Feeding and Breeding Tests

With Sheep, Swine, and Beef Cattle

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CONTENTS

Which Ewes Should We Cull?

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Culling is a form of selection. When we cull rams or ewes, we have decided that they will produce no more lambs in our flock. There may be many reasons for such culling. Generally, however, culling should be done for one of the following reasons or we will have gained nothing:

1. **Removal of permanently disabled animals that can no longer produce efficiently.** Culling animals with poor mouths, spoiled udders and such things as broken legs is a standard and necessary practice for efficient production. The animals culled for these reasons vary from high to low in productivity. In so far as the trait for which the animal was culled is permanent, there is an immediate economic gain from removing nonproductive animals.

2. **Removal of permanently low producers so that the herd will increase in average productivity thereby.** When low producers are culled, there is opportunity for gain in two ways. (1) If low producers are replaced by average or better producers, the herd productivity increases. (2) To the extent that the trait in question is heritable, there is an opportunity to raise better replacements so that the average productivity of the herd improves with time. This benefit is realized only if the producer raises his own breeding stock.

Oklahoma sheepman usually buy replacement ewes. Their opportunities for improving the productivity of their flocks lie in either (1) buying more productive ewes or (2) culling from their flocks the less productive ewes. In buying ewes the principal selection that can be made is between breeds. Whiteman *et al.*, (1960)* reported that Rambouillet ewes were superior to several crosses of Rambouillet with Columbia, Panama or Merino for fall lambing. These results are in agreement with those of many other workers. However, within a breed there are great differences in productivity but these are not readily distinguishable. If one is to cull the less productive ewes from his flock, which ewes or for which traits should he cull.

This paper is concerned with trying to answer some of these questions.

MATERIALS AND METHODS

In 1955 one hundred each of Rambouillet and ¼ Panama X ¾ Rambouillet yearling ewes were purchased and used to establish the experimental flock, at Ft. Reno. Starting during the spring of 1957 forty ewe lambs (20 from each above breeding of ewe) were kept for

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* Whiteman, Joe V., Richard Pittman and Kenneth Urban. 1960. The lambing performance of different kinds of ewes. Okla. Agr. Exp. Sta. Misc. Pub, MP-57, p. 14.

replacements and 40 yearling ewes (20 each of two different breeding groups) were purchased to compare on a lifetime basis. During 1958 and 1959 similar groups were raised and bought to make up a flock of 240 ewes for this test.

Routine records were kept on all ewes relative to mating and lambing records, growth rate of lambs and weight of wool produced. Since no ewes were culled for traits that are considered in this discussion, it is possible to determine what gain might have been made by eliminating certain ewes on the basis of their early performance.

Figure 1 illustrates the present breeding schedule for the experimental flock and represents only slight modifications of the one used throughout the study. (See footnotes)

The ewes were mated to Dorset rams during the early years of the study and to Dorset, Hampshire, Suffolk, and Rambouillet rams during more recent years. All rams were fertility tested prior to their use.

The results presented here considered only fall lambing and do not give ewes credit for lambing during January and February. Ewes that lambed during these winter months were removed from their lambs by April 15th each year and conceived during the following May-June breeding period as well as those that had lambed during the fall.

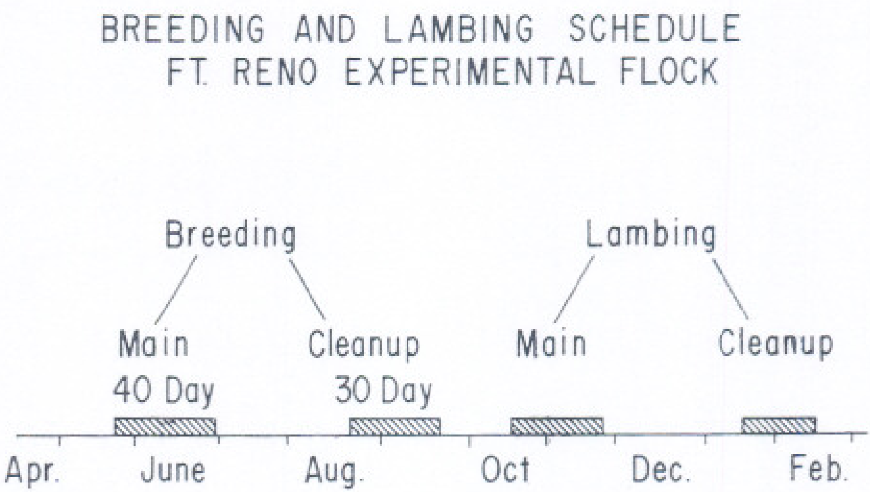

Figure 1. Sketch showing the breeding and lambing schedule of the Ft. Reno experimental sheep flock used from 1958 to the present.

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* In 1955 and 1956 breeding was for 48 days starting about May 21st. In 1957 breeding was for 32 days starting about June 1st.

**There was no cleanup breeding in 1955 or 1956. Cleanup breeding for other years was Aug. 1st to 20th in 1957; Aug. 11th to 30th in 1958 and Aug. 20th to Sept. 21st since.

RESULTS AND DISCUSSION

Failure to lamb during the fall

During any year that a ewe fails to lamb or lambs late she is a liability or at best produces little profit. Consequently, culling ewes that do not lamb during the fall is a strong temptation. If such failure to lamb during the first year or two of production is an indication that such ewes will continue to fail frequently, then culling would be justified. On the other hand if such ewes subsequently produce at a rate comparable to other ewes then culling would result in an immediate economic loss if the sheep in this project are typical.

Table 1 presents the rate of reproduction of the original ewes in the project by years. The low performance in 1957 was no doubt due in part to the 32 day breeding season used that year resulting in fewer ewes lambing. The purpose of table one is to illustrate that younger ewes are less productive. These were most productive at five years of age. Most research indicates that ewes are most productive at ages three through six or seven.

Table 1.—The Percent Lamb Crop Raised* by Years and Age of Ewe For the 167 Ewes tha Remained itn the Flock for Seven Years.

Year	Age of ewes	¼ Panama X ¾ Ramb.	Rambouillet
		87 ewes	80 ewes
1955	Yrl.	45	80
1956	2	82	99
1957**	3	67	101
1958	4	100	126
1959	5	124	130
1960	6	113	114
1961	7	109	106

* The number of lambs raised per 100 ewes in the breeding flock.
**There was a 32 day breeding season used in 1957 which contributed to fewer ewes lambing.

Culling a ewe at age two or three results in a loss in that replacement yearlings cost $15.00-$18.00 and culled ewes usually sell for $6.00-$10.00 if sold for slaughter. If numbers are to be maintained the ewe must be replaced. The yearling ewe that replaces her will probably be less productive in her first two years than the ewe she replaces would have been in her next two years of production.

In order to study what would have resulted under different hypothetical methods of culling, the records of the 87 ¼ Panama X ¾ Rambouillet and 80 Rambouillet ewes that remained in the flock from 1955 to 1961 were studied. It was assumed for most of the study that the culling would be done after one or two years of production for each ewe. Therefore, the total production for each ewe was calculated for the last five years of production as an indication of her lifetime production after probable culling age.

A study of Table 2 will indicate several interesting points for consideration. First, if all ewes that failed to lamb either during their first year or their second year had been culled, the culling rate would have been heavy—19 to 41 percent. Such heavy culling would result in great immediate loss.

Second, the increased lamb crop reared in subsequent years that would result from culling ewes failing to lamb the first year was not great. The ¼ Panama X ¾ Rambouillet ewes that would have been culled raised a 102 percent lamb crop during their 3rd to 7th years as compared to the 111 percent lamb crop of those that lambed the first year. Had the dry ewes not been culled the first year, the lamb crop would have been (actually was) 107 percent or a gain of 4 percent resulting from culling. The benefits from culling the Rambouillets would have been even less.

Third, culling for failure to lamb the second year would have been more beneficial. In the case of the ¼ Panama X ¾ Rambouillet ewes, those that had a lamb the second year raised a 15 percent higher lamb crop during the next five years than ewes failing to lamb their second year. However, the lamb crop without culling was 107 percent raised for an increase of 3 percent from culling. The advantage from culling the Rambouillet ewes would have been greater. They actually had 113 percent lamb crop and if the 13 second year dry ewes had been culled the lamb crop would have been 122 percent.

Fourth, culling ewes that did not lamb either year would have been more beneficial for the ¼ Panama X ¾ Rambouillet ewes and only 10 of the 87 ewes would have culled. These ewes are by breeding

Table 2.—The Production of Ewes (Percent Lamb Crop) That Would Have Been Culled vs. Those not Culled Under Various Systems of Culling.

System of Culling	Culled Ewes No.	Culled Lambs Born	Culled Lambs Reared	Not Culled Ewes No.	Not Culled Lambs Born	Not Culled Lambs Reared
Failure to lamb 1st year						
¼ Pan. X. ¾ Ramb.	36	105	102	51	121	111
Rambouillet	15	125	115	65	126	117
Failure to lamb 2nd year						
¼ Pan. X. ¾ Ramb.	15	97	95	72	118	110
Rambouillet	13	100	86	67	131	122
Failure to lamb both years						
¼ Pan. X. ¾ Ramb.	10	92	88	77	118	110
Rambouillet	3	100	93	77	127	117
Failure to lamb 2 of 3 years						
¼ Pan. X. ¾ Ramb.	20	96	93	67	123	112
Rambouillet	7	107	84	73	129	120

1/8 Lincoln—a breed that does not breed out of season well. It might be expected that some of them would not lamb well during the fall and should be culled. The culling should probably be based on two failures, however, rather than one. There were only three Rambouillets that failed to lamb both of the first years and, therefore, no conclusions should be drawn from their performance.

An easy management method for culling dry ewes is to notch a ewe's ear when she first fails and then when a ewe with a notched ear shows up among those not lambing, she can be marked for sale. This would permit culling those ewes that failed to lamb during both of the first two years. In these data the records of those ewes failing to lamb in two of the first three years were compared to the records of ewes lambing at least two of the three years. The results in Table 2 indicate that some benefit would have been derived from this procedure. However, the culling rate would have been high among the 1/4 Panama X 3/4 Rambouillet ewes.

Just a word about these results. During the first three or four years of production for these ewes, various management methods were being tested. The failure of a few ewes to lamb or have twins very likely can be attributed to these management changes. The manner in which the studies were run, however, were such that these estimates of the value of culling would be minimum values. In other words, the benefits of culling are probably greater than these results indicate. Since none of the management methods were extreme, it is believed that their influence on these estimates was not great.

Failure to Raise Lamb(s)

Lambs that die prior to marketing are of no benefit to the producer. It was, therefore, decided to determine to what extent, if any, the failure to raise her first lamb(s) was a characteristic of ewes. The results of this study are presented in Table 3.

Table 3.—The Productivity of Ewes (Percent Lamb Crop) That Lost Lamb(s) Early in Life vs. Those That Did not Under Various Systems of Culling.

System of culling	Culled Ewes No.	Culled Lambs Born	Culled Lambs Reared	Not Culled Ewes No.	Not Culled Lambs Born	Not Culled Lambs Reared
Lost lamb 1st year						
1/4 Pan. X. 3/4 Ramb.	23	124	112	64	111	105
Rambouillet	8	140	117	72	125	116
Lost lamb(s) either year						
1/4 Pan. X. 3/4 Ramb.	32	118	107	55	113	107
Rambouillet	13	128	109	67	126	118

A study of the lambs born vs. lambs reared values for each group of ewes indicates that under either system of culling [lost lamb(s) first year or lost lamb(s) either of first two year] the ewes that failed to raise one or more of their lambs during the first year or two had a record of losing more of their lambs during the next five years. As an example, the ¼ Panama X ¾ Rambouillet ewes that failed to raise their lamb(s) the first year lost 12 of 126 or about 10 percent of their lambs during the last five years while the rest of the ewes lost an average of 6 of 111 or about 6 percent of their lambs.

A more important consideration, however, is that the ewes that lost lambs raised about as many lambs as those that did not because during the last five years of production they had more lambs. This is not surprising since more twin lambs are lost than single lambs and these ewes had more twins.

