Feeding and Breeding Tests

With Sheep, Swine, and Beef Cattle — Progress Report, 1957-59

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Contents

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Wheat Pasture Studies with Western Feeder Lambs

ROBERT L. NOBLE, RICHARD PITTMAN AND
KENNETH URBAN

Thousands of lambs are fattened on wheat pasture in Oklahoma and adjoining areas during years that it is available. Lambs grazing lush wheat pasture make excellent gains at much lower cost per unit of gain than can be obtained in the feed lot. However, good wheat pasture is available only in years of adequate rainfall. Under conditions of moderate wheat pasture, lambs may not carry enough finish to bring the top slaughter price. Thus, the producer who utilizes wheat pasture needs information on feeding and management practices which are best adapted to the type of season encountered.

To obtain information on these problems, a study was initiated at the Ft. Reno Station in the fall of 1952. During the past six years, wheat pasture has been available for grazing three years.

Procedure

Two hundred and fifty, grade Western feeder lambs were used in this study. The prelimenary treatment of these lambs was discussed in the report, "Trucking versus Rail Shipment of Lambs."

The lambs were started on their experimental rations October 31.

The treatments used were as follows: fifty lambs per lot; one-half the lambs of each lot implanted with 6 mg. of stilbestrol.*

Lot 1. Wheat pasture (10 acres), no supplemental feed.

Lot 2. Wheat pasture (8.7 acres) and combine maize (1.3 acres).

Lot 3. Wheat pasture (10 acres), only for the first 64 days, with ¾ pound of milo per lamb daily the last 24 days.

Lot 4. Wheat pasture (10 acres) plus ¾ lb. milo per lamb daily the entire period (88 days).

Lot 5. Combine maize (3.3 acres, planted July 15) and volunteer wheat. This provided the only feed for the first 34 days; during the remaining 54 days, the lambs grazed this 3.3 acres of pasture during the day and were allowed access to a self-feeder at night. The mixture used was 45% milo, 5% molasses, and 50% alfalfa hay.

A mineral mix of 85% salt, 15% steamed bone meal was available to the lambs of all lots. The ¾ pound of milo per lamb for Lot 3 and the ¾ lb. for Lot 4 were fed once daily in the evening.

Individual weights following an overnight period without access to feed and water were taken at the beginning and the end of the trial. The lambs were sold on the Oklahoma City market, January 28. Marketing data included shrinkage, selling price, carcass grade, and yield.

* The Stilbestrol implants were supplied by Norden Laboratories, Lincoln, Nebraska.

Table 1.—Weight gains, rations fed, and financial results obtained with fattening lambs on wheat pasture. (88 days, October 31, 1957 — January 31, 1958)

Treatment	W. P. (10 acres)	W. P. (8.7 acres) maize field (1.3 acres)	W. P. (10 acres) + ¾ lb. milo last 24 days	W. P. (10 acres) + ¾ lb. milo entire period	3.3 acres of combine maize + volunteer wheat pasture for 34 days then self-fed mixture
Lot No.	1	2	3	4	5
No. lambs/lot	50	50[1]	50	50	50[1]
Initial wt.	70.2	70	69.9	69.8	69.9
Av. daily gain	.39	.36	.37	.39	.40
Financial Results ($)					
Av. selling price/cwt.	24	24	24	24	24
Total value/lamb minus shrink	24.28	23.76	23.76	24.19	24.43
Initial cost[2]	17.05	17.01	16.98	16.96	16.98
Miscellaneous cost[3]	.75	.75	.75	.75	.75
Feed cost/lamb[4]	1.55	1.55	1.86	2.85	4.03
Profit per lamb[5]	4.93	4.45	4.17	3.63	2.67
Carcass grade	3.7	4	3.7	4.3	3.6
Dressing percentage	48	48.9	47.3	49.5	46.2

[1] Two lambs in Lot 2 and 1 lamb in Lot 5 died; reason unknown.
[2] Initial cost; $21 cwt. F.O.B. Roswell; $24.3 on experiment, which includes freight, commission, feed and death loss. (15 lambs out of 500 died before experiment began)
[3] Includes cost of drenching, vaccinating, transportation to market, and marketing costs.
[4] Wheat pasture charge of 50¢ per lamb per month; also includes cost of supplemental feeds.
[5] Does not include death loss after experiment began. (3 lambs) Also does not include Gov. incentive in wool.
[6] Carcass grade—Numerical values of 6, 5, 4, 3, 2, and 1 were assigned to the grades of Av. Choice, Low Choice, high good Av. good, Low good and high utility; respectively.

Table 2.—The effects of Stilbestrol implant on feed lot performance, yield, and carcass grade

Treatment	W. P. (10 acres)		W. P. (8.7 acres) maize field (1.3 acres)		W. P. (10 acres) + ¾ lb. milo last 24 days		W. P. (10 acres) + ¾ lb. milo entire period		3.3 acres of combine maize + volunteer wheat pasture for 34 days then self-fed mixture[1]	
	without	with	without	with	without	with	without	with	without	with
No. of lambs	25	25	25	25	25	25	25	25	25	25
Total gain (lbs.)	30.4	38	33.3	31	30.6	34.3	30.6	37.8	31.2	38.9
Percentage Increase		+25		— 7.4		+12		+24		+25
Yield (%)[2]	47.4	47.7	49.2	48.7	47.5	47.0	49.8	49.2	46.3	46.0
U. S. Carcass Grade[3]	3.8	3.6	3.8	4.2	3.8	3.6	4.5	4.1	3.7	3.5

[1] Mixture used: 45% milo, 5% molasses, 50% alfalfa hay, ground and mixed.
[2] Yield—Hot carcass weight—2% + ave. market weight.
[3] Carcass grade—Numerical values of 6, 5, 4, 3, 2, and 1 were assigned to the grades of ave. choice, low choice, high good, ave. good, low good, and high utility; respectivly.

Average weight gains, marketing data and financial results are shown in Table 1. The effects of stilbestrol are shown in Table 2.

Observations

The average daily gains of all lambs grazing wheat pasture were very satisfactory (.39, .36, .37, and .39 pound per lamb daily for Lots 1, 2, 3, and 4, respectively). Wheat pasture alone gave slightly better results than a combination of wheat pasture and a maize field (compare Lots 1 and 2). Supplemental feeding (Lot 1 vs. Lot 3 or 4) did not increase gains. However, the lambs supplemented with ¾ pound milo per head daily during the entire period were fatter as indicated by carcass grade and dressing percentage.

The wheat pasture was grazed at a rate of 5 lambs per acre. On the basis of total gains of the Lot 1 lambs (1710 pounds) minus actual shrink to market (155 pounds) times market price ($24/cwt.), the wheat pasture was worth approximately $37 per acre during the 88-day grazing season.

The lambs of Lot 5 (50 lambs grazed 3.3 acres of combine maize with volunteer wheat pasture for 34 days, and then self-fed on this pasture 45% ground milo, 5% molasses, and 50% ground alfalfa hay for the remaining 54 days) also made very satisfactory gains. During the first 34 days, the lambs gained 8.5 pounds per lamb or .25 pound per day. During the remaining 54 days on pasture, the lambs consumed 2.5 pounds of the mixture per head daily and gained .47 pound per lamb per day. On the basis of the total gains during the first 34 days, this 3.3 acres returned approximately $30 per acre. The pasture was of some value during the remaining 54 days since only 5.3 pounds of mixture were required per pound of gain.

The Effects of Stilbestrol Implants

The results are shown in Table 2. Stilbestrol increased gains in four out of five treatments. In three treatments, the increase approximated 25%. No explanation can be given why stilbestrol depressed growth rate in Lot 2. Most of the growth response for Lots 1, 3, 4, and 5 occurred during the first 60 days. Stilbestrol implants decreased dressing percentage very slightly in four lots out of five treated. Carcass grade was also lowered slightly (less than ⅓ grade) by stilbestrol implants in four lots out of five. Stilbestrol as an implant **has not** been approved by the Federal Food and Drug Administration for use with lambs.

Trucking Versus Rail Shipment of Feeder Lambs

ROBERT L. NOBLE, RICHARD PITTMAN AND KENNETH URBAN

During the past five years, it has been noted that feeder lambs shipped via rail from the range area of Texas or New Mexico to the

Ft. Reno Station shrank about 9-11 percent. Since this loss in weight appeared excessive, it seemed desirable to check the shrinkage, recovery of weight loss, death loss, and economy of shipping lambs via truck as compared to rail shipment.

Procedure

Five hundred grade Western feeder lambs were purchased October 15 at Roswell, New Mexico. Two hundred of these lambs were shipped by truck, the remaining 300 via rail. On arrival at the Ft. Reno Station, the lambs were weighed, drenched, vaccinated against enterotoxemia, and ear tagged. The truck lambs and the rail lambs were penned separately. During the first day at the station, the lambs were fed prairie hay, ad lib. The following day the lambs were started on a self-feeder using a mixture composed of 25% ground milo, 5% molasses, and 70% ground alfalfa hay. This ration was self-fed for 10 days. At the end of this 10-day period, the lambs were weighed to check the recovery of weight loss.

Two hundred and fifty of these lambs were then used for wheat pasture studies and the remaining 250 lambs were used for dry-lot studies.

Observations

The results are shown in Table 1.

Table 1.—Trucking versus rail shipment of feeder lambs

	Truck lambs (200)	Rail lambs (300)
Av. Wt. at Roswell	75.7	77.6
Hours in transit*	14	58
Av. Wt. at Ft. Reno	73	70.7
Pounds loss per lamb	2.7	6.9
Percentage shrink	3.6	8.9
Cost of transportation per head	.93	.69
During 10-day feeding trial		
Pounds of gain per lamb	3	6.1
Av. feed intake per lamb	2.43	2.45
Pounds of feed/pounds of gain	8	4
Pounds of feed per lamb necessary to recover loss in weight	24	27
Death loss	3	12

* The rail lambs were unloaded, fed, and waterd at Amarillo, Texas. The lambs were off the rail car for 28 hours.

Very little difference was noted in the amount of feed necessary to recover the loss in weight. The death loss—due primarily to enterotoxemia—was higher for the rail lambs, perhaps due in part to conditions and time in transit. This work will be repeated to further study this problem.

X-Rays of Lumbar Vertebrae as a Method for Detecting Carriers of Dwarfism

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Within recent years there has been an apparent decrease in the numbers of dwarf calves produced in beef cattle herds. This reduction has been largely the result of pedigree discrimination combined, in many cases, with an increased use of progeny tested sires. However, it must be recognized that dwarfism is still a problem and continues to be an important factor influencing breeders in their selection of breeding animals.

The most effective tool the breeder may use in combating dwarfism is progeny testing. Unfortunately, because of numbers involved, this method is limited to bulls. If no dwarf calves result from the mating of a bull to sixteen or more known dwarf-carrier cows, or twice that number of daughters of a carrier bull, the breeder can feel reasonably sure that the bull does not carry the dwarf gene. If only clean bulls are used, no dwarf calves will be produced even though the cow herd may include dwarf carriers. Although progeny testing is the most accurate method available, it is expensive and time consuming, and largely practiced only by the larger purebred breeders.

Pedigree selection has been the method most often employed by the average breeder. To be effective in controlling dwarfism, selection must be based on accurate pedigree information. In many cases such information is not available, and discrimination is based on rumor and hearsay. Pedigree selection under such conditions cannot be effective and can be very detrimental to the breed. Even when accurate dwarfism pedigree information is available, wholesale discrimination against certain lines of breeding reduces the selection pressure within the breed for other economically important production traits. This reduction is proportional to the fraction that the "dirty" bloodline comprises of the total breed population. Unfortunately, this has been a sizeable fraction in some cases, and has resulted in the loss of many desirable animals.

Further consideration of pedigree selection must lead to the realization that although many of the clean lines appear to have proven themselves, there is still the possibility that some lines may actually include dwarf carriers that have never been exposed. The increased use of progeny tested bulls decreases the possibility that these animals will be exposed, although they will continue to contribute the dwarf gene to the population. If pedigree selection is to be the basis for controlling dwarfism, such lines must be eliminated as rapidly as they are detected.

Efforts to eliminate dwarfism in beef cattle are still hampered by the lack of an accurate means of identifying carriers at a young age and at a relatively low cost. A method of this sort would enable breeders to discriminate against individual animals rather than entire lines of breeding.

A very extensive research program has been conducted at several Experiment Stations in an effort to develop such a diagnostic technique. One method that was proposed was based on differences observed in x-rays of the lumbar vertebrae of very young calves. The accuracy of this method has been extensively tested at the Oklahoma Station, as well as at several other Experiment Stations. The purpose of this report is to summarize the results to date and evaluate this method.

Procedure

A detailed description of the vertebral abnormalities believed to be characteristic of dwarfism and the testing procedures used are presented in an earlier Feeders Day Report (MP-48, pp 33-42). Briefly the procedure was to x-ray the lumbar region of the spine before the calf was one week of age. On the basis of their x-rays, the calves were classified as A (dwarf), B (predicted dwarf carrier), and C (predicted clean). Although all calves with B x-rays were predicted to be carriers, they were further classified as to degree of abnormality as MB (mild B, only slightly abnormal), IB (intermediate B, definitely abnormal), and XB (extreme B, extremely abnormal).

The necessity of obtaining the x-rays only on very young calves seriously hampered an early, complete evaluation of the technique. In most cases the true dwarfism genotype of the calf was not known, and could only be determined after the animals had reached sexual maturity and could be progeny tested. A tester herd of approximately 120 cows known to be carriers of the dwarf gene is maintained at Ft. Reno to progeny test young bulls whose dwarfism genotype has been predicted on the basis of the x-ray and other techniques. A few matings were made of normal heifers with a dwarf bull. This test not only enables one to partially test the genotype of the heifers, but all calves that result are known to be heterozygous. Unfortunately, it is not often easy to find a fertile, active, dwarf bull.

Results and Discussion

Although approximately 1,000 calves have been x-rayed at the Oklahoma Station since the beginning of this project, the true dwarfism genotype was known for only 58 calves. The x-ray classifications for these calves of known genotype are presented in Table 1.

Forty-four dwarf calves, thus known to be homozygous for the recessive dwarf gene, were x-rayed. Of this number, 42, or 95 percent, had the abnormalities typical of the dwarf and were classified as "A". The two calves that did not have the typical dwarf vertebrae were classified extremely abnormal "B". The abnormalities typical of the "A" classification appear to be specific for the dwarf, since no non-dwarf calf has ever been classified "A". Although an occasional dwarf would

Table 1.—Summary of x-ray classifications of all animals of known genotype for the dwarf gene. Data for Hereford and Angus combined. Ft. Reno 1955-57.

Genotype	No.	X-Ray Classification				
		C	MB	IB	XB	A
Heterozygous						
By Progeny Test	7	2	0	2	3	0
One Parent Dwarf	7	1	1	3	2	0
Homozygous Recessive	44	0	0	0	2	42

be missed on x-ray, this method appears to be an accurate means of identifying a dwarf calf. This could be very important in cases of dead calves that cannot be definitely diagnosed as a dwarf on the basis of their appearance.

Only 14 animals heterozygous for the dwarf gene were x-rayed as calves. Eleven, or 78 percent, were predicted to be heterozygous on the basis of their x-rays. This level of accuracy of the x-ray method for predicting carriers of the dwarf gene is well below the level obtained from the combined data of all Experiment Stations that are working on this method. This pooled data reveals that there have been 187 known carriers x-rayed, of which 167, or about 90 percent, were classified as carriers on the basis of their lumbar x-rays. This pooled estimate is probably more reliable in evaluating the accuracy of the technique than is the limited data from any one station.

Table 2 is an estimate of how accurately the x-ray technique identifies animals that are free of the dwarf gene. Two years data from a grade herd at Ft. Reno, that is believed to be free of the dwarf gene, reveals that 77 percent of the calves were classified "C" and thus predicted free of the dwarf gene. This compares very closely to an esti mate of 80 percent predicted clean by all stations working with similar herds. This is the best estimate that can be obtained, but it must be recognized that such "believed clean" herds could carry the dwarf gene at a low frequency. However, until this is proven we must assume that the lines are clean, and use of the x-ray method would result in culling 20 percent of the clean animals of a line as suspected carriers.

Table 2.—Summary of x-ray classifications of calves produced in a herd believed to be free of the dwarf gene—1955-56.

No. Sires	No. Calves	Percent of All Calves in Each X-Ray Class				
		C	MB	IB	XB	A
12	235	77.0	16.6	6.4	0	0

Most of the calves that have been x-rayed in this study could not be definitely classified into either the clean or carrier group. Thus, the data from these calves could contribute only indirectly to determining the accuracy of the method. Table 3 presents a summary of the x-ray classifications of calves produced by known carrier cows in 1956-1957. The data is broken down in groups based on the breed and x-ray classification of their sires. It is readily apparent that the distribution of x-ray classifications among the calves follows very closely the x-ray classification of their sire. Bulls with "B" x-rays sired a higher percentage of calves with "B" x-rays, and a lower percentage of calves with "C" x-rays than did bulls with "C" x-rays. If the bulls with "B" x-rays were carriers, the expected distribution of genotypes among their calves would be 25 percent dwarf-free ("C" x-ray class), 50 percent carrier ("B" x-ray class), and 25 percent dwarf ("A" x-ray class). If the bulls with "C" x-rays were dwarf-free the expected distribution of their calves would be 50 percent dwarf-free and 50 percent carrier with no dwarf calves. Except for the discrepancy in the dwarf classification, the observed ratios in each sire group in Table 3 fairly closely fit the expected. While no definite conclusions as to the accuracy of the x-ray technique can be drawn from these distributions, it is further evidence of the association between the x-ray classification and dwarfism genotype of a calf.

Table 3.—Summary of x-ray classifications of all calves from known carrier cows and sired by x-rayed bulls in 1956 and 1957.

Breed	X-Ray Class	No. Bulls	No. Calves	Percent of Calves in Each X-Ray Class				
				C	MB	IB	XB	A
Hereford	B	13	52	25.0	7.7	28.8	26.9	11.5
Angus	B	6	33	30.3	15.2	36.4	18.1	0
Hereford	C	8	46	45.7	21.7	21.7	6.5	4.4
Angus	C	6	38	60.5	13.2	23.7	2.6	0

What conclusions can be drawn as to the value of the x-ray technique as a method for combating dwarfism? The estimate as derived from the pooled data from all stations can probably be considered to be reliable estimates of the accuracy of the method under field conditions. These limits of accuracy are not considered high enough to recommend the method be used as a basis for merchandising cattle. Theoretically the method could be useful in early screening of prospective breeding animals in a problem herd. Selections based on x-ray classifications made by an experienced technician should eliminate a large percentage of the carriers, and significantly reduce the frequency of the dwarf gene in the replacements for the herd. However, under present conditions, the pedigree discrimination that would be encountered in attempting to sell breeding stock offers little, or no, incentive to a breeder to attempt to clean up a herd with a dwarfism history.

Summary

Data are presented on three years study of the x-ray technique for detecting carriers of the snorter dwarf gene. Approximately 80 percent of the dwarf carriers x-rayed as young calves at the Ft. Reno Station were correctly classified from x-rays of their lumbar vertebrae. It was also observed that 20 percent of the calves from a herd believed to be free of dwarfism were classified as carriers from their x-rays.

The x-ray method is not considered accurate enough to serve as a basis for merchandising beef cattle. It can be useful in early screening of prospective breeding animals in a problem herd. However, its practical application is limited by the pedigree barrier against animals from such herds.

Snorter dwarf calves have very characteristic abnormalities of the lumbar vertebrae that have never been observed in non-dwarf calves. Lumbar x-rays accurately identify a dwarf calf, and may be very useful to breeders in determining the dwarfism status of a doubtful calf.

Contributions of Nutrition Research to Animal Production

ALLEN D. TILLMAN

Is the present-day animal nutritionist overly optimistic when he gazes into his crystal ball and predicts the effects of future discoveries upon animal production? If we look back over the past 60 to 70 years, we can readily see that at no time within this period was he optimistic enough in forecasting the enormous impact of nutritional discoveries on present-day animal production. These discoveries have made it possible for fewer farmers to produce more meat, milk and eggs upon fewer acres of land. But we must do better. When you sit down at your dinner table this evening, there will be over 35,000 more people to join you than there were at breakfast.

Important Past Discoveries in Nutrition

To better understand the importance of basic nutrition research, and to make some predictions of future happenings in this field, we must review some of the discoveries and concepts of the past that have greatly influenced the field of animal nutrition. Along these lines, let us consider the development of the purified diet concept and its effect on nutritional discoveries and important past discoveries in vitamin, protein and mineral nutrition.

1. PURIFIED DIET CONCEPT. In the year 1830 a British physician named William Prout stated that there were what he called

three staminal principles which provided the essential nutrients for animals. These principles were carbohydrate, protein and fat. Prout's idea was not seriously challenged by research workers until around 1900. During the next 10 years, several workers reported that animals fed diets composed of pure protein, carbohydrate and fat soon died and exhibited certain disease symptoms. The inclusion of minerals in the diet gave only slight improvement, but the inclusion of natural feeds of vegetable or animal origin resulted in a dramatic response in all animals. These observations led one worker to sum up the work thusly: "No animal can live on a mixture of pure protein, pure carbohydrate and pure fat, and, even when the necessary inorganic elements are carefully added, the animal cannot live. The animal body is adjusted to live either upon plant tissues or other animals, and these contain countless substances other than protein, carbohydrate and fat." He coined the term "accessory food factors" for these postulated substances.

The purified diet technique, which was accepted around 1900, has been the basis for many of the important discoveries in nutrition. The present-day purified diet contains 50 or more purified nutrients. Each can be included or omitted individually. Thus the researcher can omit one or more nutrients at a time to study the effect of this omission on the animal. By this technique it is now possible to associate certain diseases occuring in animals with the deficiency of one or more nutrients in the ration of that animal. Also, by varying the levels of a nutrient in the diet and measuring performance (growth, fattening, reproduction, etc.) of the animal, research workers can establish the quantitative requirements of animals for each of the various nutrients. The results of tests using this technique were and are being used for establishing feeding standards.

The purified diet technique also is used to study the effects of *nutrient imbalances*. This important type of study will be considered later in this paper; but, at this stage, it should be emphasized that our now meager information indicates that nutrient imbalance is one of the most complex problems in modern nutrition research. If we knew the effect of each nutrient upon the animal's utilization of each of the other nutrients, we could perhaps explain why certain forages produce such poor results when they form rations of range cattle and sheep. The purified diet technique offers an approach that will someday answer this acute problem.

2. RECOGNITION OF VITAMINS AS ESSENTIAL NUTRIENTS. The reason the researchers were unable to grow animals on a purified diet composed of purified protein, carbohydrate, fat and certain mineral elements was furnished by a Polish chemist named Funk in 1912. Working in England, Funk cured rats of polyneuritis by the administration of a water extract of rice bran. Upon closer examination of this extract, he found that it contained a chemical entity called an amine. Recognizing the profound nature of this discovery, Funk immediately reported that he had found a substance that was essential for life ("Vita") and that it contained an amine group. Combining these terms, he named the new substance "vitamine." Re-

searchers on the European continent, as well as those in America, within a very short time recognized similar substances that did not contain an amine group, thus, the name was later changed to "vitamin" which still serves as a group name for some 16 chemically and physiologically unrelated compounds that are required in very small amounts for the well being of all animals. Many of the important vitamin discoveries that have resulted in improved nutrition of animals are as follows:

a. Elucidation of the physiological effects of a deficiency of vitamin A. (1914-1940)

b. Synthesis of vitamin A. (1946-1948)

c. Stabilized vitamin A. (1949-1956) The feed nutritionist is now, for an almost negligible cost, able to fortify all rations for all livestock.

d. Discovery of vitamin D. (1922)

e. Discovery that cod liver oil contained vitamin D (1922), allowing the keeping of animals indoors the year around.

f. Discovery that the vitamin D potency of feeds could be increased by exposure to ultraviolet light (1924). Greatest impact in human nutrition in the improvement of milk.

g. Dry sources of stable vitamin D. (1940-1944)

h. Separation of the vitamins contained in the designated "Water Soluble B" fraction. (1930-1950)

i. Discovery of the importance of supplementary B-vitamins (choline, nicotinic acid, pantothenic acid and vitamin B_{12}) in practical poultry, swine, and turkey rations. (1945 to present time)

j. Discovery of vitamin B_{12} and more importantly a discovery of low-cost source of vitamin B_{12}. (1949)

k. Discovery of economical sources of B-vitamins needed in supplementing practical rations fed to swine, chicks and poults. (1948 to present time)

l. The effect of high-energy rations for chicks and swine upon the vitamin requirements of these animals. (1950 to present time)

3. PROTEIN DISCOVERIES THAT HAVE RESULTED IN IMPROVED NUTRITION OF ANIMALS. The field of protein nutrition is older than that of vitamin nutrition. Nevertheless, there are many more gaps in our knowledge of protein chemistry and we have made less progress in transferring our basic knowledge to practical feeding. But we are making progress. Many important discoveries made within the past 50 years have had a great impact upon practical feeding of animals and many more will come in the future.

Many of the important discoveries in protein chemistry and nutrition follow:

a. Discovery that the nutritive value of some proteins was improved by the addition of certain amino acids. (1905-1914) This basic discovery spurred the protein chemist and nutritionist to study the amino acid makeup of different feed proteins.

b. Discovery that the simple stomach animals were unable to synthesize at a rate required for normal growth 10 or more of the amino acids found in body protein. These amino acids were termed "dietary essentials" to distinguish them from those 12 or more amino acids found in body protein that can be synthesized within the body from the dietary essential amino acids. (1930-1940) This concept, which developed from the results of many basic researches, is fundamental to our understanding of protein nutrition today. This important concept, derived from literally hundreds of individual research projects, set the stage for research work designed to evaluate all protein systems on the basis of their essential amino acid contents.

c. Discovery of supplementary relations between various protein systems relative to their essential amino acid contents. (1945 to present time) It was found that proteins of vegetable origin differed in their proportions of essential amino acids and that in many cases one protein system contained an abundance of an essential amino acid which was deficient in another protein system. Thus, a combination of the two protein systems gave greater growth than either fed individually. Prior to this discovery, the practical feed nutritionist, compounding rations for the simple stomached animals, used only protein supplements of animal origin such as meat scraps, milk, etc. The dietary supplements of animal origin have an amino acid content closely resembling that of the new tissues they will form in the animal, and therefore, have a high value for promoting growth. The supply of protein supplements of animal origin has always been limited and this one factor limited swine and poultry production for many years. Then it was discovered that soybean meal contained an abundance of the essential amino acid, lysine. Further research showed that an "all vegetable protein ration," if the protein supplement were soybean meal, properly fortified with vitamins (particularly B_{12}, riboflavin, niacin, choline, and pantothenic acid) and minerals, promoted gains in swine and poultry equal to those obtained when the animal protein supplements were fed these animals. This discovery, which was the culmination of much individual research, is undoubtedly responsible for the unprecedented expansion of swine and poultry production in this country. The producers of these animals today would not consider the possibility of growing their animals on rations devoid of soybean meal any more than the producer of yesteryear would have considered doing without an animal protein supplement.

d. Improvement of soybean oil meal. (1940 to present time) Raw soybean contains much protein but this protein is of poor quality. That is, it supports very slow growth when fed to the simple stomached animal. The basic research work by a German immigrant in this country gave the nutritionist an idea which led to the improvement of soybean protein. This worker, in a very impractical experiment, designed a purified diet in which the protein was supplied by *pure* essential amino acids. In one of the basal rations, he deliberately omitted one of the essential amino acids and then allowed the animal to consume this diet. At definite intervals of time after feeding, he then force-fed enough of the omitted essential amino acid to make the mixture complete in regard to protein synthesis. His astounding results showed us that for protein synthesis to proceed at a maximum rate, all of the amino acids have to be present at the same time. As all proteins, when digested in the gastro-intestinal tract, are broken down to amino acids and absorbed as such into the blood stream, nutritionists immediately foresaw the possibility that if some substance in a protein system should slow down the absorption of any essential amino acid, the growth promoting value of that protein would be hindered. It was soon discovered that raw soybeans contained a substance that hindered their digestibility and that this substance was destroyed by heat. Too much heat, however, also reduced the protein quality of soybean oil meal. Thus, researchers had to find out how much heat was necessary to destroy the inhibiting material without reducing protein quality. After much basic research on this problem, there evolved the present-day high quality soybean meal, which is produced under very closely controlled temperatures.

e. Protein substitutes for ruminant feeding. (1941 to present time) Urea is now widely used as a protein substitute in rations of cattle and sheep. Discovery of the factors necessary for the proper utilization of the non-protein nitrogen compounds has been and still is a very interesting field of research.

f. Low cost fiber sources for ruminants. (1950-1956) At the present time, we are using low-quality roughages such as cottonseed hulls, cotton gin trash, corn cobs, corn stalk, etc. for feeding ruminants. The development of supplement necessary to supply nutrients missing in these roughages has been an interesting and profitable research endeavor.

g. Synthetic DL-methionine and analogues. (1950-1955) Most natural rations have a slight deficiency of the essential amino acid, methionine. Thus, the discovery of economical sources of it has improved the feeding of chicks and poults.

4. DISCOVERIES IN MINERAL NUTRITION. Minerals are needed as structural elements in the skeleton of the body and as biological catalysts in the utilization of certain organic nutrients; carbohydrates, fats and proteins. Some of the important discoveries in mineral nutrition are as follows:

a. Discovery of new mineral sources supplying calcium and phosphorus. (1942 to present time) The simple stomached animals do a poor job of utilizing the phosphorus in vegetable feeds; therefore, their rations must have additional inorganic phosphorus. The present-day supply of steamed bone meal is too small to support our enormous swine and poultry enterprizes.

b. Discovery of the importance of cobalt in ruminant nutrition. (1938-1955) Cobalt in ruminant rations is necessary for the formation of vitamin B_{12} in the rumen of these animals. A 1,000-pound cow requires approximately 1 milligram daily. The use of radioisotopes made this discovery possible.

c. The elucidation of the importance of other trace elements in animal nutrition. (1938 to present time)

d. The interrelationship of calcium and zinc in the prevention of swine parakeratosis. (1955 to present time)

e. The importance of phosphorus in ruminant digestion of fiber, thus allowing the utilization of low cost roughages. (1954 to present time)

f. New methods of determining mineral availability by the use of radioisotopes. (1948 to present time)

g. Discovery that added sulfur was needed when urea was a major source of nitrogen in a ruminant ration. (1946-1950)

5. OTHER DISCOVERIES IN WHICH THE ANIMAL NUTRITIONIST HAS PARTICIPATED. The nutritionists have also participated in discoveries that cannot be classified under the preceding headings. Nevertheless, these discoveries have aided animal production and are as follows:

a. Disease control through medicated feeds. (1950 to present time)

b. The effects of certain hormones upon livestock gains. (1950 to present time)

c. Development of a proper calorie to protein ratio for the feeding of livestock. (1955 to present time)

d. The establishing of nutrient requirement tables for better feeding of animals.

e. Nutritional improvement of barley by water treatment or by the addition of enzymes. (1957)

Present Discoveries That Are Promising But Need More Study

Many of the present discoveries show much promise of having practical application in animal production. These discoveries, which follow, need to be studied more before a general usage of each item is advocated.

a. Enzyme feeding to pigs and chicks.

b. Injectable iron-copper compounds for baby pigs.

c. Amino acid supplementation with amino acids other than methionine.

d. Interrelationship between vitamin E and selenium in nutrition.

e. Use of tranquilizers in animal feeds.

f. Thyroid feeding to brood sows.

g. Stilbestrol feeding to all animals.

