mg. of progesterone and 3.3 mg. of estradiol benzoate; Group IV, 500 mg. progesterone and 10 mg. of estradiol benzoate. All hormones were administered as a subcutaneous implant in the ear at the start of the trial. The barrows were slaughtered at a live weight of approximately 205 pounds and detailed carcass measurements were collected.

Results

Differences observed among the treatment groups in average daily gain and efficiency of gain were not statistically significant. This suggests that the differences that were found may have been due to chance and not a treat-

ment effect. The implants containing stilbestrol and the higher level of estradiol may have depressed the rate of gain slightly.

Average backfat thickness, as measured on the live animal by mechanical probe, was significantly reduced by the progesterone-estrogen treatments. The average backfat thickness of the barrows implanted with stilbestrol was intermediate between the other hormonal treatments and the controls but not significantly different from the control barrows.

The carcass data (see table) also indicate the higher level of the progesterone-estrogen preparation increased the yield of lean and decreased the percentage of fat. Carcasses obtained from the control barrows had a smaller loin eye area at the 10th rib, more trim fat, a higher dressing percent, more backfat and a lower percentage of the four lean cuts than the carcasses representing the high level of the progesterone-estrogen treatment. Differences found in the loin eye area and dressing percent and the difference of 1.7 percent in yield of the four lean cuts were significant.

Barrows implanted with stilbestrol or the lower level of progesterone and estrogen produced carcasses that differed only slightly from the control carcasses. However, these differences were rather consistent for the various measurements, which suggests that these hormonal treatments may have produced a slight improvement in the carcass composition of treated barrows. *(Project 276)*

EFFECT OF STILBESTROL AND A COMBINATION OF PROGESTERONE AND ESTROGEN ON THE AVERAGE DAILY GAIN, EFFICIENCY OF GAIN AND CARCASS COMPOSITION OF BARROWS.

Treatment level	Controls 0	Stilbestrol 6 mg.	Progesterone-Estradiol 167 mg. P-3.3 mg E	Progesterone-Estradiol 500 mg. P-10 mg E
Number of animals	12	12	12	12
Initial wt., lbs.	101	101	102	101
Average total gain, lbs.	101	102	103	102
Average daily gain, lbs.	1.85	1.77	1.85	1.74
Feed per lb. gain, lbs.	4.23	4.03	4.13	4.03
Backfat thickness, in.*	1.54	1.48	1.40	1.36
Carcass weight, lbs.	155.3	154.5	155.1	153.3
Dressing percentage, %	77.6	76.3	76.3	75.9
Backfat thickness, in.**	1.67	1.55	1.60	1.55
Loin area 10th rib, sq. in.	4.09	4.14	4.04	4.22
Four lean cuts, %	46.5	46.9	46.7	48.2
Trim fat, %	22.9	21.9	22.0	21.3

*Mechanical probe on live animal.
**Carcass measurement.

Alfalfa Hay Plus Corn Versus Soybean Oil Meal for Supplementing Corn Silage in Ewe Wintering Rations

C. V. Ross, R. L. Pavey, Melvin Karr

In the first two tests, conducted from 1956 to 1958, the use of 0.33 pounds of soybean oil meal per ewe daily was more satisfactory than 0.14 pounds of soybean oil meal for supplementing corn silage for pregnant ewes. Soybean oil meal is an excellent but expensive supplement. The question arises whether the same results could be obtained by furnishing nutrients in a cheaper form. If the protein could be furnished by hay and the energy by corn it would result in savings to the sheepman.

Main objective of this trial was to determine if soybean oil meal could be replaced by alfalfa hay and corn and produce similar results.

Another objective was to compare the consumption of two mineral mixtures composed of equal parts salt and bonemeal versus equal parts salt and dicalcium phos-

phate both fed free choice.

Forty-five five-year-old Northwestern ewes, and six yearling Texas Merino ewes were bred to two Southdown rams and pastured on bluegrass until January 10. Then they were divided into two similar lots according to previous treatment, lambing record, body weight, expected lambing date and breed and put on a full feed of corn silage in dry lot.

Lot I received 0.8 pound ground alfalfa hay plus 0.3 pound ground shelled corn per ewe per day.

Lot II received 0.3 pound soybean oil meal per ewe daily.

The level of alfalfa hay and corn was calculated to provide amounts of crude protein, energy, and concentrate equal to those provided by 0.3 pound soybean oil meal. The hay and corn were ground and mixed to assure complete and controlled consumption and to facilitate feeding by sprinkling it over the corn silage at feeding time in the same manner as the soybean oil meal.

Ewes were given free access to both the salt and bonemeal and the salt and diacalcium phosphate mixtures to observe any difference in preference of the two mineral mixtures.

Daily allowances were raised to 1 pound of hay and 0.4 pound of corn for Lot I and to 0.4 pounds soybean oil meal for Lot II from February 21 until going to pasture March 28. Steamed bonemeal was added at the rate of 0.04 pound per ewe daily, mixed with the protein supplement in each lot.

Observations

1. Ewes fed soybean oil meal made somewhat greater gains during pregnancy than those fed hay and corn. The difference was significant.

2. Fleece weights from ewes fed a supplement of alfalfa hay and corn were slightly heavier than those from ewes fed soybean oilmeal. These differences were not significant.

3. Both lots produced strong healthy lambs and suckled well. Single lambs produced by ewes on soybean oil meal were significantly heavier at birth. There was no significant difference in birth weights of twins.