These data indicate that culling ewes for losing a lamb or two during their early years of production would be of little or no benefit in increasing the lamb crop raised. This may not be the final answer, however. These data were not examined for individual causes of failure to raise a lamb. A more thorough study of more extensive data might reveal that there are individual causes of lamb losses for which ewes should be culled.

Level of Early Production

Another consideration relative to culling ewes on reproductive performance involves a study of their later production in relation to the number of lambs they produced or raised during their first two years in the flock. A summary of such a study on the records of these ewes is presented in Table 4.

These data indicate generally that there is a relationship between the number of lambs that a ewe either had or raises during her first two years of production and her production thereafter. This does not

Table 4.—The Later Production of Ewes Classified According to Their First Two Years of Production.

Classification (2 yrs.)	¼ Pan. X. ¾ Ramb. No. ewes	Lambs born	Lambs reared	Rambouillet No. ewes	Lambs born	Lambs reared
Had 0 lambs	10	92	88	3	100	93
Had 1 lamb	21	98	95	18	116	100
Had 2 lambs	36	125	115	34	119	109
Had 3, 4 lambs	20	125	115	25	147	140
Raised 0 lambs	19	85	80	6	120	97
" 1 lamb	35	123	114	24	116	104
" 2 lambs	23	122	116	31	117	109
" 3, 4 lambs	10	124	114	19	157	149
Had twins once or more	29	129	121	29	144	137
No multiple births	58	108	102	51	116	104

mean that one can have a high degree of confidence in culling one or two ewes. It means rather than such a system of culling is certainly better than culling at random.

It is doubtful that one can justify extensive record keeping on commercial ewes but a system of mass marking is practical and would be of benefit. It has been suggested that ewes that fail to lamb during the fall be ear-notched (or otherwise permanently identified) the first time they fail and marked for sale the second time they fail. It might also be worthwhile to permanently identify ewes that were the best producers during their first two years. The results in Table 4 indicate that ewes that had twins at least once during their first two years of production were distinctly more productive later than those that did not. Such young ewes could be given a unique ear tag so that the owner would know that they are among the better ewes.

Advantages of identifying ewes according to lamb production are several. If for any reason, the numbers in the flock are to be reduced, it is well to know which ewes are least productive and can be sold. If replacement ewes are to be reared, it is well to save daughters of the more productive ewes. Other benefits will be brought out later.

Early Gain of Lambs

After a ewe has a lamb, she must raise it to some age when it can take and efficiently utilize other feeds for later growth and fattening. Several studies have indicated that there is tremendous variation in the amount of milk produced by different ewes. Such studies also indicate that the amount of milk that a lamb receives has a very strong influence on his rate of gain, or the weight of a lamb at 6-10 weeks is a good indication of the amount of milk that he got from his mother.

If the amount of milk given by different ewes tends to be a permanent characteristics of the ewes, then it should be possible to evaluate ewes early in life as to their milk producing ability and perhaps cull some that were very deficient in this respect. The efficiency of such culling is proportional to the *repeatability* of the trait in question. The repeatability of a trait is a measure of the degree to which animals repeat their performance for the trait. High repeatability means that animals are very consistent for their performance and thus culling low producers for such traits would result in culling permanent low producers and would be efficient culling.

The seven years of data on the lambs raised by the old ewes was used to calculate the repeatabilities of birth weight the lamb(s) weight at 70 days of age and rate of gain from 70 days of age to about market weight. The 70 day weight was used because results at this station and those of other workers indicated that the milk production of the ewe contributes little to the lamb's feed supply beyond this age. Earlier studies indicated that there was essentially no difference in the rate of gain of the lambs from these two groups of ewes so the data was pooled for this analysis.

The results as shown in Table 5 are not very promising. There was an increase in all repeatabilities resulting from adjustment of the data but such adjusting requires a lot of records and work—probably more than the improvement attained justifies. It should also be noted that the repeatabilities were highest for birth weight and lowest for rate of gain from 70 days of age to market weight. Except for the repeatability based on adjusted birth weight these values would all be considered to be low. This means that culling on the basis of one record would not be efficient. Repeated poor performance would be a much better basis for culling and would result in more progress.

Table 5.—The Repeatabilities of Birth Weight, 70 Day Weight and Rate of Gain from 70 Days to Market Weight Based on Raw and Adjusted Data.

	Repeatability		
	B. wt.	70 days wt.	Gain
Raw data	.20	.17	.11
Adjusted data*	.37	.23	.14

* Data adjusted for the average differences due to sex, type of rearing (single or twin), year and age of dam.

Here again some system of mass identification would be beneficial. If young ewes that did not give enough milk to get single lambs well started were permanently identified, they could be removed when flock reduction occurred or when they repeated the poor performance. Also, ewes, that did an outstanding job of raising single lambs or a good job with twins should be identified as ewes from which to raise replacement ewes.

THE WEIGHT OF FLEECE

Other than having lambs and giving them a start in life, a ewe's main contribution is the wool that she produces each year. This accounts for about 20-25 percent of the income produced by most flocks of commercial sheep in Oklahoma. The wool production of the ewes is therefore another trait for which culling can be done.

Individual ewes in the Ft. Reno flock varied from 9.3 to 17.1 pounds of wool per year for the ¼ Panama X ¾ Rambouillet ewes and from 9.2 to 15.0 for the Rambouillets. With wool selling for over 50 cents per pound (including the incentive payment) the ewes that produce more wool produce considerably more money for the owner. Here again if the repeatability of wool production is high then culling light shearing ewes would be beneficial in increasing fleece weights in future years.

Table 6 shows the repeatabilities that were calculated for fleece weight for four different groups of ewes. These repeatabilities are consistently high as has been shown by other workers generally. As indicated previously, high repeatabilities mean that efficient culling can be done

Table 6.—The Repeatabilities of Grease Fleece Weight for Four Different Groups of Ewes.

Kind of Ewe	No. Ewes	No. Years	Repeatability
¼ Pan. X. ¾ Ramb.	87	6	.63
Rambouillet	80	6	.77
Dor. X. Ramb.	36	5	.84
Dor. X. Ramb.	36	4	.78

for this trait because the ewes are pretty consistent for their particular level of production. As an example the 10 percent of each group of ewes that produced the lightest fleeces at their first shearing, produced an average of 1.6, 2.2, 1.1, and 2.2 pounds less wool per year thereafter for the ¼ Panama X ¾ Rambouillet and two crossbred groups respectively.

DISCUSSION

Commercial sheep enterprises return a relatively low number of dollars on a per head basis because sheep are small animals. Consequently, management practices need to be designed for large operations. Record keeping on an individual animal basis so that most efficient culling can be done probably can not be justified because the cost of keeping records is directly proportionable to the number of animals involved.

A second consideration is relative to the basis for culling. If one culls his flock for only one trait, then improvement will be largely in that trait and other animals will probably need to be culled for other reasons. Also, as indicated previously, selling cull 2-4 year old ewes at around $8.00 and replacing them with $16.00—$18.00 yearlings results in an immediate loss. Finally no decision relative to culling an individual ewe for one trait (of the kind discussed herein) is always correct.

If one tries to tie all of these ideas together into a workable system of culling that will result in reasonably sure improvement at minimum cost, he needs to develop a system of mass identification based on the performance of the ewes for the various traits. For instance, ewes that fail to lamb might be given an ear notch and those that do a poor job of raising a single lamb tagged with a black ear tag, then ewes that produce a light fleece at shearing could be culled if they were ear-notched or had a black tag or both. Conversely, ewes that twinned early in life or did a better than average job of raising their lambs could be given a permanent identification so that they would not be culled for producing a light fleece. Further, as indicated previously, if ewes are somehow identified as to level of productivity (low, medium, high) the producer will have a better chance of saving his replacements out of his best ewes and if he reduces flock size, he will have a good basis for knowing which ones to sell.

These data indicate that culling ewes for failure to lamb will improve later lamb crops, culling poor milkers will leave a flock that will cause lambs to grow off a little faster and culling light shearers will leave a flock of heavier shearers. The improvement will not likely be profound but it will result in a higher performing flock. If one is going to have better sheep each year, than the year before, he must work at it. The system suggested here has been used before for some of these and other traits and will work.

SUMMARY

Seven years of production records for 167 ewes in the Ft. Reno experimental flock were studied to determine how the ewes might have been culled during the first year or two of production so that the remaining ewes would have been more productive for the rest of their lives. The production traits studied were whether or not the ewes lambed during the fall of their first, second or both years; their level of lamb production during their first two years; their frequency of raising the lambs produced; the birth weight, 70 day weight and post 70 day rate of gain of their lambs; and the weight of wool produced yearly.

Culling the ewes that failed to lamb during the fall of their first year would not have resulted in appreciable improvement. Culling the ewes that failed during their second year would not have required such heavy culling as culling on first year's performance and would have resulted in more improvement. The data suggested that ewes that failed to lamb during the fall in both of the first two years could be culled with considerable assurance of removing ewes that would be lower than average producers for the rest of their lives. Ewes that had twins during either or both of their first two years raised 19 and 33 percent larger lamb crops for the next five years than ewes that did not. This suggests that such ewes could be identified as better than average producers so that they would not be culled for other reasons or so that an effort could be made to save their daughters as replacements.

Culling ewes that lambed but failed to raise one or more lambs during their first two years would not have changed the flock productivity appreciably. However, the data were not adequate to permit a study of individual causes of failure to raise lambs. Such a study might yield different conclusions.

The repeatability of birth weight on unadjusted data was low but was moderate when the data were adjusted for the sex, type of birth and age of dam of the lamb and the year in which he was born. The weight of the lamb(s) at 70 days of age and rate of gain from 70 days to market weight (about 90 pounds) were traits of low repeatability in these data and consequently one evaluation of a ewe for these traits would not give one a sound basis for culling.

The repeatability of fleece weight was high when calculated for these ewes plus two groups of Dorset X Rambouillet crossbred ewes that were raised. Thus the culling of ewes that sheared the lightest fleeces would be efficient from the point of view of increasing the weight of wool

sheared by the flock but unless light shearing ewes were also poorer than average performers for lamb production, they probably should not be culled.

Procedures for mass identification of ewes according to general level of performance for the various traits were suggested. The immediate economic loss vs. the long time gain to be expected from culling and the advisability of culling ewes that were deficient in more than one trait were considered.

The Lifetime Reproductive Performance of a Hereford Cow Herd

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A beef cow herd yields only one source of income, a marketable calf at weaning time. Thus, the gross monetary return to the producer is completely dependent upon the number, weight and quality of the calves weaned. Anything that can be done to improve the performance of the beef cow herd in any of these categories will make an important contribution towards increasing the gross income of the cattleman.

The rather obvious importance of numbers of calves at weaning is shown in Table 1. This table gives the price per cwt. necessary to break even at various herd average weaning weights and calf crop percentages, assuming an annual cow cost of $80.00. It can be seen that raising the calf crop weaned percentage 10% is equivalent to an increase of 50 lbs. in average weaning weight.

Table 1.—The Necessary Selling Price Per Cwt. to Break Even at Different Herd Average Weaning Percentages and Weaning Weights Assuming an Annual Cow Cost of $80.00.

Percent Calf Crop Weaned	Average Weaning Weight (lbs.) 400	450	500	550
100	$20.00	$17.80	$16.00	$14.55
95	21.05	18.70	16.85	15.30
90	22.20	19.75	17.80	16.20
85	23.55	20.90	18.80	17.10
80	25.00	22.20	20.00	18.20
75	26.70	23.70	21.35	19.40
70	28.60	25.40	22.85	20.80

The importance of regular reproduction is evident since every cow failing to calve represents a total economic loss for the year. However, another important factor determining the size of the calf crop weaned is the death loss of calves from birth to weaning. In many herds this latter loss may be as great, or greater, than that resulting from complete reproductive failure.

Although regularity of reproduction is basic, prompt rebreeding so that as many calves are born as early as possible is also important to the cattleman. Not only will the earlier calves be heavier calves at weaning time, but there is the possibility that cows calving extremely late may not come in heat until after the end of the breeding season, and thus will be open the following year.

It hardly seems necessary to point out to cattlemen that reproductive efficiency is usually less than the theoretically possible 100%. Even in well managed herds in which every effort is made to insure reproductive efficiency and herd health, there are unavoidable calf losses. However, many are not aware of the nature, extent and causes of these losses in the industry as a whole. This report is an attempt to point out some factors affecting reproductive efficiency by summarizing the reproductive performance of an experimental cow herd through 14 years of age.