Future Discoveries

Approximately 200 nutrition and biochemistry laboratories in this country are doing research on basic and applied problems of nutrition. In these laboratories, about 800 qualified scientists are working in some phase of research. It is only reasonable to assume that newer discoveries with resultant changes in concepts, methodology, and production goals will come from these workers. Some authorities estimate that only 30 to 40 percent of the basic nutritional findings have been uncovered and that many of these may never be discovered. However, covered, and that within the next 25 years, we should see many important discoveries of a basic nature. What are likely to be the most important nutritional discoveries in the future? Here are some possibilities:

a. Establishment of complete optimal and minimal nutritional requirements of all essential nutrients for body functions. (A whale of a job.)

b. Discoveries of newer and cheaper sources of feed nutrients such as microbial residues, algae, dried sewage, new plants, etc.

c. Discovery of ways to produce hormones that will allow greater production of meat, eggs and milk more economically than at the present time.

d. Discoveries improving the nutritive value of important animal products such as eggs, milk and meat, thereby improving the value of these products for human consumption.

e. Discoveries improving the efficiency of ruminant animals. It is now known that ruminants are less efficient converters of energy than are the simple stomached animals. A large part of the difficulty lies in our inability to balance rations for the microorganisms living in the rumen. Recent research results suggest that the relative proportions of fatty acids produced in the rumen and which are available for the host animal can be varied by altering the composition of rations. Thus it is feasible to assume that a certain proportion of fatty acids will produce milk more efficiently while another proportion of fatty acids will produce fat or growth more efficiently. If these can be worked out, we shall be able to "tailor make" our rations for a given function and improve the efficiencies of these animals.

f. Discovery and classification of antimetabolites contained in feeds for ruminants. Knowledge of this nature might explain why certain forages produce poorer growth than others. Also, there might be ways of economically removing or counteracting these compounds which directly interfere with the metabolism of certain nutrients.

g. Basic discoveries of metabolic roles of nutrients in the body. When all the metabolic functions of a nutrient are established, research workers will be able to study factors affecting these functions. From studies with whole animals, we know that certain nutrient imbalances do affect growth of the animals. But we do not know how too much of one nutrient affects a specific metabolic function of another nutrient. With such information on all nutrients it might be possible to integrate this knowledge and to eventually compound a perfectly balanced ration.

In this space age, our attentions are constantly drawn to future exciting adventures out beyond the earth. No less exciting will be the new discoveries and developments in animal nutrition. As these discoveries are made and are put to use by the animal production men, our collective goal of producing more meat, milk and eggs that will sell for a price which both the producer and consumer can afford will come nearer to full realization.

Management Practices to Increase the Lamb Crop from Spring Bred Ewes

JOE V. WHITEMAN AND RICHARD PITTMAN

Most commercial lamb producers in Oklahoma try to produce and sell "spring" lambs. This system of production involves breeding the ewes so that most of the lambs are born in the fall. There are several advantages to managing the sheep flock in this manner.

1. The lambing season can be timed to come when the sheepman has the necessary time to care for the ewes.

2. Fall, winter and spring small grain pasture can be very profitably used.
3. No lambs are on the farm during the season of parasite losses.
4. Lambs are grown and fattened during cool weather.
5. The lambs are ready for market when prices are at a seasonal high.

The principal disadvantage to this system of production is that sheepmen have difficulty in obtaining a high percentage lamb crop during a short period of time.

To overcome this difficulty, sheep producers have generally used one or the other of two systems of breeding the ewes. The first system is illustrated in Figure 1. The breeding season starts usually in early April and ends in late June. The lambing season thus extends from September to sometime in November. The lambing season will last 60 to 90 days depending upon the length of the breeding season. Handling the flock in this manner will yield a good lamb crop in most years. Most of the ewes (if of predominately Rambouillet breeding) will breed and most rams are fairly fertile and active during this season. Three serious drawbacks to this system are: 1/ inefficient use of labor during a lambing season that is this long; 2/ good gaining lambs born in September and early October will reach market weight too early to bring the best price in most years; and 3/ too many of the lambs will be requiring the most feed during December, January and early February when winter pasture is in shortest supply.

The second solution that is being used to get a high percentage lamb crop is illustrated in Figure 2. Under this system of production, the breeding season starts in May or as late as early June and extends

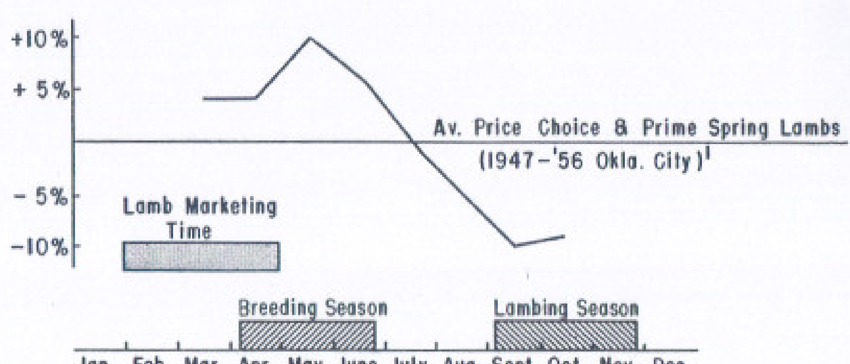

Figure 1. The breeding and lambing seasons if one is trying for all fall lambs. (Note the relationship of probable lamb marketing time to average price of lambs.)

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1. Badger, Daniel D. 1958 Economic analysis of alternative sheep enterprises in Oklahoma. M.S. Thesis, Oklahoma State University.

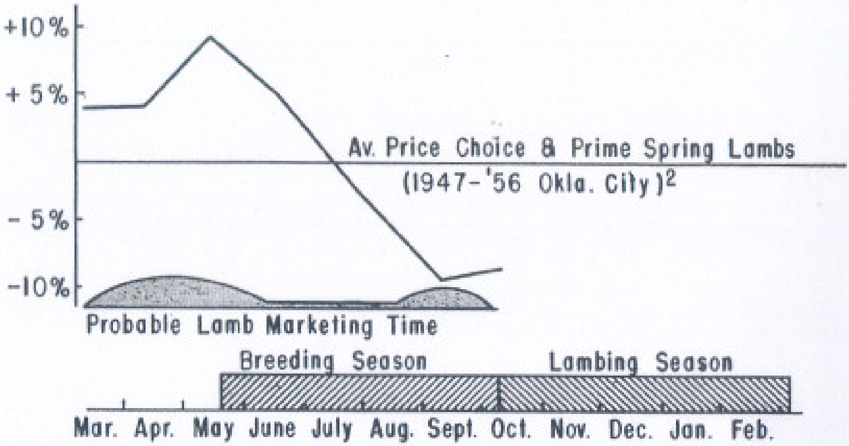

Figure 2. The breeding and lambing seasons if one starts breeding in late spring and continues until lambing time. (Note the relationship of probable lamb market time to average price of lambs.)

to early fall. The lambing season extends from sometime in October until as late as March. This system, too, will result in a good lamb crop. Depending upon the year to some extent, generally 40 to 70 per cent of the ewes will lamb in October and November, a few lambs will be born in December and January and most of the rest of the ewes will lamb in February and March. This system also has disadvantages. Again, the lambing season is too long for efficient use of labor. More serious, however, is the problem that arises as a result of the lambs born in February and March. Only the fastest gaining of these lambs will reach market weight by early June at which time the market is declining. Slow gaining lambs must be sold at light weights or additional management practices applied to prevent losses to parasites and heat. Further, ewes that lamb in February and March may not be ready to breed in May and June, but may become permanent fall breeders.

Table 1 illustrates the economic advantage associated with a high percentage lamb crop. If we get a 100 per cent lamb crop with 20 percent of the ewes raising twins and 20 percent dry, the average return per ewe will be about $8.05. This represents the return to the sheepman for his labor, permanent pasture, facilities and capital.

If management practices cause ten per cent more ewes to raise lambs at the same ratio of twins to singles, the return per ewe becomes $9.43. This is an increased return of 17 percent. A 20 percent increase in ewes lambing increases returns to $10.81 per ewe for a per-

2. Ibid.

Table 1.—Estimated costs, returns and profits from ewes with different production records

	Ewe raising: no lamb	one lamb	two lambs
Costs:			
Annual cost of ewe	$3.50	$3.50	$3.50
Annual cost of ram	.75	.75	.75
Feed costs:			
Ewe	7.00	8.00	9.00
Lamb(s)		5.00	11.00
Misc. costs	2.00	2.50	3.00
TOTAL	13.25	19.75	27.25
Returns:			
Value of lambs sold		21.00	42.00
Value of wool	7.50	7.00	6.50
TOTAL	7.50	28.00	48.50
Difference	—5.75	8.25	21.25

centage increase of 34 percent. Figure 3 shows the summary of these calculations.

An increased percentage lamb crop can also be obtained by getting a greater proportion of the ewes to raise twins. If, as in the first case, twenty percent of the ewes are dry but of the ewes that do lamb there is an increase of 10 percent twins, there is a 108 percent lamb crop and the return on the investment is increased by 13 percent. Results indicate that when we change management toward getting a greater percentage of the ewes to lamb, we frequently get a higher percentage of the ewes to produce twins.

The percent lamb crop is a measure of the prolificacy of the ewe flock under the conditions that exist. Most evidence from research indicates that whether a ewe twins, produces a single or produces no lamb is more apt to be determined by non-hereditary causes than by hereditary ones. This means that more improvement in percentage lamb crop can be made by improved feeding and management than by breeding. This does not mean that selecting for reproductive performance should be stopped. It does mean, however, that improvement in reproductive performance can also be attained by studying management and feeding practices and applying those that prove beneficial.

An economic study conducted by the University Department of Agricultural Economics[3] indicates that in an average year the return to the sheepman for his labor, fencing, land, risk and capital investment is about 16 percent. This is based on a lamb crop of about 97 percent. About two-thirds of the producers used in this survey sold lamb crops ranging from about 87 to 107 percent. These figures are

[3] Ibid.

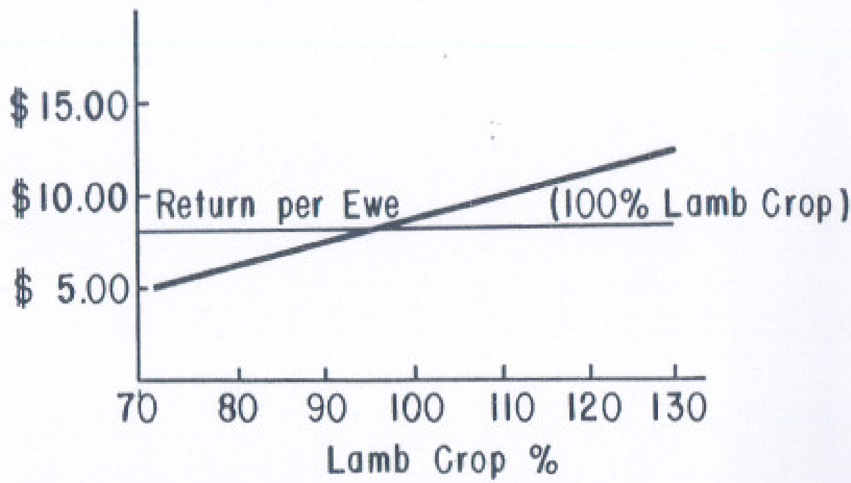

Figure 3. Estimated effect on return on investment in capital, labor, fencing, land and risk of percentage lamb crop sold.

not quoted as a criticism but as a guide so that we may know what the normal percentage lamb crop is. These figures indicate that there is considerable variation from flock to flock in ewe prolificacy as measured by percentage lamb crops sold. The reported percentage of lamb crop born averaged about 112 percent with about two-thirds of the flocks falling between 90 and 135 percent.

Research Results

Improved reproductive performance might be brought about by improvements in three general areas of breeding and management as follows:

1. Using more prolific ewes.
2. Improving ram performance.
3. Improving management so that ewes perform better.

For three years we have been studying some of these problems with a commercial ewe flock at the Ft. Reno Experiment Station, El Reno, Oklahoma. In the late spring of 1955 one hundred grade Rambouillet and one hundred ¼ Panama X ¾ Rambouillet yearling ewes were purchased to establish the flock. Dorset rams have been used on these ewes exclusively. Very briefly, the ewes are managed as follows: the breeding season has been 32 to 48 days in length, starting from May 20 to June first; lambs are born in the barn or in small lots adjacent to the barn and moved immediately into lambing pens; before leaving the lambing pens, they are paint branded and ear tagged with their mother's number and are also docked; after lambing, the ewes with lambs go to wheat pasture; the lambs are individually weighed every two weeks and are marketed when they weigh 92 or more pounds.

The lambing performance of these two groups of ewes has been very different consistently (See Table 2). The Rambouillet ewes have shown a higher reproductive performance every year. Panamas are ½ Lincoln and ½ Rambouillet. The Lincoln breeding would have to be incriminated if this difference is due to the breeding of the ewes. The difference may be due to the management of the ewes before we obtained them. The cause of this difference in performance is not known but is being studied further. Whatever the cause, it is obvious that we cannot expect groups of purchased yearling ewes to perform the same. We need to know what to look for in the ewes we buy that will indicate good reproductive performance and how to cull the poor producers that will be present in any flock. These factors are also being studied.

Table 2.—The reproductive performance of two groups of ewes of different origin and breeding.

	¼ Panama X ¾ Rambouillet	Grade Rambouillet
	1955 Results (48 day breeding season)	
Ewes lambing, %[1]	58	80
Lambs born, %	74	91
Lambs raised, %	49	77
	1956 Results (48 day breeding season)	
Ewes lambing, %	80	86
Lambs born, %	102	117
Lambs raised, %	81	108
	1957 Results (32 day breeding season)	
Ewes lambing, %	80	82
Lambs born, %	94	112
Lambs raised, %	86	99

[1] All percentages are based on the number of ewes in the breeding flock.

The management of the ewe may influence her performance. To study one phase of management, an experiment was conducted during the past two years to determine if the time of shearing would influence ewe productivity. One half of the ewes were shorn early in April and the other half were shorn about ten days before the breeding season began. (See Table 3 for the results.) These results are considered to be fairly conclusive proof that late shearing will improve ewe reproductive performance especially in years when the weather is hot during the breeding season. Closer observation of the data (not shown here) indicates that late shearing is more beneficial for the ewes that are part Panama than for the grade Rambouillet.

Table 3.—The effect of time of shearing on ewe performance.

	Shorn 4/7	Shorn 5/12
1956 Season (hot)		
Ewes lambing, %[1]	80	86
Lambs born, %	97	122
Lambs raised, %	84	100
1957 Season (cool)	4/6	5/22
Ewes lambing, %	78	89
Lambs born, %	102	109
Lambs raised, %	91	100

[1] All percentages are based on the number of ewes in the breeding flock.

During the three years since obtaining the ewes, we have been studying the effect of keeping one-half of the rams cool. A room in the sheep barn has been used to keep one-half of the rams from 8:00 a.m. until 5:00 p.m. daily from three weeks before the breeding season starts until it ends. An evaporative cooler (1955) or a used ½ ton refrigerated air conditioner (1956 and 1957) was used to cool the room. The maximum temperature in the room was usually 82-83° F. on hot days. The other rams were placed in a stall of similar size and lighting conditions but which was 8-12° F. warmer on hot days. The rams were turned with the ewes at about 6:00 p.m. and removed at about 7:30 a.m. The plan of the experiment was such that pairs of rams (one cooled and one not cooled) were assigned to groups of ewes and used in such a manner that each ram had an equal opportunity to sire as many lambs as his pair mate.

Table 4 gives the results from this experiment. The over-all advantage to cooling is an increase of about 27 percent in number of lambs born. However, due to the way in which the experiment was designed, this is an overestimate of the difference. There is no way to determine from our records what the true difference is but it is probably between 13 and 20 percent. The ram that has been kept in the cooler room has in every case out-performed his pair mate if we use number of lambs born as the measure of ram performance. In most instances the cooled ram has been more aggressive and also the cooled rams have usually settled a higher percentage of the ewes served.

Summary and Discussion

These results indicate that one kind of ewe has been about 24 percent more productive than another, that late shearing increased reproductive performance by 15 percent and that keeping rams from getting

Table 4.—The breeding performance of cooled and non-cooled rams

	Cooled	Non-cooled
1955 Results (2 pairs of yearling rams)		
Effective matings[1]	68	58
Known conceptions	43	32
Conception rate, %	63	55
1956 Results (4 pairs of yearling rams)		
Effective matings[1]	129	111
Known conceptions	89	72
Conception rate, %	69	65
Number lambs sired	122	91
1957 Results (2 pairs of 2-year-old rams)		
Effective matings[1]	64	46
Known conceptions	38	30
Conception rate, %	59	65
Number lambs sired	49	39

[1] Matings that could have resulted in conceptions.

hot resulted in about 15 per cent more lambs. One might want to add these figures together and say that the best combination of treatment is 54 percent better than the poorest combination. **Unfortunately this is not so.** It has already been indicated that the part Panama ewes respond more to the change in time of shearing than did the Rambouillets. For this and other reasons we cannot add these values together. The records do not permit us to make the desired calculation. A crude estimate would indicate that an increase of 25 to 35 percent in reproductive performance may be expected if we breed cooled rams to late shorn Rambouillet ewes as compared to breeding non-cooled rams to early shorn part Panama ewes. It should be remembered that we have no proof that the difference between the two groups of ewes is due to their breeding.

It is impossible for us to conduct our experiments in such a way as to duplicate any individual sheepman's conditions. We cannot say to what extent these results will apply to sheep managed differently as illustrated in Figures 1 and 2. We do believe, however, that application of one or more of these methods will improve the reproductive performance of many of the ewe flocks in Oklahoma. Those presently getting a good lamb crop may be able to shorten their breeding season and, thereby, their lambing season. Those getting lambs born in the fall and also late winter may find that they can get a high enough proportion of the ewes lambing in the fall that they can quit breeding for the later lambs. We feel that we have taken a stride toward our objective, namely: to learn what kind of ewes and rams we need and how to manage them to be able to get a large lamb crop in a short period of time and at a time that is most convenient to the sheepman.

Stilbestrol for Suckling Beef Calves*

R. F. HENDRICKSON, L. S. POPE AND A. B. NELSON

Stilbestrol has increased gains and improved feed efficiency rather consistently when administered to fattening cattle on full-feed. This poses the question of whether or not similar benefits can be obtained with young suckling calves by feeding small amounts of stilbestrol in the creep-feed or by implanting the drug near the base of the ear. Since many range calves are not creep-fed, the latter method may be preferable. In view of this several trials were initiated with suckling beef calves to study:

1) The effect of feeding 5 mg. stilbestrol per head daily in the creep-feed.

2) The effect of implanting 12 mg. stilbestrol, and re-implanting with 12 mg. 75 days later, where calves were not creep-fed.

3) The comparative effect of two 12 mg. pellets per calf implanted periodically vs. feeding 5 mg. stilbestrol per head daily to creep-fed calves.

Trial 1. Stilbestrol in the Creep-feed.

Procedure:

Thirty-four fall-dropped steer and heifer calves were selected from a grade Hereford herd at the Fort Reno station in January, 1957. The calves were divided into two groups on the basis of sex, age, weight, dam productivity, and sire, wherever possible. They were then placed with their dams in separate native grass pastures and given free access to a creep mixture containing 5.5 parts coarsely ground milo, 3 parts whole oats, 1 part cottonseed meal, and 0.5 part dried molasses. Stilbestrol was mixed in the creep ration for the treatment group in amounts such that the calves received approximately 5 mg. per head daily.

All calves were graded as fat slaughter calves and also as feeders on June 24 and sold on the Oklahoma City livestock market the following day. They averaged about eight and one-half months of age. In computing on-foot value, the actual value of the carcass was divided by the final weight taken at Fort Reno.

* This study was supported in part by a Grant-in-Aid from Eli Lilly and Co., Indianapolis, Indiana.

Results:

A summary of the results is given in Table 1. Weight gains were increased 7½ per cent by addition of 5 mg. stilbestrol to the creep-feed over the 158-day test period. This response is considerably less than was noted in some earlier trials, but the actual difference in weight gain was 23 lb. Examination of the data showed that heifers had a greater response to stilbestrol than steers. This response may have been affected by a difference in starting weight of the calves. The stilbestrol-fed heifers weighed 17 lb. more than the control heifers and the stilbestrol-fed steers weighed 11 lb. less than the control steers at the beginning of the test. The stilbestrol group consumed less creep-feed per calf than the control group. Generally, stilbestrol has been shown to increase feed intake slightly; the reason why this effect did not occur in this trial is not apparent.

Slaughter data indicate that calves of the basal group had a slightly higher dressing per cent and graded about ⅓ of a grade higher in the carcass than those receiving stilbestrol. The controls also tended to show more marbling in the loin eye muscle. Such differences have sometimes been observed, although in many cases there have been no

Table 1.—Effect of adding 5 mg. stilbestrol to the creep-feed of suckling calves (158 days)

	Basal Creep Ration	Stilbestrol Creep Ration
No. of calves per group[1]	17	17
Av. calf weights (lb.)		
Initial, 1-17-57	240	242
Final, 6-24-57	535	560
Av. daily gain	1.87	2.01
Feeder grade	low choice	high good
Live slaughter grade	av. good	av. good
Slaughter data:[2]		
Yield, %	59.3	58.8
Carcass grade	good to high good	low good to good
Marbling score	2.94	3.29
Creep-feed consumed per calf (lb.)	605	528
Creep-feed/cwt. gain (lb.)	205	166
Financial results ($)		
Av. cow & calf feed cost	53.73	51.71[3]
Market value per cwt.[4]	20.64	19.71
Total value per calf	110.43	110.39
Net return per calf	56.70	58.68
Difference over controls	-----	+ 1.98

[1] Nine steer calves and eight heifer calves per group.

[2] Yield based on hot carcass weight shrunk 2½% (hide off). Marbling score: 1=abundant, 3=moderate, 5=very slight.

[3] Does not include cost of stilbestrol.

[4] Based on current value of carcass according to grade and final Ft. Reno weight.

differences between stilbestrol-fed and control cattle when fed for the same length of time.

Market price based on carcass value was nearly one dollar/cwt. more for the control calves. This resulted in essentially the same total value per calf for control and treatment groups. Further trials are necessary before positive conclusions can be drawn as to the effect of stilbestrol on carcass quality of young, suckling calves.

Trials 2 and 3. Implanting Suckling Beef Calves

Procedure:

Twenty-eight spring calves (steers and heifers) were selected at the Fort Reno station and divided into two groups as equally as possible on the basis of sex, age, dam productivity, and sire. The treatment calves were implanted with a 12 mg. stilbestrol pellet on June 7, 1957, and returned with their dams to the same pasture as the controls. Approximately 75 days later, the stilbestrol group was re-implanted with another 12 mg. pellet.

Thirty, slightly older (3½ months) steer and heifer calves were selected at the Lake Blackwell station and divided into two groups, with the treatment lot receiving the first 12 mg. implant on May 24, 1957, and the second implant about 75 days later.

Management of the calves was similar at both stations. The calves were placed with their dams on comparable native grass pastures, and were not creep-fed. Both trials continued until weaning in early October when the calves (approximately 210 days of age) were weighed off experiment and assigned a feeder grade. They were hauled to Stillwater for a three-week weaning period, followed by a feed-lot test in which the long-term effects of early stilbestrol implantation could be studied. Results of this test are reported elsewhere in this publication.

Results:

The results of both trials are given in Table 2. In the Fort Reno experiment, the response to stilbestrol was an 11.5 per cent greater gain (24 lb.) for the four-month period. Essentially no increase was obtained from stilbestrol implants with steers, although a rather considerable response (34 lb.) was obtained with heifers.

Calves at Lake Blackwell showed a much greater increase in gain in favor of the implanted group. The latter gained 48 lb. (18 percent) more than their controls. Both sexes responded well to treatment in this case; that is, stilbestrol increased the gains of steers 53 lb. and of heifers, 40 lb. The reason for the difference in response with steers between stations is not apparent.

In both cases, feeder grade was nearly ⅓ of a grade higher for implanted calves. However, shortly after the second implant was given, rather noticeable side effects showed up. Depressed loins, high

Table 2.—Effect of implanting two 12 mg. pellets in suckling calves not creep-fed

	Control	Stilbestrol implanted
Fort Reno trial (123 days)		
Number of calves	13	14
Steers	4	5
Heifers	9	9
Av. age at first implant (days)[1]	82	80
Av. gain to weaning	208	232
Steers	229	230
Heifers	199	233
Feeder grade at weaning	5.7(C+)	4.5(B—)
Lake Blackwell trial (137 days)		
Number of calves	15	15
Steers	8	9
Heifers	7	6
Av. age at first implant (days)[1]	106	97
Av. gain to weaning	245	292
Steers	244	297
Heifers	246	286
Feeder grade at weaning[2]	5.7(C+)	5.0(B—)

[1] Implanted twice with 12 mg. stilbestrol each time; second implant approximately 75 days after first.

[2] Includes only those calves used in feed-lot studies to measure long term effects of stilbestrol.

tail heads, and increased udder development were prevalent in both steers and heifers and persisted until after weaning. These conditions were readily observed and feeder buyers might reduce the price paid for treated calves on the market.

Trial 4. Implanting vs. Feeding Stilbestrol

Procedure:

Three lots of 17 to 20 spring-dropped calves were used, with age, weight, condition and dam productivity being considered in allotment. All calves were started on creep-feed June 24 and fed until weaned in early October. The creep-feed was the same as that fed in Trial 1, except that liquid molasses was used in this test. One lot served as controls, the second lot was fed 5 mg. stilbestrol per day in the creep ration, and the third lot received two 12 mg. pellet implants about 75 days apart in a manner similar to that described for Trials 2 and 3. Weight gains and creep-feed consumption were recorded.

Results:

The results of this trial are summarized in Table 3. The implanted calves gained 35 lb. more than the controls or 12 per cent more.

Table 3.—Comparison of implanting vs. feeding stilbestrol to creep-fed suckling calves (137 days)

	Control	Stilbestrol in feed[1]	Stilbestrol implanted[2]
Number of calves per lot	20	17	20
Steers	10	8	8
Heifers	10	9	12
Av. age at start of test (days)	96	94	92
Av. initial wt. (lb.)	236	239	230
Av. gain to weaning (lb.)	289	287	324
Steers	309	316	340
Heifers	270	261	312
Av. daily creep feed consumed (lb.)	3.25	3.13	3.85

[1] 5 mg. per head daily.
[2] Implanted at start of test with 12 mg., re-implanted with 12 mg. 75 days later.

However, those receiving stilbestrol in the creep-feed actually gained slightly less than the control calves. Considerable difficulty was encountered in getting calves to start eating the creep ration, even though attempts were made to minimize pasture differences and to place creep-feeders in frequented areas. The "fed" lot, especially, and the control lot to a lesser extent, ate little creep-feed and gained poorly during the early part of the trial. By mid-August, the time of the second implant, calves fed stilbestrol had gained 27 lb. less than the implanted group, and 19 lb. less than controls. Although feed consumption was nearly equal from this time on, the "fed" lot never recovered from this early setback.

Summary

Four trials were conducted with young suckling beef calves to study the effect of feeding 5 mg. stilbestrol per head daily or implanting two 12 mg. pellets. Except for one lot in Trial 4, gains were increased in every case by administration of stilbestrol. In these studies, greater increases in gain were obtained from implanting than from feeding, but undesirable side effects were found with the former method, particularly after the second implant was given.

Studies on the subsequent feed-lot performance of certain of the implanted calves are reported elsewhere in this publication.

Phosphorus Requirements of Fattening Yearling Steers

L. S. POPE, JACK McCROSKEY, DWIGHT STEPHENS,
A. D. TILLMAN, AND GEORGE WALLER

Recent basic research using the artificial rumen, radioisotopes, digestion studies and growth trials have raised questions as to the optimum amount of phosphorus in fattening rations for beef cattle. There is some indication that the amount of phosphorus required to maintain the health, normal blood level and proper bone development of growing and fattening steers may be less than that required by rumen bacteria for best utilization of fibrous feeds. Some workers feel that the phosphorus requirement of the rumen bacteria may be higher than that required by the host animal. Generally, fattening rations contain relatively large amounts of phosphorus since they are high in grain and protein supplements which are rich feed sources of phosphorus. Most fattening rations will run better than 0.2 per cent phosphorus, which has been considered ample for the steer. Whether or not this is optimum for the rumen bacteria remains to be shown.

To investigate this problem and more clearly define the phosphorus requirements of fattening cattle, a feeding test involving 60 yearling steers was initiated in September, 1957, at the Fort Reno station. The effect of different levels of phosphorus intake on the weight gains of fattening steers during a 150-day trial was studied.

Procedure

Sixty, long-yearling, Hereford steers from the Lake Carl Blackwell herd were used in these trials. An initial shrunk weight (18 hours off feed and water) was taken at the start of the trial. The steers were divided into six uniform groups on the basis of weight, feeder grade, previous treatment, and summer gain. Two groups were then selected at random and received one of three different levels of phosphorus in the ration.

The cattle were fed all the sorghum silage they would consume, plus 10 lb. ground milo and 1.5 lb. protein supplement per steer daily. The protein supplement was composed of soybean meal, urea, dried molasses and minerals. No phosphorus supplement was added to the ration fed the basal group (Lot 1), while additions of monosodium phosphate were made to Lots 2 and 3 to provide increasing levels of phosphorus. Thus the phosphorus intake from the protein supplement, milo and silage was approximately 0.2, 0.3 and 0.4 percent of the dry matter of the ration for Lots 1, 2 & 3, respectively. Where monosodium phosphate was added to the supplements fed Lots 2 and 3, sufficient calcium carbonate was included to maintain a constant calcium phosphorus ratio of approximately 1.5 to 1 in all rations. Salt was available to the steers of all lots.

The cattle were fed once daily, with the silage intake adjusted according to appetite. At the completion of 150 days on test, a shrunk weight (16 hours off feed and water) was obtained. The cattle have been continued on their respective supplements and the milo has been increased to a full feed. They will be marketed in early April and further results and slaughter data obtained at that time. The results reported herein cover only the first 150 days of the trial.

Results

A summary of the results obtained with duplicate lots of steers fed rations containing different amounts of phosphorus are shown in Table 1.

The results at the end of 150 days on test indicate no beneficial effect from the addition of increasing amounts of phosphorus to the ration of steers in Lots 2 and 3. Gains of the steers were 2.34, 2.32 and 2.27 lb. per head daily when fed rations containing approximately 0.2, 0.3 and 0.4 percent phosphorus, respectively. Thus, increasing the level of phosphorus above that contained in the basal ration did not have any beneficial effect on the performance of the cattle.

It is also apparent from the average silage consumption as shown in Table 1 that the appetites of cattle in Lots 2 and 3 were not improved. Silage was fed according to appetite, but intake was essentially the same in all lots throughout the test. In certain early work, increasing

Table 1.—Effect of different levels of phosphorus in fattening rations of yearling steers (150 days).

Lot number % Phosphorus in ration (dry matter basis)	1 0.23	2 0.32	3 0.41
Number of steers per lot	20	20	20
Average weights (lb.)			
Initial 9/27/57	742	740	742
Final 2/24/58	1093	1088	1083
Average total gain	351	348	341
Average daily gain	2.34	2.32	2.27
Average daily ration (lb.)			
Sorghum silage	46.1	46.5	45.2
Ground milo	10.0	10.0	10.0
Supplement with stilbestrol[1]	1.5	1.7	1.8
Salt	.07	.07	.07
Feed required per cwt. gain (lb.)			
Silage	1970	2004	1988
Milo	429	431	440
Supplement	64	73	79
Feed cost per cwt. gain ($)[2]	20.67	21.21	21.51

[1] Supplements fed all lots supplied 1.0 lb. soybean meal, .088 lb. urea ("two sixty two" compound) and .41 lb. dried molasses per steer daily. Sufficient stilbestrol premix was included to supply 10 mg. per head daily. In addition, calcium carbonate was added at the rate of .024, .075 and .129 lbs., and monosodium phosphate at levels none, .087 and .173 lb. per steer daily for Lots 1, 2 and 3, respectively.

[2] No charge was made for the minerals added to the supplements fed.

the level of phosphorus in the ration tended to increase appetite. There was no apparent indication of such an effect in this test. Since the gains of all lots were similar, and the average daily feed consumption was essentially the same, little difference was observed in the feed required per 100 lb. of gain. Feed cost per 100 lb. gain was lowest for the basal lot, even though no charge was made for the additional minerals added to rations fed Lots 2 and 3. There was no apparent difference in appearance or slaughter condition of the cattle at the end of 150 days on feed.

Summary

A fattening trial was conducted involving sixty, long-yearling steers fed high-silage rations containing approximately 0.2, 0.3 and 0.4 percent phosphorus in the dry matter of the ration. Results from the 150-day test indicate that the basal ration, containing about 0.2 percent phosphorus, was adequate, as evidenced by daily gains, feed consumption, and feed required per 100 lb. gain.