4. Daily gains of lambs between the two lots did not differ significantly. Weaning weights were approximately the same for lambs produced by ewes on the two treatments. *(Project 142)*

Results

	Lot I		Lot II	
Protein Supplement	Alfalfa Hay and Corn		Soybean Oil Meal	
Number of ewes	25		26	
Age of ewes	5 years		5 years	
Initial weight of ewes - Jan. 10 (lbs.)	153.36		154.08	
Weight of ewes just prior to lambing (lbs.)	178.46		182.39	
Gains during pregancy (lbs.)	25.10		28.31	
Average daily ration (78 days)				
Corn silage (lbs.)	10.62		12.90	
Soybean oil meal (lbs.)	---		.35	
Alfalfa hay (lbs.)[1]	.89		---	
Shelled corn (lbs.)[1]	.35		---	
Steamed bonemeal[2]	Yes		Yes	
Salt: bonemeal (lbs.)	.0467		.0445	
Salt: Dicalcium Phosphate (lbs.)	.0104		.0148	
Nutrients consumed per head per day				
Dry matter (lbs.)	4.034		3.876	
Crude protein (lbs.)	.410		.457	
Estimated Net Energy (therms)	2.8		2.9	
Average fleece weight per ewe				
Feb. 28 (lbs.)	9.49		9.14	
Number of lambs dropped[3]	36		34	
Average birth weight of lambs (lbs.)	9.10		10.2	
Singles	10.05		11.18	
Twins	8.82		9.59	
Triplets	7.433		---	
Number of ewes not lambed	2		3	
Weaning Data - June 27	Weight (lbs.)	Daily gain (lbs.)	Weight (lbs.)	Daily gain (lbs.)
Singles	69.7	.59	66.1	.58
Twins	52.1	.48	55.6	.48
Triplets	52.0	.49	None	

1. Alfalfa hay and shelled corn were ground and mixed.
2. Beginning Feb. 21 bonemeal was mixed with the protein supplement at the rate of 0.04 pounds per ewe daily.
3. One ewe in each lot suffered a prolapsed uterus and lambs were taken by Caesarean Cysectomy.

Acceptability of Creep Rations and Response to Aureomycin by Suckling Lambs

C. V. Ross, R. L. Pavey, Melvin Karr

Previous work has indicated that lambs prefer certain feed ingredients and mixtures of ingredients. The objectives of the experiment were: (1) To make a further comparison of palatability of creep mixtures. (2) To determine the effect of physical form on acceptability of creep rations. (3) To compare the effects of two levels of aureomycin in creep rations.

Acceptability of Creep Rations (First Trial)

Thirty purebred Hampshires and Shropshire ewes and their 40 lambs were divided into two equal lots for the comparison.

The two groups were fed in similar pens and grazed similar pastures. Both groups received the same rations with the exception that 10 mgm. of aureomycin per pound of feed was added to lot 1 rations and 30 mgm. aureomycin per pound of feed was added to lot 2 ration. The six mixtures of feed compared were offered to the lambs in shallow boxes placed side by side in a feed trough. The boxes were rotated frequently to remove positional effect. Ingredients of the mixtures and acceptability are shown below:

Composition and Preference Rating of Creep Rations

Ration No.	Form	Gr. Corn	44% Solvent Soybean oil meal	Wheat bran	Distillers Solubles	Rating
1	Meal	100*				1.00
2	Meal	60	30	10	--	6.1
3	Meal	60	10	30	--	3.36
4	Meal	60	15	10	15	3.17
5	Pelleted	60	30	10	--	7.79
6	Pelleted	60	10	30	--	3.55

*Ground shelled corn was used as the standard. Consumption of corn was assigned a value of 1.0 and others were figured by dividing consumption of the test mixture by the consumption of corn.

Observations

1. Lambs ate all of the mixtures more readily than straight ground corn.

2. Lambs preferred the 60 percent corn, 30 percent soybean oil meal, and 10 percent bran mixture over the other rations offered.

3. The lambs appeared to prefer the rations in pelleted form. They consumed 27.7 percent more of the 60 percent corn, 30 percent soybean oil meal, and 10 percent wheat bran mixture when it was pelleted, and 5.6 percent more of the 60 percent corn, 10 percent soybean oil meal, and 30 percent bran mixture when pelleted.

Response of Lambs to Different Aureomycin Levels (First Trial)

	Lot I	Lot II
Aureomycin level per lb. of feed	10 mg.	30 mg.
Number of lambs	20	20
Avg. daily gain (lbs.)	.53	.52
Avg. creep consumption/lamb/day (lbs)	.480	.495
Creep feed/1 lb. gain (lbs)	.90	.94

Observations

1. All lambs were thrifty and made good gains.

2. There was little difference observed in gain or feed required per pound of gain between the two lots.

3. This test supported previous work, where little advantage was obtained from using aureomycin when lambs were thrifty.

Acceptability of Creep Rations (Second Trial)

A second trial was run with the objective: (1) To compare the acceptability of five creep mixtures for lambs; and (2) to determine the response of suckling lambs to aureomycin in creep rations.

Sixty late spring lambs out of northwestern ewes and sired by Southdown rams were divided as equally as possible into two groups of 29 and 31 lambs each. The di-

vision was based on birth date, birth weight, singles or twins, thirftiness of lambs, and winter treatment of ewes. The lambs were given free access to five mixtures of ingredients fed in shallow trays placed in grain troughs in creeps. The trays were rotated periodically to remove positional effect.