Materials and Methods

The data summarized in this report were taken from the records of the Fort Reno project 650-1 that has been described in a series of earlier Feeders Day reports (Okla. Agr. Exp. Sat. MP-22, 27, 31, 34, 43, 45, 51, 55, 57 and 67). The herd was established as a nutritional research herd in the Fall of 1948 with 120 weaner Hereford heifer calves. Because of losses, for one reason or another, prior to calving, only 117 heifers are used in this analysis as producing females in the herd.

Three rates of supplemental winter feed have been provided on native grass, with a pasture allowance of approximately six to eight acres per head, year-long. One half of the heifers in each winter treatment were bred to calve first as two-year-olds, while the remainder calved first at three. The winter feeding period extended from early November to mid-April each year. All cows have had continuous access to a mineral mixture of two parts salt and one part steamed bone meal. Except for one season, as will be discussed later, breeding has been pasture exposure to bulls from May 1 to August 15 each year. Breeding dates were not obtained.

All calves were identified at birth by an individual ear tattoo, weighed and this and other pertinent data recorded. Records were, therefore, available on each cow each year as to date of calving, sex and weight, weaning weight, and sire of calf. Cows have been removed from the herd for the following reasons: death; failure to raise a calf two successive years; disease, injury, or other unsoundnesses rendering them unfit for future production. For the purpose of this summary the cows were considered as a group ignoring differences in winter treatments.

While there were marked differences in several economic traits between the three wintering groups, there were no consistent differences in any aspects of reproductive performance that could be studied. Therefore, it was felt that the data were most useful in studying the nature and extent of reproductive losses in a cow herd through 14 years of age. The records permitted calculation of: calf crop percentages; average calving date; percent of cows calving in each 20 day period of the calving season; the frequency of occurence of open cows; and the calf losses from calving to weaning.

Results and Discussion

The data presented in Table 2 is a summary of the reproductive performance of the cow herd through 14 years of age. Although one half of the cows calved first at two years of age and the remainder at three years of age, the two groups were combined for computing these averages. Calving percentages and weaning percentages are calculated on the basis of the number of cows in the herd at breeding time.

The data represents a total of 1225 cow years. The herd average through 14 years was a 91.9% calf crop born and an 86.9% calf crop weaned. Comparable figures for the herd through 8 years of age were 94.9% born and 90.0% weaned; through 10 years of age, 94.5% born and 89.5% weaned; and through 12 years of age, 93.8% born and 88.6% weaned. Three sets of twins were dropped by the 1126 cows calving, for a twinning rate of 1 set in 375 calves. The survival rate of twins was 50%.

The decline in reproductive efficiency at ages of 12 years and older is one of the most striking features of Table 2. Actually, although the performance of the 11 year old cows was good, the decline started at 10 years of age.

The data reveals that through 9 years of age the two losses contributing to a reduced calf crop weaned percentage, cows failing to calve and calves born dead or dying before weaning, are approximately the same. However, each year after 9 years of age open cows account for an increasingly larger percent of the total loss from breeding to weaning.

The cows in this herd were bred for a limited period of approximately 100 days starting May 1 of each year. Since breeding dates were not obtained, an accurate measure of breeding efficiency, such as services required per conception, cannot be calculated. However, a crude estimate can be made by considering average calving date and the number calving in each 20 day period after the start of the calving season.

The average calving date of the two-year-old heifers is a little over a week later than the average for 3- and 4-year-old heifers. This should be expected since some of the yearling heifers bred for two year old calving may not have reached puberty until after the breeding season began. That this is the case is indicated by the observation that, although nearly as many of the 2-year-olds calved in the first 40 days, a greater percentage calved later than 60 days after the start of the calving

Table 2.—Summary of the Lifetime Reproductive Performance of a Grade Hereford Cow Herd.

	Age of Cows (years)												
	2	3	4	5	6	7	8	9	10	11	12	13	14
No. of cows	59	116	111	110	110	108	107	103	99	91	81	73	57
Percent calf crop													
Born	93.2	95.7	93.7	95.5	97.3	92.6	95.3	98.1	87.9	94.5	85.2	80.8	70.2
Weaned	84.7	92.2	89.2	90.9	91.8	88.0	90.7	93.2	81.8	90.1	76.5	76.7	66.7
Percent open cows	6.8	4.3	6.3	4.5	2.7	7.4	4.7	1.9	12.1	5.5	14.8	19.2	29.8
Percent calves dying before weaning	8.5	3.4	4.5	4.5	5.5	4.6	4.7	4.9	6.1	4.4	8.6	4.1	3.5
Ave. calving date	3-14	3-5	3-5	3-6	3-1	3-10	3-26	3-18	3-13	3-10	3-10	3-15	3-17
Percent cows calving													
1st 20 days	52.8	54.6	37.5	45.7	57.9	54.0	21.6	26.7	42.9	40.7	48.5	40.7	41.0
2nd 20 days	22.6	28.7	44.2	30.5	28.0	36.0	20.6	42.6	34.5	32.6	27.9	37.3	33.3
3rd 20 days	7.5	9.3	5.8	15.2	9.3	6.0	31.4	11.9	10.7	14.0	17.6	11.9	5.1
Later	16.9	7.4	12.5	8.6	4.7	4.0	25.4	18.8	11.9	12.8	5.9	10.2	20.5

season than was observed in older heifers. Of course it could also mean that all of the heifers were cycling at the time the breeding season began, but that a larger percentage of yearling heifers than of older heifers require more than one service to conceive.

There was little change in average calving date through 7 years of age, but a marked drop at 8 years of age. It is probable that this drop reflects a change in management rather than a decline in reproductive efficiency of the cows. An attempt was made to use yearling bulls by hand mating in the breeding season for the 8-year-old calving. Considerable difficulty was encountered in detecting all cows in heat and in getting satisfactory performance from the young bulls early in the breeding season. This early season difficulty is confirmed by the fact that only 42% of the cows calved in the first 40 days of the calving season, compared to 75% to 90% in the same period in all previous calving seasons.

Although the reason for the late calving date of the 8-year-old cows was probably management rather than a reduced fertility level of the cows, there is a lesson in the calving performance of the herd in the next two years. As 9-year-old cows the calving date was one week earlier than that of the 8-year-old cows, but is still more than a week later than the average for the years prior to 8 years of age. Also, the pattern of more cows calving later than 60 days after the start of the calving season continues. This suggests that if the average calving date of a herd is late one year, whether it be the result of poor feeding, poor management, or using bulls of low fertility, a pattern of later calving is set for several years even though the original causes have been corrected.

The average calving date of 13- and 14-year-old cows indicates some decline in breeding efficiency. However, in each year approximately 75% of the cows calved in the first 40 days of the calving season. This suggests that there is little or no reduction in the percentage of cows settling to first service as compared to their performance at younger ages. The later calving date is probably the result of the older cows requiring a somewhat longer time to recover from calving and resume cycling. Since nearly 21% of the 14-year-old cows calved later than 60 days after the start of the calving season, there is some indication that at this age there is a reduction in the fertility of some of the cows. However, the most important effect of advancing age on reproduction is the greatly increased number of open cows. The data suggests that at this age reproduction is largely an all or none proposition. The fertility of the cow is either nearly as good as it was at younger ages or she fails completely. It is unfortunate that more detailed observations were not made. It would be very enlightening to know what percent, if any, of the open cows did not show heat during the breeding season.

Two-Year-Old Calving vs. Three-Year-Old Calving

As was shown in Table 2, the heifers calving at two years of age had an average calving date that was 9 days later than the average calving date for all heifers at three years of age. Since heifers calving first at two years of age require somewhat longer to reach mature weight, there is a possibility that it could also retard reproductive performance.

Table 3 persons the reproductive performance of the two groups of heifers through 12 years of age. There were 4 more of the 3-year-old calvers left in the herd at 12 years of age. There was essentially no difference in regularity of reproduction, 65.8% of the 2-year-old calvers and 66.7% of the 3-year-old calvers had never been open. The average calf crop born percentage for 2-year-old calvers was 95.9% compared to 95.5% for the 3-year-old group. Average calf crop weaned percentages were 92.8% and 91.2% for 2-year-old and 3-year-old calvers respectively.

The later calving date of the 2-year-old heifers is reflected in a week later date for these heifers through 4 years of age. However, from 5 to 12 years of age there is no consistent difference between the two groups. On the basis of these observations alone one would conclude that the future reproductive performance of heifers is not adversely affected by calving her first at two years of age.

Table 3.—Summary of the Reproductive Performance Through 12 Years of Age of Hereford Heifers Calving First and 2 Years of Age and Those Calving First at 3 Years of Age.

	Age at First Calving	
	2 Years	3 Years
No. at Start	59	58
No. at 12 years of age	38	42
Calf crop percent		
Born	95.9	95.5
Weaned	92.8	91.2
No. never open	25	28
No. open		
1 time	9	9
2 times	3	5
3 times	1	0
Average Calving Date		
2 years	3-14	---
3	3-10	2-28
4	3-9	3-2
5	3-7	3-5
6	3-1	3-3
7	3-10	3-9
8	3-24	3-27
9	3-17	3-19
10	3-11	3-12
11	3-10	3-11
12	3-9	3-10

Culling Open Cows vs. No Culling of Open Cows

One question that is currently of great interest to cattlemen is whether open cows should be culled at the end of the breeding season on the basis of a pregnancy check. This management practice could have two effects on the reproductive performance of the herd: the temporary effect of raising calf crop percentages in the next calf crop; and a permanent effect in raising the over-all reproductive efficiency of the herd by removing cows of low fertility.

The temporary effect listed above has, of course, the obvious consequence of improving the calf crop percentage in the next calving season. This is shown in Table 4 in which the actual reproductive performance of the herd is compared with what theoretically would have occurred had all open cows been culled in the fall after the end of the breeding season. The assumption is made that all open cows would have been detected by a pregnancy check. The data is somewhat biased because culling of open cows was carried out if the cow was open two years in a row.

The increase in the percentage of calves weaned through 10 years of age averages about 5%, ranging from an increase of 1.9% in 9 year old cows to an increase of 11.1% at 10 years of age. The improvement is marked in cows 12 years of age and older, and certainly suggests that if cows of these advanced ages are in the herd they should be checked at the end of the breeding season and culled if open.

The improvement in calf crop percentage is not without cost. With the culling actually practiced in the herd, 84% of the original cows were still in the herd at 10 years of age. This is in contrast to an estimated 60% that would still have been in the herd with strict culling of open cows. To have maintained numbers at the original level through 10 years of age would have required 47 replacements had strict culling been practiced, compared to 18 required with no culling of cows the first time that they were open. Since this means that more first calf heifers would have been in the herd each year, the advantage of an increased number of calves at weaning would have been partially offset by a lower average weaning weight. It is also likely that the added cost of a replacement heifer would not have been completely offset by the salvage value of the cow culled.

Just how effective the culling of open cows would be in permanently improving the reproductive efficiency of the herd could not be adequately studied in the data available. As mentioned previously the data is biased somewhat because cows were culled if they were open two years in a row. Thus, their future reproductive performance could not be determined. However, the data reported in Table 5 provides some estimate of just how effective culling often open cows one year would be in eliminating the cows that were open in later years.

It can be calculated from the data in Table 5 that the percentage of cows still in the herd at 8, 10 and 12 years of age that had been open one or more times were, respectively, 21.5%, 28.3% and 33.3%. How-

Table 4.—Summary of the Theoretical Reproductive Performance of Cows in Ft. Reno Project 650-1, 1950 Through 1962, had there been no Culling of Open Cows in the Fall and had there been Culling of All Open Cows on the Basis of a Pregnancy Check in the Fall.