Effect of Pelleting Roughage for Beef Calves

JACK McCROSKEY, L. S. POPE AND KENNETH URBAN

Increasing the consumption and utilization of roughage by beef cattle has been a critical problem for many years. Recent tests have indicated that pelleting feeds may increase feed consumption and efficiency of utilization. At present prices, the cost of fine grinding and pelleting of feeds limits the practical use of this method of feed preparation for cattle and sheep. However, increased costs of feed processing may be offset by greater gains and feed efficiency. A pilot trial was initiated at the Fort Reno station in the fall of 1957 to test the effect of pelleting a roughage mixture containing equal parts of finely ground alfalfa hay and cottonseed hulls on the consumption and utilization of roughage by steer and heifer calves.

Procedure

This test was designed so that comparisons could be made between pelleted and chopped roughage when either mixture was fed free choice, or in equal and controlled amounts. In addition, a palatability test was made to determine which form of roughage the calves preferred when both were offered on a free-choice basis. The roughage mixture was composed of equal parts of average quality alfalfa hay and cottonseed hulls, with 5 percent molasses added to each mixture. In order to pellet the roughage, fine grinding of the alfalfa hay was necessary. Pellets (¾ inch in diameter) were made from the mixture. The chopped roughage was identical to the pelleted roughage mixture except that the alfalfa hay was coarsely ground.

All lots received equal amounts of a concentrate mixture composed of milo and cottonseed meal to assure normal gains. A small amount of dried molasses was added to the concentrate mixture about mid-way through the trial in order to increase consumption by the calves. A mineral mixture of 2 parts salt and one part steamed bone meal was available to all calves.

Twenty-eight, spring-dropped, Hereford calves from the station herd were selected at weaning. The calves were divided into four lots of six calves each on the basis of sex, age, shrunk weight, and sire. Each lot contained three steers and three heifers. An extra lot of four calves (three steers and one heifer) was used for the free-choice test of chopped vs. pelleted roughage.

The calves were started on feed in early November, after a short adjustment period following weaning. Two groups of calves were fed the pelleted roughage while two other groups received the same roughage in the chopped and mixed form. One group within each type of roughage preparation was fed roughage free choice, while the other received a controlled amount. The extra group of four calves had access to both forms of roughage in self-feeders placed side by side to determine which form they preferred. Initially the calves were fed in large dirt pens. Later they were moved to smaller paved lots with an open shed for protection. The trial lasted for a period of 108 days, at the end of which a shrunk weight (off feed and water for 12 hours) was taken.

Results

Table 1 shows the average gains, feed consumption, and feed required per cwt. gain for each lot, together with the cost per cwt.

Table 1.—Effect of pelleting roughage for beef calves.

Feeding system	Roughage ad. lib.		Roughage controlled	
Lot number	1	2	3	4
Roughage form	Pelleted	Chopped	Pelleted	Chopped
Number of calves/lot	6	6	6	6
Days on feed	108	108	108	108
Average weights (lbs.)				
Initial 11-8-57	410	405	410	413
Final 2-24-58	589	613	578	592
Total gain	178	207	168	178
Average daily gain	1.65	1.92	1.56	1.65
Average daily feed consumption				
Roughage	15.3	15.1	11.2	11.2
Concentrate	3.7	3.7	3.7	3.7
Total	19.0	18.8	14.9	14.9
Feed per cwt. gain (lbs.)	1155	983	956	902
Feed cost per cwt. gain ($)[1]	19.63	13.58	16.85	13.19

[1] An additional cost of $6.00 per ton for pelleting the roughage fed Lots 1 and 3 was used in arriving at feed costs per cwt. gain.

gain. The gains were not improved by the use of a pelleted roughage in this test. Greatest gains were exhibited by the lots fed chopped and mixed roughage, whether fed ad lib. or at equal intakes.

In comparing pelleted roughage (Lot 1) vs. chopped roughage (Lot 2) when the calves were allowed to consume all they wanted, it is evident that although the cattle fed the pellets ate slightly more roughage, their gains were less than those of Lot 2. Also, in the lots which received a controlled roughage intake (Lots 3 and 4), calves gained slightly more when fed roughage in the chopped form. The reason for this difference is not apparent. However, changes may occur in the food nutrients during the pelleting process, or in the efficiency of utilization by the ruminant.

These results indicate it is not practical to pellet roughage for beef calves when rate of gain and cost of pelleting are considered. The quality of roughage may have a bearing on whether or not pelleting will increase performance. Probably lower quality roughages are more favorably affected by pelleting than high quality roughages. The quality of alfalfa in this roughage mixture was rather good, which might partially explain why pelleting failed to increase consumption and rate of gain.

Free-Choice selection of roughages.—Results with 4 extra cattle show that they preferred the roughage mixture in the pelleted form. These calves consumed an average of 9.5 lb. of pellets and 4.3 lb. of chopped roughage per head daily. Thus they ate 2.2 times as much pellets as chopped roughage. For the first few weeks of the trial, however, they ate about 5 times as much pellets as chopped roughage. These data indicate an improvement in palatability through pelleting.

Summary

Four lots of six calves each were used to test the effects of pelleting roughage on rate and efficiency of gain. During the 108-day feeding period the calves were fed roughage on a free-choice basis and in controlled amounts, both in the pelleted and chopped forms. One lot of four calves was given a choice of both forms of roughage, free-choice. Cattle that were fed pelleted roughage, free-choice, ate only slightly more feed than those fed chopped roughage. Greatest gains were obtained from cattle fed roughage in the chopped form, either when fed in controlled amounts or on a free-choice basis. When given a choice of pellets and chopped roughage, the calves preferred the pelleted form about 2.2 to 1.

Effect of Stilbestrol Implants on Gains of Steers Grazing Native Grass and Their Subsequent Feed-Lot Performance

A. B. NELSON, L. S. POPE, R. F. HENDRICKSON AND W. D. CAMPBELL

The majority of the cattle fed fattening rations are receiving stilbestrol, either in the feed or as implants in the ear. Experiments have indicated that greatest response to stilbestrol administration occurs when cattle are full-fed for rapid fattening, with little or no response when cattle are "wintered" on a ration of relatively low energy content. Results of tests with grazing cattle have been variable and are apparently related to kind and quality of pasture. In areas of the country where legumes and legume-grass mixtures predominate, stilbestrol implantation has resulted in marked increases in gain.

In Oklahoma, many steers graze native grass pastures during the summer with no supplemental feed except minerals. In such cases, the preferred method of stilbestrol administration would be implants in the ear. One implantation may last for the entire grazing season. During the summers of 1956 and 1957, tests were conducted at this station to determine the value of stilbestrol implants for steers grazing native grass pastures.

Many questions have been raised by cattle feeders as to the effect of implanting steers during the grazing season on their performance in the feed lot while being finished for slaughter. Little information is available on this point. As a further step in this study, the feed-lot performance of the controls and implanted cattle used in the summer grazing test was observed during fattening experiments at the Ft. Reno station.

Implanting Steers on Native Grass Pastures

Procedures

On May 20, 1957, 60, choice grade, Hereford, yearling steers were divided into four lots on the basis of weight. These steers had previously been used in a wintering experiment at the Lake Carl Blackwell experimental range area. At the beginning of the summer test each of the steers in Lots 2 and 4 was implanted with three 12 mg. pellets (total of 36 mg.) of stilbestrol near the base of the ear.

All cattle were allowed to graze the native grass pastures (Bluestem and associated grasses). Steers in Lots 1 and 2 were fed no supplement other than salt, ad lib. Those in Lots 3 and 4 were self-fed a mixture of salt and milo in order to increase the energy intake of the steers in these groups. The salt served as a regulator of consumption of the mixture. Although the milo intake was quite variable throughout the summer and the salt content was changed several times, the average salt content of the mixture was 10.5 percent. The milo consumption was slightly lower than desired with a greater consumption in Lot 4.

Results

A summary of the weight gains and milo consumption and cost is given in Table 1. In the comparison of Lots 1 and 2, stilbestrol implants increased gains 27 lb. or 13.9 percent. When milo was fed (Lots 3 and 4), stilbestrol implants resulted in 21 lb. additional gain. This was an increase of 10.4 percent. The average increase, when all lots are considered, was 12.2 percent. These results are in contrast to those obtained in the summer of 1956 when stilbestrol implants (45 mg.) had no effect on gains. (These results were reported in Okla. Agr. Exp.

fed all the silage they would consume plus 10 lbs. of ground milo for the first 150 days, 1.5 lb. of a soybean meal-urea-dried molasses supplement and salt. All steers received 10 mg. stilbestrol in the daily ration. Three levels of phosphorus were provided by additions of monosodium phosphate, with 2 lots on each phosphorus level. At the end of 150 days on test, a shrunk weight was obtained and the cattle were given a full-feed of milo. The steers were slaughtered in early April at Oklahoma City and slaughter data and carcass grades were obtained.

Results

The feed-lot performance of 30 steers which had served as controls during the summer grazing tests vs. 30 which received 36 mg. stilbestrol in late May are shown in Table 2. The feeding period has been divided into 83 days, 150 days, and the entire 192 days since the performance of the two groups appeared to differ according to length of time on feed.

Yearling steers, previously implanted on summer pasture, graded slightly higher than the controls when they entered the feed-lot. It is also apparent that they had continued to outgain the controls from the time the final Lake Blackwell weight was taken, September 4, and the steers were placed on test at Ft. Reno, September 27. Hence the implanted steers entered the feeding pens with 32 lb. per steer advantage over the controls. During the first 83 days on feed, gains were almost identical between the two groups. However, gains of the previously implanted group dropped off markedly after 83 days, and by the end of 150 days they had gained 0.14 lb. per day less than the controls. When milo was full-fed during the last 42 days, the difference appeared to narrow (.07 lb. per head daily).

Table 2.—Effect of previous stilbestrol implantation on the performance of yearling steers in the feedlot (192 days)[1]

	Controls	Implanted in May, 1957, with 36 mg. stilbestrol
Number steers compared	30	30
Av. feeder grade at start of test	B—	B
Av. weights (lb.)		
Initial 9-27-57	725	757
Daily gain for first 83 days	2.93	2.96
Daily gain for 150 days	2.38	2.24
Final weight 4-7-57	1136	1154
Av. Daily gain for 192 days	2.14	2.07
Av. Carcass grade and score[2]	Gd + (4.33)	Gd + (4.17)
Dressing percentage	60.77	60.75

1 Steers received a full-feed of sorghum silage plus 10 lb. milo and 1.5 lb. supplement per head daily for first 150 days, followd by a full-feed of milo to 192 days. Steers of both group received 10 mg. stilbestrol in the supplement fed daily.

2 Carcass grade score: Choice=2, low choice=3, high good=4, and good=5.

This difference in total weight put on in the feed lot during the first 150 days favored the controls by 21 lb. per head, which made up for 65 percent of the difference in weight advantage observed in favor of the implanted group at the start of the feeding trial. Yet at the end of the trial the difference in gain favored the controls by only 13 lb. per steer. To the feeder buyer, the implanted cattle would have been worth about $0.45 less per cwt. at the start of the trial. Improved summer gains on pasture from implanting partially disappeared in the feed lot. However, it should be borne in mind that pasture gains are generally more economical.

Final slaughter grades and dressing percentage at 192 days were almost identical. Implanted cattle showed numerous high tailheads, teat development, flat loins, etc., when they entered the feed lot at the end of the summer phase. These became much less noticeable as the fattening period progressed and at the end of the trial were not adverse enough to effect the selling price of cattle.

The implants administered to these cattle at the start of the grazing period may not have been completely absorbed at the time the fattening tests started, hence the implanted steers may have continued to receive stimulation from the pellets, in addition to that coming from silbetsrol in the ration. This may have had a bearing on their performance during the first 83 days on feed. Further, it should be borne in mind that the rations fed for the first 150 days in dry lot contained only limited amounts of milo and thus the steers were not receiving an extremely high intake of energy—although gains were quite satisfactory. The implanted steers had higher maintenance requirements due to heavier weights. When milo was full-fed the last 42 days, previously implanted steers outgained the controls.

Summary

Implantation of 36 mg. of stilbestrol increased the gains of yearling steers grazing native grass. In the 107-day period the implants increased gains 13.9 percent and 10.4 percent for cattle not fed and fed supplemental milo, respectively, or an average of 24 lb. per steer.

Following the pasture tests, the steers were fed high-silage rations with limited amounts of grain and supplements containing stilbestrol for 192 days in dry lot. At the start of the fattening period, there was a 32 lb. per steer advantage for stilbestrol-implanted cattle. Control steers outgained those implanted during the previous summer by 0.07 lb. per head daily or 13 lb. per steer, during the fattening phase. Under the conditions of this study, approximately 40 percent of the improvement in gains on summer pasture from stilbestrol implantation had disappeared after 192 days in dry lot.

Effect of Three Levels of Carotene Intake During Lactation on the Performance of Beef Cows and Their Calves

L. S. POPE, JERRY L. PITTS, AND GEORGE WALLER

Nearly ten years of vitamin A research have been completed a this station dealing with the requirements of beef cattle. The resul indicate that mature beef cows can store sufficient amounts of vitami A in the liver during a normal green pasture season to supply thei needs for considerable time when fed rations devoid of carotene. Suc liver stores may be sufficient to maintain the health of the cow for mor than a year, but may not be enough to provide for transfer of vitami A potency in the milk such that the calf is protected from a deficienc Therefore, recent work has centered around the requirements of lacta ing beef cows in order to protect the calf against a vitamin A deficienc The results reported herein are from the second trial, involving thre levels of carotene fed to lactating beef cows which were partially de pleted of liver vitamin A stores at calving time. (The results of th first trial were reported in the Okla. Agr. Exp. Sta. Misc. Pub. MP-48.

Procedure

Sixteen, bred, coming three-year-old Hereford heifers were selecte from the Lake Carl Blackwell herd in the fall of 1956. The heifer were wintered on dry, weathered, native grass at the Lake Blackwel range, with 2.5 pounds of cottonseed meal per head daily and mineral free-choice, until mid-February. On February 15, 1957, the heifer were moved to dry lot. They were fed a ration consisting of weathered native grass hay (cut in December and devoid of carotene) ad lib. plus 5 pounds of ground milo and 3 pounds of cottonseed meal pe head daily. A mineral mixture of two parts salt and one part steame bone meal was available to the cows, free choice. The cows were con tinued on the same ration until the experiment was terminated at th end of the third month of lactation.

After calving, the cows were divided into three lots and receive a carotene supplement* mixed with the concentrates and fed individual ly, twice weekly, at levels that would provide 0, 5 and 10 mg. of caroten per hundred pounds of body weight per day during the three month of lactation. The levels of 5 and 10 mg. of carotene per cwt. daily wer approximately 50 and 100 percent of Morrison's recommendations fo beef cows during lactation.

The cows and their calves were removed from the experiment whe the calves had reached three months of age. All calves had access to a creep-feed devoid of carotene. Data were obtained on the body weight

* The carrot oil concentrate used was generously supplied by Nutritional Research Associates Inc., South Whitley, Ind.

of the cows and calves at parturition and at monthly intervals. The calves were closely observed throughout the experiment for symptoms of vitamin A deficiency and a record was maintained on scours and other abnormalities during the course of the study. Blood samples were taken from the cows in early March before calving, at parturition and at 1, 2 and 3 months after calving. The calves were bled as soon as possible after birth and at 1, 2, and 3 month intervals. Liver samples were taken by the biopsy technique from the cows at parturition and at the end of three months lactation. Liver samples were taken from the calves at three months of age. Milk samples were taken from the cows at the end of three months lactation.

Results

A summary of the data obtained is presented in Table 1. This includes the weight changes of the cows, birth weights of the calves, and gains of the calves to three months of age. Other data shown are the plasma carotene and vitamin A levels of the cows and calves at parturition and at 1, 2, and 3 months post-partum; also the liver vitamin A levels of the cows at parturition, and of the cows and calves when the calves were three months of age.

No deficiency symptoms were observed in the cows during this study. Carotene supplementation during early lactation had no consistent effect on the weight gains of the calves to three months of age. However, two calves were lost in Lot 1 whose dams received no supplemental carotene during lactation. The losses appeared to be due to secondary infections, perhaps due to low vitamin A nutrition. There was wide-spread incidence of scours in calves of all lots that did not seem to be associated with the amount of carotene given the dams. Plasma carotene and vitamin A levels of the cows and their calves tended to reflect the level of carotene fed during lactation. The plasma carotene levels of the cows were found to be significantly higher in the lots receiving supplemental carotene at 1, 2, and 3 months following parturition. Plasma vitamin A levels tended to lag behind carotene, but were significantly different at two months after parturition.

The plasma carotene levels of the calves from supplemented dams were significantly higher at three months of age. In terms of depletion of liver stores, cows fed the highest level of carotene intake showed less depletion of liver stores during lactation, although cows of all lots were depleted of liver stores during the three-month lactation period. Liver vitamin A levels of all calves were surprisingly low at 3 months, but did reflect the level of carotene given their dams.

It appears from this and other work that beef cows, if depleted of their liver vitamin A stores during gestation, must receive relatively large amounts in the feed during lactation in order to maintain the blood levels of their calves. None of the levels used in this study was sufficient to prevent further depletion of the cow's liver stores during lactation. The highest level of carotene supplementation practiced in this study would approximate the feeding of 6 to 8 pounds of average

Table 1.—Effect of three levels of carotene intake during lactation on the performance of beef cows and their calves.

Carotene intake of cows per cwt. per day during lactation.	Lot 1 0 mg.	Lot 2 5 mg.	Lot 3 10 mg.
Number of cows per lot	5	5	6
Average cow weights (lb.)			
At parturition	849	738	843
Loss first 3 months lactation	—9	—85[1]	—25
Average calf weights (lb.)			
At birth	73	69	58
Gain to 3 months of age	100[1]	94[1]	95
Plasma carotene (mcg./100 ml.)			
Cows: parturition	37.9	46.7	55.1
1 month	40.8	104.8	192.8
2 months	25.8	111.5	258.2
3 months	23.9	114.0[2]	275.4
Calves: Birth	15.3	10.0	12.1
1 month	16.8	12.8	11.9
2 months	10.4	18.4	18.2
3 months	12.1[2]	29.1[2]	41.3
Plasma vitamin A (mcg./100 ml.)			
Cows: parturition	15.4	12.1	18.4
1 month	15.7	16.0	18.1
2 months	7.6	17.0	19.0
3 months	10.0	14.3[2]	16.2
Calves: Birth	17.4	16.3	14.5
1 month	12.0	7.3	15.7
2 months	7.1	7.2	8.3
3 months	4.6[2]	4.8[2]	6.3
Liver vitamin A (mcg./gm dry matter)			
Cows: parturition	64.0	80.7	78.6
3 months	23.8	11.4	46.5
Calves: 3 months	4.5	5.4	8.2

[1] Does not include weights on cow from Lot 2 that died of unknown cause, or her calf, or from 2 calves of Lot 1 that died during third month of experiment.
[2] Blood samples not obtained from cow of Lot 2 that died during third month, or her calf, or from 2 calves in Lot 1 that died.

quality alfalfa hay per head daily. Calves in this study had adequate plasma vitamin A levels at birth, but were soon depleted to a deficient or borderline condition in three months.

The vitamin A values of milk samples from cows taken at 3 months lactation were 4.83, 4.03, and 7.12 mg. per 100 ml. for Lots 1, 2, and 3, respectively. In view of the poor transfer of vitamin A and carotene through the milk of the beef cow, it would appear that supplying the calf with vitamin A directly may be the most efficient method wherever possible.

Summary

Further tests were conducted to study the effect of different levels of carotene intake during early lactation on beef cows which had been partially depleted of their vitamin A stores prior to calving. Sixteen, pregnant, three-year-old Hereford heifers were divided into three lots and received 0, 5, and 10 mg. of carotene per 100 lb. body weight per day for the first three months of lactation. Data obtained indicate little effect of carotene supplementation on the weight changes of the cows or gain of the calves to three months of age. However, two calves were lost from cows receiving no supplemental carotene. Plasma carotene and vitamin A levels of the cows reflected directly the levels of carotene fed. Liver stores in all the cows were depleted regardless of level of supplementation, but tended to be depleted at a less rapid rate with cows receiving the most carotene. Blood and liver levels of all the calves appeared dangerously low, even at the highest level of carotene supplementation of their dams. It appears that large amounts of carotene must be fed the lactating beef cow in order to permit transfer of sufficient vitamin A through the milk to protect the calf against a deficiency and to avoid death loss.

Performance Testing Boar Pigs

J. A. WHATLEY, JR., J. B. PALMER AND D. F. STEPHENS

To gain information on performance testing boars for rate of gain, economy of gain and probe backfat thickness, individual feeding tests of boar pigs were initiated at Fort Reno in 1954. The records of 138 of these individually fed boars have been included in this study. Sixty Line OK3 Duroc boars and 78 Line OK14 Hampshire boars were fed.

Test Procedure

Boars were selected for the feeding test when weaned at 56 days of age. At weaning, the boars were taken to the Boar Test Barn and placed on the test ration. When each boar weighed approximately 50 lbs., he was started on the feeding test. As each boar reached approximately 170 lbs. he was weighed off the test, but a limited number of boars weighed over 180 lbs. when removed from the test. At the conclusion of the test each boar was probed in four places for backfat thickness. Two probes were made on each side of the back about 1½ inches off the midline. The front probes were made about 2 inches behind the shoulder and the rear probes were made over the center of the loin. The four probes were averaged and adjusted to a 170 lb. standard weight.

The ration fed each season varied somewhat but was essentially the same except for two seasons in which wheat or milo was substituted for corn (Table 1). Beginning with the 1956 Fall farrowed boars, the ration

Table 1.—Fort Reno boar test rations fed from 1954 spring through 1957 fall

When Fed	1954 Spr.	1954 Fall	1955 Spr.	1955 Fall	1956 Spr.	1956 Fall	1957 Spr.	1957 Fall
How Fed	meal, self fed	meal, self fed	meal, self fed	meal, self fed	meal, self fed	pellets, self fed	pellets, self fed	pellets, self* fed
Ingredient								
Corn	73.3		73.3	73.3	73.3	74.0	74.2	
Wheat		73.3						
Milo								75.0
Soybean meal	13.6	13.6	13.6	13.6	13.6	13.5	13.3	12.5
Tankage	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Alfalfa meal	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Bone meal	1.5	1.5	1.5	1.5	1.5	1.0	1.0	1.0
Trace mineralized salt	1.0	1.0	1.0	1.0	1.0	.9	.9	.9
Aurofac	.5	.5	.5	.5	.5	.5	.5	.5
Fortafeed	.1	.1	.1	.1	.1	.1	.1	.1
Vita A & D sup.	—	—	+	+	+	+	+	+
Zinc sulfate	—	—	—	—	—	—	—	+

* Half of boars in the 1957 fall test were restricted in feeding.

was pelleted. In the Fall of 1957, litter mate boars were paired. One litter mate was self fed ad lib, while the other was restricted to a 30 minute morning and afternoon feeding of all that he would consume during those periods.

Line Comparison

A summary of the average performance of boars by lines and seasons is shown in Table 2. Comparing the performance of boars from the two lines in the five seasons in which both lines were fed, the Line OK3 boars gained .12 lbs. per day faster and required .10 lbs. less

Table 2.—Average performance of boars by line and season

		Line Ok 3				Line Ok 14			
Year	Seas.	No. Boars	Av. daily gain (lbs.)	Feed per lb. gain (lbs.)	Probe back fat (ins.)	No. boars	Av. daily gain (lbs.)	Feed per lb. gain (lbs.)	Probe back fat (ins.)
1954	Spr.	9	2.05	3.26	1.15				
1954	Fall	6	2.04	3.72	1.36				
1955	Spr.	9	1.86	3.32	1.41	8	1.89	3.19	1.25
1955	Fall	6	1.98	3.30	1.41	11	1.79	3.71	1.29
1956	Spr.	11	1.81	3.17	1.35	12	1.64	3.44	1.26
1956	Fall	10	1.87	2.98	1.39	11	1.81	2.81	1.22
1957	Spr.	9	1.92	2.92	1.42	13	1.71	3.05	1.16
1957	Fall					12	1.64	3.22	1.11
1957	Fall*					11	1.48	3.27	1.04

* Boars restricted to a 30 minute morning and afternoon feeding.

feed per lb. of gain than the Line OK14 boars. The OK14 boars, however, had .16 inches less backfat at 170 lbs.

Variation and Selection Intensity

Considerable variation was noted in the performance of boars of the same line and even between litter mate boars. Within each line and season the average range in performance was .54 lbs. in average daily gain, 1.08 lbs. in feed required per lb. of gain and .41 inches in probe backfat thickness. This wide variation offers considerable opportunity to select for performance in these traits. However, selection for several traits reduces the amount of selection that can be applied for each trait. The boars chosen for breeding were selected on the basis of rate of gain, economy of gain, probe backfat, and soundness of legs. Thus selection was on the basis of a combination of four traits. Some additional selection for dam's productivity had been made in the initial selection of boars to be placed on the feeding test.

The actual selection intensity for each of the three measured traits is shown in Table 3. This selection intensity is expressed as the selection differential, or the difference in the average performance of the selected boars and the average performance of all boars (after corrections were made for seasonal differences). The selection differentials in Table 3 indicate that about twice as much emphasis in selection was placed on feed required per pound of gain and probe backfat as on rate of gain.

Although the selection differentials appear to be low, selection in a herd of the intensity shown in Table 3 and applied on boars could in a 10-year period increase the average daily gain .08 lb., reduce the feed required per lb. of gain .27 lb., and reduce the backfat thickness .16 inch.

Table 3.—The advantage of selected boars over all boars tested in Lines OK 3 and OK 14
(Selection differentials)

Line	No boars		Selection differentials in		
	Tested	Saved	Av. daily gain lbs.	Lbs. feed per lb. gain	Probe backfat, inches
OK 3	60	10	+.02	—.23	—.13
OK 14	78	20	+.07	—.15	—.04

Rate of Gain and Economy of Gain

There is no question that economy of gain is one of the most important items in swine production, but individual feeding tests to measure this trait directly for selection are expensive, because of the housing, pens and equipment necessary to test very many boars. It is

Table 4.—The relation between feed required per pound of gain and average daily gain*

No. boars	Av. daily gain, lbs. Class-limits	Av.	Lbs. feed per lb. gain
3	1.35-1.49	1.40	3.99
11	1.50-1.59	1.54	3.54
15	1.60-1.69	1.65	3.26
33	1.70-1.79	1.74	3.28
28	1.80-1.89	1.85	3.18
30	1.90-1.99	1.94	3.21
12	2.00-2.09	2.04	3.00
6	2.10-2.22	2.16	2.98
average		1.82	3.24

* The performance of individual boars in average daily gain and lbs. of feed per lb. of gain were corrected for differences in lines and seasons so that the data on all boars could be pooled for this table.

generally assumed that there is a high correlation between rate and economy of gain. Thus, indirect selection for economy of gain can be made by selecting for rate of gain, which can be measured with much less labor and expense.

In the present study the correlation between average daily gain and feed per lb. of gain on boars from the same line and fed in the same season was —.44. For each increase in rate of gain of .1 lb. per day, there was a decrease in feed required per lb. of gain of .09 lb. This tendency for the faster gaining boars to be more economical is clearly shown in Table 4. However, this relationship is not extremely high and selection for economy of gain directly would be roughly twice as effective as selecting for economy of gain indirectly by selecting for rate of gain only. Whether this increase in selection accuracy will pay for the added cost of individual feeding tests is debatable. It might be justified in top purebred herds where the identification of a very economically gaining boar could have an important genetic influence on the herd and on the breed.

Rate of Gain and Fatness

There was a very slight tendency for the faster gaining boars to be fatter than the slower gaining boars (Table 5). The correlation was +.16, which is low and not significant. An increase in average daily gain of .1 lb. per day increased probe backfat thickness only .01 of an inch. The relationship between these two traits is so slight that there is little difficulty in selecting low probing, meaty boars that are also fast gaining boars.

Economy of Gain and Fatness

It is believed by some that meat type hogs are not economically gaining hogs. This is contradicted by data from these boar tests. Table 6 shows a slight tendency for the more economical boars to have less backfat than the less economically gaining boars. This relationship is slight (the correlation between feed required per lb. of gain and probe

Table 5.—The relation between probe backfat thickness and average daily gain*

No. boars	Av. daily gain, lbs.		Probe back-fat, ins.
	Class-limits	Av.	
3	1.35-1.49	1.40	1.19
11	1.50-1.59	1.54	1.32
15	1.60-1.69	1.65	1.23
33	1.70-1.79	1.74	1.24
28	1.80-1.89	1.85	1.26
30	1.90-1.99	1.94	1.31
12	2.00-2.09	2.04	1.30
6	2.10-2.22	2.16	1.32
average		1.82	1.27

* The average daily gain and lbs. feed per lb. of gain for each boar were corrected for line and season differences so that the data on all boars could be pooled for this table.

backfat thickness was +.19), but certainly there is no indication that the fatter boars are more efficient gainers.

Summary

During the period from 1954 through 1957, 138 boars from two lines of breeding were individually fed from 50 lbs. to 170 lbs. weight. Line Ok3 boars gained .12 lbs. per day faster and required .10 lbs. less feed per lb. of gain but the line Ok14 boars had .16 inches less backfat.

Twenty-two percent of the boars tested were saved for breeding and these selected boars differed from all boars tested by +.05 lbs., —.18 lbs. and —.08 inch in average daily gain, feed required per lb. of gain and probe backfat, respectively.

Rate of gain and feed required per lb. of gain were negatively associated. For each increase in rate of gain of .1 lb. per day, there was a decrease in feed required per lb. of gain of .09 lb.

There was a slight but non significant tendency for the faster gaining boars to have more backfat and also a slight tendency for the more economically gaining boars to have less backfat.

Table 6.—The relation between probe backfat thickness and feed required per pound of gain*

No. boars	Lbs. feed per lb. gain		Probe back-fat, ins.
	Class-limits	Av.	
6	less than 2.69	2.56	1.26
10	2.70-2.89	2.84	1.20
35	2.90-3.09	3.00	1.26
37	3.10-3.29	3.20	1.25
20	3.30-3.49	3.38	1.29
17	3.50-3.69	3.58	1.34
6	3.70-3.89	3.80	1.32
7	3.90+	4.11	1.28

* Lbs. feed per lb. gain and probe backfat for each boar were corrected for line and season differences so that the data on all boars could be pooled for this table.

Inheritance of Color Pattern and Shade of Hair Color in Hereford Cattle

MARION E. STANLEY, DOYLE CHAMBERS AND
DAVID E. ANDERSON

The red and white color pattern of Hereford cattle has long been one of the breed's distinguishing trade-marks. The breed originated in England some two hundred years ago from cattle of mixed colors and breeding. By selection for a given type and color pattern, a beef animal with red body, white face and under-parts, white feet, white at the end of the tail, and white feather along the top of the neck to the rear of the shoulders, has been developed. Certain deviations from the above color pattern do, however, still occur among the progeny of registered parents, and some discrimination against individuals with these departures is usually made by breeders in the selection of breeding stock.

The two deviations which are most severely criticized by American breeders include "red-necks" and "line-backs." Red-necks are those cattle whose white feathering along the top of the neck is missing or greatly reduced while line-backs are those which have white hair along the topline behind the shoulders. The degree of these deviations varies quantitatively and the amount of emphasis placed upon these color deviations varies with individual breeders. Other deviations such as "red-eye", "smutty-nose" and "black-tail" do occur and breeders usually practice some selection against these also. It was reported in 1957 (See Okla. Agri. Exp. Sta. Misc. Pub. MP-48, p. 28) that the amount of eyelid pigmentation was highly heritable in Hereford cattle and that cattle with pigmented eyelids had fewer cases of eyelid cancer than cattle with non-pigmented lids. No lid lesions were observed to develop on completely pigmented lids, but the pigmentation of the eyelid did not prevent the development of lesions on the eyeball or on the nictitating membrane.

As a result of the above observation, a study was conducted to determine the relationship between eyelid pigmentation and color pattern of Hereford cattle with particular reference to the deviations of line-back and red-neck. It was also designed to study the inheritance of these two traits and to determine the nature of the inheritance of shade of hair color which may vary from light yellow to dark red. Considerable variation in breeder preferences for shade of hair color exists in different parts of the United States.