Ground shelled corn was used as the standard for comparing the rations. The only difference between the rations fed the two lots was the aureomycin incorporated in the ration of lot 2. Lot 1 received no aureomycin.

Observations

1. Lambs in both lots preferred the mixtures of ingredients to ground shelled corn.

2. The mixture containing 55 percent ground shelled corn, 30 percent soybean oil meal, 10 percent wheat bran, and 5 percent cane molasses was consumed in greatest quantities by lambs in both lots. Adding a sweetener appeared to enhance the acceptability of creep rations.

COMPOSITION AND PREFERENCE RATINGS OF CREEP RATIONS FED IN MEAL FORM

Ration No.	Gr. shelled corn	S.B.O.M. (44% CP)	Wheat bran	Cere-lose	Cane Molasses	Corn Syrup	Preference Rating: Lot 1	Preference Rating: Lot 2
	%	%	%	%	%	%		
1	100	--	--	--	--	--	1.0	1.0
2	60	30	10	--	--	--	1.92	2.82
3	55	30	10	5	--	--	2.03	2.92
4	55	30	10	--	5	--	2.42	2.99
5	55	30	10	--	--	5	2.19	2.97

Response of Lambs to Aureomycin (Second Trial)

	Lot I	Lot II
Aureomycin level per pound of feed	None	30 mgm.
Number of lambs	31	29
Average days on test	76	77
Average initial weight (lbs.)	20.35	19.79
Average final weight (lbs.)	57.16	59.28
Average daily gain (lb.)	.48	.51
Average creep consumption per lamb (lbs.)	.23	.24
Average creep feed per lb. of gain (lb.)	.47	.47
Average live grades*	5.3	5.7

*U.S. grades were assigned numerical value as follows:
Medium choice 8, Low choice 7, High good 6, Medium good 5.

Observations:

1. With the exception of one lamb in the lot receiving aureomycin and two in the control lot, all lambs appeared healthy.

2. Lambs on aureomycin made slightly greater gains and graded somewhat higher, but none of the differences were great enough to be statistically significant.

3. These results confirm previous studies, indicating little advantage can be expected from the use of aureomycin when lambs are thrifty and suckling heavily milking ewes. *(Project 142)*

Response of Implanted Lambs to Enzymes Fed in Rations Varying in Protein and Energy

JOHN C. REA, C. V. ROSS

Objectives of this experiment were: (1) To determine the effects of adding enzymes to lamb fattening rations; (2) to compare stilbestrol and hexestrol as implants for fattening lambs; (3) to determine the effect on lambs of varying levels of protein and energy in fattening rations; (4) to formulate satisfactory procedures for summer fattening of Texas spring lambs.

Two-hundred and eight Texas spring lambs were selected from a car load of 270 lambs which arrived in Columbia May 31. They were fattened in a 2 x 2 x 2 x 2 factorially designed experiment in which the factors were enzymes versus no enzymes, stilbestrol versus hexestrol implants, high energy versus low energy and 11 percent protein versus 14 percent protein in the rations.

After the lambs arrived in Columbia, they were rested, vaccinated, sheared and fed on light rations. A severe outbreak of pinkeye coupled with a high incidence of internal parasites forced a delay of initiation of the experiment until July 1, 1959.

All lambs were self-fed complete pelleted rations. Aureomycin was added to all rations at the rate of 10 mgm. per pound of feed. Mineral mixture composed of equal parts salt and steamed bone meal was fed ad libitum.

Lambs were graded alive and marketed when they had sufficient finish to grade choice. They were slaughtered in three groups at 50, 71, and 83 days after the start of the experiment.

TREATMENT OF LAMBS

Lot	Number of Lambs	Treatment
1	13*	Hexestrol - 11% protein - low energy** - No enzymes
2	13	Stilbestrol - 11% protein - low energy - No enzyme
3	13	Hexestrol - 11% protein - low energy - Enzymes***
4	13	Stilbestrol - 11% protein - low energy - Enzymes
5	13	Hexestrol - 11% protein - high energy - No enzymes
6	13	Stilbestrol - 11% protein - high energy - No enzymes
7	13	Hexestrol - 11% protein - high energy - Enzymes
8	13	Stilbestrol - 11% protein - high energy - Enzymes
9	13	Hexestrol - 14% protein - low energy - No enzymes
10	13	Stilbestrol - 14% protein - low energy - No enzymes
11	13	Hexestrol - 14% protein - low energy - Enzymes
12	13	Stilbestrol - 14% protein - low energy - Enzymes
13	13	Hexestrol - 14% protein - high energy - No enzymes
14	13	Stilbestrol - 14% protein - high energy - No enzymes
15	13	Hexestrol - 14% protein - high energy - Enzymes
16	13	Stilbestrol - 14% protein - high energy - Enzymes

*Eight wethers and five ewes in each lot.
**Differences in energy levels were approximately 100 Cal./lb. of feed.
***Enzymes were added to the ration at the rate of 100 mg./lb. of feed.