		No Culling of Open Cows					Culling of Open Cows in Fall after Breeding				
		No. of Cows in Herd at Calving	Percent of Original No. of Cows	Percent Calf Crop		No. Replacements Needed	No. of Cows in Herd at Calving	Percent of Original No. of Cows	Percent Calf Crop		No. Replacements needed
Year	Age of Cows			Born	Weaned				Born	Weaned	
1950	2	59	100	93.2	84.7	0	55	93.2	100	90.9	4
1951	3	116	99.1	95.7	92.2	1	110	94.0	100	96.4	3
1952	4	111	94.9	93.7	89.2	5	103	88.0	100	95.1	7
1953	5	110	94.0	95.5	90.9	1	99	84.6	100	93.9	4
1954	6	110	94.0	97.3	91.8	0	96	82.1	100	93.8	3
1955	7	108	92.3	92.6	88.0	2	88	75.2	100	94.3	8
1956	8	107	91.5	95.3	90.7	1	84	71.8	100	96.4	4
1957	9	103	88.0	98.1	93.2	4	81	69.2	100	95.1	3
1958	10	99	83.8	87.9	81.8	4	70	59.8	100	92.9	11
1959	11	91	77.8	94.5	90.1	8	67	57.3	100	95.5	3
1960	12	81	69.2	85.2	76.5	10	54	46.2	100	87.0	13
1961	13	73	62.4	80.8	76.7	8	40	34.2	100	95.0	14
1962	14	57	48.7	70.2	66.7	16	24	20.5	100	100.0	16

ever, of the cows that had been open, the percent at each age that had been open only once were: at 8 years of age, 82.6%; at 10 years of age, 82.1%; and at 12 years of age, 70.4%. It is evident that the bulk of the cows that would have been culled because they were open would never have been open again through 10 years of age. Thus, culling of open cows in this herd would have had little effect in reducing the number of open cows in future years. This also points to an added cost of this management practice, the culling in their peak years of production of many cows that would have been regular producers thereafter.

One observation that is not reported in Table 5 does point out one situation in which culling open cows would have been beneficial in this herd. Five heifers open their first year were kept through the second calving season, and four were also open the second year. Since they had been open two years in a row they were culled so their future performance was not determined. However, the observations that were made indicates that culling based on failure to calve their first year may eliminate heifers that, for a variety of possible reasons, will never breed. In this instance the culling of open heifers would result in a permanent improvement in the reproductive efficiency of the herd in future years.

The decision as to whether to cull open cows must be based on several considerations. This practice must be considered to be of value primarily in reducing the number of open cows that are wintered. It will be relatively ineffective in reducing the numbers of cows that have calved at least once that will be open in future years. A large number of cows culled prior to ten years of age will probably be regular producers thereafter. Many of these cows will be entering their years of peak production, so the probable increased value of their calves over those from the replacement heifers must be considered.

It is not possible from the data summarized in this study to make many concrete recommendations as to whether culling of open cows should be regularly practiced. It does appear that one should give serious consideration to culling heifers that fail to calve their first

Table 5.—Summary of the Regularity of Reproduction of Hereford Cows Still in the Herd at 8, 10 and 12 Years of Age.

	Age of Cows		
	8 Years	10 Years	12 Years
No. of cows in herd	107	99	81
No. weaning a calf every year	64	50	36
No. that had never been open	82	71	54
No. in herd at each that had been open			
one time	19	23	19
two times	4	3	7
three times	0	2	1

year. This is especially true if they are culled on the basis of a pregnancy check in the fall of their yearling year. At this time their net salvage value is most nearly equal to the cost of a replacement heifer. The data also indicates that if cows older than 10 years of age are in the herd they should be checked after each breeding season and all open cows culled. For cows of all other ages the decision cannot be simply arrived at in many cases. There is little reason for suggesting that poor producing cows should be kept if open in preference to replacing them with heifers. However, it is questionable whether high producing cows should be culled on the basis of one open season. The genetic loss to the herd may offset by several times the net economic gain from the elimination of the feed cost of one open cow.

Summary

The lifetime reproductive performance of a grade Hereford cow herd through 14 years of age was studied. The data includes 1225 cow years. There were 117 heifers at the start of the experiment, and the number of cows remaining in the herd and the average percent calf crops were: through 8 years of age, 107 cows, 94.9% born and 90.0% weaned; through 10 years of age, 99 cows, 94.5% born and 98.5% weaned; through 12 years of age, 81 cows, 93.8% born and 88.6% weaned; and through 14 years of age, 57 cows, 91.9% born and 86.9% weaned.

The cows in this study began to decline in reproductive performance at 10 years of age, with a marked decline in cows 12 years of age or older. The decline in older cows was almost entirely one of failure to conceive, since the average calving dates of older cows differs little from that of younger cows.

There was no adverse effect of two year old calving on the future reproductive performance of the heifers. At 8, 10 and 12 years of age respectively, 21.5%, 28.3% and 33.3% of the cows still in the herd had been open at least once. However, the percent of the cows that had been open only once in this group of cows was; at 8 years of age, 82.6%, at 10 years of age, 82.1%, and at 2 years of age, 70.4%. It appears that culling of open cows would have increased the calf crop percentage approximately 5% in the following calving season, but would have been relatively ineffective in reducing the number of open cows in the herd in future years.

High Concentrate Ration for Fattening Feeder Lambs; The Effect of Sex or Sex Condition and Initial Weight on Gain and Feed Efficiency

Robert L. Noble, Don Ely, George Waller, Jr.

Considerable interest has been shown in recent years in the use of high concentrate rations for fattening cattle and lambs. This study is in part a continuation of last year's study of high concentrate rations (containing approx. 83% concentrates) as compared to a standard fattening ration for lambs (containing approximately 50% concentrates). The base grain used in this year's study was milo.

Also since there is considerable variation in the initial weight of lambs and since feeder lambs can be purchased either as wethers, ewe lambs, or a mixture of the two, this year's work also studied the effect of initial weight and sex or sex condition on rate of gain and feed efficiency with feeder lambs.

Procedure

One hundred and seventy-four grade Western feeder lambs were used in this study. The lambs were purchased at Roswell, New Mexico. The lambs were shorn prior to shipment by truck to the Ft. Reno Station. After arrival (November 6) at the station, the lambs were grazed on Bermuda grass pasture until the start of the experiment on December 4. During this preliminary period the lambs were drenched with plenothiazine, implanted with 3 mgs of stilbestrol, and weighed.

The wether lambs were divided into three weight groups, those weighing from 60-70, 70-80, and 80 and above. The ewe lambs were divided into two weight groups; those weighing 60-70, and 70-80 pounds. Sufficient numbers of wethers were available to divide each weight group into two lots expect the heavy wether. The average initial weight of each lots was as follows:

Wethers			
Lot 1	64.8	Lot 2	64.6
Lot 3	74.2	Lot 4	74.5
Lot 5	84.0		
Ewes			
Lot 6	63.8	Lot 7	64.9
Lot 8	73.6	Lot 9	73.1

The lambs of the odd numbered lots were fed the high concentrate ration which contained approximately 72% TDN and only 8% fiber. The lambs of the even numbered lots were fed the standard ration which contained approximately 64% TDN and 16% fiber. Both rations were approximately equal in protein and mineral content. The composition of the ration is shown in Table 1.

Table 1.—Composition of Rations (percent)

Lot Number	Standard 2,4,6,8	High Concentrate 1,3,5,7,9
Ingredient		
Ground milo	45.0	70.0
Alfalfa hay	50.0	12.5
Molasses	5.0	5.0
Soybean Oil meal	—	7.0
Cottonseed hulls	—	5.5
Salt & Aurofax[1]	—	—
Total	100.0	100.0
Proximate Composition[2]		
Dry matter	89.42	88.22
Crude protein	11.70	11.43
Fiber	15.34	8.07
TDN	63.77	72.41
Calcium	.78	.45
Phosphorus	.25	.28

[1] 10 pounds of salt and 2 pounds Aurofax 10 added per ton to both rations; 10 pound $CaCo_3$ added to high concentrate ration.

[2] Based on chemical analysis and T.D.N. calculated on basis of chemical analysis plus digestion coefficients given by Morrison in "Feeds and Feeding," 22nd edition.

The lambs were started on feed on December 4. They were hand fed for the first five days, after this period the lambs were turned loose on self-feeders.

Individual weights following an overnight period without access to feed and water were taken at the beginning of the trial and at the end of the trial. Intermediate weights without shrinking the lambs were taken at approximately 30 day intervals. The lambs were sold on the Oklahoma City market.

Average weight gain, feed consumed, market data, and financial results are shown in Table 2.

Observations

High Concentrate vs. Standard Ration

1. The wether lambs in each weight group fed the high concentrate ration gained more rapidly and required less feed per cwt. than the lambs on the standard ration. With the wether lambs, the feed required per cwt. gain was less than 700 pounds.

2. The ewe lambs varied in their response to the two rations. In one weight group, the ewe lambs fed the high concentrate ration gained more rapidly on less feed, in the other weight group the reverse occurred.

Table 2.—Weight Gains, Rations Fed, and Financial Results Obtained with Fattening Lambs in Dry Lot

Treatment	High[1] Concentrate Ration	Standard Ration	High[1] Concentrate Ration	Standard[2] Ration	High[1] Concentrate Ration
WETHERS					
Lot number	1	2	3	4	5
No. lambs per lot	17[3]	17	26	26	29
Initial weight 12/4/62	64.8	64.6	74.2	74.5	84.0
Days on feed	76.0	92.0	60.0	60.0	42.0
Ave. daily gain	.47	.39	.46	.41	.59
Ave. daily feed intake	3.16	2.90	3.17	3.79	3.90
Lbs. feed/lb. gain	6.8	7.5	6.9	9.3	6.55
Feed costs/lb. gain $	16.3	15.0	16.6	18.6	15.7
Financial results $					
Ave. purchase price del.[4]	17.6	17.6	17.6	17.6	17.6
Ave. selling price	17.5	17.5	17.5	17.5	17.5
Total value/lamb	17.60	17.60	17.80	17.30	19.00
Initial cost/lamb	11.40	11.40	13.10	13.10	14.80
Feed cost/lamb[5]	5.80	5.32	4.60	4.60	3.90
Misc. cost/lamb[6]	1.00	1.00	1.00	1.00	1.00
Net profit or loss/lamb	—.60	—.12	—.90	—1.40	—.70

EWE LAMBS

Lot Number	7	6	9	8
No. lambs per lot	16	16	13	14
Initial weight 12/4/62	64.9	63.8	73.1	73.6
Days on feed	92	92	60	60
Av. daily gain	.45	.40	.43	.52
Ave. daily feed intake	3.10	3.20	4.1	4.42
Lbs. feed/lb. of gain	7.60	8.0	9.5	8.4
Feed cost/lb. of gain $	18.2	16.0	22.80	16.8
Financial results $				
Ave. purchase price del.[4]	17.6	17.6	17.6	17.6
Ave. selling price	17.5	17.5	17.5	17.5
Total value/lamb	18.60	17.61	17.31	18.34
Initial cost/lamb	11.42	11.23	12.87	12.95
Feed cost/lamb[5]	6.79	5.87	5.94	5.31
Misc. cost/lamb[6]	1.00	1.00	1.00	1.00
Net profit or loss/lamb	—.61	—.49	—2.50	—.92

[1] High concentrate ration — 70% ground milo, 12.5% ground Alfalfa hay, 7% soybean oil meal, 5.5% cottonseed hulls, 5% molasses, plus 10 lbs. salt and 2 lbs. Aurofax 10 per ton (see Table 1).

[2] Standard ration—45% ground milo, 5% molasses, 50% ground alfalfa hay, plus 10 lbs. salt, 10 lbs. $CaCo_3$, and 2 lbs. Aurofax 10 per ton.

[3] One lamb died, Lot 1. Reason Unknown.

[4] $16.25 per cwt. F.O.B. Roswell, New Mexico. $17.60 per cwt. delivered, includes cost of transportation, commission and misc. costs; allows $1.80 net credit on wool.

[5] Cost of ration per ton: High concentrate $48, Standard Ration $40, includes $5 per ton for grinding and mixing both rations.

[6] Includes 65¢ per lamb for marketing, 25¢ per head for transportation to market, and 10¢ per head for drenching.

3. Within weight groups and ration groups, wether lambs did not consistently gain more rapidly than ewe lambs; however, in three cases out of four they required less feed per cwt. gain.

4. Considering gain based on body weight, there was little difference in average daily gain of the three weight groups. The heavier lambs gained considerably faster, but difference was due mostly to greater body size.

5. The death loss in this trial was extremely low—only one lamb died.

6. This study would again indicate that a positive margin is necessary to return a net profit with lambs fed in dry-lot even with excellent gains and feed efficiency.