Nature of the Data and Methods of Analyses

The data were obtained from 312 Hereford cows and 434 calves sired by 38 different bulls during 1956 and 1957 at the Ft. Reno Livestock Experiment station. An additional 83 female progeny of the above parents dropped during 1954 and 1955 were used in parts of the study. Each animal was scored visually for topline pattern by evaluating the amount of white on the neck, shoulders, and back. The system of classification contained nine classes with numerical values being assigned to each animal according to the following key:

Numerical Score	Description of Topline Pattern
1	Red-neck (no white present on topline)
2	White flecks, or small white spots, on neck
3	White patches on neck but not enough to be desirable
4	Sufficient white on neck to be desirable but sparing
5	Perfectly marked individual
6	More white than necessary but not a line-back
7	Small white spots on back or loin
8	Large white spots on back or loin
9	Line-back (white extending along entire topline)

The first three classes (1, 2, 3) would be discriminated against by breeders who discriminate against red-necks and the last three classes (7, 8, 9) would be discredited by those who discriminate against line-backs. The three remaining classes (4, 5, 6) could be considered to be desirably marked.

Each animal was scored for shade of hair color by comparing its hair coat to a color standard containing seven different hair samples which varied from light yellow to very dark red. The light yellow animals were scored as 1 while the darker colored animals received the larger scores with a score of 7 being assigned to the darkest red animals.

The values for eyelid pigmentation were obtained from color photographs and were expressed as a percentage of the eyelid length which was pigmented. It varied from zero for animals devoid of eyelid pigment to 100 for those having completely pigmented eyelids.

Heritability estimates were calculated for topline pattern and for shade of hair color by four different methods: (1) the intra-sire regression of offspring's score on dam's score; (2) the paternal half-sib, intra-class correlation using a nested classification which removed the average effects of year, age of dam, and line or experimental treatment; (3) the paternal half-sib, intra-class correlation without adjustment for the above sources of variation; and (4) the regression of offspring's score on mid-parent's score (the average score of the sire and dam).

The correlations between topline pattern and eyelid pigmentation, shade of hair color and eyelid pigmentation, and topline pattern and shade of hair color were calculated within groups and pooled.

Results and Discussion

It was found that the scores for both the topline color pattern and shade of hair color were controlled to a marked extent by hereditary factors as shown in Table 1. The heritability estimates for these traits ranged from 35 to 67 percent. The estimates based upon the intra-sire regression of offspring on dam were somewhat higher than those

Table 1.—Heritability estimates for topline pattern and shade of hair scores

Methods of Analysis	Extent of Data	Heritability Estimates	
		Color Pattern	Shade of Color
(1) Intra-sire regression of offspring on dam (b x 2)	517 dam-daughter pairs	.67	.59
(2) Paternal half-sib, intra-class correlation (nested) (r x 4)	43 degrees freedom for sires	.35	.36
(3) Paternal half-sib, intra-class correlation (un-nested) (r x 4)	37 degrees freedom for sires	.42	.56
(4) Regression of offspring score on mid-parent score (b x 1)	419 parent-offspring pairs	.54	.49

b = regression coefficient
r = correlation coefficient

obtained from the paternal half-sib, intra-class correlations. The estimates obtained by regression of offspring score on mid-parent scores were intermediate to those obtained by the other methods and they may be somewhat more reliable. These heritability estimates indicate that one could expect to increase or decrease the amount of white along the topline of Herefords rather rapidly by selecting for more or less white. They also indicate the possibility of changing the shade of hair color by selecting for lighter or darker shades of color.

Although the heritabilities of the scores for both the amount of white on the topline and the shade of hair color are rather high, these do not necessarily indicate the degree of success one may expect to attain by selecting for a given desired color pattern or shade when the goal is an intermediate amount of white or shade of color. They do indicate that one could reduce the amount of white toward zero (red-neck) or increase the amount of white toward 100 percent (lineback), but since these extremes are discriminated against by breeders and an intermediate amount of white at a specific location is desired, it is interesting to look at the results one could expect to obtain with varying degrees of selection for the desired color pattern. Table 2 shows the distribution of the offspring's color pattern corresponding to that of their parents. Of the 419 offspring in this study for which the scores of both sires and dams were known, 294 (70 percent) were considered to be desirably (scores 4, 5, and 6) marked with 59 (14 percent) having too little white (scores 1, 2, and 3) and 66 (16 percent) having misplaced white (scores 7, 8, and 9) and falling in the line-back classification. Among the 252 offspring from desirably marked parents (scores 4, 5, and 6) 188 (75 percent) were desirably marked with equal numbers of the remaining offspring being classified with too little or too much

Table 2.—Distribution of offspring color pattern according to color pattern of parents

Class of Parents	Offspring Class				% Each Class		
	Total	R	D	L	R	D	L
Total	419	59	294	66	14.1	70.2	15.7
DxD	252	32	188	32	12.7	74.6	12.7
5x5	142	18	108	16	12.7	76.1	11.2
RxR	8	7	1	0	87.5	12.5	0
RxD	74	16	52	6	21.6	70.3	8.1
DxL	69	2	44	23	2.9	64.8	33.3
RxL	14	2	8	4	14.3	57.1	28.6
LxL	2	0	1	1	0	50.0	50.0

D includes scores 4, 5 and 6 (cattle classified desirable)
5 is the score assigned to cattle marked most desirably
R includes scores 1, 2, and 3 (cattle classified "red-neck")
L includes scores 7, 8, and 9 (cattle classified "line-back")

white. If one further restricts the color pattern of the parents to those perfectly marked (score of 5) only 142 offspring were available and of these only 108 (76 percent) were desirably marked (scores 4, 5, and 6) with the remainder being equally divided among the red-neck and line-back groups.

These data suggest rather strongly that the amount of white preferred by breeders is due to some sort of intermediate genetic situation which may never become completely fixed by selection of breeding stock based upon their own appearance. The data in this study, however, did not include enough matings of the extreme types to determine the exact number of gene pairs involved or the specific mode of gene action concerned with either the amount of white on the topline or the shade of hair color. The fact that breeders differ in their preferences for the shade of hair color, some preferring the yellow and others the darker red shades, means that the genetic situation which apparently exists with regard to the intermediate is not likely to be such a handicap to those who prefer the extremes. The major handicap to the effective selection for shade of hair color involves errors in classification due to certain environmental factors which influence shade of hair color such as age, season, and age of dam.

It was stated earlier that one of the purposes of this study was to determine whether or not the selection for eyelid pigmentation would disrupt the Hereford color pattern with regard to the amount of white on the topline or the shade of hair color. The correlation between the amount of eyelid pigmentation and topline pattern scores was .06 for 585 individuals and was not significant. This indicated that there was little if any relationship between the two items and that one could expect to increase eyelid pigmentation without adversely affecting topline color pattern. There was a small but significant correlation of .12 between the amount of eyelid pigmentation and shade of hair color score. This indicated a tendency for the darker animals to have eyelids with slightly more pigment, but the correlation is so small that one could increase eyelid pigmentation without any appreciable effect upon the shade of hair color. The correlation between the scores for topline pattern and shade of hair color for 974 animals was —.07 and barely significant, meaning that there was a tendency for the animals with the most white along the topline to have the darkest shade of red color. Again the correlation is so small that one can assume that the two traits are independent for all practical purposes.

Summary

A study of the inheritance of topline color pattern and shade of hair color was made from scores obtained from 517 offspring and their 312 dams and 38 sires at the Ft. Reno station during 1956 and 1957. The results indicated that the amount of white along the topline of Herefords and the shade of hair color were sufficiently heritable (.35 to .67 for amount of white on topline and .36 to .59 for shade of hair color using different methods of analyses) that one could expect to make changes in either trait by selection for either more or less white on topline or for lighter or darker hair coat. A study of the data, however, indicates that the preferred amount of white on the topline of Herefords is the result of an intermediate genetic situation and that it is not likely that selection of breeding stock for this trait will fix the color pattern for this preferred intermediate. Additional data need to be obtained to determine more precisely the nature of the genetic situation with regard to the number of gene pairs involved and the specific mode of gene action concerned with the expression of this trait. The correlations between the two traits above and the amount of eyelid pigmentation were so small that one could assume the three items to be independent. One could, if he wished, increase the amount of eyelid pigmentation without disrupting the color pattern or changing the shade of hair color in his herd.

Fattening Trial with Western Feeder Lambs in Dry Lot

ROBERT L. NOBLE, RICHARD PITTMAN and

GEORGE WALLER, JR.

The number of lambs fattened in Oklahoma varies from about 25,-000 to 75,000, depending on feed availability and price outlook. Most of these lambs are fattened by grazing on wheat pasture, however, some are fed in dry lot. This project was initiated in the fall of 1952 at the Ft. Reno Station to study various methods of fattening feeder lambs, making maximum use of home-grown feeds.

Procedure

Two hundred and thirty-five grade Western feeder lambs were used in this study. The preliminary treatment of these lambs was discussed in the report "Trucking vs. Rail Shipment of Lambs".

The lambs were started on their experimental ration November 6. The treatments were as follows:

Lot 1—Pellets; 45% milo, 5% molasses, 50% alfalfa hay.

Lot 2—Pellets; same as for Lot 1 plus 20 grams of aureomycin per ton.

Lot 3—Mixture; 45% milo, 5% molasses, 50% alfalfa hay.

Lot 4—Mixture; same as for Lot 3 plus 20 grams of aureoymcin per ton.

Lot 5—Long alfalfa hay, whole milo; self-fed.

Lot 6—Long alfalfa hay, whole milo; self-fed. Plus aureomycin in drinking water.

Lot 7—2# mixture (same mixture as for Lot 3), plus silage, full-fed, and 1 pound of milo last 33 days.

Lot 8—Same as Lot 7 except mixture contained 20 grams of aureomycin per ton.

Lot 9—1.5# alfalfa hay, silage full-fed for first 70 days; then self-fed pellet (same as for Lot 1) for last 48 days.

Lot 10—1.5# alfalfa hay, silage full-fed with aureomycin in drinking water first 70 days; then self-fed pellet (same as for Lot 2) last 48 days.

One-half of the lambs of each lot were implanted with 6 mgs. of stilbestrol.

A mineral mix of 75% salt and 25% steamed bone meal was available to the lambs of all lots. The mixture and the pellets were as identical as possible, except for pelleting. The cost of pelleting was $3.00 per ton.

Individual weights following an overnight period without access to feed and water were taken at the beginning and the end of the trial. Intermediate weights were taken about every 30 days. The lambs were topped-out as they reached market weight and were sold on the Oklahoma City market. The marketing dates and prices received were as follows: December 17, $20.50/cwt.; January 15, $23.25/cwt.; January 28, $24.00/cwt.; February 17, $23.00/cwt.; and March 4, $22.50/cwt.

Average weight gains, marketing data and financial results are shown in Tables 1 and 2. The effects of stilbestrol and aureomycin are shown in Table 3.

STANDARD FEEDING PROGRAM—Heavy Lambs

Table 1.—Weight gains, rations fed, and financial results obtained with fattening lambs fed in dry lot.

Treatment	*Pellets* self-fed 45% milo 5% molasses 50% alfalfa hay		VS. *Mixture* self-fed 45% milo 5% molasses 50% alfalfa hay		VS. Whole milo Long alfalfa hay; self-fed		VS. 2 lb. mixture silage; full feed 1lb milo (last 33 days); hand-fed	
Lot No.	without Aureo. 1	with Aureo. 2	without Aureo. 3	with Aureo. 4	without Aureo. 5	with Aureo. 6	without Aureo. 7	with Aureo. 8
No. of lambs	23[1]	23	23	23	23[1]	23	23	23[1]
Initial weight	82.2	82.3	81.7	82.7	79.7	80.4	77.1	79.2
Final weight	103.7	105.6	105	105.3	97.1	100	107.8	108.2
Av. No. days on feed	41	41	53	41	50	50.5	104	104
Av. daily gain	.52	.57	.43	.55	.35	.40	.30	.28
Av. daily ration								
Pellet	4.0	3.8	—	—	—	—	—	—
Mixture	—	—	3.1	3.7	—	—	—	—
Alfalfa hay	—	—	—	—	1.36	1.33	2.	2.
Milo	—	—	—	—	2.06	1.82	—	—
Silage	—	—	—	—	—	—	3.	3.
Feed per cwt. gain								
Pellet	770	667	—	—	—	—	—	—
Mixture	—	—	720	673	—	—	—	—
Alfalfa hay	—	—	—	—	386	333	—	—
Milo	—	—	—	—	589	455	—	—
Feed cost per cwt. gain	15.79	13.67	13.68	12.79	16.53	13.26	19.97	21.30
Financial Results ($)								
Av. selling price/cwt.	20.50	20.50	21.50	20.50	21.30	21.20	23.00	23.00
Total value per lamb (minus actual shrink+wool credit)[2]	23.08	23.47	24.09	23.22	22.64	23.07	26.80	26.81
Initial Cost[3]	21.10	21.00	20.86	21.19	20.50	20.69	19.85	20.33
Misc. cost[4]	.60	.60	.60	.60	.60	.60	.60	.60
Feed cost/lamb	3.36	3.22	3.10	2.89	2.91	2.69	6.15	6.17
Loss per lamb	—1.98	—1.45	—.47	—1.46	—1.37	— .91	+ .20	— .29
Shrinkage to market, %	2.5	2.5	2.5	2.5	2.5	2.5	1.3	1.3
Dressing percent	50.5	49.2	49.5	50.0	51.3	50.5	49.0	50.6
Carcass Grade[5]	4.1	3.9	4.1	4.3	3.7	3.8	3.8	4.0

1 Two lambs in Lot 5, 2 lambs in Lot 9, and 1 lamb in Lot 8 died. (4 enterotoxemia, 1 urinary calculi)
2 Estimated wool return; 50c/pound which includes government incentive.
3 Initial cost: $21.00 F.O.B. Roswell, New Mexico; $24.00 on experiment—before shorn; includes death loss. (15 out of 1500 lambs died before the experiment began)
4 Includes cost of drenching, vaccinating, and marketing.
5 Carcass grade—numerical values of 6 5, 4, 3, 2, and 1 were assigned to the grades of av. choice, low choice, high good, av. good, low good, and high utility; respectively.

DEFERRED FEEDING PROGRAM (Medium wt. lambs)

Table 2.—Weight gain, rations fed, and financial results obtained with fattening lambs in dry lot.
(118 days, Nov. 6, 1957—March 3, 1958)

Treatment	Deferred Phase – 70 days Silage, full feed 1.5 lb. alfalfa hay	
	without Aureomycin	with Aureomycin
Lot No.	9	10
No. of lambs	26	25
Initial weight	74	74.1
Av. daily gain	.06	.07
Feed cost per lamb	2.58	2.54
	Full-feeding Phase – 48 days Self-fed Pellets	
	without Aureomycin	with Aureomycin
Initial wt.	78.3	79.1
Final wt.	96.6	102.0
Av. daily gain	.44	.48
Av. daily ration (pellets)	3.8	3.9
Feed per cwt. gain	864	812
Feed cost per cwt. gain	17.71	16.65
Financial Results:		
Av. selling price	22.50	22.50
Total value/lamb[1] (minus actual shrink to mkt. and wool credit)	24.22	24.85
Initial cost[2]	19.00	19.10
Misc. cost[3]	.60	.60
Total feed cost/lamb	6.35	6.41
Loss per lamb	—1.73	—1.26
Shrinkage to mkt., %	1.4	1.4
Dressing percentage	49.5	50.1
Av. carcass grade	3.9	3.4

1 Initial cost: $21.00 F.O.B. Roswell, New Mexico; $24.00 cwt. on experiment—before shorn; includes death loss prior to start of experiment.
2 Estimated wool return; 50c pound which includes government incentive.
3 Includes cost of drenching, vaccinating, and marketing.
4 Carcass grades—numerical values of 6, 5, 4, 3, 2, and 1 were assigned to the grades of av. choice, low choice, high good, av. good, low good and high utility, respectively.

Results

Pellets vs. mixture vs. self-feeding long alfalfa hay and whole milo—Pelleting the entire ration increased average daily gains by about .06 pound per day; however, the lambs fed the mixture required about 20 pounds less feed per cwt. gain. Average daily feed consumption was .5 pound higher for the lambs fed the pellets. Due to cost of pelleting ($3.00 per ton) and the increased efficiency of feed utilization, the feed cost per cwt. gain was about $1.00 cheaper for the lambs fed the mixture.

The lambs self-fed long alfalfa hay and whole milo gained approximately .15 of a pound less than the groups fed the mixture or pellets. These lambs also required more feed per cwt. gain and the feed cost per cwt. was greater.

Table 3.—The effects of stilbestrol (6 mg. implant) and aureomycin on gain, yield, and carcass grade

	without Aureomycin		with Aureomycin	
	without Stilbestrol	with Stilbestrol	without Stilbestrol	with Stilbestrol
Pellets: self-fed (41 days)				
No. of lambs	11	12	11	12
Total gain	19	23.9	21.8	24.8
Yield	51.3	49.6	50.2	48.2
Grade	4.4	3.9	4.1	3.8
Mixture: self-fed (41 days)				
No. of lambs	11	12	11	12
Total gain	16.8[1]	18.8[1]	17.7	25.5
Yield	49.3	49.7	50.4	49.7
Grade	4.2	4	4.4	4.2
Long alfalfa hay & whole milo: self-fed (Aureomycin in drinking water) (50 days)				
No. of lambs	11	12	11	12
Tital gain	15.3	19.4	17.1	21.3
Yield	50.8	51.7	51	50
Grade	3.6	3.7	4.1	3.5
Deferred lambs: (roughage alone first 70 days; then self-fed pellets 48 days)				
No. of lambs	13	13	13	12
Total gain (last 48 days only)	19.1	22.8	21.7	23.9
Yield	49.9	49	50.7	49.4
Grade	3.8	4	3.5	3.3
High roughage ration: (2lb mixture, silage free choice (3lb), and 1lb milo last 33 days) (104 days)				
No. of lambs	11	12	11	12
Total gain	27.2	34.3	25.2	32.5
Yield	50.6	47.5	50.7	50.5
Grade	4.4	3.3	4	4.1

1 Adjusted to 41 days.

Limited gain feeding and deferred feeding—Lots 7, 8, 9, 10— The average daily gains of these two groups of lambs this year were considerably lower than for similar groups fed the same rations last year; perhaps due to the quality of alfalfa hay. The feed required and the feed cost per cwt. of gain were considerably higher for these lambs than those self-fed. The marketing date on these lambs was later and they sold for $2-$3 per cwt. higher.

The effect of stilbestrol and aureomycin (see Table 3)—Considering all lots of lambs, stilbestrol increased average daily gain by about 21%.

One lamb out of the 255 implanted (this includes those implanted on wheat pasture) died from a blockage of the urinary tract. Most of the increase in gain due to stilbestrol came during the first part of the feeding period. Stilbestrol decreased dressing percentage and carcass grade (less than 1/6 grade) slightly in most instances.

Aureomycon increased average daily gains and feed efficiency of each group of lambs except those fed the high roughage ration (Lots 7 and 8).

The average daily gain of all groups was satisfactory, and the feed slightly on the high roughage ration and also decreased feed efficiency.

Theaverage daily gain of all groups was satisfactory, and the feed cost per cwt. of gain, in most instances, was considerably lower than the selling price; however, due to initial cost, death loss, shrinkage, miscellaneous costs, and negative margin, practically all groups showed a net loss.

Effect of Different Levels of Winter Supplement and Age at First Calving Upon the Performance of Beef Cows and Replacement Heifers

J. E. ZIMMERMAN, L. S. POPE AND DWIGHT STEPHENS

The most common system of cow herd management in the Southwest is to graze year-long on native grass pasture, with supplemental feed during the winter as required. The amount of winter supplement required is dependent upon the length of the lactation period before spring grass appears, the type and amount of forage available, the quality of supplemental feed provided, and weather conditions. Since winter supplemental feed is the major cash cost in the operation of a commercial cow herd, it is important to feed the most economical quantity of supplement in terms of the number, size and quality of calves at weaning as well as the condition, thriftiness and longevity of the cows.

A study was initiated at this station with 90 weanling Hereford heifer calves in the fall of 1948 to study the effect of the level of winter supplement and age at first calving on the lifetime performance of range beef cows. This report gives the results of the ninth year (1956-57) of this experiment and contains a summary of results obtained to the fall of 1957.

In the fall of 1954, more carefully controlled studies were undertaken to evaluate the effects of different levels of supplemental feed with heifers bred to calve at two years of age. By repeating these range trials several years, variations in climate and range conditions could be minimized. Thus, a series of repetitions was initiated using weanling Hereford heifer calves, the majority of which were from the original cows. From the records available, it was possible to allot the calves according to age, sire, dam's average productivity, body weight and grade. Four groups of heifers have now been included in the study. Results obtained to the fall of 1957 are reported.

Original Study with Cows Wintered at Different Levels and Calving First at Two or Three Years of Age.

In the fall of 1948, six lots of 15 heifer calves each were placed on experiment. These heifers were obtained from the experiment station herd and a large commercial herd. Since the summer of 1949, the study has been carried out at the Fort Reno Station. The cattle have grazed year-long on native grass pastures consisting mostly of bluestem, Indian and switch grass and less desirable annual grasses. The stocking rate has varied from 8 to 12 acres per cow and adequate grass has been available at all times. A mineral mix consisting of two parts salt and one part steamed bone meal was available throughout the year. During the winter feeding period (early November to mid-April) the cows have received the following supplemental feeds per head per day in addition to the weathered native grass:

Lots 1 and 2 (low level)—1.0 pound of cottonseed cake.

Lots 3 and 4 (medium level)—2.5 pounds of cottonseed cake.

Lots 5 and 6 (high level)—2.5 pounds of cottonseed cake and 3.0 pounds of oats.

The supplements were fed every other day, twice the daily allowance at each feeding. In establishing these levels, consideration was given to the prevailing practices of many ranchers in the state, and to available information on the requirements of beef cows. It was believed that the low level would supply about two-thirds of the digestible protein needed by range beef cows, whereas, the high level would not only supply ample protein but additional energy. Heifers in Lots 1, 3 and 5 were pasture-bred during the early summer of 1950. Heifers in Lots 2, 4 and 6 were not bred until one year later and calved first as three-year-olds in the spring of 1951.

To date, these cows have been subjected to their respective winter treatments for ten consecutive years. Since the data for the winter of 1957-58 are incomplete, this report deals with cow performance during the 1956-57 season, and will summarize the results obtained to the fall of 1957 (first nine years of tests).* The results of the 1956-1957 test are shown in Table 1, and a summary of results obtained to the fall of 1957 is given in Table 2.

The winter of 1956-57 was mild, with above average rainfall. There was some growth of annual grasses throughout the winter. Winter weight losses followed a very inconsistent trend, with the lots receiving the least supplement losing the least weight. A trend had been noted in the three previous winters for the medium level lots to lose slightly more weight than the low level lots, but the differences were small. Cows in Lots 5 and 6 (high level) have lost the least weight in previous winters, but during the winter of 1956-57 they lost more weight than the low level lots and almost as much as the medium level lots. It

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* Detailed data for other years may be found in Okla. Agr. Expt. Sta. Misc. Pub. MP-19, 22, 27, 31, 34, 43, 45 and 48 (1948-1957).

Table 1.—Weight data, feed costs, and calf production records for cows wintered at low, medium and high levels of supplemental feed (1956-57).

Age at first calving	Two-year-olds			Three-year-olds		
Lot number	1	3	5	2	4	6
Level of winter supplement	Low	Med.	High	Low	Med.	High
Winter Phase (161 days)						
No. of cows/lot 1955[1]	14	14	10	14	11	13
Average cow weights (lbs.)						
Fall 10/30/56	1103	1165	1164	1182	1128	1223
Gain to calving	+110	+67	+128	+112	+ 83	+113
Loss from calving to 4/9/57	—138	—256	—251	—146	—231	—217
Spring 4/9/57	1075	976	1042	1148	981	1113
Cost of winter feed/cow ($)	12.58	20.09	33.51	12.58	20.09	33.51
Summer Phase (206 days)						
Average cow weights (lbs.)						
Spring 4/9/57	1075	976	1042	1148	981	1113
Fall 11/1/57	1132	1133	1164	1193	1102	1199
Summer gain	+57	+156	+122	+ 45	+121	+ 86
Summer feed cost/cow ($)	17.79	17.79	17.79	17.79	17.79	17.79
Total yearly feed cost/cow ($)	30.37	37.88	51.30	30.37	37.88	51.30
Calf production records						
Number of calves born[2]	14	15	10	13	11	12
Number of calves weaned[3]	13	13	10	13	10	11
Average calving date	3/22	3/7	3/8	3/20	3/15	3/8
Average calf weights (lbs.)						
At birth (corrected for sex)	85.1	81.6	87.3	82.8	81.9	80.0
At weaning (corrected for age and sex)	479	503	474	494	476	490

1 The project was initiated in the fall of 1948 with 15 heifers per lot. As of Nov. 1 1956 a total of 14 had been removed. During 1956-57 one cow was removed from each of Lots 2, 3, 4, 5 and 6.
2 One set of twins included in Lot 3.
3 One calf in each of Lots 1, 4 and 6 was stillborn; one calf in Lot 3 was premature; and one calf in Lot 3 died at two weeks of age of an acute virus infection.

Table 2.—Summary of 9½ years results in long-time study with beef cows wintered at different levels (1948-1957).

Age at first calving	Two-year-olds			Three-year-olds		
Lot number	1	3	5	2	4	6
Level of winter supplement	Low	Med.	High	Low	Med.	High
No. of cows at start of experiment	15	15	15	15	15	15
No. remaining on test Nov. 1957	14	13	9	13	10	12
Ave. weight changes of cows on test (lbs.)						
Initial weight 10/29/48	473	471	476	476	461	470
Ave. winter weight loss	—98	—108	— 64	—101	— 98	— 71
Ave. summer gain	172	181	142	180	169	152
Final wt. 11/1/57	1132	1133	1164	1193	1102	1199
Calf production records at 9½ yrs. of age.						
Heifers assisted at first calving	6	8	4	-	-	1
Calves lost at first calving	1	1	2	-	-	2
Total number of calves weaned	104	106	85	95	81	84
% calf crop weaned[1]	91.2	93.8	87.6	96.0	86.2	84.8
Total no. of calves weaned/cow	7.30	7.50	7.01	6.72	6.03	5.94
Average calving date	3/15	3/8	3/9	3/16	3/6	3/5
Average calf weights (lbs.)						
At birth (corrected for sex)	76.8	76.5	78.4	77.0	77.8	78.3
At weaning (corrected for age and sex)	480	476	477	494	474	492
Total feed, pasture and mineral cost/cow ($)	254.55	337.54	453.84	254.55	337.54	453.84
Cow cost per cwt. calf weaned	7.27	9.45	13.74	7.66	11.80	15.53

[1] Based on the total number of cows remaining on test and bred to calve in each year.

has been a consistent observation that the low level cows are better "rustlers" and spend more time grazing than cows receiving more supplemental feed, but this probably could not account for the unusual trend in weight loss. The lots were not rotated between pastures during the winter of 1956-57, as they had been in previous winters, and pasture differences may have been responsible for part of the difference in weight loss.

Summer weight gains were greatest for those lots which lost the most weight during the previous winter. Average weights of all lots in the fall of 1957 were within 35 pounds of the average weight in the fall of 1956. No significant differences were noted in number of calves born, number weaned, birth weights or weaning weights of the calves. However, it is interesting to note that cows in Lot 3 which lost the most weight during the winter weaned the heaviest calves. The average calving date was slightly later for the low level lots.

In Table 2, data obtained to the fall of 1956 (first nine years of the test) are summarized. Both low level of wintering and two-year-old calving adversely affected the body weight of the cows, but differences have been small. The high level lots have, with the exception of the winter of 1956-57, lost the least weight each winter and gained the least during the summer, while losses and gains of the low and medium level lots have generally been similar.

There have been no consistent differences in birth weights (corrected for sex) or weaning weights (corrected for age and sex) among the lots. The average calving date has consistently been from 7 to 12 days later for the low level lots than for the medium and high level lots. There has been some advantage for the lower levels of winter supplement in percent calf crop weaned. More cows have been removed from the high level lots. Most of these cows were removed for failure to wean a calf two years in a row.

A comparison of the performance of cows bred to calve first at two years of age versus those calving first at three years of age is given in Table 3. Here the results from 30 additional cows of the same age have been included. They received the same winter treatment as Lots 3 and 4, but were given additional supplement during the late summer during the first five years of the experiment. The results indicate that cows bred to calve first at two years of age may experience more difficulty at first calving (60 percent of the heifers had to be assisted at first calving). The average weaning weight per calf is somewhat lighter for cows calving first as two-year-olds, but this is due entirely to the lighter weights of the calves they produced at two years of age. Cows calving first at two years of age have had a slight advantage in percent calf crop weaned and have weaned 1.15 more calves per cow than those cows calving first at three years of age.

Second Trial

A second trial was initiated in October, 1954, with 42 heifers from the experimental herd. These heifers were divided into three lots of

Table 3.—Production records at 9½ years for cows that calved first as two- and three-year-olds.

Age at first calving	Two-year-olds	Three-year-olds
Number of cows at start of experiment	60	60
Number of cows remaining Nov. 1, 1957	48	46
Number of possible calvings[1]	437	390
Number of calves weaned	400	344
Percent calf crop weaned	91.5	88.2
Number of calves weaned per cow	7.32	6.17
Average weaning weights (corrected for age and sex)	478	487
Average calving date	3/11	3/9
Cow cost/cwt. calf weaned	9.90	11.51

1 Considers the total number of times the cows should have calved. Percent calf crop is based on this figure.

14 heifers each on the basis of shrunk weight, age, sire and dam's productivity, with one lot being wintered at each of the levels used in the first trial. All of the heifers were bred to calve first at two years of age. During the winter of 1956-57, in an attempt to establish greater differences among treatments, the low level lot received no supplemental feed, the medium level lot received 2 pounds of cottonseed meal all winter plus 2 pounds of milo after February 20, and the high level lot received 2.5 pounds of cottonseed meal all winter with 3 pounds of milo to January 15 and 5 pounds during the rest of the winter period.

Results of the second trial (1956-57) may be found in Table 4. This includes data for the second calf crop produced by these cows.* Differences in weight gain among the lots were very small considering the large differences in amount of supplemental feed provided. It must be emphasized that grazing conditions were quite favorable during the winter of 1956-57. There was a large supply of annual grasses (primarily rescue grass, downy brome and hairy brome) throughout the winter. The low level heifers gained an average of 79 pounds during the winter with no supplemental feed. Summer gains were small as might be expected considering the fleshy condition of the heifers at the end of the winter period. The difference in average weight in the fall of 1957 between the high and low level lots was only 84 pounds compared to a difference of 118 pounds the previous fall.

There were no significant differences between the lots in number of calves born or number weaned. The average calving date for the high level lot was about two weeks earlier than for the other lots. There

* Data for other years may be found in Okla. Agr. Expt. Sta. Misc. Pub. MP-45 and 48 (1956-57)

Table 4.—Summary of performance of beef cows wintered at low, medium and high levels of supplemental feed. (Second trial, 1956-57).

Lot number Level of winter supplement	1 Low	2 Med.	3 High
No. of cows per lot 11/2/56	12	14	14
No. of cows remaining 11/1/57	12	13	11
Average cow weights (lbs.)			
Fall 11/2/56	922	994	1040
Gain to calving 2/4/57	+124	+119	+156
Gain from calving to 4/12/57	— 45	— 51	— 43
Spring 4/12/57	1001	1062	1153
Total winter gain	79	68	113
Fall 11/1/57	1091	1111	1175
Summer gain	90	49	22
Winter feed cost per cow ($)	7.72	19.50	35.70
Summer feed cost per cow ($)	17.79	17.79	17.79
Total yearly feed cost per cow ($)	25.51	37.29	53.49
Calf production records			
Number of calves born	11	14	13
Number of calves weaned[1]	10	13	11
Average calving date	3/11	3/9	2/23
Average calf weights (lbs.)			
At birth (corrected for sex)	78.3	82.6	79.7
At weaning (corrected for age and sex)	399	421	425

[1] One calf in each lot was stillborn. One calf in Lot 3 died at one week of age of unknown causes.

was a trend, as observed in the previous year, for higher levels of winter supplement to be reflected in slightly heavier calves at weaning. However, the difference in average calf weights between the low and high level lots was only 26 pounds, and the low level proved to be most profitable in this comparison.

Third Trial

The third trial was initiated in October, 1955, with 3 lots of 14 heifers each from the station herd. Allotment and management of these heifers were the same as for the second trial, except that the level of supplemental feed was varied during each winter in an attempt to attain the following gains from early November to mid-April:

First Winter as calves

Low level—no gain during the winter period.

Medium level—0.5 lb. gain per day.

High level—1 lb. or more gain per day.

Second winter as bred yearlings

Low level—no gain to calving, marked loss of body weight after calving with a total loss of approximately 250 lbs. from fall to spring.