RESPONSE OF LAMBS TO HORMONES, ENZYMES AND TWO LEVELS OF ENERGY AND PROTEIN

Treatment	No. Lambs	Avg. Initial Wt. (lbs.)	Avg. Days on Feed	Avg. Daily Gain (lbs.)	Feed/100 lbs. gain (lbs.)	Carcass[1] yield (%)	Carcass[2] grade
Hexestrol	104	71.46	67.4	.408	907	48.5	5.53
Stilbestrol	104	70.68	68.0	.397	918	48.3	5.34
Enzymes	104	71.01	68.4	.400	935	48.3	5.35
No Enzymes	104	71.13	67.0	.405	891	48.5	5.51
11% protein	104	71.12	69.1	.389	909	48.2	5.50
14% protein	104	71.02	66.3	.417	923	48.6	5.40
Low Energy	104	71.10	71.4	.358	1021	47.7	5.40
High Energy	104	71.0	64.0	.447	804	49.1	5.50
11% protein Low energy	54	71.0	71.5	.359	1006	47.5	5.40
11% protein High energy	54	71.2	66.7	.418	799	48.8	5.60
14% protein Low energy	54	71.1	71.3	.358	1037	47.9	5.40
14% protein High energy	54	70.9	61.3	.478	809	49.3	5.30

[1] Carcass yield = $\frac{\text{chilled carcass weight}}{\text{weight out of feed lot}} \times 100$

[2] Carcass grades were assigned values as follows: high choice 9, medium choice 8, low choice 7, high good 6, medium good 5, low good, 4.

COMPONENTS OF RATIONS FOR DIFFERENT PROTEIN AND ENERGY

	Ration I				Ration II				Ration III			
	11% P. L.En.	11% P. H.En.	14% P. L.En.	14% P. H.En.	11% P. L.En.	11% P. H.En.	14% P. L.En.	14% P. H.En.	11% P. L.En.	11% P. H.En.	14% P. L.En.	14% P. H.En.
Ground Ear Corn	36.0	59.5	27.0	50.0	36.0	69.5	27.0	60.0	36.0	70.5	27.0	61.0
Cane Molasses	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
1st cutting Clover Hay	56.0	30.0	57.0	31.5	56.0	18.5	57.0	20.0	55.0	18.0	56.0	19.5
S.B.O.M.	3.0	5.5	11.0	13.5	3.0	7.0	11.0	15.0	4.0	6.5	12.0	14.5

NOTE: Ration I fed 17 days, Ration II fed 32 days and Ration III fed 34 days.

Observations

1. Lambs on high energy rations made significantly faster and more efficient gains with higher carcass yields than similar lambs on a low energy ration.

2. Lambs fed rations containing 14 percent protein gained faster (approaching significance) and yielded significantly higher than those fed 11 percent protein.

3. Lambs fed high energy rations containing 14 percent protein made faster gains and had higher carcass yields than any other combination of protein and energy levels.

4. Lambs implanted with hexestrol were somewhat superior to those implanted with stilbestrol in gains, feed efficiency, and carcass grades and yields. However, the differences were not significant.

5. Side effects due to hormone implantation were minimal with no appreciable differences between lambs implanted with hexestrol or stilbestrol.

6. Under the conditions imposed by this experiment, there was no measurable effect from the use of enzymes. *(Project 356)*

Comparison of Phenothiazine and Ruelene for Worming Lambs

C. V. Ross, Melvin Karr

The objective of the experiment was to compare the effectiveness of phenothiazine and an organic phosphate (Ruelene) for worming lambs.

In the first experiment 54 crossbred lambs out of northwestern ewes and Southdown rams were placed in groups based on body weight, worm egg counts, and previous treatment. They were then assigned at random to two treatments as follows.

1. Control, drenched: 1⅓ oz. of a 40 percent concentration of phenothiazine per lamb.
2. Organic phosphate, drenched: 150 mgm Ruelene (mixed with water) per kg body weight.

All lambs were treated at the beginning of the experiment and again 28 days later. They grazed similar sudan pastures for the first 5 weeks. Then they were moved to two similar lespedeza pastures for the final three weeks of the experiment. A mineral mixture composed of equal parts of salt and bonemeal was available to them at all times.

The lambs were weighed by-weekly and individual fecal samples were taken at the time of weighing. Worm egg counts were made on all fecal samples. The counts were expressed as the number of stomach worm eggs per gram of dry feces.

Observations

1. Pastures were poor due to dry weather; neither lot gained well.

2. The average daily gain was 45 percent greater for the lambs treated with Ruelene, compared to those treated with Phenothiazine. This difference is highly significant.

3. Lambs receiving Ruelene maintained thriftier condition throughout the test and graded slightly higher at the end of the experiment.

4. Based on worm egg counts, there was a great variability of infestation of the lambs.

5. Using worm egg counts as a criteria, Ruelene appeared to reduce level of infestation more efficiently than Phenothiazine.

Fifty-six lambs which were the most unthrifty ones from a car load of Texas Spring lambs were used in a second experiment.

All lambs were divided into groups based on weight, worm egg counts, and general thriftiness. They were then assigned at random to four treatments as follows:

1. Control, drenched: 1⅓ oz. of 40% concentration of phenothiazine per lamb.
2. Ruelene, drenched: 100 mgm per kilogram body weight.
3. Ruelene, drenched: 150 mgm per kilogram body weight.
4. Ruelene, drenched: 200 mgm per kilogram body weight.