The Reproductive Performance of Hereford Heifers on Different Levels of Winter Feeding and Summer Grazing

E. J. Turman, L. S. Pope, B. J. Watkins, D. O. Pinney, D. D. McNutt, and D. F. Stephens.

The common practice of restricting the breeding of beef cow herds to a single limited season each year forces the producer to make the decision as to whether to breed heifers first as yearlings or as two-year olds. Several important factors must be considered in arriving at this decision: the size and condition of the yearling heifers; the level of winter feeding that will, or must, be provided; the amount of gain they can be expected to make during their yearling summer grazing season; and, probably most important, the amount of attention that can be given to the heifers during their first calving season.

The results of previous studies at Ft. Reno have indicated that if a beef heifer is sufficiently well developed she may calve first at two-years of age, and her later reproductive performance, mature size, and life span will not be adversely affected. It is true that two-year-old heifers may have a lower calf crop percentage and wean lighter weight calves than do older heifers. However, their performance at older ages is equal to that of heifers calving first at three-years of age, and, because of the extra calving season, their lifetime performance is greater. The most serious limitation of two-year-old calving is the increased number of difficult births. Most studies have shown that nearly one-half of the heifers will require assistance. The producer must be in a position to provide careful attention during the calving season. If he cannot provide this additional attention he would be wise to delay breeding.

If heifers are to be bred to calve at two years of age they must have reached sexual maturity and established a regular estrual cycle by 15 months of age. Several factors are known to influence the age of puberty. There are indications that there is a difference between the beef breeds. There is also good evidence that the hybrid vigor expressed by crossbreds in other traits is also seen in earlier puberty. However, probably the most important single factor is the nutritional level on which the heifers are maintained from weaning until puberty. This is particularly true in the case of spring bred heifers that must reach puberty during the critical winter feeding period.

Previous work at Ft. Reno has shown that the heifers on a high level of winter feeding, that necessary to produce daily gains of 1.0 to 1.25 lbs. per day, had the best reproductive performance. However, because of the cost involved, the best practical level was the moderate level, which gave winter gains of 0.5 lbs. per day, even though reproductive performance was not as good. Most heifers fed at a low level, which gave no gain during their yearling year, conceived but calf crop weaned percentages and weaning weights were reducted to the point that the moderate level was more profitable. It should be pointed out that these results were obtained under the conditions at Ft. Reno where, in most years, good grass is available from early spring through late summer.

The average calving date has been later for heifers maintained on the lower levels of winter feeding during their yearling winter. Since age at first estrus and breeding dates were not obtained it was not possible to determine whether this later calving was the result of delayed puberty or poor fertility or a combination of both.

This report is concerned with the effect of four levels of winter feeding and two levels of summer grazing on the occurrence of first estrus and breeding performance of yearling beef heifers. The data presented was obtained on heifers that were part of Project 650 at Ft. Reno.

Experimental Procedures

One hundred five weaner Hereford heifer calves were selected in the fall of 1961 from the Ft. Reno experimental herd. They were alloted to seven groups of 15 each on the basis of sire, dam's productivity, age, grade and shrunk weight. The heifers were started on winter treatment in early November and fed (approximately 160 days to mid April) according to the following program:

Lot 1. (High-Continuous Summer Grazing) Gains of approximately 1.0 lb. per day until April 15, then continuous access to native grass pasture during the summer.

Lot 2. (High-Restricted Summer Grazing) Winter gains as in lot I until April 15, then were allowed access to native grass pasture on Monday, Wednesday and Friday and were confined to dry lots on other days.

Lot 3. (Moderate-Continuous Summer Grazing) Winter gains of 0.5 lbs. per day until April 15, then continuous access to native grass pasture as above.

Lot 4. (Moderate-Restricted Summer Grazing) Winter gains as in lot 3. Restricted grazing during summer.

Lot 5. (Low-Continuous Summer Grazing.) No gain or loss in weight until April 15, with continuous access to native grass pasture during the summer.

Lot 6. (Low-Restricted Summer Grazing) No gain or loss in weight until April 15, then restricted grazing during the summer.

Lot 7. (Low-High, Continuous Summer Grazing) Fed at the same level as lots 5 and 6 until March 15, and then fed at the High level until start of the breeding season on May 1. The heifers had continuous access to native grass pastures during the summer.

Lots 1 and 2, 3 and 4, and 6 and 7 ran together in dry native grass pastures during the winter. The heifers were weighed at two week intervals and the daily level of supplemental feed (cottonseed cake and ground milo) adjusted to produce as nearly as possible the gains outlined above. In order to obtain the desired gains it was necessary to start supplemental feeding of the high level lots on November 18, and of the moderate and low level lots on December 19. The heifers in lot 7 were separated from lot 6 on March 15 when lot 7 was raised to the high level which included sorghum silage as well as ground milo cottonseed cake. The heifers in Lot 5 were fed the same as lot 6 but ran in a separate pasture.

The heifers were started on test between seven and nine months of age at an initial weight of approximately 440 lbs. The occurrence of estrus was determined by the use of vasectomized bulls that were either painted daily on the brisket with grease or wore a harness with a grease filled pad covering the brisket. The heifers were checked daily for grease marks on the rump. Since birth dates of the heifers were known, age at first estrus could be calculated. Weight at first estrus was calculated from the weights at the regular two week weigh periods before and after first estrus. Vasectomized bulls were available only for Lots 1 and 2, 3 and 4, and 6 and 7, so no estrus dates were obtained for Lot 5 prior to the breeding season.

All heifers were exposed to fertile bulls wearing grease marking harnesses between May 1 and August 14, 1962. Breeding groups were checked several times daily and any heifer with a grease mark was recorded as bred on that date. All heifers were checked for pregnancy by rectal palpation approximately 45 days after the end of the breeding season.

Results and Discussion

Occurrence of First Estrus:

The average age and weight when first estrus was attained by heifers in the various lots is presented in Table 1. These figures are somewhat misleading in comparing the different lots because the averages were calculated only on heifers that reached puberty. Two heifers in Lot 6 never reached puberty during the study, therefore the averages for this lot are over estimates.

The average age at which first estrus occurred in the 90 Hereford heifers checked in this study was 371 days. The averages for the wintering levels were: high, 353 days; moderate, 373 days; and low, 386 days. Restricting grazing did not affect age at puberty of heifers on the high level, probably because most had cycled before the amount of grass became a factor. However, the average age at puberty was delayed 30 days in the heifers wintered at the moderate level and which were limited in their access to grass during the grazing season. These observations indicate that the moderate level of winter feedings does interfere with the reproductive development of the heifers, since a number of the heifers apparently do not reach puberty until after grass is available in the Spring. However, this delay in attainment of puberty does not handicap the heifers in their subsequent breeding performance in the breeding season. Comparisons of this sort could not be made in the low level group because the heifers on continuous summer grazing were not checked for estrus prior to the breeding season.

A higher percentage of the heifers in the high level of winter group (83.3%) had reached puberty before the start of the breeding season on May 1, than had those on the moderate level (66.7%) or low level (60%). These observations indicate that one of the reasons for a later average calving date in the low level groups of previous trials was they did not reach puberty until after the breeding season had started.

The data presented in Table 2 gives the percent of heifers in each level of wintering group that reached puberty each month from ages of 9 months to 17 months. If the heifers are to calve at two years of age they must be bred at 15 months of age. As can be seen from the accumulative total column of Table 2, the high level was the only group in which all heifers had attained puberty by that age. In the case of the heifers on the moderate level, 90% had reached sexual maturity by 15 months of age, but only 70% of the low level heifers would be ready to breed at that age. It is interesting to note that level of feeding had little or no effect on the small group of heifers that will reach puberty

Table 1.—The Effects of Different Levels of Winter Feeding and Summer Grazing on the Weights and Reproductive Development and Performance of Yearling Hereford Heifers.

	Level of Supplemental Winter Feeding						
	High		Moderate		Low		Low-High
Summer Grazing	Con-tinuous	Re-stricted	Con-tinuous	Re-stricted	Con-tinuous	Re-stricted	Con-tinuous
Lot	1	2	3	4	5	6	7
No. of heifers	15	15	15	15	15	15	15
Avg. Body Wts. (lbs.)							
Oct. 26, 1961	437	438	438	438	439	436	438
Mar. 15, 1962	564	570	505	519	438	453	448
May 2, 1962	647	652	568	585	442	445	527
Sept. 11, 1962	815	738	760	706	683	611	735
Avg. gain per heifer (lbs.)							
Winter (10-26-61 to 4-17-62)	183	181	82	101	—18	— 7	46
Summer (4-17-62 to 9-11-62)	195	119	240	167	262	182	251
Occurrence of first estrus							
Avg. age (days)	359	347	358	388	----	371	400
Avg. weight (lbs.)	547	533	504	539	----	453	498
No. heifers in which first estrus occurred before May 1.	12	13	11	9	---	10	8
No. of heifers establishing a regular estrus cycle before May 1.	8	11	8	8	---	0	1
No. of heifers never in heat during breeding season (May 1-Aug. 14)	0	0	0	0	0	7	0
Breeding Performance							
No. settled	14	14	15	14	11	8	14
Percent of heifers settled on first service (%)	60	69	71	67	80	88	64
Avg. date of first breeding	5-23	5-20	5-30	5-28	6-19	7-5	6-4
Avg. date of conception	6-3	5-28	6-10	6-10	6-26	7-7	6-19
Avg. cost per heifer for supplemental winter feed	28.32	28.32	12.35	12.35	2.98	2.98	13.16

under 1 year of age. However, in the majority of the heifers, higher levels of feeding hastens sexual maturity.

The weights given in Table 1 at which first estrus occurred varied depending on the level of winter feeding. These data indicate that the Hereford heifers used in this study tended to reach puberty at a certain age rather than at a certain weight.

Table 2.—The Effects of Levels of Winter Feeding on the Age at Which Hereford Heifers Reach Puberty as Evidenced by the Occurrence of First Estrus.

	Percent of Heifers Reaching Puberty During This Month			Accumulative Total-Percent of Heifers That Have Reached Puberty by This Age		
Age	Low	Moderate	High	Low	Moderate	High
9 Months	3.3	3.3	0	3.3	3.3	0
10 Months	13.4	10.0	10.0	16.7	13.3	10.0
11 Months	13.3	20.0	36.7	30.0	33.3	46.7
12 Months	16.7	23.4	23.3	46.7	56.7	70.0
13 Months	13.3	6.6	20.0	60.0	63.6	90.0
14 Months	3.3	10.0	3.3	63.3	73.3	93.3
15 Months	6.7	16.7	6.7	70.0	90.0	100.0
16 Months	16.7	6.7	0	86.7	96.7	100.0
17 Months	6.6	3.3	0	93.3	100.0	100.0

Regularity of the Estrous Cycle:

The age at which first estrus occurs is of less practical importance than the age at which a regular estrous cycle is initiated. Many of the heifers in this study reached puberty, as measured by the occurrence of first estrus, at a relatively early age, but did not continue to cycle. In several cases two or more months elapsed between the occurrence of first and second estrus. As can be seen in Table 1, more than 50% of the heifers on the high and moderate levels of winter feeding had established a regular cycle before the breeding season began on May 1. However, only 1 heifer out of the 30 checked in the low levels had established a regular cycle.

Breeding Performance:

The breeding performance of heifers on the high and moderate levels of winter feeding were very similar. The greatest difference of any practical significance was the dates of first breeding and conception of the moderate level groups were approximately 1 week later than those for the high level groups. A slightly higher percentage of the moderate level heifers conceived on first service. Restricting summer grazing had no effect on breeding performance of heifers in these two wintering groups.