Medium level—moderate gain to calving (50 lbs.) with approximately 150 lbs. loss from calving to the end of the winter period.

High level—high gain to calving (100 lbs. or more) with essentially no loss while nursing calves.

Results of the third trial for 1956-57 may be found in Table 5*. Average gains for these heifers were 21, 80 and 156 for the low, medium and high level lots, respectively, during the first winter as calves (1955-56). During the second winter (1956-57) the gains to the start of the calving period approached the desired level. After calving the level of supplement seemed to have little effect on the weight losses of the

Table 5.—Summary of performance of beef heifers wintered at low, medium and high levels of supplemental feed (third trial, 1956-57).

Lot number Level of winter supplement	1 Low	2 Med.	3 High
No. of cows per lot 11/2/56	14	14	14
No. of cows remaining 11/1/57[1]	11	11	14
Average cow weights (lbs.)			
Fall 11/2/56	835	848	897
Gain to calving 2/4/57	— 7	38	81
Gain from calving to 4/12/57	—84	—91	—116
Spring 4/12/57	744	795	862
Total winter gain	—91	—53	—35
Fall 11/1/57	872	866	930
Summer gain	128	71	68
Winter feed cost per cow ($)	7.72	20.34	35.85
Summer feed cost per cow ($)	17.79	17.79	17.79
Total yearly feed cost per cow ($)	25.51	38.13	53.64
Calf production records			
No. of calves born	13	12	14
No. of calves weaned[2]	10	10	12
Ave. calving date	3/6	3/3	2/19
No. of heifers requiring assistance	9	7	12
Ave. difficulty at calving score[3]	3.54	3.00	3.86
Ave. calf weights (lbs.)			
At birth (corrected for sex)	75.0	72.4	78.4
At weaning (corrected for age and sex)	349	361	372

[1] One cow in Lot 1 died in calving and one died two weeks after calving of malignant edema. One cow in Lot 1 was removed after becoming sensitive to sunlight. One Lot 2 cow was removed after a pasture injury, one was killed by lightning and one was removed after showing no evidence of being in heat through two breeding seasons.

[2] Number weaned in Lot 1 includes an orphan calf raised by a foster dam. Its weight is not included in the average weaning weight. Two calves in each of Lots 1 and 2 were stillborn; one calf in Lot 1 and one in Lot 3 were injured at calving and died soon after; and one calf in Lot 3 died soon after birth of unknown causes.

[3] A numerical score was used to evaluate difficulty at calving. A score of 1 indicates cow calved normally without assistance, and 7 indicates extreme difficulty in which both cow and calf were lost.

* Data for previous years may be found in Okla. Agr. Expt. Sta. Misc. Pub. MP-48 (1957)

Table 6.—Summary of body measurements (fourth trial).

Lot number Level of winter supplement	1 Low	2 Med.	3 High
Height at withers (in.)			
Fall, 1956	40.7	40.4	40.4
Spring, 1957	41.3	41.7	42.1
Fall, 1957	42.5	42.8	43.2
Length of body (in.)			
Fall, 1956	45.2	45.4	45.2
Spring, 1957	44.5	46.6	46.8
Fall, 1957	49.3	51.8	52.1
Hearth girth (in.)			
Fall. 1956	55.6	55.8	55.8
Spring, 1957	54.1	57.6	61.3
Fall, 1957	62.2	64.2	66.1
Width at hips (in.)			
Fall, 1956	13.7	13.9	14.1
Spring, 1957	14.1	15.1	15.9
Fall, 1957	16.9	17.8	17.8

heifers, with the high level lot showing the greatest loss. During the calving period, the low level lot received no supplemental feed, the medium level lot received 2 pounds of cottonseed meal plus 2 pounds of milo and the high level lot received 2.5 pounds of cottonseed meal and 5 pounds of milo per day. Weight losses for the entire winter period were inversely related to the level of supplement. Losses for the low level lot were somewhat less than desired even though no supplement was fed. Lot 1 made the greatest summer gain and Lot 3 the smallest gain. The difference in average weight between Lots 1 and 3 was reduced from 118 to 58 pounds between April and November.

No definite trends were established in the number of calves born or number weaned. Lots 1 and 2 were very close in average calving date, while the average date for Lot 3 was about two weeks earlier. This is very similar to the results obtained in the second trial during 1956-57. More heifers had to be assisted at calving in Lot 3, but there was little difference in the average difficulty at calving score.

As in the second trial, the extra winter supplement for Lots 2 and 3 was reflected in heavier calves at weaning. However, $28.13 worth of supplement fed to Lot 3 resulted in an average of only 23 pounds extra weight per calf and again the low level was most profitable.

Fourth Trial

A fourth trial was initiated in November, 1956, with 45 heifer calves from the experimental herd divided into 3 lots of 15 head each. Allotment was on the basis of shrunk weight, age, dam's productivity, sire and grade. The amount of winter supplemental feed was adjusted in an attempt to attain a desired amount of gain as described for the third trial.

Winter gains during 1956-57 were —8, 80 and 170 pounds for the low, medium and high level lots, respectively. The low level lot received .75 pound per head of cottonseed meal every other day from January 12 to February 25 and no supplement during the rest of the winter. The medium level heifers received 2 pounds of cottonseed meal per head per day all winter plus 2 pounds of milo per head per day after February 20. The high level lot was given 2.5 pounds of cottonseed meal per head per day all winter, and in addition received 3 pounds of milo to December 21, then 4 pounds to January 12, and 6 pounds per head per day for the rest of the winter.

Summer gains were inversely related to winter gains and averaged 237, 218 and 155 pounds for the low, medium and high level lots, respectively. Average weights for the three lots in the fall of 1957 were 708, 785 and 815 pounds. Table 5 contains a summary of some body measurements taken each fall and spring. The treatments resulted in very little difference in the height of the heifers, but affected the other measurements to some extent.

Fifth Trial

A fifth trial was initiated in October, 1957, with 60 heifers from the experimental herd. They were allotted into four lots of 15 heifers each on the basis of shrunk weight, age, dam's productivity, sire and grade. The first three lots are now (winter of 1957-58) being wintered in the manner described for the third and fourth trial. The fourth lot is being wintered at a "very high" level. They are being self-fed a 65 percent concentrate ration in dry lot. All lots will be pasture mated in the summer of 1958 to calve first at two years of age.

Summary

The results of the ninth consecutive year in a long-time study at the Ft. Reno station on the effects of low, medium and high levels of supplemental feed on the performance of range beef cows are presented. Data obtained indicate a slight effect of level of winter feed on mature weight of the cows, but no significant difference on birth or weaning weight of the calves. There has been a trend for the low level lots to calve slightly later, but to wean a larger percent calf crop. The cost per cwt. of calf weaned has been least for those cows wintered at the low level, and has been less for those calving first as two-year-olds than for the cows calving first as three-year-olds. The first trial is now in its tenth consecutive year.

Four repetitions are now in progress with heifers from the experimental herd. Body weight was affected somewhat in all trials by level of winter feeding; however, summer gains have tended to compensate to a large extent for differences in winter gain. Weaning weights of calves from the second and third trials were increased by higher levels of winter feed, but the differences in weaning weight were not great enough to pay for the extra feed cost of the medium and high level.

Inheritance of Productivity of Beef Cows

DOYLE CHAMBERS, NAT M. KIEFFER, and L. S. POPE

More than a million beef cows over two years of age are being kept by Oklahoma cattlemen for the production of beef calves, most of which are marketed at weaning time as feeders or as fat slaughter calves. The success of this system of production depends heavily upon items of cow productivity which include regularity of reproduction, mothering ability, and length of productive life. Some of these items have been treated in some aspect in previous Oklahoma Agr. Exp. Sta. Pubs. (No. M.P. 48, pp. 23-28, on regularity of reproduction, pp. 28-33, on one factor affecting longevity; No. M.P. 45, pp. 30-38, and No. M.P. 31, pp. 10-16, on mothering ability of beef cows as measured by calf weights).

It has been found that there are wide differences among beef cows in their lifetime productivity as measured by the seven-month weights of their calves. Many cows produce as many pounds of calf in four years as others in the same herd produce in five years even when they have all weaned the same number of calves sired by the same bulls. These differences probably exist because some cows transmit to their calves greater growth potential and some cows provide the calf with a more favorable environment during the suckling period. It has been shown that a high producing cow one year is likely to be among the higher producing group each year and that a low producing cow one year tends to repeat her poor performance each year. This has led to the performance testing programs in this and other beef cattle producing states. The goal is to identify those individual differences which exist among beef cows within each herd. Breeders have been able to remove many of the poor producing cows during the past two or three years when economic and weather conditions required a reduction in the size of the breeding herds. Some kept replacement females from the more productive cows only, expecting that part of the advantage of the dams would be passed on to their daughters. Very few data have been available which could be used to determine how effective such selection might be.

Nature of the Present Study

The data for this study were obtained from a high-grade Hereford herd of approximately 100 cows which have been in a long-time management study at the Ft. Reno experiment station and from daughters of these cows which are being used in a modified replication of the earlier study. The older cows were dropped during the winter of 1947-48. Half of these cows calved first at two years of age during the spring of 1950 and the remainder calved first at three years of age in 1951. The calves were identified and weighed at birth, and weaning weights were obtained during early October when the calves were approximately seven months of age. Beginning with the breeding season of 1952, the cows have been assigned to breeding groups of equal numbers balanced according to management treatment imposed during the winter and past average productivity. It was therefore possible to identify both sire and dam of each calf dropped from 1953 through 1957. Some cows have produced as many as eight calves during this period and all cows remaining in 1957 had produced either 6, 7, or 8 calves. The average lifetime performance for this group of cows, as measured by the 210-day weights of their calves adjusted to a steer equivalent, has been 483 pounds per year with a range of 162 pounds. The highest producing cow during this time has been one which weaned 8 calves at 539 pounds and the poorest producing cow weaned 8 calves at 377 pounds each. The cows were not culled for low performance during this time.

In 1954 it was decided that this experiment should be replicated using daughters of the foundation herd for each replication. All heifers were to calve at two years of age and they were to be on different levels of supplemental winter feeding. Thirty-three 1954 heifer calves by four different sires and twenty-six 1955 heifer calves by five different sires have now produced one or two calves. It was therefore possible to relate the performance of these 59 daughters to the performance of their dams and get an early estimate of the heritability of mothering ability or cow productivity as indicated by calf weaning weights. These 59 daughters were by seven different sires (two sires were repeated in 1954 and 1955 calf crops) and were from 46 different dams (only 13 cows had two daughters in the study).

Results and Discussion

The number of heifers by each sire and the average 210-day weights of their calves are presented in Table 1. The average lifetime production for the dams of each group of heifers is also presented. Although within each breeding season the cows were assigned to each sire so that their average lifetime production was equal, the heifers in each group did come from cows which differed somewhat in past productivity due to chance in sex determination. It is obvious that the daughters by different sires weaned calves which differed considerably in 210-day weights.

Table 1.—Distribution of the data by sires of the heifers and by seasons in which their calves were produced

Sires	No. of heifers	Production of 1954 Heifers				Lifetime Prod. of Dam	
		1956 Calves		1957 Calves			
		No.	Ave. Wts.	No.	Ave. Wts.	No. Calves	Ave. Wt.
247	9	8	421	9	441	6.33	504
311	10	10	420	10	399	7.20	492
182	3	2	464	3	457	7.67	493
901	11	9	397	10	398	6.54	479
		Production of 1955 heifers					
182	2	—	—	2	378	7.00	481
901	10	—	—	10	352	7.50	494
120	5	—	—	5	369	6.50	504
242	4	—	—	4	328	7.50	482
219	5	—	—	5	360	6.80	490

Table 2.—Heritability estimates of cow productivity obtained from intra-sire, intra-season regression of daughters production on that of her dam

Items	Studied	Number Pairs	Regression Coefficient	Heritability
(1)	First Record of Daughter and Dam	59	.15	.30
(2)	1957 Record of Daughter and Dam	56	.19	.38
(3)	Lifetime Averages of Daughters and Dams	59	.43	.86
(4)	1956 and 1957 Records of Daughters and Dams	25	.45	.90

The calves dropped in 1956 by the 1954 heifers were sired by a pair of half-brothers from line 2 at Ft. Reno. The 1957 calves produced by the same heifers were sired by a pair of half-brothers from non-related stock, and the 1957 calves produced by the 1955 heifers were sired by a pair of half-brothers from line 3 at Ft. Reno. The dams of these 1954 and 1955 heifers were bred to different bulls each year from lines 2 and 3. The 1957 calves were lighter in weight than one might expect based upon the weights of 1956 calves and earlier experience. The calves at Ft. Reno in all lines and experimental treatments were about 40 to 50 pounds lighter at 210 days of age in 1957 than in previous years, probably because of poor quality forage available in 1957. This would not be expected to affect the heritability estimates however because they were from an intra-season analysis.

In order to get an estimate of the relative importance of hereditary factors upon the expression of cow productivity as measured by 210-day calf weights, the production of daughters within each sire and season group was related to the production of their dams. The statistical procedure was to obtain an intra-sire, intra-season regression of the heifer's performance on that of her dam. Four different regressions were obtained. They are presented in Table 2. When the first record of the daughter, which was made in 1956 for those heifers dropped in 1954 and in 1957 for the 1955 heifers, was regressed on the first record of her dam, which was made in either 1950 or 1951, a heritability estimate of .30 was obtained from the 59 daughter-dam pairs which made up these data. Fifty-six of the daughters and their dams produced calves in 1957. When these single records for both daughters and dams were used in the regression analysis, heritability was estimated at .38, which is not appreciably different from the first estimate. On the other hand when the average of all records for both daughters and their dams were used in the regression analysis, a heritability estimate of .86 was obtained. About half of the daughters had two records which could be averaged and all of the dams had from six to eight records from which to obtain an average. One additional estimate was obtained by regressing the average production of the 25 daughters which were dropped in 1954 on the 1956 and 1957 production of their dams. This estimate was also very high (.90) and is very close to the estimate obtained when all records were considered.

Another method, which is somewhat more crude but perhaps more meaningful, of calculating these heritability estimates is to divide the dams of the heifers by each sire into high-producing and low-producing groups and to compare the production of their unselected daughters with that of their dams. This is shown in Figure 1. In this case the 30 dams which were classified as high producing cows in each sire and season group had an average production of 497 pounds on their first calves which were either produced at three years of age or whose weights were adjusted to that age. The low producing 29 cows weaned first calves which averaged only 425 pounds. The daughters of the high producing half weaned calves which averaged 396 pounds while the daughters of the low producing cows weaned calves which averaged 386 pounds. All of these heifers were calved at two years of age and the records were not adjusted for age or season. If we divide the 72 pound difference between the two groups of dams, which had been sorted on the basis of their first records, by the 10 pound difference between their unselected daughters and multiply the resulting fraction (.14) by 2, because the sire's effect is not included in this regression, we obtain an estimate of heritability of .28 as compared to .30 obtained by the more refined technique. If the differences between dam and daughter groups are weighted to adjust for differences in the number of daughters by each sire, a 71-pound

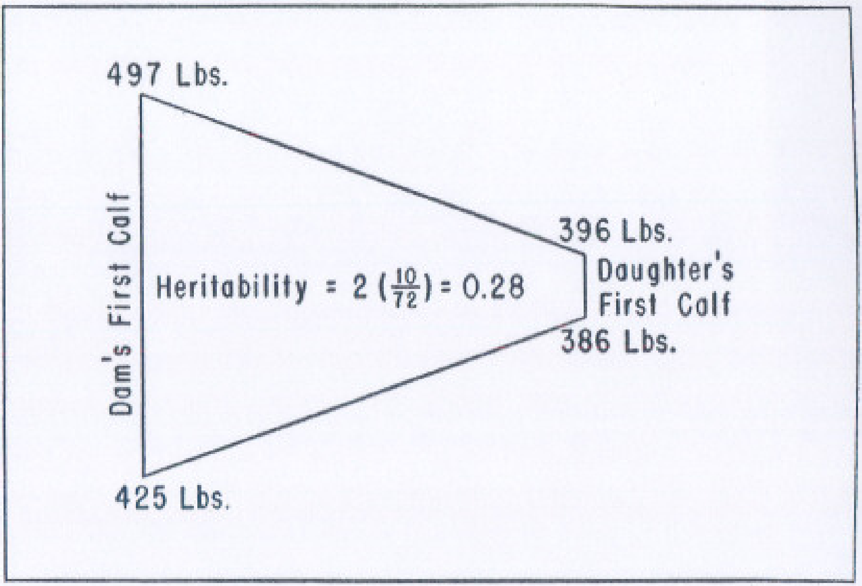

Figure 1.—Heritability of cow productivity from the intra-sire regression of the daughter's first record on that of her dam.

difference in the dams is obtained and when divided by the 12 pound weighted mean difference obtained for their daughters, the fraction is .17 and the estimate of heritability becomes .34. These estimates are essentially the same and indicate that approximately 30 percent of the variation in 210-day calf weights from first calf heifers can be accounted for by hereditary differences among the heifers. It is of interest that when the single records of the daughter and of her dam made in the same season (1957) were studied, the heritability estimate was slightly larger (.38) than when the first records of each were considered.

When the average lifetime performance of the dam was related to one or two records of the daughter, the heritability estimate was increased considerably and this was expected to be the case because the average of six to eight records per dam is a much more reliable estimate of the real genetic worth of the cow than a single record. It was also very interesting that a very high estimate (.90) was obtained from the 1954 daughter group by comparing the average of the 1956 and 1957 records of both dams and daughters. This estimate however is based upon fewer than half of the dam-daughter pairs used in the other estimates and may be the result of chance.

Although the amount of data used in this study is quite limited, the estimates are rather consistent and suggest that the selection of replacement heifers from the more productive dams should be effective in raising the average 210-day weights of beef calves. Selection of heifers based upon the average of two or more records of their dams should be much more effective than that based upon the first record or any other single record of the dams. These results are to be expected when selecting among heifer calves which are by the same sire. The average 210-day calf weights from daughters of the different sires, given in Table 1, indicate the importance of the sire upon the productivity of his daughters. These data indicate the importance of selecting the daughters of sires which transmit greater mothering ability potential, but the sire can be evaluated only by considering the performance of his female relatives—his mother, sisters, and daughters. Initial selection of a bull should be based upon the average lifetime production of his dam and his unselected sisters, but final selection must await the performance of his female offspring. Although the trait of cow productivity is a maternal trait expressed only by the female, the greatest opportunity for improving this trait in a herd is probably by the selection of sires, because of the high replacement rate required for females and the low reproductive rate of the cows. A much smaller percentage of the males is required and the number of offspring may be increased for sires which prove outstanding. Obviously the greatest improvement can be expected when one selects all of his breeding animals for the same traits. The producers who are marketing calves at weaning time and the breeders who are providing the bulls which they use share the responsibility for the improvement of this important economic trait in beef cattle.

Stilbestrol and Urea in Rations for Wintering Beef Cattle

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The administration (implanting and feeding) of stilbestrol to fattening cattle is generally accepted as a means of increasing gain and improving feed efficiency. There are indications that the response from stilbestrol is less when the energy content of the ration is low, such as is the case with our usual winter rations. During the 1957-58 winter feeding season, tests were conducted to study the effect of implanting or feeding stilbestrol to calves wintered on prairie hay or dry native grass pasture. Many of the calves in these tests were allotted to different groups in such a manner that we could study the use of urea in protein supplements. Cattle and sheep are able to utilize, to varying degrees, the nitrogen from urea. This utilization is possible because of the microorganisms in parts of the ruminant stomach. The utilization of non-protein nitrogen is apparently affected, therefore, by the nutrition of the microorganisms. Efficient utilization of urea will result only when other nutrients are provided in needed amounts.

There have been many studies which indicate that urea may satisfactorily replace part of the protein in the rations of fattening cattle. There is a lesser number of tests on the value of urea in wintering rations in which the quantity of concentrate feed offered as a supplement to grass hays or dry, native grass pasture is very limited. Tests conducted at this station in recent years have indicated that urea is apparently not efficiently utilized by cattle wintered on dry range grass when it is added to a mixture of corn and cottonseed meal to produce a pellet containing 40 per cent protein with one-third of the nitrogen furnished by urea. However, the addition of trace minerals or dehydrated alfalfa meal to the urea-containing pellet resulted in increased gains. Prairie hay apparently furnishes nutrients not present in dry range grass, because the addition of trace minerals to a urea-containing pellet fed as a supplement to prairie hay did not increase gains.

Additional tests on the use of urea in wintering rations have been conducted during the 1957-58 winter feeding season in order to study the effect of various additives in increasing gains of cattle fed urea-containing supplements.

The chemical composition of protein supplements and hays fed in these tests is given in Table 1.

Trial I.—Urea in Protein Supplements for Wintering Steer Calves Grazing Native Grass

Procedure

Sixty, grade, Hereford, steer calves were divided into 4 lots of 15 on November 11, 1957, and were allowed to graze the native grass

Table 1.—Chemical composition of feeds.

	Percent dry matter	Percentage Composition of Dry Matter						
		Ash	Protein	Fat	Fiber	N.F.E.	Ca	P
Trials I and II								
40 percent protein pellet	92.90	7.65	43.33	3.31	13.50	32.21	0.59	1.29
Urea-containing pellet	92.04	7.36	44.50	2.85	8.93	36.36	1.03	1.30
40-Urea plus trace minerals	92.01	7.34	46.33	2.90	9.46	33.99	1.06	1.30
40-Urea plus 4 trace minerals	91.33	7.29	46.53	2.93	8.95	34.30	1.07	1.30
Trial III								
40 percent protein pellet	92.15	8.52	42.86	5.23	10.63	32.76	0.75	1.54
Urea-containing pellet	91.55	8.01	43.69	4.50	8.38	35.42	1.06	1.37
40-Urea plus trace minerals	91.37	7.86	42.28	4.48	8.15	37.23	1.00	1.38
40-Urea plus trace minerals and aureomycin	91.86	7.89	43.82	4.08	7.84	36.37	1.01	1.38
40-Urea plus trace minerals and B vitamins	91.31	7.58	43.67	3.94	8.63	36.18	1.11	1.31
Winter-cut prairie hay	94.49	5.56	3.31	1.82	42.18	47.13	0.42	0.04
Trial V								
Cottonseed meal	90.46	6.42	42.84	4.62	12.95	33.17	0.35	1.00
Cottonseed meal plus stilbestrol	90.45	6.51	43.26	4.65	12.76	32.82	0.34	1.04
Prairie hay	94.75	6.53	5.08	1.66	32.26	50.47	0.48	0.05

pastures on the south side of Lake Carl Blackwell. In addition to the dried grass, they were fed an average of 2 lb. per head daily of the following protein supplements:

Lot 1. 40 per cent protein supplement.

Lot 2. 40 per cent protein supplement containing urea.

Lot 3. Same as Lot 2 plus trace minerals (iron, copper, cobalt, manganese, iodine, and zinc).

Lot 4. Same as Lot 2 plus iron, copper, cobalt and zinc.

The 40 per cent protein supplement was 97.9 per cent cottonseed meal, 1.1 per cent dicalcium phosphate and 1.0 per cent monosodium phosphate. The latter two ingredients were added at such rates that the calcium and phosphorus contents of all pellets were approximately equal. The 40 per cent protein supplement containing urea was 59 per cent cottonseed meal, 33 per cent ground yellow corn, 5 per cent urea* and 3 percent dicalcium phosphate. Urea furnished approximately one-third of the nitrogen in this pellet. The third supplement was the same as that fed to Lot 2 except trace minerals** were added at the rate of 0.1 lb. per 100 lb. of the supplement. According to the manufacturer's recommendations the additional minerals provided were, in mg. per lb. of pelleted supplement: manganese, 55.4; iodine, 1.72; cobalt, 1.18; iron, 43.6; copper, 3.3; and zinc, 3.04. At the rate fed, the trace minerals cost only 1 or 2 cents per head during the winter.

Previous tests have indicated that the addition of the trace mineral mixture described above increased utilization of a urea-containing protein supplement. In an attempt to determine which of the minerals was responsible for the increased utilization, the calves in Lot 4 were fed the same supplement fed to Lot 2 except that four trace minerals (iron, copper, cobalt and zinc) were added in the same amounts as fed in Lot 3. Many of the minerals in the commercial mixture were present in the form of sulfates. Since sulfates may affect the utilization of urea, the supplement in Lot 4 contained iron, copper and cobalt as carbonates and zinc as the oxide.

All pelleted supplements were fed every other day. A mixture of 2 parts salt and 1 part steamed bone meal was available in all lots.

Results

Average weights and winter gains of the steers are given in Table 2. The steers fed the cottonseed meal pellets gaind 7 lb. in the 130-day period. All other groups of cattle were fed the urea-containing pellet and lost weight. In contrast to the results in five previous tests, the addition of trace minerals did not improve the utilization of urea (Lot 2 vs. 3). The steers in Lot 4 lost considerably more weight than other steers. The reason for this greater loss is not apparent.

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* Urea was furnished by Nitrogen Division, Allied Chemical and Dye Corporation.

** Mineral mixture furnished by Calcium Carbonate Company.

Table 2.—Trial I. Urea in protein supplements for wintering steer calves grazing native grass (130 days)

	Lot 1 40-CSM	Lot 2 40-Urea	Lot 3 40 Urea + trace minerals	Lot 4 40-Urea + 4 minerals
Number of steers	15	15	15	15
Average weight per head (lb.)				
Initial 11-11-57	475	474	479	477
Final 3-21-58	482	461	463	434
Gain	7	—13	—16	—43

Trial II. Urea in Protein Supplements for Wintering Yearling Heifers Grazing Native Grass

Procedure

Sixty-eight, grade, Hereford, yearling heifers were divided into 3 lots on November 11, 1957, and allowed to graze the native grass pastures on the south side of Lake Carl Blackwell. In addition to the dried grass, they were fed an average of 2 lb. per head daily of the following protein supplements:

Lot 1. 40 per cent protein supplement containing urea.

Lot 2. Same as Lot 1 plus trace minerals (iron, copper, cobalt, manganese, iodine and zinc).

Lot 3. Same as Lot 1 plus iron, copper, cobalt and zinc.

These supplements are the same as those fed to Lots 2, 3 and 4, respectively, in Trial I. The feeding procedures were as described in Trial I.

Results

Results of this trial are summarized in Table 3. All groups of heifers lost weight. The losses were 63, 85 and 72 lb. in Lots 1, 2 and 3, respectively. Heifers which were fed supplemental trace minerals lost more weight than those not fed trace minerals. These results are in general agreement with those obtained in Trial I but not in agreement with results obtained in previous years. The feeding of four trace

Table 3.—Trial II. Urea in protein supplements for wintering yearling heifers grazing native grass (130 days)

	Lot 1 40-Urea	Lot 2 40-Urea + trace minerals	Lot 3 40-Urea + four minerals
Number of heifers	22	23	23
Average weight per head (lb.)			
Initial 11-11-57	705	711	710
Final 3-21-58	642	626	638
Gain	—63	—85	—72

minerals (Lot 3) did not result in decreased gains as noted in Trial I.

The difference in results obtained this year from those in previous years is apparently related to the composition of the forage in the pastures. The 1957 growing season was relatively wet and cool and the pastures contained a large quantity of forage.

Trial III. Urea in Protein Supplements for Wintering Calves on Winter-Cut Weathered Forage

Procedure

In Trials I and II, cattle have been wintered on dry range grass and pelleted supplements. In Trial III, the roughage was native grass forage harvested in early November. This roughage was lower in protein and phosphorus and higher in crude fiber than good quality prairie hay harvested from similar areas in July. The composition of weathered forage was more like the dry grass available in the pastures during the winter than prairie hay. Prairie hay was not used as the roughage because previous tests have indicated relatively efficient utilization of urea-containing pellets when fed as supplements to good quality prairie hay.

On November 5, 1957, fifty, grade, Hereford calves were divided into 5 lots of 10 head (6 heifers and 4 steers per lot). They were fed the mature harvested forage and an average of 2 lb. per head daily of the following supplements:

Lot 1. 40 per cent protein supplement.

Lot 2. 40 per cent protein supplement containing urea.

Lot 3. Same as Lot 2 plus trace minerals.

Lot 4. Same as Lot 3 plus aureomycin (chlortetracycline).

Lot 5. Same as Lot 3 plus B vitamins.

The supplements fed to Lots 1, 2 and 3 were the same as those described in Trial I. The trace minerals, aureomycin and B vitamins were added to determine whether or not they would increase utilization of a urea-containing supplement as measured by weight gain of the calves. Aurofac 10 was added to the supplement fed Lot 4 in order to furnish 75 mg. aureomycin per head daily. The B vitamins added to the pellet fed to Lot 5 were riboflavin, pantothenic acid, niacin and choline. These were added as Fortafeed** and fed at the rate of 0.025 lb. per head daily. A mixture of 2 parts salt and 1 part steamed bone meal was available in all lots. An estimate of the roughage intake was obtained from a record of the numbers of bales fed and the average weight of a sample of bales. Since the roughage contained many weeds and the calves sorted out much of these materials an accurate measurement of feed intake could not be obtained. It is estimated that the calves consumed approximately 10 lb. per head daily although they were fed approximately 14 lb.

* Aurofac 10 is manufactured by American Cynamid Co. and furnishes 10 gm. aureomycin hydrochloride per lb. of material.

**Fortafeed is manufactured by American Cynamid Co. and furnishes 2 gm. riboflavin, 4 gm. pantothenic acid, 9 gm. niacin and 90 gm. choline chloride per lb. of Fortafeed.

Results

Weight data are given in Table 4. The average weight change during the 137-day feeding period was a loss in every lot. The losses varied from 6 to 32 lb. If these cattle had been fed good quality prairie hay and 2 lb. of the supplements as fed in this test, the expected gain would have been approximately 80 lb. Such data indicate nutritive value of the mature harvested grasses fed in this test.

The loss of 6 lb. in Lot 1 is considerably less than the losses in the other lots. The differences in gains of cattle in the lots fed the urea-containing supplements are minor and indicate no apparent value of any of the additives for increasing utilization of urea.

Table 4.—Trial III. Urea in protein supplements for wintering calves on winter-cut weathered forage (137 days)

		Lot 1 40-CSM	Lot 2 40-Urea	Lot 3 40-Urea + trace minerals	Lot 4 40-Urea + T.M. + Aurofac[1]	Lot 5 40-Urea + T.M. + Fortafeed[2]
Number of head		10	10	9[3]	10	10
Average weight per head (lb.)						
Initial	11- 5-57	498	498	509	500	498
Final	3-22-58	492	474	489	468	469
Gain		— 6	—24	—20	—32	—29

[1] 75 mg. aureomycin per head daily furnished by Aurofac 10 (American Cynamid Co.).
[2] 0.025 lb. Fortafeed per head daily. Manufactured by American Cynamid Co. and furnishes 2 gm. riboflavin, 4 gm. pantothenic acid, 9 gm. niacin and 90 gm. choline chloride per lb. of Fortafeed.
[3] One calf removed because of refusal to eat supplemental feed.

Trial IV. Effect of Stilbestrol Implants on Gains of Steer Calves Wintered on Native Grass

Procedure

The 60 steer calves used in Trial I of this experiment were divided into groups within each lot in order to study the effect of implanting two levels of stilbestrol. The treatments were:

Group 1. No implant.

Group 2. One 12 mg. implant*.

Group 3. Two 12 mg. implants*.

The experiment was started on November 11, 1957. The calves were allowed to graze the native grass pastures and were fed 2 lb. per head daily of supplemental protein feed. In addition, a 2 to 1 mixture of salt and steamed bone meal was available.

Results

The average gains of the steers are given in Table 5. Apparently the stilbestrol implants had some effect on winter weight changes. The

* Stimplants furnished through courtesy of Chas. Pfizer and Co. Inc.

Table 5.—Trial IV. Effect of stilbestrol implants on gains of steer calves wintered on native grass (130 days)

Lot No. Stilbestrol Implant*		Lot 1 none	Lot 2 12 mg.	Lot 3 24 mg.
Number of steers		19	20	19
Average weight per steer (lb.)				
Initial	11-11-57	479	476	481
Final	3-21-58	452	466	469
Gain		—27	—10	—12

* Stimplants furnished by Chas. Pfizer and Co., Inc.

control steers of Lot 1 lost an average of 27 lb. per head. Those implanted with 12 and 24 mg. of stilbestrol lost 10 and 12 lb., respectively. These differences were relatively consistent within the four groups of cattle fed protein supplements as described in Trial I.