All lambs were treated at the beginning of the experiment and again 28 days later. They were self fed for

RESPONSE OF GRAZING LAMBS TO PHENOTHIAZINE VERSUS RUELENE

	Lot I	Lot II
Treatment	1 1/3 oz. Pheno. per lamb	150 mgm. Ruelene per kg body weight
Number of lambs	27	27
Days on test	56	56
Initial weight (lbs.)	63.5	64.2
Final weight (lbs.)	67.6	71.6
Avg. daily gain (lbs.)	.073	.132
Worm eggs/gm feces		
Initial (drenched)	74	15
14 days	700	63
28 days (drenched after fecal samples taken)	2,185	2,511
42 days	844	74
56 days	3,040	1,344
Avg. live grade	4.9	5.1

PHENOTHIAZINE VS. RUELENE FOR WORMING FATTENING LAMBS IN DRY LOT

Lots -	1	2	3	4
Treatment	1 1/3 oz. Pheno.	100 mgm. Ruelene *	150 mgm. Ruelene *	200 mgm. Ruelene *
Avg. No. days on test	42	42	42	42
Avg. initial wt. (lbs.)	60.4	59.0	60.0	59.5
Avg. final wt. (lbs.)	77.8	82.2	80.4	79.6
Avg. daily gain (lbs.)	.41	.55	.48	.48
*Avg. live grade	4.0	4.7	4.7	5.0
Worm eggs/gm. feces				
Initial (drenched)	650	864	557	600
14 days	43	7.8	0	0
28 days (drenched)	43	15.6	0	7.8
42 days	92	0	0	15.6

*Ruelene per KGM body weight.
**Live grades were assigned numerical values as follows:
Good / = 6, medium good = 5, Good - = 4, Cull = 0.

42 days as a group in dry lot on a ground, mixed ration composed of:

40% shelled corn
5% soybean oil meal
10% Molasses
45% Hay (1st cutting alfalfa)
10 mgm/lb. aureofac 2-A

Fecal samples were taken from each lamb and analyzed for worm eggs at the beginning of the test. Individual fecal samples were taken bi-weekly thereafter. The samples were divided into two groups of five and one group of four for each treatment and analyzed for worm eggs. Lambs were weighed bi-weekly.

Observations

1. Within the first two weeks the lambs treated with organic phosphate appeared much thriftier.
2. Average grades for the lambs on Ruelene were slightly higher at the end of the test.
3. The lambs receiving Ruelene had somewhat higher average daily gains than lambs on phenothiazine.
4. Although average initial worm egg counts were low indicating a low infestation, there were some lambs in each lot that were heavily infested. *(Project 142)*

The Cause and Prevention of Dark-Cutting Beef

H. B. HEDRICK

Beef that cuts dark red to purplish black is termed dark-cutting beef. The occurrence of dark-cutting beef constitutes a sizeable annual loss to the processor and the producer. The consumer associates this condition with beef of old animals or meat that has deteriorated. In most instances dark-cutting beef has to be sold at a reduced price.

In addition to color, dark-cutting beef differs from normal appearing beef in chemical and other physical characteristics. It has an abnormally high pH, low glycogen content, and a sticky, gummy texture. Normally when a beef carcass is ribbed, the color of the muscle is purplish and upon exposure to the atmosphere brightens to a cherry red. The muscle pigment myoglobin is oxygenated to oxymyoglobin, the bright cherry red consumers associate with quality beef.

In the case of dark-cutting carcasses oxygenation of myoglobin to oxymyoglobin does not occur at a sufficient rate to produce the desirable red color.

The pH and dark color of muscle are closely related. At pH 5.4 the color of beef muscle is bright cherry red, at 5.8 the color is "shady" or dark red, and at 6.2 to 6.8, purplish black. The membrane of the muscle cell is less permeable to oxygen at the higher pH levels. In addi-

tion to being less permeable to oxygen at the higher pH levels, the membrane of the muscle cell is less permeable to the passage of moisture out of the cell, therefore accounting for the characteristic sticky, gummy texture.

When a sample of dark muscle is ground or finely chopped, it brightens up almost instantaneously. When the muscle cells are torn apart and broken, oxygen then reacts with myoglobin to form oxymyoglobin.

Many hpyotheses have been advanced for the cause of dark-cutting beef. Prominent among these are: type of roughage the animals consumed, pasture feeding, addition of hormone to the ration or hormone implants, method of slaughter, and length of time on feed. There are no valid explanations physiologically whereby any of these factors could directly cause the dark-cutting condition.

Studies were conducted at this station over a four-year period to determine the cause of dark-cutting beef and possible preventive methods. These studies were concluded in 1959. One hundred-twenty cattle were used in these studies.

Periodic excitement induced by a "hot-shot" during the 24-hour pre-slaughter period or subcutaneous injection of 3 milligrams of adrenaline per 100 pounds body weight 24 hours prior to slaughter consistently produced the dark-cutting conditon in Good and Choice grade cattle. Either induced excitement or injection of adrenaline stimulates various abnormal conditions cattle are subjected to during marketing and the pre-slaughter period.

Many of the abnormal conditions which cattle are subjected to during marketing, such as emotional excitement, exposure to bad weather, injury and muscular fatigue, impose stress upon the animal's body. The animal is placed in an emergency situation. To survive, the animal uses its immediately available energy source first. Both the central nervous system and the muscles of cattle are dependent upon glucose and short chain fatty acids as energy sources for the performance of their functions.

When cattle are subjected to a stressful situation a number of physiological changes occur. The sympathetic nerve centers located in the back part of the inner brain (hypothalamus) are aroused and nerve impulses are carried throughout the body to the vascular system and the organs involved in metabolism. The adrenal medulla is stimulated and causes a discharge of adrenaline and noradrenaline. Adrenaline elicits extensive physiological changes in almost every system in the body. Among these changes is the reduction of glycogen in the muscle. If the animal is subjected to prolonged stressful conditions, the glycogen stores in the muscle will be reduced to a level that the post mortem biochemical changes necessary for bright cutting beef will not occur. For beef to cut bright, adequate glycogen must be present at the time of slaughter for conversion to lactic acid, which will lower the pH of the muscle sufficiently for oxygenation of the muscle pigment.