The breeding performance of the two groups of heifers maintained at a low level for the entire level was far from satisfactory, especially for the group that were restricted in their summer grazing. The percent of heifers settling during the breeding season for the two low level groups were 73.3% for those on continuous summer grazing and 53.3% for those restricted in their summer grazing. These conception figures compare to 93.3% or more for all other groups. Not only did fewer heifers settle, but the dates of conception were delayed. The low level group on continuous grazing had an average conception date some three

Performance and Progeny Tests for Evaluating Boars

J. A. Whatley, Jr.

The appraisal of a prospective breeding animal is actually an estimation of his breeding value. In making this estimate we can consider (1) the merit of the individual himself, (2) the merit of the ancestors in his pedigree, (3) the merit of collateral relatives such as full and half brothers and sisters of the individual, and (4) the merit of the individual's progeny after he is old enough to have been progeny tested. After considering the information available we then can select or cull an individual according to whether we think his breeding value will permit him to contribute toward the genetic improvement of the herd. The choice of herd sires is the most important decision a breeder makes, because they will contribute half of the inheritance of the next generation in the herd. This decision is also important because of the greater opportunity for selection in males than in females. It is therefore desirable to do everything possible to increase the accuracy of estimating the breeding values of herd sire prospects. Initial decisions must be made on individuality, pedigree, and family information, but these should be checked by adequate and accurate progeny tests as soon as possible.

Testing Procedure

In the Oklahoma project[1] of the Regional Swine Breeding Laboratory boar pigs from the more productive sows are placed on a feeding test at weaning (about 56 days). The feeding period is from 56 days to a final weight around 175 lbs. Rate of gain during the test is measured on each individual and efficiency of gain is measured on 2-4 boar pigs by the same sire. Most of the pens include only litter mate boars, but in some pens boars from two litters of comparable age and by the same sire are fed together. Efficiency of gain, expressed as feed required per lb. of gain, is thus measured on a family group of full or half brothers. In a few instances feed records of this kind are not obtained on boars because of a shortage of pen space for testing. Such boars are fed the same ration but in larger groups and no feed records are taken. Boars are weighed off of the feeding test individually at approximately 175 lbs. At this time backfat thickness is measured on each boar by probing with a Lean Meter. Each boar is also scored with a 1 to 9 scoring system for length, meatiness, and soundness of legs. The backfat probes are adjusted to a 200 lb. barrow equivalent basis to permit a fairer comparison of boars, barrows, and gilts of somewhat different weights at the time of probing. The above performance information is then considered in the selection of boars for the breeding herd.

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[1] This is a cooperative project between the Oklahoma Agricultural Experiment Station and the Regional Swine Breeding Laboratory, Agricultural Research Service, U. S. Department of Agriculture.

Pedigree screening is used to determine which boars will be performance tested. The performance test on individuals and on brothers and sisters is used to determine which boars will be selected for breeding. These boars are then progeny tested as the final test of breeding value.

Selected boars are progeny tested by mating each boar to 6 or 7 gilts of another breed for a crossbred progeny test. The progeny tests include feeding and slaughter tests on samples of pigs by each sire. If enough pigs are available, 2 or 3 pens of 8 to 10 pigs each are fed by each sire. The feeding test is from about 56 days of age to a final weight of approximately 210 lbs. Rate of gain is measured on each individual pig but efficiency of gain is measured on each lot. Each gilt is probed at the final weight and probes are adjusted to a 200 lb. barrow equivalent basis. Gilts are also scored for length, meatiness, and soundness of legs. Barrows are not probed or scored, but a sample of barrows by each sire are slaughtered at the Wilson & Co. plant in Oklahoma City for carcass data. An effort is made to slaughter 6 to 10 barrows by each sire but in some cases the availability of carcass barrows is less than the minimum desired.

Results

The performance and progeny test records on 5 Duroc boars from line Ok 8 are shown in Table 1. This line is being developed specifically for crossbred sow productivity when crossed with the Beltsville No. 1 line Ok 9. Consequently, the primary basis for selection of these boars was the litter production records of their crossbred half-sisters. This selection differential was 0.6 of a pig in the size of litter raised by the crossbred half-sisters of these selected boars and the 5 line 9 boars listed in Table 2 as compared to the average litter size for all crossbred gilts. Because of the selection for crossbred half-sib's productivity, selection on the boar's performance was not as great as it might otherwise have been. Some variation is shown in performance of the 5 selected boars as shown in the upper portion of Table 1. This is particularly true in average daily gain, which ranged from 2.08 lbs. for boar 677 to 1.61 lbs. for boar 634. The 44 boars selected at weaning and performance tested gained 1.67 lbs. per day. This was .17 lbs. per day faster than the average of the entire line. The tested boars also had less backfat and were scored higher than the line average in all items. The tested boars, however, were fed a somewhat different ration than the rest of the herd, although under the same general conditions, so that some caution must be used in comparing the performance of the tested boars with the remainder of the herd. The five selected boars as compared to the 44 that were tested gained considerably faster, were more efficient in feed conversion, had less backfat, and were scored higher for length, soundness of legs and particularly meatiness.

The lower portion of Table 1 gives the progeny test results on the 5 Duroc boars. The progeny performance should not be compared to the individual performance of the sires because of the different conditions under which the sires and their progeny were tested. The boars and their progeny were tested in different years. The boars were fed a fortified pelleted ration with a corn-milo grain base over a period from 56 days to 175 lbs., whereas their progeny were fed to a heavier weight of 210 lbs. on a non-pelleted wheat base ration which does not produce as rapid or efficient gains as the boar test ration. However, boar performances can be fairly compared with one another and progeny performances can also be compared fairly with one another. It is interesting to note that the slowest gaining boar (634) also had the slowest gaining progeny, but that the fastest gaining progeny were by boar 91 who ranked third in his own rate of gain. Boar 634 sired pigs distinctly superior to those of the other boars in backfat thickness, loin eye area and yield of lean cuts. Boar 677 was scored slightly higher than 634 for meatiness, but this was not supported by the progeny test. This indicates the desirability of obtaining carcass data from a progeny test. Live animal appraisals will generally be related to an individual's progeny test but errors in appraisal will occur and these can be detected by a progeny test.

The performance and progeny test records of the line Ok 9 boars are shown in Table 2. The boars and their progenies were farrowed in the same seasons and were contemporaries of the line 8 boars and their progenies in Table 1. The slowest gaining boar in this group as in the previous group sired the slowest gaining progeny, but the fastest gaining progeny were sired by the second fastest gaining boar. There was no particularly outstanding sire on the carcass progeny test. All boars

Table 1. Performance and Progeny Test Summary on Line Ok 8 Duroc Boars Siring 8x9 Crossbred Pigs, Ft. Reno 1962 Spring

Boar	91	200	465	634	677	Av. of 5 Boars Selected	Av. of 44 Boars Tested
Performance Test							
Av. daily gain, lbs.	1.86	1.93	1.74	1.61	2.08	1.84	1.67
Lbs. feed per lb. gain	2.78	2.60	2.78	2.54	no test	2.67	2.84
Probed backfat, in.	1.47	1.45	1.48	1.51	1.54	1.49	1.55
Length score	7	6	6	7	6	6.4	6.2
Meatiness score	6	7	6	7	8	6.8	5.8
Legs score	4	6	6	5	6	5.4	5.2
Progeny Test on 8x9 Crossbred Pigs							
No. pigs on feeding test	18	16	20	19	20	93	
Av. daily gain, lbs.	1.66	1.40	1.52	1.34	1.52	1.49	
Lbs. feed per lb. gain	3.55	3.56	3.56	3.62	3.69	3.60	
No. barrows slaughtered	6	3	6	5	6	26	
Carcass length, in.	29.8	31.3	29.6	29.7	30.6	30.1	
Carcass backfat, in.	1.50	1.37	1.66	1.45	1.47	1.51	
Loin eye area, sq. in.	3.63	3.76	3.26	4.22	3.89	3.77	
% lean cuts	36.9	35.8	36.0	38.3	35.6	36.1	

Table 2. Performance and Progeny Test Summary on Line Ok 9 Beltsville No. 1 Boars Siring 9x8 Crossbred Pigs Ft. Reno 1962 Spring.

Boar	184	255	602	1090	1214	Av. of 5 Boars Selected	Av. of 28 Boars Tested
Performance Test							
Av. daily gain, lbs.	1.71	1.51	1.88	1.57	1.52	1.63	1.66
Lbs. feed per lb. gain	2.75	2.66	2.69	2.78	no test	2.72	2.76
Probed backfat, in.	1.44	1.62	1.47	1.72	1.60	1.57	1.59
Length score	8	8	8	8	8	8.0	7.7
Meatiness score	8	6	8	6	6	6.8	6.1
Legs score	6	3	4	5	4	4.4	4.5
Progeny Test							
No. pigs on feeding test	20	20	19	20	20	99	
Av. daily gain, lbs.	1.59	1.35	1.51	1.48	1.58	1.50	
Lbs. feed per lb. gain	3.84	3.68	3.61	3.80	3.84	3.76	
No. barrows slaughtered	6	3	6	6	4	25	
Carcass length, in.	30.4	30.4	30.1	30.6	29.8	30.2	
Carcass backfat, in.	1.56	1.45	1.42	1.52	1.60	1.51	
Loin eye area, sq. in.	3.51	3.12	3.43	3.32	3.33	3.57	
% lean cuts	36.5	37.0	37.2	36.4	35.3	36.3	

sired pigs with small loin eye areas. The progeny by boar 255 were the poorest of the group. The somewhat high probed backfat measurements on the five selected boars were an indication of this possibility in the progeny test. The five selected boars were actually little better for most traits than the average of the 28 boars tested. The low selection differentials for these line 9 boars were caused by the substitution of second choice boars for three of the boars originally selected. One of the originally selected boars was injured before the breeding season began and the other two boars failed to breed. The three substitutes for them were 255, 1090, and 1214 who were slower gaining and considerably fatter than the three boars originally selected. It is rather interesting that these three substitute boars were scored lower for meatiness than boars 184 and 602 and their progenies also had smaller loin eyes. The progeny test indicates that the scores for meatiness of all boars were overestimates of their breeding values.

The performance and progeny test records on 7 line Ok 14 Hampshire boars are given in Table 3. These boars were farrowed in the Fall of 1960 and tested at the Stillwater station. Their crossbred progeny were farrowed one year later and tested at the Ft. Reno station. Line 14, unlike lines 8 and 9, is being selected for crossing ability in pig performance, i.e., rate and efficiency of gain and carcass merit. Boars are progeny tested by mating to crossbred 8x9 and 9x8 gilts. At weaning 25 boars were selected for performance tests. At the conclusion of the performance test 8 boars were selected, but one of these failed to breed resulting in progeny test information on only the 7 boars listed. Boar 14 was selected in order to have a very slow gaining sire on the progeny test and boar 74 was chosen in order to extend the range in backfat thickness of the boars to be progeny tested. These selections and the loss of one boar through breeding failure reduced the selection differentials, so that the selected boars were little different in performance from all the tested boars. Possible exceptions were the advantages in backfat thickness and meatiness scores of the selected boars over the average.

As in the case of the other two sets of boars the slowest gaining boar (14) sired the slowest gaining set of progeny. The feed records on all of the progeny were poor because of low quality, weevil damaged wheat in the ration of the progeny. For this reason, perhaps not much significance should be attached to the feed efficiencies of the progenies of these boars. Some rather wide differences are indicated, however, with progeny of boar 90 considerably superior to the others.

In the carcass test the number of carcasses from certain boars were somewhat limited and therefore limit the reliability of progeny comparisons. The longest pigs were sired by 91 and this checks with the length score on 91 himself. Boar 204 sired the shortest pigs and he was scored as one of the shorter boars. Boar 72 sired the pigs with the lowest backfat thickness but since there were only 4 pigs slaughtered by him this appraisal must be considered with caution. However, a later progeny test with purebred pigs by boar 72 supports the evidence of his desirable breeding value for low backfat thickness. Boar 47 sired the fattest

Table 3. Performance and Progeny Test Summary on Line Ok 14 Hampshire Boars Siring 14x18-9 Crossbred Pigs, Ft. Reno 1961 Fall.