Trial V. Effect of Feeding 5 mg. Stilbestrol to Calves Wintered on Prairie Hay

Procedure

Thirty-two weanling calves were divided into two lots on the basis of sex and weight on November 5, 1957. There were 11 heifers and 5 steers per lot. They were fed prairie hay **ad lib.** and 1.25 lb. of protein supplement per head daily as follows:

Lot 1. Pelleted cottonseed meal.

Lot 2. Pelleted cottonseed meal plus stilbestrol*.

Stilbestrol was added to the cottonseed meal at the rate of 5 mg. for each 1.25 lb. of cottonseed meal because the desired intake was 5 mg.. per calf daily. A mixture of 2 parts salt and 1 part steamed bone meal was available in both lots. Twice the daily allowance of hay and protein supplement was fed every other day.

Results

The calves consumed 10.5 to 11 lb. prairie hay per head daily. Considerable wastage of the hay made accurate measurement intake difficult, but there were no apparent differences between lots in consumption of hay.

The average gains are given in Table 6. Gains of both groups of calves were nearly the same (55 vs. 48 lb.) indicating little, if any, effect of stilbestrol on gains of calves fed prairie hay and pelleted cottonseed meal.

Trial VI. Effect of Stilbestrol Administration to Suckling Calves Upon Subsequent Performance in Wintering Studies

Procedure

Tests at this station (as reported elsewhere in this publication)

* Stilbstrol furnished through the courtesy of Eli Lilly and Co.

Table 6.—Trial V. Effect of feeding 5 mg. stilbestrol to calves wintered on prairie hay (137 days)

		Lot 1 Control	Lot 2 Fed Stilbestrol
Number of head		16	16
Average weight per head (lb.)			
Initial	11- 5-57	422	416
Final	3-22-58	477	464
Gain		55	48
Daily gain		0.42	0.37

have shown that implanting suckling beef calves with stilbestrol increased gains approximately 14 per cent. In one test spring-dropped calves were divided into three lots and all calves were creep-fed. The calves in the second lot were implanted with two 12 mg. pellets of stilbestrol (one on May 24 and the second August 13). Stilbestrol was included in the creep-ration of the third lot in such amounts that each calf consumed approximately 5 mg. per day. In this trial feeding stilbestrol had little effect on gains but implanting increased gains 36 lbs.

In order to provide preliminary data on the effect of summer treatment on gains during the winter, the calves were divided into 5 lots of 10 on the basis of sex, summer treatment and weight. Each of the lots contained, therefore, calves which had served as controls during the summer, calves which had been implanted with stilbestrol and those which had been fed stilbestrol. The calves were fed winter-cut, weathered forage and 2 lb. of protein supplement as described in Trial II of this article.

Results

There was apparently little difference in weight changes between steers and heifers. The average weights and gains are given in Table 7. In the summer test, feeding 5 mg. of stilbestrol per head daily in the creep-feed of suckling calves did not increase gains. However, stil-

Table 7.—Trial VI. Effect of stilbestrol administration to suckling calves upon subsequent performance in wintering studies

Lot number Stilbestrol during summer	1 None	2 Implanted[1]	3 Fed[2]
Number of calves	13	17	16
Summer gain (lb.)	284	320	288
Gain from weaning to 11-5-57 (lb.)	—24	—30	—36
Av. weight per calf 3-22-58 (lb.)	470	516	467
Winter gain (lb.)	—28	—14	—25
Net gain[3]	232	276	227

[1] One 12 mg. implant in May and a second 12 mg. implant in August.
[2] Fed 5 mg. of stilbestrol per head daily.
[3] Gain from beginning of summer period until end of winter period.

bestrol implants (one in May and one in August) increased gains 36 lb. or nearly 13 per cent. There was some variation in losses of weight during the period from weaning in October to beginning of the winter test on Nevember 5. In this approximately 30-day period, the losses varied from 24 to 36 lb.

In the wintering test, the calves in Lots 1 and 2 lost nearly the same amount of weight. This would be expected since there was practically no difference in gains during the previous summer. The calves which had been previously implanted lost slightly less weight during the winter. One of the purposes of this test was to determine whether or not the subsequent winter gain of cattle would be decreased when the calves had been implanted with stilbestrol during the summer. In this preliminary test the weight advantage present at weaning was increased during the wintering period. The total gains from the beginning of the summer to the end of the winter were 232, 276 and 227 lb. for Lots 1, 2 and 3, respectively.

Summary

The value of stilbestrol and urea in rations for wintering beef cattle and the subsequent performance of calves previously administered stilbestrol were studied in 6 trials.

Cattle fed a urea-containing supplement (40 per cent protein) did not gain as much as those fed pelleted cottonseed meal. The addition of trace minerals, aureomycin or certain B vitamins failed to increase the utilization of urea.

The feeding of 5 mg. of stilbestrol to calves fed prairie hay and cottonseed meal had little effect on winter gains. Implanting steer calves with 12 or 24 mg. of stilbestrol apparently slightly decreased winter weight losses of steer calves fed protein supplements while grazing native grass.

The subsequent winter weight loss of calves which had been implanted with stilbestrol during the previous summer was slightly less than the gains of those not previously implanted. This is in agreement with the results of fattening tests which are reported elsewhere in this publication.

Effect of Rapid vs. Moderate Rates of Gain on Feed Efficiency and Carcass Composition of Steer Calves

L. S. POPE, R. L. HENRICKSON, J. R. LeGENDRE AND GEORGE ODELL

Recent surveys suggest that consumers prefer leaner beef rather than fatter cuts. Flavor and tenderness are important considerations. Nutritive values for different grades of beef have been based principally on their caloric or energy value, and were established in an era in which larger and fatter cuts were preferred than are currently demanded by consumers. Today, beef is included in the diet more for its flavor and as a source of protein than for its energy value. Hence, feeding regimes should be established that will result in the greatest amount of protein tissue at cheapest cost—and still retain flavor, tenderness and other desirable qualities.

Few studies have been undertaken to determine the effect of different rates of gain of fattening calves on the quantity and quality of beef produced. Hence, a pilot study was established in the fall of 1956 using individually fed steer calves which were fattened so as to gain at different rates until each had achieved 365 lb. of total feedlot gain. The effects of these treatments were evaluated in terms of economy of conversion of digestible nutrients to body weight and the physical and chemical composition of the carcass. A more extensive trial is now in progress and will be completed in July, 1958. This report gives the results of the first trial (1956-57).

Procedure

Sixteen, Hereford steer calves from the same Experiment Station herd were selected for this study in October, 1956. One-half of the calves were sired by one bull, the remaining calves by one of two half-brother bulls. The calves were approximately 8 months of age when started on feed. They were individually fed in stanchioned stalls, twice daily, during the trial. Allotment was made on the basis of sire, age, weight and feeder grade. All calves were fed for sufficient time to make 365 lb. total feedlot gain, which has been demonstrated in feeding trials at this station to be the average amount gained by steers full-fed from weaning to Choice slaughter grade. Four treatments were employed (4 calves per treatment) as follows:

Lot 1—Rapid rate of gain.

Lot 2—Rapid rate of gain until one-half of desired feedlot gain was obtained, then moderately for remainder of period.

Lot 3—Reverse of Lot 2—moderate for first half and then rapidly.

Lot 4—Moderate rate of gain throughout.

As stated above, it was believed that calves of Lot 1 would grade Choice after completing 365 lb. feedlot gain. All calves received rolled milo, cottonseed meal, dehydrated alfalfa meal pellets and cottonseed hulls, with minerals free-choice. To obtain the high rate of gain, a milo intake of approximately 2 lb. per cwt. was employed—which is essentially the grain intake achieved when cattle are full-fed. The moderate level was approximately one-half of this, or 1 lb. milo per cwt. per day.

Shrunk weights were taken initially and at the end of the trial. As each calf achieved the desired feedlot gain, it was removed and slaughtered at the meats laboratory. Detailed physical and chemical tests were conducted to determine the yield of wholesale cuts, their composition and desirability.

Results

A summary of average daily gains, feed consumption and feed required per cwt. gain are shown in Table 1. Carcass data relative to

Table 1.—Average feedlot performance and nutrient intake of individually-fed steer calves fattened at different rates

	Lot 1 High	Lot 2 High-moderate	Lot 3 Moderate-high	Lot 4 Moderate
No. of steers/treatment	4	4	4	4
Total days on feed	177	197	189	188
Av. weights (lb.)				
Initial	520	525	507	525
Final	885	882	872	893
Av. daily gain				
Phase I	2.60	2.48	2.18	2.23
Phase II	1.69	1.40	1.76	1.72
Total period	2.06	1.84	1.93	1.96
Ave. daily gain minus fill (lb.)[1]	1.68	1.39	1.53	1.40
Av. daily ration (lb.)				
Rolled milo	13.4	8.6	10.3	6.6
Cottonseed meal	1.0	1.2	1.2	1.4
Dehyd. alfalfa pellets	1.0	1.0	1.0	1.0
Cottonseed hulls	4.8	7.6	6.2	9.4
2-1 mineral mix	ad. lib.	ad. lib.	ad. lib.	ad. lib.
Feed required per lb. gain (lb.)[2]				
Concentrates	7.0	5.3	6.0	4.0
Roughage	2.8	4.6	3.7	5.3
TDN required per lb. gain (lb.)[2]	6.8	6.2	6.4	5.5
Feed cost per lb. gain (¢)[2]	21.7	19.6	20.2	17.4

[1] Contents of rumen, reticulum, omasum and abomasum determined at time of slaughter and deducted from live animal weight.
[2] Based on average live gain, with no consideration for differences in "fill" at slaughter.

yield, grade, rib eye area, marbling, yield of wholesale cuts, physical and chemical composition of ninth-, tenth-, and eleventh-rib cuts, and tenderness are given in Table 2. While the numbers involved in this test were small, the use of individual feeding techniques and the fact that nearly 100 observations were made on each carcass enhances the value of the data.

Steers of Lot 1, fed to gain rapidly throughout, made daily gains of 2.06 lb. per day, while those fed moderately gained 1.96 lb. per day. This was surprisingly good for the "moderates," although when the "fill" of the stomachs at slaughter time was removed, the moderately fed cattle lost some of this advantage. Even though final live weights in this experiment were taken after a 36-hour period off feed and water, there were considerable differences in "fill". When this difference is considered, a greater spread between Lots 1 and 4 in daily gain (0.28 lb. per day) becomes apparent. Such discrepancies point up the shortcomings of "live weight" as the means of evaluating ration effects.

Gains of Lot 2, fed on the high-moderate regime, were poorest of the four treatments. The poor performance of this group in respect

Table 2.—Live animal and carcass grades, and composition of carcasses of steers fattened at different rates of gain

	Lot 1 High	Lot 2 High-moderate	Lot 3 Moderate-high	Lot 4 Moderate
Final grade score on-foot[1]	12.5	16.0	12.5	15.0
Carcass grade score[1]	11.5	14.0	13.0	15.0
Dressing percent	63.5	61.2	62.3	61.1
Area of eye muscle (sq. in.)	8.69	8.30	8.79	9.14
Marbling score[2]	15.3	16.2	18.3	19.5
Wholesale cuts (%)				
Round	17.9	18.6	17.4	18.7
Rump	4.9	5.0	4.9	4.9
Rib	8.1	8.4	8.2	7.9
Loin	14.9	14.8	14.7	14.8
Chuck	25.3	26.0	25.4	26.0
Others[3]	28.8	27.1	28.6	27.5
Composition of 9-10-11th rib cut (%)[4]				
Fat	35.6	29.9	34.8	27.7
Muscle	51.5	56.0	52.8	57.4
Bone	14.1	15.3	14.1	15.8
Chemical composition of eye muscle (%)				
Water	69.84	69.98	69.80	71.31
Fat	6.83	6.82	6.41	5.77
Protein	22.28	21.98	22.46	22.55
Ash	1.08	1.02	1.10	1.07
Tenderness of loin steak (shear test, lb.)[5]	20.9	19.3	17.0	20.2

[1] High choice=8, Av. choice=10, Low choice=12, High good=14, and Av. good=16.
[2] Av. opinion of 3 judges; lowest value=best marbling.
[3] Includes yield of flank, kidney knob, plate, brisket and shank.
[4] Calculated from physical separation of 9-10-11th rib cut.
[5] Average of 9 shears per steak; least lb.=most tender.

to Lot 4 could have been due to increased maintenance requirements during the last half of the feedlot period. While the steers of Lot 3, fed on the moderate-high plan, appeared disappointing in average daily gain based on live weights, removing "fill" resulted in this group being the second best gainers.

Wide differences in the amount of grain consumed can be seen in Table 1. Since live weight gains were so similar, concentrates required per 100 lb. gain favored the cattle fed moderately throughout (Lot 4), although somewhat more roughage was required. Applying current feed prices to these results reveals that Lot 1, followed closely by Lot 3, was most costly, with least costly gains for Lot 4. When Morrison's digestible nutrient values are applied to the average daily rations consumed, the least TDN was required per lb. of gain for the moderate (Lot 4) and most for the high (Lot 1) treatments, with other groups intermediate. It is apparent that the young, growing calves used in this trial could use the moderate regime for very efficient gains, while attempts to fatten them above this level were distinctly inefficient.

From the carcass grades and slaughter data shown in Table 2, the following observations seem justified:

1. As would be expected, final live grades and carcass grades favored steers fed to gain rapidly (Lot 1). Those fed to gain moderately (Lot 4) were lowest in grade, with other treatments tending to reflect the level of grain fed during the last one-half of the trial.

2. Dressing percent favored the steers fed at the high or moderate-high levels (Lots 1 and 3). High level steers showed more abundant marbling, while moderately fed cattle, or those fed on the moderate-high regime, showed the least.

3. Area of rib eye muscle differed only slightly due to treatment, but tended to be largest for steers fed continuously at the moderate level (Lot 4) and least for those fed on the high-moderate regime.

4. Yield of wholesale cuts, when expressed as percent of carcass, showed only small differences as influenced by treatment. Yields of rump, rib and loin were essentially the same regardless of treatment. Yields of round and chuck tended to be higher, and other cuts lower, for those calves fed at the moderate or high-moderate levels.

5. Physical composition of the ninth-, tenth-, and eleventh-rib cut, which has been accepted as a reliable indication of carcass composition, revealed much higher fat content for calves fed to gain rapidly (Lot 1) or on the moderate-high program (Lot 3), with much less fat and more muscle tissue for those fed at the other two levels. The difference between Lots 1 and 4 in muscle content amounted to approximately 6 percent in favor of Lot 4, while fat differences approached 8 percent in favor of Lot 1. With other lots, these measurements tended to reflect the level of grain fed during the last half of the fattening period.

6. Moisture content of eye muscle was slightly higher for calves fed moderately, perhaps an association with greater protein deposition in this cut. Fat was decreased in calves fed the moderate level throughout, while protein and ash remained essentially the same.

7. Tenderness (Warner-Bratzler shear values) of loin steaks favored calves fattened at a moderate-high rate, and was less favorable for calves fattened rapidly. Shear values were not correlated with marbling scores, nor were they correlated with fatness of eye muscle as determined by chemical analysis.

Further comparisons have been made of selected tissues, and palatability studies are underway to determine flavor and acceptability of loin and round steaks from each carcass.

Summary

The results from the first in a series of fattening trials to determine the effect of different rates of gain on efficiency of feed conversion and carcass composition are reported. Sixteen steer calves were individually fed to make 365 lb. total feedlot gain. One group of 4 calves was fed so as to gain at each of the following rates: High throughout; high for one-half total feedlot gain and then moderately; moderately and then high, and moderately throughout. The high level of gain was achieved by feeding 2 lb. milo per cwt., while calves fed to gain at a moderate rate received 1 lb. per cwt.

Results of the first trial indicate that steer calves fed to gain rapidly for 365 lb. produced a higher grading carcass, with more marbling and a higher percentage of fat. Such treatment, however, resulted in less efficient conversion of digestible nutrients to gain, less round, smaller rib eye area and less lean tissue in the carcass. Gains and carcass desirability of the moderately-fed group proved very encouraging for this type of feeding regime. Changing from high to moderate, or the reverse, after one-half of the feedlot gain had been achieved, generally gave results intermediate to feeding for either high or moderate gains throughout. It appears that the high-moderate treatment may be the least desirable of the four methods studied.

Mixed Rations vs. the Free-Choice Feeding of Milo and Supplement for Growing and Finishing Pigs

J. C. HILLIER AND J. J. MARTIN

Does the feeding of a complete ration containing ground milo plus the protein, vitamin, mineral and antibiotic supplements to be fed, all mixed together, produce faster and/or more economical gains than would be obtained from a free-choice system of feeding? In the free-choice system, the ground milo is fed in one part of the feeder and the supplement containing the necessary protein, mineral, vitamin and antibiotic materials in another part of the feeder, with the pigs free to choose how much of each they eat.

The relative performance on these two systems is important to the feeder for the free-choice system requires the mixing of only about 25 percent as much feed as is required if a complete mixed ration is used. Information on this point is also important to the feeders in deciding whether to buy a complete mixed ration or a supplement and grain that could be fed free-choice.

The pigs used in these two trials were started on feed shortly after they were weaned, averaging nine to ten weeks of age. They were of Hampshire, Poland China and Yorkshire breeding with an equal number of each breed in each lot within trials. All of the pigs used were gilts.

The pigs were fed in concrete-floored pens of which approximately one-third of the area was covered by a shed open to the south. A fine mist was sprayed over a section of the pen during the day in the summer. The pigs were free to move about under the mist or in other sections of the pen as they desired. In winter a section of the covered area was bedded.

Weights were taken every fourteen days until the pigs approached 200 pounds in weight. At that time the weights were taken as seemed desirable and the pigs were removed from the test as near the desired weight as possible..

Two mixed rations and four free-choice rations were compared. Previous tests indicated that lysine is the first limiting amino acid in a milo soy meal type of ration. To improve the lysine level of the ration, 3 percent fish meal was used to replace a part of the soy meal in one mixed ration and a comparable amount in two supplements. Vitamin A acetate was used to replace alfalfa leaf meal as a source of this vitamin in two of the supplements. It was felt that the removal of alfalfa meal from the supplement would lower the fiber content and improve the energy level of the ration. Since pigs receiving the vitamin A acetate in place of alfalfa meal in Trial 1 consumed more supplement than seemed necessary 20 percent ground milo was used in the supplement for Lots 5 and 6 during the second trial in an attempt to reduce the protein intake on this supplement.

A comparison of the results obtained on the two mixed rations (1 and 2) with those produced by the two free-choice rations containing comparable ingredients, (3 and 4), shows that the two types of rations produced about the same rate of gain in trial 1 (summer, 1957). About 3 percent less feed was required per unit of gain when the mixed ration was fed than when free-choice feeding was practiced.

A comparison of the rate and economy of gain made by Lots 3 and 4 with those made by 5 and 6 (alfalfa meal vs. vitamin A concentrate) shows that the two types of supplements produced about equal gain. However, about 7 percent less feed was required by the group receiving the vitamin A concentrate in place of the alfalfa leaf meal.

The supplements containing the fish meal (Lots 4 and 6) produced about the same rate and economy of gain as those in which soy meal alone (Lots 3 and 5) was the source of supplemental protein. Considering all lots, those rations containing soy meal alone as the supplemental protein (1, 3 and 5) produced almost the same rate and economy of gain as those in which fish meal provided a part of the supplemental protein. However, since fish meal is a more expensive source of protein, pigs fed rations containing this feed had a feed cost per unit of gain that was 36 cents per hundred above that for those receiving only soy meal ($8.48 vs. $8.84).

In Trial 2 the rate and economy of gain was almost the same for the comparable lots receiving a mixed ration and those receiving ground milo and supplement free-choice (1 and 2 vs. 3 and 4). Rations 5 and 6

Table 1.—Mixed rations vs. free-choice feeding of milo and supplement—Rations Used—Trial 1—Summer 1957

Lot No.	1	2	3	4	5	6
Method of Feeding	Mixed Ration	Mixed Ration	Free-Choice	Free-Choice	Free-Choice	Free-Choice
	Ration	Ration	Supplement	Supplement	Supplement	Supplement
Ration (%)						
Milo (ground)[1]	76.3[2]	79.3	--	--	--	--
Soy meal	15.8	10.1	68.9	57.6	88.9	77.6
Fish meal	--	3.0	--	12.0	--	12.0
Dehyd. alfalfa meal	5.0	5.0	20.0	20.0	--	--
Bone meal	2.0	1.7	7.5	6.8	7.5	6.8
Salt	0.5	0.5	2.0	2.0	2.0	2.0
Antibiotic and B vitamin mix[3]	0.4	0.4	1.6	1.6	1.6	1.6
Vitamin A[4]	--	--	---	---	+	+
Total	100.0	100.0	100.0	100.0	100.0	100.0
Percent protein						
Ration or Supplement	16.8	16.5	35.3	37.5	40.9	43.2
As consumed	15.3	15.3	15.3	15.3	16.9	17.0
Ratio of grain to supplement	--	--	5.0	5.6	4.3	4.6
Cost of ration or supplement Dollars/cwt.[5]	2.41	2.53	3.67	4.34	4.12	4.79

[1] Kafir 4414, a white colored variety was fed to all lots.

[2] The ration listed was fed until the pigs reached an average weight of 100 pounds. From 100 to 200 pounds a ration containing 14.0% crude protein was fed—same ingredients as above.

[3] The antibiotic—B vitamin mix supplies 5.4 mg. of antibiotics; 5.4 mcg. of B_{12}, 2.0 mg. of riboflavin, 4.0 mg. of pantothenic acid, 9.00 mg. of niacin and 90 mg. of choline per pound of ration in lots 1 and 2 and was calculated to supply about the same amount to the other lots through the supplement. Zinc sulphate was also added at the rate of 0.02% of the complete rations.

[4] The vitamin A concentrate was added at a rate to supply 4,000 I U per pound of ration as consumed.

[5] The costs listed for rations 1 and 2 are for the ration used until the pigs reach 100 pounds. The rations fed from 100 to 200 pounds cost $2.34 and $2.45 per hundred, respectively, for rations 1 and 2. Milo was figured at $2.00 per cwt.

Table 2.—Mixed rations vs. the free-choice feeding of milo and supplement—Summary of results—Summer 1957
Average of duplicate lots

Lot No. Method of Feeding	1 Mixed Ration	2 Mixed Ration	3 Free-Choice	4 Free-Choice	5 Free-Choice	6 Free-Choice
No. of pigs	16	15	13	13	14	16
Av. initial wt. (lbs.)	56.9	58.0	57.8	56.9	58.1	57.1
Av. final wt. (lbs.)	200.1	195.9	195.4	195.6	191.7	196.9
Av. daily gain (lbs.)	1.58	1.49	1.51	1.53	1.50	1.53
Feed/lb. gain						
Complete ration	3.57	3.65	--	--	--	--
Milo	--	--	3.14	3.17	2.84	2.83
Supplement	--	--	.62	.58	.67	.62
Total feed/lb. gain	3.57	3.65	3.76	3.75	3.51	3.45
Feed cost/lb. gain ($)	8.45	9.01	8.56	8.85	8.44	8.66

Table 3.—Mixed rations vs. free-choice feeding of milo and supplement—Rations used—Trial II—Winter 1957-58

Lot No. / Method of Feeding	1 Mixed Ration	2 Mixed Ration	3 Free-Choice	4 Free-Choice	5 Free-Choice	6 Free-Choice
	Ration	Ration	Supplement	Supplement	Supplement	Supplement
Ration (%)						
Milo (ground)[1]	76.3[2]	79.6	--	--	20.0	20.0
Soy meal	15.8	10.1	68.9	57.6	68.9	57.0
Fish meal	--	3.0	--	12.0	--	12.0
Dehyd. alfalfa leaf meal	5.0	5.0	20.0	20.0	--	--
Dicalcium Phos.	1.5	1.5	5.5	5.1	5.5	5.4
Calcium Carbonate	0.5	0.5	2.0	1.7	2.0	2.0
Salt	0.5	0.5	2.0	2.0	2.0	2.0
Antibiotic and			--	--	+	+
B vitamin mix[3]	0.4	0.4	1.6	1.6	1.6	1.6
Vitamin A	--	--	--	--	+	+
Total	100.0	100.0	100.0	100.0	100.0	100.0
Percent Protein						
Ration or Supplement	16.7	16.4	35.2	37.5	34.0	36.2
As consumed	15.5	15.6	15.3	15.6	16.7	17.9
Ratio of grain to supplement	--	--	5.0	5.7	3.4	2.8
Cost of ration or supplement ($)	2.38	2.5	3.59	4.28	3.78	4.47

[1] Kafir 4414, a white colored variety was fed to all lots.

[2] The ration listed was fed until the pigs reached an average weight of 100 pounds. From 100 to 200 pounds, a ration containing 14% crude protein was fed.

[3] The antibiotic–B vitamin mix supplies 5.4 mg. of antibiotics; 5.4 mcg. of B_{12}, 2.0 mg. of riboflavin, 4.0 mg. of pantothenic acid, 9.00 mg. of niacin and 90 mg. of choline per pound of ration in Lots 1 and 2 and was calculated to supply about the same amount to the other lots through the supplement. Zinc sulfate was also added at the rate of 0.02% of the complete rations.

[4] The vitamin A concentrate was added at a rate to supply 4,000 I U per pound of ration as consumed.

[5] The costs listed for rations 1 and 2 are for the ration used up to a weight of 100 pounds. The rations fed from 100 to 200 pounds cost $2.32 and $2.45 for rations 1 and 2, respectively.

Table 4.—Mixed rations vs. the free-choice feeding of milo and supplement—Summary of results—Winter 1957-58
Average of duplicate lots

Lot No. / Method of Feeding	1 Mixed Ration	2 Mixed Ration	3 Free-Choice	4 Free-Choice	5 Free-Choice	6 Free-Choice
No. of pigs	15	15	13	14	14	15
Av. initial wt. (lbs.)	65.4	65.8	66.3	65.0	65.1	65.5
Av. final wt. (lbs.)	199.3	196.8	197.1	198.4	196.5	201.4
Av. daily gain (lbs.)	1.59	1.57	1.56	1.48	1.55	1.77
Feed/lb. gain (lbs.)						
Complete ration	4.29	4.44	--	--	--	--
Milo	--	--	3.72	3.65	3.07	2.97
Supplement	--	--	.77	.71	.86	1.08
Total feed/lb. gain (lbs.)	4.29	4.44	4.49	4.36	3.93	4.05
Feed cost/lb. gain ($)	10.03	10.93	10.17	10.37	9.40	10.77

(vitamin A) produced about .14 pound more grain per day on about 10 percent less feed per unit of gain than Rations 3 and 4 (alfalfa meal). Again in this trial, rations containing fish meal produced only slightly faster gains than those not containing this ingredient.

In general, the results of these trials indicate that:

The advantage of feeding a mixed ration over the free-choice feeding of milo and supplement is small from the standpoint of both rate and economy of gain.

The supplement must be compounded specifically to meet the deficiencies of the grain with which it is to be fed. The relative palatability of the grain and supplement is an important factor to consider.

The addition of fish meal to a milo-soy meal type of basal ration did not improve the rate or economy of gain to any appreciable extent and proved to be uneconomical.

Replacing alfalfa meal in the supplement with vitamin A acetate, as a source of this vitamin, improved the gain slightly and reduced the feed required per unit of gain by 7 to 10 percent.

Levels of Supplemental Winter Feeding of Beef Cows and Creep-Feeding Fall Calves

A. B. NELSON, R. F. HENDRICKSON, N. W. ROBINSON, W. D. CAMPBELL and G. R. WALLER

In recent years there has been an increase in number of cows calving in the fall in our area. This change in calving season has resulted in a need for additional data on feeding and managing such cattle grazing native grass (Bluestem and associated grasses) yearlong. The cow's requirements for nutrients are markedly increased while she is suckling a calf and supplemental winter feed represents a large portion of the total cost of producing a calf. The amount and kind of supplemental feed needed is determined by the amount and quality of forage available in a pasture. In parts of our state the native grasses furnish practically all of the roughage consumed by a cow herd.

Questions to be considered in planning a winter feeding program include: What is the effect of level of winter feeding on weaning weights of calves and rebreeding rate of the cows? Should creep-feeding be recommended for fall-dropped calves which are to be marketed as feeders in mid-summer? Basically our problem concerning level of wintering is the fact that we do not know what percent of her body weight a cow can lose during the winter and still produce a heavy calf at weaning and rebreed so that another calf is produced the next year.

In order to provide information on the above and other questions, an experiment having the following objectives, was initiated in the fall of 1954.

1. To compare two levels of supplemental winter feeding of beef cows suckling calves.

2. To study the value of creep-feeding suckling calves born in the fall and sold as feeder calves.
3. To study the relationship between the level of winter feeding of cows and creep-feeding of their calves.

The results obtained during the 1954-55 and 1955-56 seasons have been summarized and reported in Okla. Agr. Exp. Sta. MP-45 and 48, respectively. Reported in this article are the results of the 1956-57 test, a 3-year summary, preliminary results for 1957-58 with the same cows, and preliminary results for two-year-old heifers producing their first calf.

Part 1. 1956-57 Experiment

Procedure

All except one of the 80, grade, Hereford cows used in this trial had been used in a similar trial during 1955-56. One cow died during the previous trial and was replaced with one of similar breeding. The 4 lots of 20 head each were weighed on September 29, 1956, and were allowed to graze the native grass pastures at the Lake Carl Blackwell experimental range area and during the winter were fed the following amounts of supplemental feed and their calves were fed as follows:

Lot 1. 1.5 lb. pelleted cottonseed meal; calves not creep-fed.
Lot 2. 1.5 lb. pelleted cottonseed meal; calves creep-fed.
Lot 3. 2.5 lb. cottonseed meal; 3 lb. ground milo; calves not creep-fed.

Lot 4. 2.5 lb. cottonseed meal; 3 lb. ground milo; calves creep-fed.

Supplemental feeding was started on October 25 and continued until April 19. The mixture of cottonseed meal and milo was pelleted for convenience in feeding. The pellets were fed in bunks every other day in amounts to furnish the above-listed pounds per head daily. A mineral mixture of 2 parts salt and 1 part steamed bone meal was available at all times. The creep-feed was a mixture containing 55 percent rolled milo, 30 percent whole oats, 10 percent cottonseed and 5 percent cane molasses. The mixture was available in mid-December but only small quantities were consumed until late January.

Purebred Hereford bulls had been placed with the cows on December 15, 1955; therefore, the first calves were born in late September, 1956. Cows were rebred starting December 19, 1956, for calving in the fall of 1957.

Results

A summary of the data collected in the 1956-57 season is given in Table 1.

The cows on the low level of wintering, Lots 1 and 2, lost 295 and 313 lb., respectively, during the winter period. These losses were only slightly different from the losses of 264 and 309 lb. for Lots 3 and 4, respectively. The average difference was only 18 lb. This difference has been considerably greater in previous tests. The cows in Lot 4 lost more

Table 1.—Creep-feeding fall calves and levels of wintering cows suckling calves (1956-57)

Lot number Level of feeding cow Calf feeding	1 1½ lb. CSM None	2 1½ lb. CSM Creep-fed	3 2½ lbs. CSM 3 lb. milo None	4 2½ lbs. CSM 3 lb. milo Creep-fed
Number of cows raising calves[1]	19	14	18	17
Average weight per cow (lb.)				
Initial 9-29-56	1099	1129	1096	1153
Spring 4-19-57	804	816	832	844
Weaning 7-29-57	1026	1089	1002	1119
Fall 9-21-57	1086	1105	1104	1146
Winter gain	—295	—313	—264	—309
Gain to weaning	— 73	— 40	— 94	— 34
Yearly gain	— 13	— 24	8	— 7
Average weight per calf (lb.)				
Birth[2]	80	78	78	79
Weaning 7-29-57[3]	474	539	487	575
Average birth date of calves, Oct.	14	28	18	9
Supplemental feed per animal (lb.)				
Cow[4]				
Cottonseed meal	266	266	442	442
Milo	—	—	531	531
Calf (creep-feed)	—	1051	—	975
Total feed cost per head ($)				
Cow	34.04	34.04	53.30	53.30
Calf[5]	—	32.37	—	30.06
Total	34.04	66.41	53.30	83.36
Selling value ($)				
Per 100 lb.				
Steers	24.50	24.50	24.50	24.50
Heifers	21.00	21.00	21.00	21.00
Per head	104.68	119.48	107.64	127.66
Selling value minus feed cost ($)	70.64	53.07	54.34	44.30

1 There were originally 20 cows per lot. One cow in Lot 1 died of unknown causes. In Lot 2 there were 3 open cows. In addition, 1 calf was born dead and 2 cows died from accidental urea poisoning. Two calves died in Lot 3. In Lot 4 one cow was open, 1 cow drowned and 1 calf died following castration and dehorning.
2 Corrected for sex by the addition of 3 lbs. to the weight of each heifer calf.
3 Corrected for sex by the addition of 30 lb. to the weaning weight of each heifer after correction to 280 days of age.
4 177 days of feeding.
5 Creep-feed cost $3.08 per 100 lb.

weight than those in Lot 3 even though both were fed the same amount of supplemental feed. The cow gains from late September until late July (weaning) were quite variable with slightly greater losses on the high level. However, when the 2-month period following weaning is included, the gains are slightly in favor of the high level. The gains of the cows from September to weaning were in favor of creep-feeding. However, the winter gains and yearly gains were not in favor of creep-feeding. Most of the differences in gain were small and probably are not of practical importance.