When an animal's glycogen stores are diminished due to increased secretion of adrenaline, other corrective physiological mechanisms are stimulated. The anterior pituitary is stimulated to produce adrenocorticotrophin (ACTH) which in turn augments adrenal glucocorticoid secretion. The glucocorticoids accelerate the formation of glycogen from the protein stores of the body.

Not all cattle respond equally to a given stressful situation. Some cattle are excited much more easily than others. The environment in which cattle are raised and fattened has an influence upon the manner in which their physiological mechanisms react. The influence genetic variations have upon the susceptibility of animals to stress cannot be ignored as a contributing factor.

From the results of our studies it can definitely be concluded that dark-cutting beef is caused by animals being subjected to prolonged stress prior to slaughter. The muscle glycogen stores of cattle cannot be depleted in a few minutes or an hour. However, if an animal is subjected to stress over a period of approximately 24 hours the muscle glycogen stores will be diminished and the dark-cutting condition will occur.

Muscle glycogen can be depleted much faster than it can be replenished to normal levels. Carcasses from cattle injected with adrenaline at periods from 24 to 96 hours preslaughter showed improvement as time increased between treatment and slaughter. However these carcasses were not as light and bright in color as controls. For hold-over feeding to be effective in reducing the incidence of dark-cutters, it would appear that the period of feeding would have to exceed four days and be under optimal conditions.

Administration of tranquilizers (phenothiazine derivatives) prior to stress did not prevent dark-cutting beef. There were indications that these compounds caused a reduction in reflexes and the onset of excitement. Cattle injected with these compounds appeared listless, drowsy, and slight to severe ataxia occured, depending upon dosage given. Edema was present in the carcass surrounding the site of injection and constituted an economic loss equivalent to dark-cutting condition. Indiscriminate use of tranquilizers in an effort to prevent dark-cutting beef should be avoided.

The most economical and feasible method of preventing dark cutting beef is careful and proper handling of cattle from the time they leave the farm until they are slaughtered. Special care should be exercised to prevent excitement, injury, or fatigue while loading cattle at the farm, while transporting, and in handling cattle on the

way to the market and at the market or slaughtering plant.

Studies on broiled steaks showed no significant difference in eating qualities between dark and bright beef from animals of the same approximate age and degree of finish. If the housewife could be assured that the undesirable appearance of dark-cutting beef was not due to deterioration, she could purchase dark beef with the same assurance of eating satisfaction as if she purchased normal bright beef. *(Project 238)*

Differences Between Castrate and Non-Castrate Pigs of Each Sex

S. E. Zobrisky

Differences in growth, carcass and meat characteristics between the sexes of littermate pigs were studied. Sixty-four littermate hogs were divided into four equal groups of boars, barrows, gilts and spayed gilts. These hogs were managed alike in respect to ration and environment. Half of the males and half of the females were castrated at weaning (56 days of age). The hogs were slaughtered at approximately 200 pounds. Their carcasses were measured and processed according to standard procedures.

The growth data from these 64 littermate pigs are presented in Table 1. It should be noted that the differences between the males and females at birth, 21 days, and at weaning were quite small and, for the most part, insignificant. The greatest difference in slaughter weight was between the boars and spayed gilts whereas the greatest difference in slaughter age was between the barrows and spayed gilts.

These facts should be noted in Table 1.

1. The boars and non-castrate gilts differed less than the boars and barrows, particularly in respect to weight and age at slaughter.
2. The barrows gained the fastest, whereas the spayed gilts gained the slowest.

Carcass weights and dressing percentages are in Table 2. The barrows dressed out slightly greater than the non-castrate gilts. The spayed gilts and boars were about equal in dressing percent.

The weight of trimmable carcass fat and also back fat (Table 3) indicate the finish (or fatness) of these

TABLE 1--GROWTH DATA

Variables	BOARS		BARROWS		GILTS		SPAYED GILTS	
	Average	S.E.*	Average	S.E.*	Average	S.E*	Average	S.E.*
Birth weight, lb.	3.54	0.15	3.77	.16	3.58	.11	3.48	.15
21 day weight, lb.	10.98	0.59	15.03	1.31	12.24	.37	10.16	.54
Weaning weight, lb.	39.57	1.04	33.86	.81	38.00	.46	36.28	2.48
Slaughter weight, lb.	192.93	1.45	198.12	1.82	195.62	2.00	199.44	1.81
Age at slaughter, days	167.43	2.90	156.43	2.25	164.14	2.96	176.86	4.42

*Standard error.

TABLE 2--CARCASS YIELDS

Variables	Male				Female			
	BOARS		BARROWS		GILTS		SPAYED GILTS	
	Average	S.E.*	Average	S.E.*	Average	S.E.*	Average	S.E.*
Carcass weight, lb.	142.96	1.49	150.24	1.26	147.34	1.49	147.72	1.37
Dressing percent	74.13	.62	75.88	.62	75.13	.43	74.12	.67

*Standard error.

TABLE 3--CARCASS YIELDS

Variables	Male				Female			
	BOARS		BARROWS		GILTS		SPAYED GILTS	
	Average	S.E.*	Average	S.E.*	Average	S.E.*	Average	S.E.*
Total carcass tr. fat, lb.	24.9	.86	34.47	.92	28.82	.95	31.19	.68
Backfat weight, lb.	9.16	.35	13.79	.37	11.38	.31	12.30	.40

*Standard error.