Boar	14	47	72	74	90	91	204	Av. of 7 Boars Selected	Av. of 25 Boars Tested
Performance Test									
Av. daily gain, lbs.	1.42	1.48	1.86	1.83	1.52	1.73	1.80	1.66	1.67
Lbs. feed per lb. gain	3.00	2.99	3.06	3.06	2.99	2.99	2.89	3.00	2.96
Probed backfat, in.	1.42	1.49	1.47	1.61	1.52	1.43	1.43	1.48	1.53
Length score	6	7	6	6	6	8	6	6.4	6.4
Meatiness score	6	6	8	6	6	6	7	6.4	6.0
Legs score	6	4	6	6	6	6	6	5.7	5.8
Progeny Test on 14x8-9 Crossbred Pigs									
No. pigs on feeding test	33	21	17	18	16	33	29	167	
Av. daily gain, lbs.	1.49	1.59	1.51	1.57	1.60	1.55	1.52	1.54	
Lbs. feed per lb. gain	3.90	3.65	4.02	4.35	3.23	3.74	3.60	3.78	
No. barrows slaughtered	9	5	4	4	3	9	6	40	
Carcass length, in.	29.8	30.2	29.6	29.8	29.9	30.4	29.5	29.9	
Carcass backfat, in.	1.49	1.55	1.30	1.50	1.41	1.45	1.50	1.47	
Loin eye area, sq. in.	4.31	4.58	4.35	4.24	3.71	4.29	4.18	4.27	
% lean cuts	40.8	39.6	41.3	40.8	41.4	40.2	40.4	40.6	

pigs but he, himself, was only average in probed backfat thickness. Boar 47 sired the progeny with the largest loin eyes which were slightly larger than those from boar 72. A later progeny test with purebred pigs from these same two boars yielded loin eye areas of 5.44 for sire 72 and 4.90 for 47. The boars both bred quite well in respect to loin eye area. Boar 90 with only 3 carcasses showed a low loin eye area of 3.71 sq. in. On a more extensive purebred progeny test later, his progeny averaged 5.16 sq. in. of loin eye area. This emphasizes that progeny test information on a limited number of progeny should be considered only as preliminary information that should be evaluated with caution until more extensive information is available.

It is interesting to note that it was necessary to cull boar 91 at the conclusion of the progeny test in spite of the fact that his tests were fairly extensive and his progeny performed well in all respects. He sired a number of cryptorchid pigs and a higher than normal number of "off belted" pigs. For these reasons he was culled, although his progeny performance in other respects were quite good.

Summary

Performance and progeny test records have been presented on sets of boars from three lines in three different breeds. A study of these records indicates the usefulness of a herd testing program for the evaluation of individual performance and also a progeny testing program for the selected sires to improve the efficiency of overall selection. Individual performance, pedigree and family performance are extremely useful in the initial selections of young herd sires and these are correlated to the breeding values of these individuals for heritable traits, but they are not perfect indicators of breeding value. The progeny test gives new information about breeding value which will make the overall testing and selection program more complete and more reliable. To carry out such a program it is necessary to performance test a much larger number of boars than needed for service in order to permit selection on performance test results. It is also necessary to select more boars to be progeny tested than are actually needed for service to permit more opportunity to select on progeny test results and also increase the chances of locating the really superior sires.

Alternate Low and High Winter Feed Levels on Growth and Performance of Beef Heifers

L. Smithson, L. S. Pope, D. F. Stephens and D. O. Pinney

Experiments conducted at this station since 1948 have shown repeatedly that spring-calving cows, under good range conditions, can tolerate low levels of supplemental feed and rather severe winter weight loss, provided they can recover on summer grass. With young replacement heifers, the effects of winter treatment are more severe. In experiments conducted to date, beef females have been continued on the same low, moderate or high planes of nutrition each winter until they reached mature size in order to study accumulative effects.

Such data fail to answer the following questions: What is the optimum plane of nutrition to two years of age if heifers are well-fed thereafter? Which is most damaging, a low plane of nutrition the first winter as a weaner calf or the second winter as a bred yearling? Can larger amounts of feed be used more effectively by the weaner calf, or is it more important to feed liberally the following winter as a bred yearling? In other words, what is the optimum growth pattern for beef heifers during the critical years of growth and development. If feed levels can be reduced during either the first or second winters without affecting mature size and reproduction, a considerable saving in feed cost may be realized.

The effects of Low vs. High planes of nutrition during the first winter (7 to 12 months of age) or second winter (19 to 25 months of age) were investigated in two trials at the Ft. Reno station. As in previous experiments, the heifers grazed native range grass, year-long. A basic concept in these studies has been that the first step toward profitable cow-calf operations is to provide plenty of grass, both summer and winter, supplemented as cheaply and effectively as possible during the dormant periods. Data are now available on the growth and production of heifers to 2.5 years of age. The heifers used in Trial II will be continued on test at the Moderate level to study subsequent performance.

Procedure

In each of two trials, 75 weaner Hereford heifer calves from the experiment station herd were started on test at approximately 8 months of age. The calves were allotted to treatment according to age, sire, previous treatment of their dams, shrunk weight and grade. The heifers were divided into five uniform lots of 15 head each. The feeding plan for the first two winters, number of heifers started on test, and number successfully weaning calves at 2.5 years of age are shown in Table 1.

All heifers grazed native grass pastures at 8 acres per head, yearlong. The grasses were predominantly big and little bluestem, Indian,

Table 1.—Design of Experiment and Number of Heifers Completing Test

Lot Number	1st winter as calves	2nd winter as breed yearlings
1	Low — 30	Low — 18
2	Low — 30	High — 20
3	Moderate — 30	Moderate — 21
4	High — 30	High — 22
5	High — 30	Low — 20

switch, grama and less desirable annual grasses. The heifers were fed their respective supplements daily, by lots, from approximately November 1st to April 15th. The amount and kind of supplement fed each lot was varied to provide the desired gain or loss of body weight during the winter. Ample summer grazing was available so that recovery could be made from the effects of poor winter treatment if possible.

In the overall plan of the experiment, two lots were started on a Low plane of nutrition during the first winter, one on a Moderate and two on a High plane. Following a summer grazing season on good native grass, one lot on each of the Low or High planes were reverted to the opposite level during the second winter. The gain or loss patterns which were followed the first and second winters were:

I. First Winter—Weaner Calves
Low—No gain from fall to spring.
Moderate—Approximately 0.5 lb. per head daily gain (Nov. to mid-April).
High level—1 lb. or more per head daily gain.

II. Second Winter—Bred Yearlings
Low level—Loss of 20% or more of fall body weight (including calving loss) to spring.
Medium level—Approximately 10 to 12% loss from fall to spring.
High level—Less than 5% loss from fall to spring.

The above levels of wintering were achieved by frequent adjustments in the amount and kind of supplement offered. Low-level heifers were placed in drylot on wheat straw, with no supplemental feed for approximately 3 to 4 weeks at the beginning of each winter period to initiate an early weight loss. Following this, they returned to dry grass pasture, with no supplement until approximately mid-January. This was followed by 1.0 lb. of cottonseed meal per head daily until late March, with a small amount of grain as necessary to prevent excessive loss.

The Moderate regime required an average daily feed intake of approximately 2 lbs. of cottonseed meal and 1 lb. of ground milo throughout the winter. The High level required 2 lbs. of cottonseed meal and from 5 to 7 lbs. of ground milo per head daily throughout the winter period.

Where heifers were reversed in treatment from Low to High, or High to Low, the feeding pattern followed was the same as practiced for the continuously treated group (Low-Low or High-High). A mineral mix of 2 parts salt and 1 part steamed bone meal was available throughout the year.

All heifers were exposed as yearlings (approximately 15 months of age) to purebred bulls. The breeding period lasted from approximately May 1 to August 15th; hence, the first calves were dropped in early February.

A routine yearly vaccination for Leptospirosis has been necessary at Fort Reno for some years. Due to an oversight, this was omitted with the first group of heifers. A large "storm" of abortions among bred yearling heifers occurred during November and December in Trial 1. Vaccination of remaining heifers at this time halted the spread of the disease, but the abortions in each treatment made it necessary to eliminate data on all affected heifers beyond 18 months of age.

Results and Discussion

The average results of the two trials in terms of body weight change, and calf and milk production, are summarized in Table 2. As planned, the winter change in body weight of beef heifers was directly related to the feed levels. Low levels of supplemental feed significantly affected growth and development of beef heifers to 13 months of age, although remarkable recovery was made on summer pasture as yearlings.

Winter gain of the Moderate and High groups were a direct reflection of higher feed levels. The overall pattern of winter-summer gains for the reversed groups (Low-High and High-Low) are shown graphically in Figure 1.

Note that the switchover in treatment during the second winter resulted in some gain for the Low-High group, but a marked weight loss for the High level heifers reverted to Low treatment. Despite these changes, average body weights at 2.5 years were quite similar.

Although heifers wintered each year at the Low level showed remarkable recovery of body weight, and to some extent in skeletal size, they did not approach the High level at either 18 or 30 months of age. A continual winter treatment at the Low, Moderate or High levels caused a marked spread in weights during the second winter, while the heifers were bearing their first calves. At 2½ years of age, after weaning their first calves, there was a difference of 128 lbs. in body weight between Low-Low and High-High wintered heifers, with Moderate-level heifers intermediate. Two summers on good grass were not sufficient, therefore, to recover the weight disadvantage from the preceeding winters. Judging from the results of other studies, however, this difference can be recovered to a great extent at 5½ years of age.

Differences in skeletal size due to treatment were quite small, considering height and length measurements at 2.5 years of age. The re-

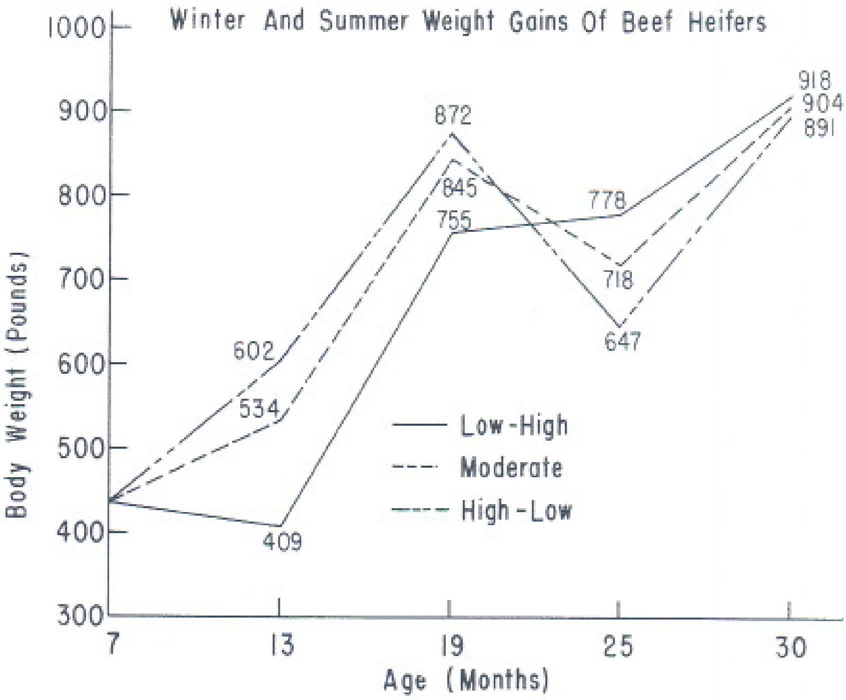

Figure 1.

sults are shown graphically in Figure 2. Both height and length were retarded by the Low-Low regime, and were greatest for heifers carried at the High level at least one winter during the trial. Other measures of skeletal size, such as width and heart girth, tended to show a similar pattern.

Data on reproductive performance and milk production have been summarized in Table 2. The most severe effect of a Low plane of nutrition the first winter was to delay conception and retard calving date. Yearling heifers, coming out of the winter in poor condition, are slow to initiate a normal estrual cycle. This delays conception and strings out the subsequent calf crop. Approximately 4 weeks difference in average calving date was apparent between the Low-Low and High-High groups. From data obtained on the second calf crop in Trial 1, a reversal pattern for this adverse effect can be seen for Low-High and High-Low groups. Heifers wintered at a High level tended to calve early the subsequent year, regardless of the first winter's treatment.