The calves were weaned on July 29 and sold at the Oklahoma City livestock market. The weaning weight of the calves in Lot 1 was 474 lb. The creep-fed calves of Lot 2 weighed 539 lb. The calf weights in Lots 3 and 4 were 487 and 575 lb., respectively. The increased gain resulting from creep-feeding was 65 lb. for calves from the low-level cows and 88 lb. for those from the high-level cows. This was the opposite of results obtained in the two previous tests in which creep-feeding resulted in greater increases in gain for calves from the low-level cows.

The steers were sold as feeders at $24.50 per 100 lb. The heifers sold as feeders for $21.00 per 100 lb. The fatter heifers of the creep-fed lots were appraised for slaughter at $20.50. The other heifers would have sold for approximately $19.50 per 100 lb. for slaughter. The slaughter value of the steers was estimated to be $19.50 per 100 lb. As has been noted in previous tests the value per calf was greater as feeders than as slaughter calves.

The calves in Lot 2 consumed an average of 1051 lb. of creep-feed per head which cost $32.37 in this test. In Lot 4 the 976 lb. of creep-feed cost $30.06 per calf. The cost of feed for the cows in Lots 1 and 2 (low level) was $34.04. When this cow-feed cost and creep-feed cost were subtracted from the selling value per calf, the "net return" was more than $17 per head in favor of not creep-feeding ($70.64 vs. $53.07). In Lots 3 and 4 (high level) the difference was approximately $10 per head in favor of not creep-feeding ($54.34 vs. $44.30).

The cost of the increased feed for Lots 3 and 4 as compared to Lots 1 and 2 was considerably greater than the increased value of the calves sold. The 25 lb. average increase in weaning weight was not equal in value to the $18.11 average increase in feed costs. Not included in these measures is any difference in rebreeding rate. This will be discussed in Part 2 of this report.

Apparently either increased level of winter feeding or creep-feeding will increase gain of the calves and the calves will probably be slightly fatter at weaning. However, when costs of feed and selling prices of calves prevailing when these tests were conducted are considered, both practices decreased profits.

Part 2. Three-Year Summary

There are many factors which can influence the gains of cows and calves in an individual year. It is usually advisable, therefore, to conduct a test in several years and make recommendations on the basis of the average results. Such has been done and a summary of the data collected in 1954-55, 1955-56 and 1956-57 is reported in this part of the article.

Procedure

The procedure was the same as that outlined in Part 1. The results given in Part 1 are included in this 3-year summary. In all three years of the study the cows in Lots 1 and 2 were fed an average of 1.5 lb. of pelleted cottonseed meal per head daily during the winter feeding period. In Lots 3 and 4, 2.5 lb. cottonseed meal and 3 lb. ground yellow corn were fed during the first two years. In the third year ground milo replaced the corn, and the mixture of cottonseed meal and milo was pelleted for convenience in feeding. The calves in Lots 2 and 4 were creep-fed. Each lot of cows was moved to a different pasture each year.

The number of cows per lot varied from 17 to 20 in each of the years. The number of cows weaning calves does not indicate the relative value of the treatments concerning reproductive rate because all open cows were removed from the experiment in the first trial. Since that time open cows have been left in the experiment in order that accumulative effects could be noted.

Results

A summary of results obtained during the first three years (1954-55, 1955-56, 1956-57) of this test is given in Table 2. There were small differences in average winter weight losses of the different lots of cows. None of these differences was statistically significant. The average loss for those fed the higher amounts of supplement (Lot 3 and 4) was 232 lb., which was 39 lb. less than those fed on the lower level. Also, the average winter loss was greatest for those cows whose calves were creep-fed. This difference was 25 lb. in favor of not creep-feeding. The average percentage of initial weight lost in the different lots varied from 21 to 26.5 percent. The greatest loss in any one lot within a year was 28 percent. At the present time we do not know the effect of such losses. Because of the great variation among the cow weights, additional tests are necessary before recommendations relating to the practical importance of any of these differences can be made.

There are definite differences in weaning weights of the calves. The high level of feeding cows increased calf weights an average of 29 lb. This difference was statistically significant at the 5 percent level of probability. The difference with non-creep-fed calves was 39 lb. and the difference with creep-fed calves was 19 lb. in favor of the high level of feeding. Creep-feeding increased gains an average of 58 lb. Statistical significance was at the 1 percent level in this case. On the low level of cow feeding, the difference was 68 lb. and on the high level the difference was 48 lb.

The average amount of creep-feed consumed was approximately 850 lb. With a cost of $2.88 per 100 lb., the creep-feed cost an average of $25.08 per head in Lot 2 and $23.79 in Lot 4. Increasing the amount of supplemental feed to the cows increased feed costs approximately $22 per head.

All lots of calves were sold at approximately the same price per

Table 2.—Levels of supplemental winter feeding of beef cows and creep-feeding fall calves (three-year average)

Lot number Level of feeding cow Calf feeding (supplemental)	1 1½ lbs. CSM None	2 1½ lbs. CSM Creep-fed	3 2½ lbs. CSM 3 lbs. grain None	4 2½ lbs. CSM 3 lbs. grain Creep-fed
Total No. of cows raising calves[1]	53	48	52	53
Average weight per cow (lb.)				
Initial	1071	1105	1088	1106
Spring	822	812	859	871
Winter change (196 days)	—249	—293	—229	—235
Weaning	1042	1064	1064	1095
Change to weaning	— 29	— 41	— 24	— 11
Fall	1078	1110	1101	1143
Yearly change	7	5	13	37
Average weight per calf (lb.)				
Birth[2]	75	75	77	75
Weaning[3]	451	519	490	538
Average birth date of calves	Oct.31	Nov. 12	Nov. 2	Nov. 1
Supplemental feed per head (lb.)				
Cow				
Cottonseed meal	281	281	467	467
Grain[4]	—	—	547	547
Mineral[5]	47	48	48	47
Calf (creep-fed)[6]	—	871	—	826
Total feed cost per head ($)				
Cow[7]	33.96	33.98	55.90	55.88
Calf[8]	—	25.08	—	23.79
Total	33.96	59.06	55.90	79.67
Selling value ($)				
Per 100 pounds[9]				
Steers	21.60	21.93	21.93	21.93
Heifers	18.25	18.83	18.83	19.00
Per head[10]	87.12	102.95	96.99	107.25
Selling value minus feed cost ($)	53.16	43.89	41.09	27.58

1 Pregnancy examination in the summer of 1955 indicated 5 open cows in Lot 1 and 1 cow in each of the other lots. These cows wre removed from the experiment and replaced with cows of similar age and breeding. In 1956 there were 3 open cows in Lot 2 and 2 in Lot 4. These cows were left in the experiment in order that accumulative effects could be noted. In 1957 there were several open cows as follows: Lot 1, 2; Lot 2, 4; Lot 3, 1; and Lot 4, 2.

2 Corrected for sex by the addition of 3 lbs. to the birth weight of each heifer.

3 Corrected for sex by the addition of 30 lbs. to the weaning weight of each heifer after correction for age by interpolation.

4 Corn was fed during the 1954-55 and 1955-56 seasons and milo during the 1956-57 season.

5 Mineral mixture was 2 parts salt and 1 part steamed bone meal.

6 Creep-feed mixture during the first season was 60 percent coarsely cracked corn, 30 percent whole oats, 10 percent cottonseed meal and 10 percent cane molasses. In later seasons the corn was changed to 55 percent rolled milo and the molasses reduced to 5 percent.

7 Includes pasture cost and prices of feeds at the time tests were conducted.

8 Based on prevailing feed prices which was an average of $2.88 per 100 lbs. of creep-feed.

9 Based on actual selling prices. Prices as feeders were as high or higher (usually) than prices for slaughter.

10 Based on an equal number of steers and heifers in each lot using the age and sex corrected weaning weights as the steer selling weight and this weight minus 30 lbs. (sex correction factor) as the average weight of heifers.

100 lb. Exceptions were in the first year when there were lower values for both steers and heifers in Lot 1 and a higher value for heifers in Lot 4. The steer prices listed are as feeder steers. In most cases the feeder price for heifers was considerably higher than the price for slaughter. However, in some instances the slaughter price of creep-fed heifers was higher than the feeder price. The selling prices for heifers listed in the table are the averages of the highest selling value whether they sold as feeders or for slaughter. All lots of cattle would have sold as choice feeder calves. Creep-feeding resulted in the production of fatter calves. However, no live slaughter or carcass grades were obtained since most were sold as feeders.

When creep-fed calves do not sell at a higher price per 100 lb. than non-creep-fed calves, the value of the increased gain must be greater than the cost of the creep-feed in order for creep-feeding to increase profits. In these tests creep-feeding decreased profits. The difference between Lots 1 and 2 was $9.27 and the difference between Lots 3 and 4 was $13.51. Under the conditions of our tests creep-feeding should not be recommended.

The high level of winter feeding of the cows decreased profits $12.07 for non-creep-fed calves and $16.31 for creep-fed calves. The increased selling value of the calf was considerably less than the increased cost of winter feed.

In different years there has been considerable variation in the number of open cows in each lot. This number has varied from 0 to 5. The three-year totals are 7, 7, 2 and 5 for Lots 1, 2, 3, and 4, respectively. This information may be noted in a footnote on Table 2. When the total number of open cows in the three years is considered, there is a tendency for more open cows on the low level. This phase of the test requires further study before conclusions can be made.

Part 3. Preliminary Results, 1957-58

The cows used in the test during 1956-57 were continued on test and the preliminary results for the past winter season are summarized in Table 3.

There were only small differences in weight losses between lots of cows fed 1.5 lb. of supplemental feed and those fed 5.5 lb. The average difference between the high and low levels was only 8 lb. In this test cows whose calves were creep-fed lost considerably more weight during the winter.

Average calf weights on March 31 were 222, 291, 247 and 314 lb. for Lots 1, 2, 3 and 4, respectively. Increased level of wintering cows has increased calf weight 24 lb. However, when corrections are made for the greater number of steers in Lots 3 and 4 this difference will be lessened. Creep-feeding increased gains 68 lb. (69 in Lot 1 vs. 2, and 67 in Lot 3 vs. 4). Average consumption of creep-feed since December 19 was 350 lb. per head in Lot 1 and 331 lb. in Lot 4. The average

Table 3.—Levels of supplemental winter feeding of beef cows and creep-feeding fall calves (Preliminary results, 1957-58)

Lot number Level of feeding cow Calf feeding (Supplemental)	1 1½ lb. CSM None	2 1½ lb. CSM Creep-fed	3 2½ lb. CSM 3 lb. milo None	4 2½ lb. CSM 3 lb. milo Creep-fed
Number of cows per lot[1]	16	14	17	16
Average weight per cow (lb).				
Initial 9-21-57	1105	1160	1129	1179
Spring 3-31-58	868	865	895	896
Winter change (191 days)	—237	—295	—234	—283
Ave. birth weight per calf (lb.)[2]	80	79	78	80
Ave. calving date, October	16	18	24	23
Ave. wt. per calf, 3-31-58 (lb.)[3]	222	291	247	314
Total feed per animal (lb.)				
Cow[4]				
Cottonseed meal	228	228	380	380
Milo	---	---	456	456
Calf (creep-feed)[5]	---	350	---	331
Supplemental feed cost per head ($)				
Cow	7.30	7.30	22.42	22.42
Calf	---	9.28	---	8.77
Total	7.30	16.58	22.42	31.19

[1] Originally there were 18 cows in each of Lots 1 and 2 and 19 in each of Lots 3 and 4. Two cows failed to calve in Lot 1, 4 in Lot 2 did not calve, 1 cow failed to calve and 1 calf died in Lot 3, and in Lot 4, 2 cows did not calve and 1 calf died.
[2] Corrected for sex by the addition of 3 lb. to the weight of each heifer.
[3] No corrections for age or unequal number of steers and heifers within a lot. There are 8, 7, 11 and 11 steers in Lots 1, 2, 3, and 4, respectively.
[4] Supplemental feeding started 10-30-57.
[5] Creep-feed cost $2.65 per 100 lb.

cost of creep-feed consumed was approximately $9. Final data will be recorded when the calves are sold in July.

Part 4. Preliminary Results with Two-Year-Old Heifers, 1957-58

All of the cows used in the tests reported thus far in this article had produced at least one calf before being placed in the test. The response of a younger animal to the two levels of wintering feeding may be considerably different from the results obtained with older cows. Therefore, 48 yearling heifers were bred to Hereford bulls during the 1956-57 winter season. They were to calve in the fall of 1957 when they were approximately 2.5 years old.

The heifers were weighed on September 28, 1957. Division of cattle into 2 lots was made on October 31 at which time winter feeding was started. On this date 34 heifers were suckling calves and 17 were placed in Lot 1 and 17 in Lot 2. Only 8 pregnant heifers remained and 4 were placed in each lot. Of the 6 remaining heifers which were in the test during the breeding season, 2 died while calving (one drowned), 1 aborted and 3 calves were born dead. After the allotment of 21 head per lot, 1 failed to calve in Lot 1 and 1 calf in each of Lots 1 and 2 became very thin and weak and was removed from the experiment in December.

All heifers were allowed to graze the native grass pastures. Those in Lot 1 were fed an average of 1.5 lb. of pelleted cottonseed meal per head daily. Those in Lot 2 were fed 5.5 lb. of a pelleted mixture made up of 2.5 lb. cottonseed meal and 3 lb. ground milo. None of the calves were creep-fed.

A summary of the production data is given in Table 4. The heifers fed 1.5 lb. of cottonseed meal pellets lost an average of 281 lb. in 181 days. This was a loss of 29 percent of their body weight in the fall. The loss in Lot 2 was 233 lb. or 24 percent.

The small difference in calving date was not due to the level of feeding because the feeding levels were the same during the breeding season. Of the 4 heifers in each lot which had not calved when supplemental feeding was started on October 31, 1 in Lot 1 calved relatively early and 1 failed to calve and her weights were removed from the data. All of the 4 in Lot 2 calved relatively late.

Both groups of calves are very light with growth apparently retarded. There are 3 calves in Lot 1 which have gained only 5 lb. in 3 months. The average weights on March 28 were 161 and 177 lb. for those in Lots 1 and 2, respectively. These weights may be compared to weights

Table 4.—Levels of supplemental winter feeding of beef cows. Preliminary results with two-year-old heifers, 1957-58.

	Lot 1 1½ lb. CSM	Lot 2 2½ lb. CSM 3 lb. milo
Number of cows per lot	19	20
Average weight per cow (lb.)		
Initial 9-28-57	964	962
Spring 3-28-58	683	729
Winter change (181 days)	—281	—233
Average birth weight per calf (lb.)[1]	76	76
Average calving date, October	9	15
Average wt. per calf, 3-28-58 (lb.)[2]	161	177
Total feed per animal (lb.)[3]		
Cottonseed meal	222	370
Milo	---	444
Supplemental feed cost per head ($)	7.10	21.83

[1] Corrected for sex by the addition of 3 lb. to the weight of each heifer.
[2] No corrections for age or unequal number of steers and heifers within a lot. There are 11 steers and 8 heifers in Lot 1 and 9 steers and 11 heifers in Lot 2.
[3] Supplemental feeding started 10-31-57.

of 222 and 247 lb. in Lots 1 and 3, respectively, from older cows fed similarly as reported in Part 3 of this article. The two-year-old heifers are not producing satisfactory calves with either level of winter feeding. The calves will be sold in mid-summer and the cows will be continued on the experiment next year.

Summary

Cows which had previously produced at least one calf before being placed in the experiment have been fed 1.5 lb. of pelleted cottonseed meal or 5.5 lb. of a pelleted mixture of 2.5 lb. cottonseed meal and 3 lb. ground milo. The calves produced by one group of cows within each level of wintering have been creep-fed. The 3-year average increase in gain from creep-feeding was 58 lb. Also, the high level of winter feeding of the cow increased calf gains 29 lb. Neither practice was profitable when costs prevailing during the time of the tests were considered. Preliminary results obtained during the fourth test and with 2.5-year-old heifers are presented.

Protein Supplements for Wintering Fall-Calving Cows

J. A. MILLER, A. B. NELSON and G. R. WALLER

One of the main considerations in any cattle wintering program is the provision of adequate protein. The purchase of protein supplement represents a great portion of the cost of wintering cattle on native grass. Several experiments have been conducted at this station to study the relative value of supplements containing 20, 30 and 40 percent protein when fed to heifer calves wintered on prairie hay or allowed to graze native grass during the winter. Results of these experiments have been summarized in Okla. Agr. Exp. Sta. Bulletin B-437.

Results of these studies indicated that the supplements were not of equal value when fed at the same level of intake under similar management conditions. However, these tests did not provide data concerning the effect of the various supplements when fed to the same animals for several successive winters. The need for information on this and related problems led to the present study which has the following objectives:

1. To determine the relative value of supplements containing 20 and 40 percent crude protein when fed for several successive winters to commercial beef cattle grazing native grass.
2. To compare a 20 percent protein supplement composed of corn and cottonseed meal to one composed of several feed ingredients for wintering commercial cattle grazing native grass pasture.
3. To determine the value of a feed supplement containing approximately 50 percent of the total nitrogen as urea for wintering commercial beef cattle grazing native grass.

Experimental Procedure

To accomplish these objectives, one hundred grade Hereford heifer calves were divided into 5 lots of 20 head each on November 2, 1953. Each of these lots was placed in pastures which provided approximately 5 acres of native grass per heifer. In addition to the dried grass at the Lake Carl Blackwell experimental range area, the heifers were fed a protein supplement during the winter months as follows:

Lot 1—1 lb. of 40 percent protein pelleted cottonseed meal.

Lot 2—2 lb. of 40 percent protein pelleted cottonseed meal.

Lot 3—2 lb. of 20 percent combination pellet.

Lot 4—2 lb. of 20 percent protein pellet (CSM and corn).

Lot 5—2 lb. of 40 percent pellet containing urea.*

The 40 percent protein pellet contained 97.99 percent cottonseed meal and 2.01 percent dicalcium phosphate.

The 20 percent protein combination pellet consisted of several different feed ingredients. Included were several different sources of protein, dehydrated alfalfa meal, molasses and minerals which furnished nutrients that might add to the value of a simple mixture of corn and cottonseed meal. The percentages of the various ingredients in this 20 percent protein combination pellet were: cottonseed meal, 12.5; linseed meal, 12.5; soybean oil meal, 12.5; dehydrated alfalfa meal, 5; yellow corn, 41.7; molasses, 10; monosodium phosphate, 3.7; ground limestone, 1; salt, 1; and trace mineral mixture**, 0.1. According to the manufacturer's recommendations the additional trace minerals provided were, in mg. per lb. of pelleted supplement: manganese, 55.4; iodine, 1.71; cobalt, 1.18; iron, 43.6; copper, 3.3; and zinc, 3.04.

The simple 20 percent protein pellet was composed of 37 percent cottonseed meal, 58.84 percent yellow corn, 2.36 percent dicalcium phosphate, and 1.80 percent monosodium phosphate.

The 40 percent protein pellet containing urea was the same as the simple 20 percent protein pellet except that 7.64 percent of the corn was replaced with urea in order to make the nitrogen content of the pellet equivalent to 40 percent protein (Nx 6.25). The value of this pellet can be related to the simple 20 percent protein pellet or to the 40 percent protein pelleted cottonseed meal. The amount of urea in this pellet is above the amounts which can be included according to state law in mixed feeds prepared for sale.

The calcium and phosphorus contents of all pellets were equalized by the addition of ground limestone, dicalcium phosphate, and monosodium phosphate. The cost per ton of the various supplements was calculated from the cost of the several feed ingredients plus a mixing and pelleting charge of $5.00 per ton. On this basis the cost was approxi-

* Urea was supplied by DuPont Company, Wilmington, Delaware.

** Trace mineral mixture furnished by Calcium Carbonate Company, Chicago, Illinois.

mately the same with a difference of approximately $4 between the highest and lowest costs per ton.

At all times except during the summer of 1955, a mixture of 2 parts salt and 1 part steamed bone meal was available in all lots. During the summer of 1955 the only mineral supplement available was salt because the heifers were used in a test to determine the value of a salt and phenothiazine mixture in the control of cattle grubs.

The pellets were fed in the kinds and amounts as listed to the same cattle as heifer calves during the winter of 1953-54 and as yearling heifers during the winter of 1954-55. At the beginning of the winter feeding period for 1955-56, the allowance of supplemental feed was increased to 1.5 lb. per head daily in Lot 1 and 3 lb. per head daily in the other lots. Thus, as two- and three-yar-olds, the same cattle were continued on their respective rations as in the two previous winters with only the amount of each supplement being fed changed. All cattle were allowed to graze the native grass pastures yearlong. After the first two years the acres of native grass available per head were increased from 5 to approximately 8 acres per head. The chemical composition of the protein supplements fed during the 1956-57 season is given in Table 1.

Table 1.—Chemical composition of protein supplements (1956-57)

	Percent dry matter	Percent composition of dry matter						
		Ash	Protein	Fat	Fiber	N.F.E.	Ca	P
40% protein pellet	92.29	8.89	43.81	3.69	13.78	29.83	0.73	1.19
20% protein combination pellet	91.21	10.38	24.33	3.07	6.01	56.21	0.85	1.55
20% protein simple pellet	90.98	7.92	24.80	4.74	6.45	56.09	0.77	1.41
40% protein with urea pellet	89.52	6.69	46.70	4.02	6.37	36.22	0.73	1.33

The yearling heifers were bred to registered Hereford bulls during a period extending from January 3 to March 27, 1955, thus the first calves were born in the fall and early winter when the heifers were approximately 2.5 years old. These calves were weaned August 4, 1956. The two-year-olds were rebred to registered Hereford bulls during a period from December 19, 1955, to April 24, 1956. The second group of calves was born in the fall of 1956 and weaned August 5, 1957.

Observations

The data summarized in Table 2 include only the results from those cattle originally allotted to this study which have weaned two calves, one in 1956 and one in 1957. As stated previously, 20 heifer calves were allotted to each lot, but due to various reasons (see Table 2) the data from certain individuals have been omitted in the calculation of the results. All cattle in good health have been retained in the herd to determine whether or not they will calve in future years. Because an

Table 2.—Protein supplements for wintering fall-calving cows (summary)

	Lot 1 40-CSM	Lot 2 40-CSM	Lot 3 20 Comb.	Lot 4 20-Simple	Lot 5 40-Urea
Number of cows[1]	14	13	15	10	12
Average weight (lbs.)					
Initial 11-2-53	479	476	481	495	479
Winter gain 4-13-54[2]	2	6	—2	—9	—13
Fall 10-30-54	680	685	683	684	674
Winter gain 4-19-55[2]	6	—8	—23	—15	2
Fall 10-10-55	977	960	953	956	948
Winter gain 4-24-56[3]	—221	—141	—181	—214	—146
Fall 9-26-56	1010	1023	1018	992	1020
Winter gain 4-26-57[3]	—324	—255	—273	—311	—321
Final 9-28-57	945	983	985	961	1037
Total gain	466	507	504	466	558
Calf data 1955-56					
Number of steers	6	4	6	6	5
Number of heifers	8	9	9	4	7
Average birth date 1955	10/30	11/23	11/4	11/12	11/14
Average birth weight[4]	74	73	74	74	75
Average weight 4-24-56[5,7]	194	239	219	205	212
Avg. daily gain to 4-24-56	.73	1.00	.88	.79	.83
Avg. final wt. 8-4-56[8,10]	389	436	413	415	426
Calf data 1956-57					
Number of steers	8	9	7	2	6
Number of heifers	6	4	8	8	6
Average birth date 1956	10/21	10/13	10/14	10/11	10/16
Average birth weight[4]	76	75	77	74	73
Average weight 4-26-57[6,7]	180	220	197	197	192
Avg. daily gain to 4-26-57	.55	.76	.63	.65	.63
Avg. final wt. 8-4-57[9,10]	333	405	394	347	381
Reasons for omitting cow data					
Calved spring 1954	0	0	0	2	0
Calved spring 1955	1	4	1	1	0
Calf born dead or died later 1955-56	0	0	0	1	2
Calf born dead or died later 1956-57	0	1	0	2	1
Cow open during 1955-56	3	1	4	3	2
Cow open during 1956-57	1	1	0	0	3
Cow died during study	1	0	0	1	0
Cows open 6-21-57[11]	10	5	6	4	6
Cow died or sold 1957-58	0	1	2	0	0

1 20 heifer calves were originally in each lot, but results are given only for cattle which have weaned two calves. Reasons for removal of cattle are given near the bottom of the table.
2 Weight losses recorded during the first two years indicate no statistically significant differences among lots and years.
3 Weight losses recorded during the third and fourth years while the cows were suckling calves were statistically significant (P is less than 0.01) differences among lots and between years. The cows in Lot 2 lost significantly (P is less than 0.01) less weight than the cows in the remaining lots, and those in Lot 1 lost significantly (P is less than 0.01) more weight than those in Lots 3, 4 and 5. The weight losses during the third winter were significantly less (P is less than 0.01) than the weight losses during the fourth winter.
4 Corrected for sex by adding 3 lb. to the actual birth weight of each heifer.
5 Corrected for age by adjusting all calves to a standard age of 165 days, and for sex by adding 16 lb. to the age-corrected weight of each heifer.
6 Corrected for age by adjusting all calves to a standard age of 190 days, and for sex by adding 16 lb. to the age-corrected weight of each heifer.
7 There was a significant (P is less than 0.01) difference in the April calf weights among the treatments of their dams and between years. The calves from cows of Lot 2 were significantly (P is less than 0.01) heavier than calves from any of the other lots. Lot 1 calves were significantly (P is less than 0.05) lighter than the calves from Lots 3, 4 and 5, which were practically equal.
8 Corrected for age by adjusting all calves to a standard age of 270 days, and for sex by adding 20 pounds to the age-corrected weight of each heifer.
9 Corrected for age by adjusting all calves to a standard age of 290 days, and for sex by adding 20 pounds to the age-corrected weight of each heifer.

Table 2.—Continued

10 Statistical analysis indicated a significant (P is less than 0.01) difference in weaning weight among lots and between years. Lot 2 weights are significantly (P is less than 0.01) greater than the other and Lot 1 weights are significantly less (P is less than 0.01) than those in Lots 3, 4 and 5, which were practically equal. The significant (P is less than 0.01) year difference was in favor of the first calf crop.

11 Indicates the number of open cows that had previously weaned two calves and for which results are reported, but not the total number of open cows in any one lot. Although the records of many cows have been removed from the data, all live cows have remained in the test.

important economic factor is the number of calves weaned per cow of calving age, rebreeding data for the cattle, whether or not they were suckling a calf, were collected near the end of each lactation and used as a measure of the value of the various protein supplements.

A summary of observations recorded during the 4 years is given in Table 2. The following comparisons have been made.

Lot 1 vs. Lot 2

During the first two feeding seasons the gains of heifers fed 1 lb. and 2 lb. of 40 percent protein pelleted cottonseed meal were nearly the same. The protein requirement of growing heifers grazing dried native grass pastures was apparently met by the lower level of supplemental feeding. However, during the winters in which the cows were suckling calves the losses were considerably greater in Lot 1 (1.5 lb. pellets) than in Lot 2 (3 lb. pellets). These weight losses include losses at calving and while suckling a calf during the winter months. The difference in loss was 80 lb. in 1955-56 (—221 vs. —141) and 69 lb. in 1956-57 (—255 vs. —324). Statistical significance between these and various other weights may be noted in the footnotes of Table 2. The differences in weight gains in Lots 1 and 2 indicate that the additional nutrients fed to the cattle of Lot 2 were needed and utilized by the animal body. The total gains in the four-year period were 466 and 507 lb. for Lots 1 and 2, respectively.

The birth weights of the calves were practically the same in both lots within each year. The weights of the calves at the end of the 1955-56 winter feeding period were 194 and 239 lb. for the 1.5- and 3-lb. level of supplemental feeding, respectively. Similar weights in April, 1957, were 180 and 220 lb., respectively. The average difference was 42 lb. One would expect that any difference in value of the ration would be reflected in weights of the calves at this time before the availability of green grass had a chance to mask or overcome any poor results due to inadequate protein intake. Weaning weights of the calves in August also showed a considerable advantage for the higher level of feeding. Calves produced by cows fed 3 lb. of cottonseed meal pellets weighed an average of 60 lb. more at weaning. The difference in individual years was 49 and 72 lb.

Lot 2 vs. Lots 3 and 4

There were minor differences in winter gain during the first two winter seasons, although there was a slight advantage for cattle fed the

40 percent protein supplement. The winter weight losses while the cows were suckling calves were greater for the cows fed 20 percent protein supplements. The average difference was 57 lb. in 1955-56 and 36 lb. in 1956-57. Apparently the greatest need for supplemental feed was for protein and not energy. The 20 and 40 percent protein supplements were not equal in value for reducing weight losses when fed at a level of 3 lb. per head daily. The cows in Lot 2 were the only cattle in the experiment that appeared to be in a relatively satisfactory condition as judged by their general appearance during the winter.

Only minor differences in birth weights of calves were recorded. The cows fed the 40 percent protein supplement raised heavier calves. The two-year average calf weight in April at the end of the winter feeding season was 25 lb. greater for the 40 percent than the 20 percent protein supplement. The difference at weaning in August was 28 lb.

Lot 3 vs. Lot 4

The winter losses as calves and as yearlings were practically the same in both groups fed the 20 percent protein pellets. However, while suckling calves the cows fed the combination pellet (Lot 3) lost less weight than those fed the corn and cottonseed meal pellet. This advantage was 33 lb. in the third season and 38 lb. in the fourth season. These weight changes suggest that the ingredients furnished in the combination pellet apparently provide increased quantities of certain nutrients needed by range cattle for increased utilization of the forage.

In 1956, the April weight of the calves was 14 lb. in favor of the combination pellet. However, when weaned in August the average weight of the two groups of calves was essentially equal. In 1957 both groups of calves weighed the same in April, but in August the calves produced by the cows fed the combination pellet were heavier.

Lot 1 vs. Lots 3 and 4

This comparison is a study of three pellets furnishing equal protein but a considerable difference in amounts of other nutrients. The cattle in Lot 1 were fed 1 lb. (1.5 lb. after the second year) of 40 percent protein pelleted cottonseed meal. Those in Lots 3 and 4 were fed twice as many pounds of a 20 percent protein pellet. Gains during the first two years were slightly in favor of 1 lb. of 40 percent protein pellet. During the next two years the added nutrients fed Lots 3 and 4 resulted in less winter weight loss. The average loss of Lots 3 and 4 was 25 lb. less than the loss in Lot 1 in the third year and 32 lb. less while suckling the second calf.

Calf weights, both in April and August, have been lower in Lot 1. One of the main additions to the supplement fed to Lots 3 and 4 was energy supplied by grain. The results indicate that this added energy (and other nutrients) was needed and utilized. However, the provision of added protein was more valuable (Lot 2 vs. Lots 3 and 4).

Lot 5 vs. Lots 2 and 4

When urea was added to a supplement containing 20 percent protein in such amounts that the protein content (Nx 6.25) of the pellet was increased to 40 percent (Lot 5), the average winter loss of both groups of cattle was nearly the same. However, there was considerable variation between years. There were minor differences in favor of the 20 percent protein pellet in two years and a small difference in favor of the urea-containing pellet in one year. While suckling their first calves (year 3), the cows fed the urea-containing pellet lost considerably less weight than those in Lot 4. Differences in weight gain between the cattle in Lots 2 and 5 (cottonseed meal pellets vs. urea-containing pellets) were not great until the fourth year when the Lot 2 cows lost an average of 66 lb. less.