TABLE 4--CARCASS YIELDS

Variables	Male				Female			
	BOARS		BARROWS		GILTS		SPAYED GILTS	
	Average	S.E.*	Average	S.E.*	Average	S.E.*	Average	S.E.*
Belly, Lb.	21.24	0.35	23.11	0.49	22.46	0.29	24.07	0.47
Four lean cuts, Lb.	75.63	1.14	70.26	1.00	73.65	1.14	71.56	0.77
Loin weight, Lb.	23.27	0.42	21.73	0.40	23.84	0.77	22.51	0.45
Ham weight, Lb. untrimmed	28.99	0.63	29.06	0.72	31.00	0.85	30.09	0.34

*Standard error.

TABLE 5--CARCASS YIELDS

Variables	Male				Female			
	BOARS		BARROWS		GILTS		SPAYED GILTS	
	Average	S.E.*	Average	S.E.*	Average	S.E.*	Average	S.E.*
Ham fat, gm.	2006.28	63.83	2438.14	36.52	2308.00	71.77	2448.43	31.78
Ham lean, gm.	4043.43	135.10	3708.14	122.68	4273.28	87.23	3903.57	239.60
Ham bone, gm.	650.28	13.73	563.00	15.95	601.85	9.86	587.00	10.50

*Standard error.

TABLE 6--CARCASS MEASUREMENTS

Variables	BOARS	BARROWS	GILTS	SPAYED GILTS
	Average	Average	Average	Average
	N = 16	N = 16	N = 16	N = 16
Ham lean area, sq. in.	19.34	17.38	18.85	17.70
Last rib loin eye area, sq. in.	4.75	4.06	4.60	4.46

littermate hogs when slaughtered. The barrows were the fattest, followed by the spayed gilts, non-castrate gilts and boars.

The variables in Table 4 also suggest that the boars and non-castrate gilts, and barrows and spayed gilts tend to pair up in respect to weight of belly, four lean cuts and loin. However, the untrimmed hams from the females were definitely heavier than those from the male carcasses. This difference between males and females was expected. Research has shown many times that female hogs have heavier hams than male hogs. However, the component breakdown of these hams is another story, as is shown in Table 5. The non-castrate hogs (boars and gilts) had less fat and more lean and bone in their hams than the castrate hogs (barrows and spayed gilts).

Table 5 emphasizes that the presence of the gonads had more influence on composition of the ham than did sex.

The areas of loin eye and ham lean of the four sexes are shown in Table 6. It should be noted that the lean area of the ham and loin eye parallel the yield of lean and bone in the ham and also the yield of four lean cuts.

In Table 7 are presented the length of carcass and leg as well as thickness of backfat. The non-castrate hogs had longer carcasses and legs than the castrate hogs. Conversely, the castrate hogs had a greater thickness of backfat than the non-castrates.

These results indicate that non-castrate and castrate littermate hogs differ more in their carcass composition than in their rate of gain. The differences in rate of gain, carcass yields, and carcass measurements between boars and non-castrate gilts were less than between the boars and barrows, boars and castrate gilts, barrows and non-castrate gilts, and barrows and castrate gilts.

In conclusion it appears that the live hog and carcass characteristics were influenced to a greater extent by

TABLE 7--CARCASS MEASUREMENTS

Variables	Male				Female			
	BOARS		BARROWS		GILTS		SPAYED GILTS	
	Average	S.E.*	Average	S.E.*	Average	S.E.*	Average	S.E.*
Carcass length, mm.	745.12	6.68	733.69	5.29	748.75	4.40	730.75	5.79
Leg length, mm.	541.94	3.31	520.75	3.24	531.38	3.10	520.75	3.54
Av. Backfat thickness, mm.	33.58	1.12	41.21	1.12	38.00	0.53	40.64	1.05

*Standard error.

the presence of the gonads than by the sex of the individuals. This suggests that littermate gilts possibly would provide a better index of the meatiness of littermate boars than would littermate barrows. *(Project 397)*

Meat Acceptance Studies

H. D. NAUMANN, J. L. MCBEE, JR., D. C. BUBACK

Boneless Beef

Merchandising of beef is handicapped by the location of much tender beef in some of the less tender cuts. Another handicap is the rather confusing assortment of beef cuts presented to the consumer in the modern self-service meat counter.

This study was designed to develop cutting and fabrication techniques which would give the maximum yield of steaks and utilize the remaining part of the carcass in the most efficient way. Further, it was designed to discover the practicality of naming the beef cuts by the method of cooking that was desirable for that cut.

Seventy-five sides of U.S. Good beef were fabricated into boneless cuts and tested by 30 families in Columbia, 80 families in Mexico, and 148 families in Jefferson City. The six roast and boneless steak groups were oven roast, pot roast, thin steak, thick steak, minute (cube) steak, and swiss steak.

Consumers were generally satisfied with the beef as fabricated in this study. This boneless method of fabrication affords a maximum yield of steaks and increased versatility in the utilization of forequarter cuts.