Calf weights were greater in Lot 2 compared to Lot 5 (27 and 28 lb. in April of 1956 and 1957, respectively) (10 and 24 lb. in August of the two years, respectively). Although the feeding of pelleted cottonseed meal has resulted in heavier calves than feeding the urea-containing pellet, the calves produced by cows fed this latter pellet were slightly heavier than those in Lot 4 (20 percent protein pellet). This would indicate some, but not complete, utilization of urea.

General

Measures of the value of certain rations in a cow and calf program include weight changes of the cow, calf weights, general appearance of animals and reproductive rate. Cows may have an excellent general appearance and the calves produced may be of a desirable weight. However, an important consideration is the birth date and number of calves produced. No conclusions concerning variation in birth date have been made because the largest difference in the four years was only 10 days.

Data from several cows have not been included in the summary presented in Table 2. The reasons for removal of the cows are reported in the lower part of the table. Many of these reasons were not related to the experimental rations. It should be noted that of the 91 cows in the experiment at the end of two years, 13 did not produce calves. This would be an 85 percent calf crop born without consideration of later calf losses. The open cows were found in all lots with a variation from 4 in Lot 3 (combination pellet) to 1 in Lot 2 (high level of cottonseed meal pellets). The weights of the calves weaned in 1956 were considered satisfactory for first-calf heifers.

During the 1955-56 breeding season, while the cows were suckling their first calf, 5 cows failed to rebreed (1 each in Lots 1 and 2, and 3 in Lot 5). The summer of 1956 was very hot and dry with an abnormally low amount of rainfall. Therefore, only litle forage was produced in the pastures. The average acreage available per cow had been previously limited to approximately 5 acres but in 1956 the acreage was increased to 8-9 acres per head. (This is the recommended average stocking rate for the Lake Carl Blackwell experimental range area). The amount of dry forage available for consumption during the winter in the pastures was relatively low but considered to be apparently adequate. As measured by winter weight losses of the cows, performance of the calves, and rebreeding of the cows, this may not have been true.

The winter losses of the cows were considerably greater in 1956-57 than during the previous winter. The average increase in loss was 116 lb. (—181 vs. —297 lb.) The average losses varied from 25 to 32 percent of the weight at the beginning of the winter season in 1956-57 and from 15 to 23 percent in the 1955-56 season. The average difference in daily gain of calves during the winter period was 0.21 lb. (0.85 vs. 0.64 lb.). One would expect the second calf produced by a cow to be considerably heavier than the first calf. However, the reverse was true in this test. The average weight of the calves weaned in 1957 was 44 lb. less than those weaned in 1956. Also, of the 64 cows which have produced two calves, only 33 rebred for calving in the fall of 1957. During the 4 years this study has been in progress 5 cows died or were sold. None of these 5 losses is believed to be due to experimental treatment. Although the data in Table 2 include records collected from the 64 cows which have produced two calves, there were 95 cows remaining in the experiment. Thirty-three percent of these cows failed to conceive during the 1956-57 breeding season. The definite cause of the poor growth and reproductive performance is not apparent, although apparently related to nutrient intake. All cows have been retained in the herd to determine whether or not they have rebred during 1957-58. Additional observations must be recorded before definite conclusions are made concerning the value of the various supplements.

In another experiment, fall-calving cows of breeding similar to that of cows used in the above test and varying in age from 5 to 7 years grazed native grass yearlong and were fed 1.5 lb. of pelleted cottonseed meal per head daily at the Lake Blackwell range area and produced calves weighing from 422 to 474 lb. in individual years. The 3-year average weight of calves from these cows of similar breeding was 451 lb., and the weight in 1957, when the calves in the study reported in this article were very light, was 474 lb. This is considered a relatively low level of supplemental feeding of fall-calving cows but the production is considerably greater than in the experiment discussed herein.

Summary

One hundred grade Hereford heifer calves were started on a study of the value of different protein supplements fed during several consecutive winters to cattle grazing native grass pasture yearlong. The cattle in each lot have been fed the same kind of supplement for four consecutive winters and data have been collected for two calf crops. Only 64 cows have produced two calves and only 33 of these remain for the 1957-58 season. However, 95 cows remain in the test and are furnishing information not recorded in this report. Because of poor performance in 1956-57, additional data are needed before definite statements can be made regarding the relative value of the supplements fed in this test.

On the basis of data collected thus far, the following summary statements have been made. Only minor differences in weight gains between the five lots of cattle were recorded during the first two years. During the third and fourth years while suckling calves, cows fed 3 lb. per head daily of pelleted cottonseed meal lost less weight during the winter and produced heavier calves than cattle fed 1.5 lb. pelleted cottonseed meal, 3 lb. of 20 percent protein combination pellet or 3 lb. of 40 percent protein pellet containing urea. Feeding 1.5 lb. of pelleted cottonseed meal was the least desirable practice. There were only minor differences in production due to feeding two 20 percent protein pellets or the urea-containing pellet. However, the combination pellet was apparently slightly more desirable than the simple pellet. The test is being continued in order that more data may be collected.

Effect of Rolling vs. Pelleting Milo, Previous Implantation, and Certain Feed Additives on the Feedlot Performance of Steer and Heifer Calves.

L. S. POPE, R. F. HENDRICKSON, LOWELL WALTERS,
GEORGE WALLER AND W. D. CAMPBELL

With the high investment in cattle, feed, and labor, it is essential that the feeder seek new methods of feed processing or ration ingredients that will increase gain and lower the cost per cwt. gain. Several new antibiotics and other feed additives have appeared on the market over the past few years. New equipment is constantly being developed to better prepare grains and roughages for fattening cattle. Much attention has been given to pelleting or cubing either the grain or the complete ration.

Much interest has developed in the use of hormone implants for feeder cattle. Elsewhere in this publication, it is shown that two, 12 mg., stilbestrol implants given to suckling beef calves will increase weaning weights by approximately 36 pounds. An important question from the standpoint of the feedlot operator is whether or not this early implantation of feeder calves, or older cattle, will adversely affect their performance during the fattening period. To obtain information on this point, certain calves were selected from the station herd which had been previously implanted at about 100 days of age, together with a like number which were not implanted. The feedlot performance of these calves was studied during a 155-day feeding period.

Many benefits are claimed from the use of hormone-like drugs and other feed additives in cattle fattening rations. The wide use of stilbestrol for fattening cattle has raised questions as to whether our rations are adequate in some nutrients, such as protein. The development of certain new antibiotics has raised questions as to whether fattening cattle will benefit from their use. Recent studies suggest that low levels of tranquilizer in fattening rations will increase gain and improve feed efficiency.

This report gives the results of the second in a series of trials to study the effect of previous implantation as well as certain antobiotics, tranquilizers and a high protein intake on the performance of beef calves. The results of the first trial can be found in Okla. Agri. Exp. Sta. Misc. Pub. MP-48 (1956-57).

Procedure

Part 1.

Twenty, choice, Hereford, heifer calves were selected from the Fort Reno and Lake Blackwell experimental herds for use in a fattening test in which the objectives were:

1. To study the value of rolled milo versus finely ground and pelleted milo.
2. To study the effect of previous implantation as suckling calves on subsequent feedlot performance.

The calves were divided into two lots on the basis of age, weight, sire, and previous implantation. Each lot consisted of 10 calves, five of which served as controls and five which had been implanted the previous summer as suckling calves. All calves received 10 mg. of stilbestrol in the daily ration while on the fattening test. The daily ration consisted of a full-feed of grain (either rolled or pelleted), 1.5 lb. cottonseed meal, 1.0 lb. of dehydrated alfalfa meal pellets and approximately 11 lb. sorghum silage. A mineral mixture consisting of two parts salt and one part steamed bone meal was available to the calves at all times.

Part 2.

Fifty, choice, Hereford, steer calves were selected from the Fort Reno and Lake Blackwell herds for a study on the effect of high protein levels, antibiotics and tranquilizers in fattening rations. Of the calves selected for this study, 15 steers had been implanted with two, 12-mg. stilbestrol pellets at the base of the ear during the previous summer as suckling calves; an equal number had served as controls during the summer test. These calves were so alloted into the five lots during the fattening test that each lot contained three previously implanted, and three control steers.

The steers were fed all the rolled milo they would consume, 1.5 lb. of cottonseed meal (containing 10 mg. stilbestrol), 1.0 lb. dehydrated alfalfa meal pellets, and approximately 11 lb. of sorghum silage, with a 2-1 mineral mix free choice. The protein supplements and feed additives fed per steer daily were: Lot 3, controls; Lot 4, an additional 1.0 lb. cottonseed meal to test the effect of a higher protein level on feedlot performance of calves; Lot 5, 75 mg. of a new antibiotic "Ilotycin" (Erythromycin, Lilly) mixed in the cottonseed meal; Lot 6, 1 to 5 mg. of a new tranquilizer Hydroxyzine* added to the protein supplement, and Lot 7, 10 mg. of the tranquilizer Chlorpromazine* added to the protein supplement.

*The Hydroxyzine was supplied by Chas. Pfizer and Co., Terre Haute, Ind.; the Chlorpromazine by Smith Kline and French Laboratories, Philadelphia, Pa.

All cattle were hand-fed one-half the daily ration allowance, morning and evening. The feeding test continued for 155 days. At that time, an appraisal of the market value of the cattle was made by a committee from the Oklahoma City yards. Following Feeders' Day, the cattle will be sold on the Oklahoma City market and data will be obtained on shrink to market, yield, and carcass grades. Chemical composition of the feeds used in the trial are shown in Table 1.

Table 1.—Chemical composition of feeds (percent as fed)

Feed	Moisture	Ash	Crude Protein	Fat	Crude Fiber	N-free Extract	Ca	P	Carotene mcg./gm.
Milo	12.35	1.49	11.44	3.14	1.65	69.93	.07	.24	
Cottonseed meal	7.52	5.93	42.25	4.31	11.68	28.31	.19	.79	
Cottonseed meal + Stilbestrol	7.92	5.76	41.63	1.06	11.45	32.18	.19	.73	
Dehyd. alfalfa pellets	7.80	10.00	16.94	3.32	25.83	36.11	1.30	.21	26.6
Sorghum silage	74.75	1.58	2.19	0.47	6.03	14.98	.09	.03	1.5

Results

Part I.

The average results obtained in the comparison of heifer calves fed either rolled or ground and pelleted milo are shown in Table 2. Gains were increased slightly for calves fed the pelleted product. Pelleted milo proved less palatable to the calves of Lot 2, although average daily grain intake differed only slightly. Fine grinding and pelleting of milo in this test reduced the grain required per cwt. gain by about 8 percent, and feed cost per cwt. gain by $0.60 per cwt. There was a further advantage of $0.96 per cwt. in the appraised value of the pelleted milo cattle; these advantages resulted in an increase of $11.15 per head in the net return per heifer in favor of pelleting.

While these results must be regarded as preliminary, the indications point to an increase in feed effeciency from fine grinding and pelleting vs. a medium degree of rolling. Somewhat similar results have been obtained in Kansas tests. In large commercial feedlots, differences in efficiency of feed utilization as small as 5 percent could lead to a distinct difference in profits.

Effect of High Protein, Antibiotic and Tranquilizers.

The average results from Part 2 of this study in which 50 steer calves were used to test the benefit of a high protein intake, a new antibiotic and two tranquilizers are shown in Table 3. The most marked advantage appeared where an additional pound of cottonseed meal was fed. The greater amount of protein supplement increased gains of Lot 4 cattle by 0.17 lb. per head daily over Lot 3. While the addition of this higher

Table 2.—Rolled vs. pelleted milo for fattening heifer calves

Preparation of milo	Lot 1 Medium Rolled	Lot 2 Finely ground and pelleted (3/8")
Number of heifers per lot	9[1]	10
Av. weights (lb.)		
Initial 10/26/57	498	497
Final 4/3/58	826	838
Av. daily gain	2.09	2.17
Av. daily ration (lb.)		
Rolled milo	11.96	
Pelleted milo		11.49
Cottonseed meal + stilbestrol[2]	1.50	1.50
Dehyd. alfalfa meal pellets	1.00	1.00
Sorghum silage	11.58	10.77
2-1 mineral mix	.10	.06
Feed required per cwt. gain (lb.)		
Milo	572	529
Cottonseed meal	72	69
Dehyd. alfalfa pellets	48	46
Sorghum silage	554	496
Feed cost per cwt. gain ($)[3]	18.64	18.04
Financial results ($)		
Total heifer and feed cost[4]	175.69	175.76
Appraised value per cwt.	26.44	27.40
Total value per heifer	218.39	229.61
Net return over heifer + feed[5]	42.70	53.85

[1] One heifer removed from data for Lot 1 due to founder.
[2] Cottonseed meal fed per head daily contained 10 mg. stilbestrol.
[3] Charge of $0.10/cwt. for rolling; $0.25/cwt. for fine grinding and pelleting.
[4] Initial feeder price=$23.00 per cwt.
[5] No charge made for labor, equipment, spraying, trucking or marketing.

level of cottonseed meal increased the amount required per cwt. gain by 37 lb., the saving in milo was 53 lb. and in silage, 30 lb. This led to slightly reduced feed cost per cwt. gain. With the slightly higher appraisal on the value of Lot 4 cattle, the additional cottonseed meal increased net returns of Lot 4 by $5.88 per head over Lot 3. It would appear that calves of the age and weight used in this experiment require higher levels of protein supplement than 1.5 lb. per head daily where they are being stimulated by stilbestrol in the ration. Results of the 1956-57 trial indicated a greater early period gain from the higher protein level—but no effect when final weights were taken at approximately 160 days.

Calves of Lot 5, receiving 75 mg. of Ilotycin per head daily, gained slightly more than the controls. An outbreak of respiratory infection occurred in all lots during the fourth week of the trial, and observations indicated less disturbance among the calves of Lot 5. Early in the trial these calves appeared to have more "bloom" and a better hair coat, which many feeders take as an indication of health. However, final results showed little effect on gain, feed efficiency or net return from feed-

Table 3.—Effect of additional protein, antibiotic and tranquilizers on performance of fattening steer calves receiving stilbestrol.

Treatment	Lot 3 Basal	Lot 4 Basal + 1 lb. CS. meal	Lot 5 Basal + 75 mg. Ilotycin	Lot 6 Basal + 1-5 mg. Hydroxyzine[1]	Lot 7 Basal + 10 mg. Chlorpromazine
Number steers per lot	10	10	10	10	10[2]
Av. weights (lb.)					
Initial 10/28/57	489	475	482	478	471
Final 4/3/58	833	846	837	838	819
Av. daily gain	2.22	2.39	2.29	2.32	2.25
Av. daily ration (lb.)					
Rolled milo	12.08	11.73	12.03	12.02	11.76
C.S. meal + Stilbestrol[3]	1.50	2.50	1.50	1.50	1.50
Dehyd. alf. pellets	1.00	1.00	1.00	1.00	1.00
Sorghum silage	11.52	11.69	11.47	11.19	11.83
2-1 mineral mix	.07	.06	.09	.08	.08
Feed required per cwt. gain (lb.)					
Milo	544	491	525	518	523
C.S. meal + stilbestrol	68	105	66	65	67
Dehyd. alfalfa pellets	45	42	44	43	44
Sorghum silage	519	489	501	482	526
Feed cost per cwt. gain ($)[4]	17.60	17.36	17.40	16.73	17.15
Financial results ($)					
Total steer + feed cost[5]	187.70	187.79	187.07	184.44	182.27
Appraised value/cwt.	26.40	26.70	26.45	26.45	26.50
Total value per steer	219.91	225.88	221.39	221.65	217.04
Net return over steer + feed	32.21	38.09	34.32	37.21	34.77

[1] 1 mg. per head daily fed for 98 days, then increased to 5 mg.
[2] Two steers lost from this lot during 3rd month due to urinary calculi. Data on these steers not included.
[3] Cottonseed meal fed per head daily contained 10 mg stilbestrol.
[4] Rolling charge of $0.10 per cwt. on milo. Cost of antibiotic supplement to Lot 5, $1.29 per steer. No charge made against Lots 6 and 7 for tranquilizers fed as these are still in experimental stage. No charge made for labor, equipment, spraying, trucking or marketing.
[5] Initial cost of steers=$26.00 per cwt.

ing the antibiotic. Further tests are needed to demonstrate more clearly the effect of this material in fattening rations.

Gains of Lot 6 calves fed the tranquilizer, Hydroxyzine, were somewhat greater than those of Lot 3 which served as controls. The other tranquilizer, Chlorpromazine, gave no apparent response at the 10 mg. level fed. No signs of sedation were noted in any of the cattle fed tranquilizers. Two steers were removed from Lot 7 because of urinary calculi, but whether or not this was related to the Chlorpromazine fed is not known. Some improvement in efficiency of feed utilization was observed in Lot 6 where the calves received Hydroxyzine, but appraised market values were similar. Further tests will be attempted on the Hydroxyzine product before definite conclusions are reached.

Effect of Previous Implantation on Feedlot Gain

In Table 4 a comparison is made between heifers and steers implanted as suckling calves and their controls. The results were variable.

Table 4.—Effect of previous implantation as suckling calves on subsequent feedlot performance[1]

	Controls	Previously Implanted
HEIFERS		
Number compared	10	10
Av. weights (lb.)		
Initial	491	502
Final	806	848
Av. daily gain	1.98	2.18
Feed cost per cwt. gain ($)[2]	19.72	17.91
Appraised value per cwt. ($)	27.25	26.78
Net return over heifer + feed cost ($)	45.41	50.33
STEERS		
Number compared[3]	14	14
Av. weights (lb.)		
Initial	478	529
Final	829	872
Av. daily gain	2.24	2.18
Feed cost per cwt. gain ($)[2]	17.66	18.15
Appraised value per cwt. ($)	26.65	27.19
Net return over steer + feed cost ($)	35.34	38.25

1 See article on "Stilbestrol for Suckling Beef Calves" for implanting procedure used.
2 One-half of controls and implants fed in same pens, thus an equal feed intake was assumed for both groups in arriving at this estimate.
3 One implanted calf from Lot 7 developed urinary calculi and was removed from this comparison together with his control.

Heifers previously implanted showed a marked increase in gain, (1.98 vs. 2.18 lb.), while steer calves were slightly depressed (2.24 vs. 2.18 lb.). The reason for this difference in response between steers and heifers is unknown and may be due to chance variation. In both groups, the previously implanted cattle showed greater net return.

Elsewhere in this publication it has been shown that, with long-yearling cattle, previous implantation on summer grass decreased subsequent feedlot gain. Results of the 1956-57 trial showed no consistent effect of implanting calves on subsequent feedlot performance. In the experiment reported here, all calves received 10 mg. stilbestrol in the daily ration. This may be important in avoiding a depression in gain in the feedlot following implantation on pasture. Considerable riding and evidence of estrus were noted among implanted heifers at the start of the feeding trial, but became less noticeable as the trial progressed.

Summary

Fattening trials with heifer calves indicate that finely ground and pelleted milo may improve gains and feed efficiency over rolled milo

at a rate sufficient to more than offset the added cost of feed preparation. Steer calves receiving 2.5 lb. cottonseed meal per head daily showed increased gain and feed efficiency as compared to calves receiving only 1.5 lb. Adding a low level of antibiotic (Ilotycin) or two tranquilizers to the daily ration gave only small increases in gain. Heifer calves previously implanted with stilbestrol as suckling calves out-gained their controls during the fattening period, while steer calves gained slightly less. Both groups showed greater net return than their controls.

Fattening Steers and Heifers on Rations Containing Different Levels of Concentrate

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and KENNETH URBAN

The number of cattle being fattened in large commercial feed-lots in the southwest has increased greatly in the last ten years. The problems of feed preparation and ration formulation are unique for this enterprise. For one thing, the amount or percent of concentrate in the rations used may vary considerably from one feedlot to another, with apparent equal success.

Generally, ground or rolled milo is the principle grain used in self-fed mixtures, with cottonseed hulls, alfalfa hay or chopped bundle feed as the roughage. Molasses is frequently added to improve palatability.

Opinions vary as to how much concentrate a fattening ration should contain in order to obtain maximum feed intake, rapid gains, and to reach market grade as quickly as possible. This report deals with the third trial in a project designed to study the performance of beef calves self-fed mixed rations in which the amount of concentrate was varied 35 to 80 percent. The performance of steers vs. heifers was also compared. The results of two previous trials may be found in Okla. Agri. Exp. Sta. Misc. Pub. MP-45 (1956) and MP-48 (1957).

Procedure

Ninety-six, choice, Hereford calves were obtained in early September from the Lazy S Ranch near Springer, Oklahoma. They were fall and early winter calves and had not been creep-fed. The drove consisted of an equal number of steers and heifers, selected to be as nearly alike in age and quality as possible. Upon arrival at the Fort Reno station, the calves were supplemented on native grass for approximately three weeks until the start of the feeding trial. The cattle were contracted in mid-summer at a price of $24.00 per cwt. for the steers and $22.00 per cwt. for the heifers.

The calves were started on feed in late September. Within each sex, allotment was based on shrunk weight and feeder grade. Each lot consisted of triplicate pens of four calves each within each sex. The calves were fed in small pens, with concrete exercise slabs and an open shed to the north under which the self-feeders were located. A watering device and mineral box (2 parts salt, 1 part bone meal) were available in each pen.

The mixtures fed by lots are shown in Table 1, together with the chemical composition and cost of each of the mixed rations. The concentrate portion of the ration consisted of ground milo, cottonseed meal and molasses; while the roughage was one-half cottonseed hulls and one-half chopped alfalfa hay. Small amounts of ground limestone were added as necessary to provide approximately the same calcium and phosphorus levels in all rations. All calves were started directly on their respective rations with the exception of those fed the 80:20 concentrate to roughage ratio. These calves were fed the 65:35 ration for 10 days and then placed on the 80:20 mix.

The cattle were weighed off the test and shipped to Oklahoma City when it was estimated that they had reached a slaughter grade of High Good to Low Choice. On-foot grades were estimated by a committee from the Animal Husbandry department and a Commission firm. In all, three shipments were made during the trial and the calves were selected individually for each shipment. Marketing and slaughter data included dressing percentage, carcass grade, marbling score and current value for each carcass. Carcass grades were established by a representative of the Animal Husbandry department. The live or "on foot" value of the cattle was obtained from the actual carcass value and based on the final weight off test at Fort Reno.

Table 1.—Composition and cost of self-fed mixtures

Lot number Conc.: Roughage ratio	1 & 2 35:65	3 & 4 50:50	5 & 6 65:35	7 & 8 80:20
Feeds used (%)				
Ground milo	17.0	33.2	49.7	65.1
Cottonseed meal	11.0	9.5	7.7	7.0
Molasses	7.0	7.0	7.0	7.0
Chopped alfalfa	32.5	25.0	17.5	10.0
Cottonseed hulls	32.5	25.0	17.5	10.0
Ground limestone	0.0	0.3	0.6	0.9
	100.0	100.0	100.0	100.0
Ration composition (%)				
Dry matter	90.25	89.57	88.89	88.25
Ash	4.71	5.16	4.71	4.30
Crude protein	12.16	12.13	12.01	12.26
Ether extract	2.15	2.30	2.44	2.59
Crude fiber	31.73	17.30	12.83	8.47
N-free extract	42.96	47.82	52.80	57.34
Estimated T.D.N. content (%)	56.60	61.35	66.10	70.83
Cost per cwt. ($)	1.59	1.72	1.85	2.00

Results

Average daily gains, feed consumption, and feed required per hundred pounds gain are shown in Table 2. On-foot value, carcass data, and financial returns are given in Table 3. In Table 4, an over-all comparison is made of steers vs. heifers.

Average daily gains, within sex, showed little difference among the lots despite the wide variation in concentration of the rations fed. Although the self-fed mixtures varied from 57 to 71 percent TDN, actual TDN intake was not greatly affected. This was due to marked differences in total feed intake, as shown in Table 2. This has been a consistent observation during the three trials that have been conducted to date. Although a rather wide difference can be seen in the amount of concentrate or roughage required to produce 100 lb. gain, when expressed on the basis of TDN per 100 lb. gain, little difference due to the rations fed can be seen. These data would indicate that the TDN of the concentrates and roughages fed in this trial have about the same value for fattening calves, which is contrary to the views of many authorities who consider that for fattening purposes, the TDN measurement overestimates the productive energy value of roughages.

Considering steers and heifers (within treatment) together, the feed cost per cwt. gain was $17.77, $17.85, $19.04 and $18.32 for calves fed 35, 50, 65 or 80 percent concentrate mixtures, respectively. It must be borne in mind that these cost figures are subject to fluctuations in the price of concentrates and roughage, hence could vary from year to year. Steer calves fed the 65 percent concentrate ration, and heifers fed the 50 percent mixture, required less time to reach market grade, with little difference among the other lots.

Dressing percent (yield) based on final Ft. Reno weights indicates that calves fed the 35 percent concentrate ration (Lots 1 and 2) and those fed the 80 percent mixture (Lots 7 and 8) had lower yields than those fed either 50 or 65 percent rations. The reason for this lowering at the extremes of the ratios tested is not apparent since all lots, within sex, appeared to grade about the same. With the exception of the slightly higher marbling score for heifers on the 50:50 ration (Lot 4), there was no apparent effect of ration on marbling. On-foot values, as calculated here, tended to reflect differences in dressing percentage and thus are not as meaningful as they may appear at first glance. There were only small differences in net return, both sexes considered, among the treatments—with the 50:50 ratio giving the greatest net return and the 65:35 the least. The feed costs used in computing net returns did not include the added costs of handling feed for lots fed the 35:65 or 50:50 rations, nor the increased costs of chopping roughage for these cattle. Depending on the circumstances, these costs could be a disadvantage if more total feed, or mixtures with a greater percentage of roughage, were required.

Steers vs. Heifers

From the results given in Table 4, it is apparent that steer calves outgained heifers by 0.26 lb. per head daily. This corresponds closely to

Table 2.—Performance of steers and heifers self-fed rations varying in concentrate-to-roughage ratios (12 calves/lot)

Conc: Roughage Ratio	35:65		50:50		65:35		80:20	
Lot number	1	2	3	4	5	6	7	8
Sex	Steers	Heifers	Steers	Heifers	Steers	Heifers	Steers	Heifers
Av. days on feed	177	169	174	158	166	170	179	171
Av. weights (lb.)								
Initial 9-26-57	555	527	558	527	560	530	560	528
Gain to 144 days[1]	323	287	317	303	313	280	321	271
Total gain	406	345	394	332	375	336	413	328
Av. daily gain	2.30	2.05	2.27	2.11	2.23	2.00	2.32	1.93
Av. daily feed consumption (lb.)[2]								
Concentrate	8.57	7.98	11.29	11.30	14.42	13.81	16.16	14.72
Roughage	15.92	14.82	11.29	11.30	7.76	7.44	4.04	3.68
Total	24.49	22.80	22.58	22.60	22.18	21.25	20.20	18.40
Av. daily T.D.N. intake (lb.)	13.66	12.90	13.85	13.87	14.66	14.05	14.31	13.03
Feed per cwt. gain (lb.)								
Concentrates	373	409	499	539	647	690	700	766
Roughage	693	760	499	539	349	372	175	191
Total	1066	1169	998	1078	996	1062	875	957
T.D.N. per cwt. gain (lb.)	603	662	612	661	658	702	620	678
Feed cost per cwt. gain ($)	16.95	18.59	17.17	18.54	18.43	19.65	17.50	19.14

[1] First shipment of cattle made after 144 days on feed.

[2] Computed from records of feed consumed and composition of rations.

Table 3.—Carcass data and financial results

Conc: Roughage Ratio	35:65		50:50		65:35		80:20	
Lot number	1	2	3	4	5	6	7	8
Sex	Steers	Heifers	Steers	Heifers	Steers	Heifers	Steers	Heifers
Carcass yield (%)[1]	57.40	57.86	63.00	59.44	60.00	58.53	57.86	58.69
Av. U. S. carcass grade	Gd. +	Ch.—	Gd. +	Ch.—	Gd. +	Ch.—	Gd. +	Ch.—
Numerical score[2]	6.1	5.1	5.7	5.1	6.0	5.3	6.0	5.0
Marbling score[3]	3—	3+	3—	2—	3—	3+	3—	3+
Financial results ($)								
On-foot value/cwt.[4]	25.83	26.34	28.43	27.01	26.32	26.57	26.06	26.72
Market value/calf ($)	247.95	229.41	250.51	231.77	243.46	230.66	253.52	228.97
Feed cost/calf ($)	68.93	61.26	67.58	61.42	68.12	66.84	72.32	62.92
Total steer and feed cost[5] ($)	202.13	177.20	201.50	177.36	202.52	183.44	206.72	179.08
Net return/calf	45.82	52.21	49.01	54.41	40.94	47.22	46.80	49.89

1 Hot carcass weights shrunk 2½%, based on final Ft. Reno weights.
2 Numerical score: 1=prime, 4=choice, 7=good, 10=standard.
3 Marbling score: 1=abundant, 3=moderate, 5=slight to none.
4 On-foot value computed from carcass value according to grade and yield, and based on final live weight at Ft. Reno.
5 Steers charged into feedlots at $24.00/cwt., heifers at $22.00.

Table 4.—Comparison of steers and heifers based on lot averages[1]

	Steers Lots 1,3,5 & 7	Heifers Lots 2,4,6 & 8
Av. days on feed	174	167
Av. weights (lbs.)		
Initial	558	528
Gain to marketing	397	335
Av. daily gain	2.28	2.02
Total feed consumed/calf/day (lbs.)	22.36	21.26
Feed per cwt. gain (lbs.)		
Concentrates	555	601
Roughage	429	466
Feed cost/cwt. gain	17.51	18.98
Marketing data:		
Yield (%)	59.57	58.63
Av. carcass grade	Gd.+(6.0)	Ch.—(5.1)
On-foot value/cwt. ($)	26.66	26.66
Net return/calf ($)	45.64	50.93

[1] Individual lot data shown in Tables 2 and 3.

results of previous trials. Heifers required about 8-9 percent more concentrate and roughage than steers, and feed costs per cwt. gain were $1.47 per cwt. less for the steers. Dressing percent also favored the steers. Despite more rapid and efficient gains, heifers proved most profitable in these trials due to the fact that the heifers' carcasses were 1/3 of a grade higher, making them equal to the steers in on-foot value, and initial cost was $2.00 per cwt. less. Again, similar results have been obtained in previous trials. Under Olahoma conditions, depending of course on the demand for female replacements, and whether or not they can be purchased open, heifers appear to be a better buy than steers for feedlot purposes.

Summary

The third in a series of trials with long-aged steer and heifer calves was conducted to study the effect of self-fed mixtures varying from 35 to 80 percent concentrate on gains, feed efficiency, and carcass merit. Only small differences were observed among the lots due to the rations fed. Although the mixtures containing higher levels of concentrate supplied more TDN per lb. of ration, feed intake among the lots was such that actual TDN intake was similar. Thus there were relatively small differences in rate of gain, TDN per cwt. gain, days on feed required to reach a slaughter grade, or carcass grades of the cattle. A lowering of dressing percentage was noted on the two extreme mixtures (35 and 80 percent concentrate). Steers outgained heifers and converted feed more efficiently, but were less profitable due to lower carcass grade and higher initial cost.

Feeders' Day Feed Prices for 1957-1958

Corn	1.14	per bu.
Oats	.78	" "
Milo	40.00	per ton
Cottonseed Meal	62.00	" "
Cottonseed Meal with Stilbestrol	68.00	" "
Cottonseed Pellets	64.00	" "
Corn Gluten Meal	86.00	" "
Soybean Meal	66.00	" "
Soybean Pellets	68.00	" "
60% Tankage	77.50	" "
Dehydrated Alfalfa Meal	50.00	" "
Dehydrated Alfalfa Pellets	52.00	" "
Molasses	54.00	" "
Omolass	114.00	" "
Aurofac	520.00	" "
Fortafeed	900.00	" "
Salt	16.00	" "
Trace Mineral Salt	48.00	" "
Steamed Bone Meal	93.00	" "
Ground Limestone	16.00	" "
Dicalcium Phosphate	92.00	" "
Prairie Hay	17.00	" "

Alfalfa Hay	25 per ton
Cottonseed Hulls	18.00 " "
Sorghum Silage	10.00 " "

Cost of Native Grass Pasture (Per Head)

Cows—year long	25.00
summer	17.50
winter	7.50
Yearlings—year long	18.00
summer	14.00
winter	4.00
Calves—winter	3.50