MEAN RATING OF BEEF CUT GROUPS BY MUSCLE ORIGIN*

Muscle Origin	Oven Roast	Pot Roast	Minute Steak	Swiss Steak	Thin Steak	Thick Steak	Mean	Range
Clod	2.29	---	2.04	---	2.58	2.42	2.33	.54
Clod (Blade End)	---	1.96	2.09	---	---	---	2.04	.13
Chuck Roll (Blade)	2.06	---	2.30	2.11	2.87	2.26	2.26	.81
Chuck Roll (neck)	---	2.40	---	2.44	---	---	2.43	.04
Inside Chuck	---	---	2.19	2.00	---	---	2.13	.19
Rib Eye	---	---	---	---	2.02	1.96	2.00	.06
Brisket	---	1.91	---	---	---	---	1.91	--
Short Loin	---	---	---	---	2.04	2.34	2.15	.30
Top Sirbutt	---	---	---	---	2.33	2.10	2.24	.23
Bottom Sirbutt	---	---	1.83	---	2.34	---	2.00	.51
Rump	---	---	1.89	2.36	3.05	---	2.55	1.16
Bottom Round	---	1.77	2.01	2.00	---	---	1.94	.24
Top Round	---	2.09	2.14	---	2.99	2.77	2.51	.90
Knuckle	1.97	---	---	1.78	2.67	2.56	2.46	.89
Heel of Round	2.00	2.04	---	---	---	---	2.02	.04
Mean (weighted)	2.11	1.99	2.04	2.12	2.37	2.26	2.20	.38

*Like extremely was given a rating of 1, while dislike extremely was given a rating of 9, neither like nor dislike was given a rating of 5.

Effect of Freezing on Tenderness of Beef

Although freezing does not usually improve the quality of meat, it has been suggested that it increases tenderness. If true, there would be a potential commercial application of this effect.

The effects of freezing, temperature of freezing, and grade on the tenderness of beef loin steaks were determined by taste panel and mechanical methods in this study. Loin steaks from 24 Choice grade short loins and 24 Utility grade short loins were used to provide extremes in tenderness. The steaks were evaluated before and after freezing at various temperatures.

The fresh steaks were slightly more tender as judged by the taste panel than the steaks which had been frozen. Thus, freezing did not increase the tenderness but had a slightly adverse effect.

Since tenderness is such an important factor in the acceptability of beef, considerable effort is being expended in determining the usefulness of mechanical devices that will measure tenderness in raw beef. This study is the first in a series to determine the efficiency of the shear and press instruments indicated in the table.

(Project 348)

THE EFFECT OF FREEZING ON BEEF TENDERNESS

Method	Fresh	Frozen
Taste Panel Score	5.20	5.03
Warner-Bratzler Shear (Cooked), lbs.	20.53	20.29
Warner-Bratzler Shear (Raw), lbs.	18.91	19.54
Tenderness Press (Cooked), lbs.	469.33	478.33
Tenderness Press (Raw), lbs.	152.25	192.54
Micro-Tenderness Press (Cooked), lbs.	56.38	57.19
Micro-Tenderness Press (Raw), lbs.	7.37	7.99

The Relationship Between the Potassium Isotope (K^{40}) and Meatiness of Live Hogs

S. E. ZOBRISKY

A new method of measuring meatiness in live hogs was tried with surprising success in this study. It proved 99 percent accurate, compared with chemical analysis of cut up carcasses.

Three hogs were placed in a "whole body scintillator" that has been used by the Atomic Energy Commission's Los Alamos laboratory to measure lean and fat in humans.

All tissue contains some radioactive potassium (K^{40}) which gives off gamma rays that can be measured by the scintillator.

The isotopic potassium is directly proportional to the nitrogen and moisture in the body and indirectly proportional to the amount of fat. Thus the lean-fat ratio can be determined mathematically once the K^{40} is measured.

The body tissues contain only so much K^{40}. Any excess taken into the body is cast off in urine and feces. Thus the measurement is an accurate one based on lean-fat ratio, rather than intake of the radioactive potassium. sium.

The hogs were anesthetized, tied, and slipped into plastic bags for counting with the scintillator. Later they were slaughtered and the carcasses underwent exhaustive chemical analysis at the Experiment Station chemical laboratory to check the scintillator method. Even hair, hoofs, blood, and wash water were checked for factors that would throw the comparisons off.

The figures from the scintillator and carcass chemical analysis were only 1 percent apart.

Advantages of being able to measure meatiness in the live animal are clear to both breeders and slaughter plant buyers. In the immediate future we probably won't be able to find a way to adapt these machines to farmer use due to their high cost. There are only two scintillators of this type in the country today and they cost in the neighborhood of $100,000 apiece. Improvements and price reduction will likely come. In the meantime, the machines offer a potent research tool in selective breeding and in many types of animal investigations.

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Current Projects in Animal Husbandry

Beef Cattle

- Production of Young Beeves—Slaughter Cattle at or near Weaning
- Improvement of Beef Cattle Through Breeding
- Rations for Fattening Cattle

Swine

- Performance Testing of Swine
- Method of Selection and Breeding for Swine Improvement
- Protein Nutrition of Swine
- Factors Affecting Sow Performance
- Evaluation of Some Economic Traits of Swine

Sheep

- Some Factors Affecting Productivity of Ewes
- Reproduction of Sheep
- Lamb Fattening

Nutrition

- Ruminant Digestion
- Mineral Balance
- Roughage Changes
- Nitrate Poisoning

Breeding

- Endocrine Secretions in Reproductive Physiology of Farm Animals
- Anatomy of Reproduction

Meats

- The Effect of Ante-Mortem Handling During Marketing on Subsequent Carcass Quality
- Stability in Cured Meats Using Ascorbic Acid and other Stabilizers
- Meat Microbe Development
- Meat Tenderness
- Tolerances of Meat Storage
- Meat Acceptability
- Improving the Objective Identification of Swine
- Economic and Technological Problems in Marketing Pork and Beef
- Objective Indices of Meatiness