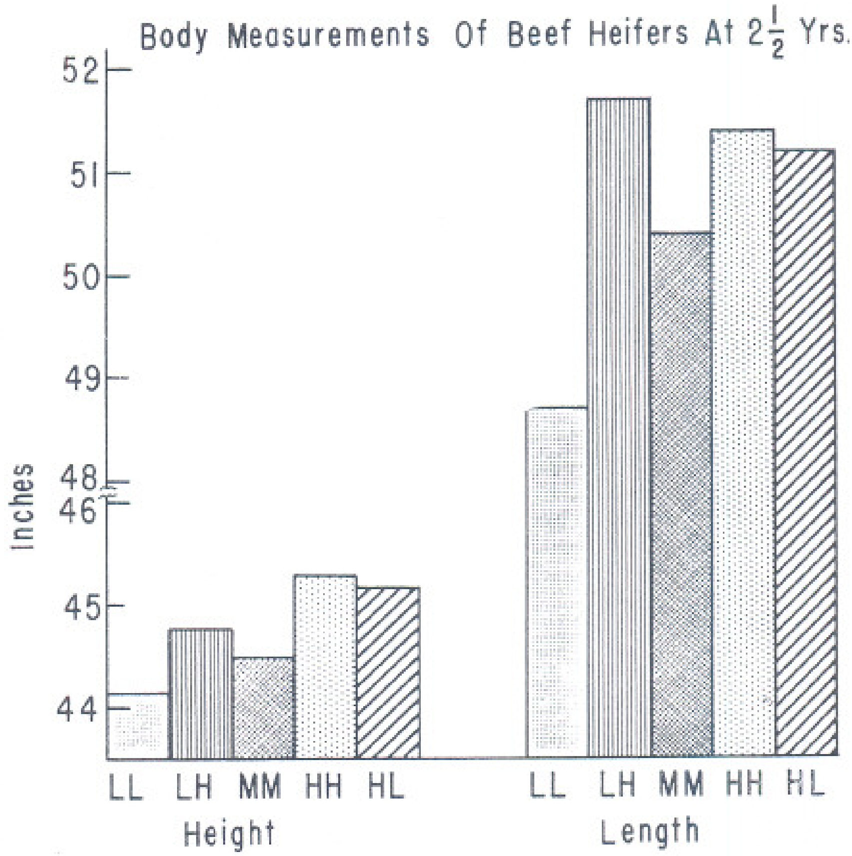

Figure 2.

An opposite pattern was evident for the Low treatment. Heifers wintered on High level as calves conceived early, but were delayed in rebreeding the following year if changed to a Low level. Thus, the winter feed level immediately preceeding the breeding season, particularly the protein and energy intake during the later winter and early spring, is the most important factor in initiating estrus and early conception. The later calving date of the Low-Low heifers was primarily responsible for the lighter weaning weights of their calves.

The percentage calf crop weaned, based on number of heifers exposed in each group and after removing heifers that aborted due to Leptospirosis, was disappointing in all treatments. Average results for 5 previous trials at Ft. Reno show that we can expect about an 80% calf crop from 2-year-old heifers. There is a tendency in these trials

Table 2.—Effect of Alternate Winter Treatment (Low-High and High-Low) on Growth and Reproductive-Performance of Two-Year Old Heifers.

Lot No. 1st winter treatment 2nd winter treatment	1 Low Low	2 Low High	3 Mod. Mod.	4 High High	5 High Low
Average weight change lbs.					
8 to 18 months of age					
Winter gain	— 26	—28	97	147	164
Summer gain	355	346	314	277	270
Net yearly change	329	318	411	424	434
18 to 30 months of age					
Winter gain	—193	9	—128	—67	—230
Summer gain	237	153	187	141	243
Net yearly change	44	162	59	74	13
Fall wt. at 30 months of age,* lbs.	831	918	904	959	891
Winter supplement/head (lbs.)					
1st winter					
C.S. meal	92	92	240	289	289
Grd. milo	79	79	384	949	949
2nd winter					
C.S. meal	89	289	211	289	89
Grd. milo	30	823	126	823	30
Av. winter supplemental feed cost/head, ($)	8.52	34.38	25.99	52.17	33.81
Calf production data:					
Av. calving date					
First calf	4/3	3/27	3/19	3/12	3/8
Second calf**	3/28	3/2	3/13	2/28	3/20
% calf crop	65	73	70	72	78
Av. birth weight, (lbs.)	65	72	71	72	67
Av. weaning weights, (lbs.)	388	409	408	412	383
Av. daily gain of calves	1.56	1.62	1.61	1.65	1.50
Av. daily milk production,*** lbs.	7.62	7.84	7.40	7.33	6.41

*Includes only heifers calving and raising a calf.

**Data for second trial only.

***Determined by weight changes of calves at two, 12-hour periods at 3-4 samplings, during lactation.

for the continual low level of wintering (Low-Low) to be more severe than any other treatment. Heifers on the High-Low treatment conceived early, but did not lactate as well, as indicated by the milk production data. This reduced the average daily gain of their calves. The reverse treatment, Low-High, resulted in heifers calving later and closer to spring grass, which did not adversely affect milk flow.

Data on average daily gain of the calves from birth to weaning was similar, except for the High-Low treatment. Such heifers, calving in late winter, were in poor nutritional shape for lactation. The opposite regime, Low-High, gave results comparable to the High-High level.

Average weaning weights differed significantly only for the Low-Low treatment. Calves from High-Low heifers were as heavy as those from other treatments, due to their greater age at weaning. The "lb. of calf turned off" per heifer bred, as shown in Figure 3, differed significantly for the Low-Low or High-Low regimes only. Heifers carried on Moderate and High levels, or those reverted from Low to High, were best in performance.

The most severe effect of plane of nutrition was apparently during the second winter, as it then affected both lactation and rebreeding.

All heifers in the second trial will be continued at the Moderate level until they have weaned two more calf crops. Any effect of a carryover from the first or second winter on mature body size and performance will be apparent at that time.

Summary

Results of two trials in which heifers were wintered at Low, Moderate or High levels for the first winter as calves, and in which two lots were reversed from Low to High, or vice versa, during the second winter have been obtained.

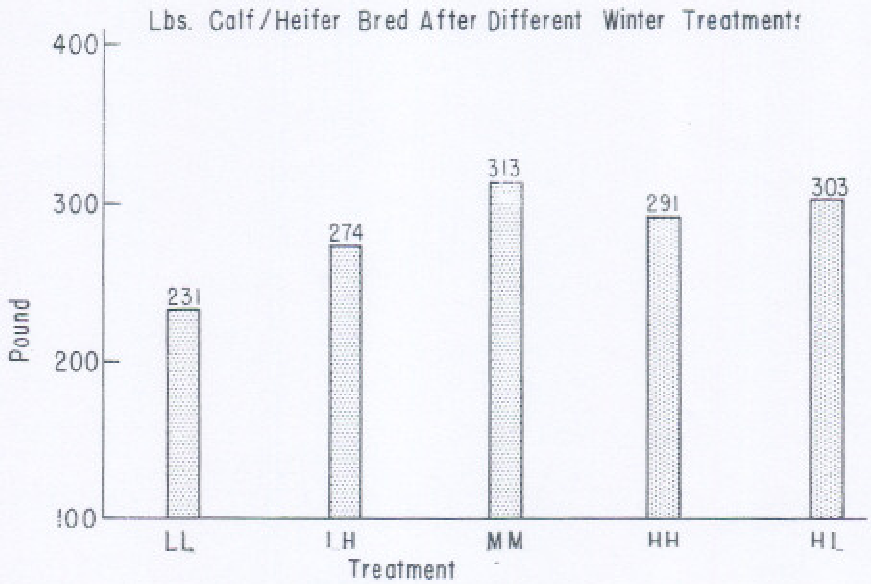

Figure 3.

The plane of nutrition during the first winter as a weaner calf is most severe on the growing heifer in retarding body and skeletal development, and in delaying the appearance of heat and conception. Adverse effects in terms of body weight and skeletal development, however, can be largely recovered on good summer pasture, or by a High plane of nutrition during the second winter. A continual Low or Moderate plane of nutrition during the winter still apparent in terms of body weight and skeletal size at 2.5 years.

A reversal in plane of nutrition from High to Low appears to be more severe on the young heifer than the opposite treatment. Although heifers on the High regime make good gains as calves and conceive early, they have little body reserve for milk production if fed poorly the second winter, and gains of their calves from birth to weaning have been disappointing. In addition, they are slow to rebreed for the following calf crop.

Of the programs studied, the pattern appeared most beneficial for the young heifer. Neither of the alternate planes of nutrition studied in these experiments were more advantageous than the Moderate level each winter.

Feeding Protein Supplements to Range Beef Cows at 2, 4 or 6-Day Intervals

L. S. Pope, A. B. Nelson and W. D. Campbell

Cattle wintering on native range in Oklahoma and most parts of the Southwest need additional protein from November to mid-April. It is common practice to feed a protein supplement either daily or every other day, at twice the daily allowance. In an attempt to reduce labor, or where cattle are wintered in rough range areas, and it is difficult to "cake" them uniformly, self-limiting supplements such as those containing salt are commonly used.

Theoretically, it is desirable that the protein (or nitrogen) necessary for the rumen bacteria to break down fibrous feeds be provided each 24-hour period. This would assure an even source and amount of protein or nitrogen for the rumen bacteria. Tests at several stations have failed to show a significant difference between feeding the protein supplement every day or on alternate days.

More recent tests in west Texas, at the Woodward station, and at Nebraska have shown that under certain conditions it may be possible to lengthen the feeding interval. Such a procedure was tested under "tall grass" conditions at the Lake Blackwell range, where protein is critically deficient during the winter. Two trials have been completed, and another is in progress, in which mature beef cows calving in February and March were wintered on bluestem pastures and supplemented with the same average daily allowance of cottonseed meal—but fed at 2, 4 or 6-day intervals. The results of the first two trials are presented.

PROCEDURE

Two groups of mature cows were used in this study. Within each group, they were allotted to one of three treatments, with 16 or 20 cows each, on the basis of past history, age and body weight. Within each group, one lot was fed an average of 2½ lb. of cottonseed meal pellets every other day (5 lb. per feed). Cows of Lot 2 received the same average daily cottonseed meal intake, but fed each 4th day (10 lb. per head). Cows of Lot 3 received the entire 6-day allowance at one feeding (15 lb. per head). The supplements were fed in troughs to prevent waste. The cows grazed comparable bluestem pastures, and were rotated frequently to minimize pasture differences. A mineral mix of 2 parts salt and 1 part bone meal was available, free choice, at all times.

RESULTS

The average results obtained in the two trials are summarized in Table 1. Only those cows successfully raising a calf to weaning were included in the data. All cows lost weight up to calving, as indicated by their weight change from early October to the last weighing before calving (February 1). Such weight losses amounted to 72, 47, and 70 lb. per head for the 2, 4 and 6-day feeding regimes, respectively.

The same pattern existed for the entire winter period, as shown by the weight loss from October to May 1. Overall, body weight losses during the winter were within the range acceptable for spring calving cows (less than 18% of fall weight), and showed no adverse effect from the lengthened feeding interval practiced in Lots 2 and 3.

Average birth dates of the calves were similar since the cows were not on treatment during the winter prior to breeding. Birth weights, however, might be expected to reflect the level of nutrition of the dam prior to calving. These showed no adverse effect from 4 and 6-day feeding intervals.

Gains of the calves from birth to spring were slightly in favor of those from dams on the 4 and 6-day regimes. Average weaning weights, corrected for sex, were 433, 440, and 428 lb. for Lots 1, 2 and 3, respectively, and again showed no detrimental effects.

Results of the trial now in progress, with 20 cows per treatment and the same feeding intervals as described above, show averaged losses of 79, 65 and 85 lb. per head to calving (February 1).

Table 1.—Effect of Feeding Protein Supplements to Range Beef Cows At 2, 4 and 6-Day Intervals*

Lot Number Interval between feedings Cottonseed meal per head per feeding, lb.	1 2 days 5	2 4 days 10	3 6 days 15
Number of cows per lot	36	34	32
Average weight per cow, lb.			
Initial, Nov. 10	1035	1042	1038
Winter, before calving, Feb. 1	963	995	968
Spring, May 1	850	894	868
Fall, Oct. 10	1066	1056	1048
Gain to calving	— 72	— 47	— 70
Winter gain	— 185	— 148	— 170
Yearly gain	31	14	10
Av. birth date of calves, March	5	7	8
Av. weight per calf,** lb.			
Birth	77	78	77
Spring	144	158	151
Weaning	433	440	428

* Average of two trials.

** Corrected for sex by the addition of 8 lb. to birth wt., 7 lb. to spring wt., and 24 lb. to weaning weight of each heifer calf.

Despite a theoretical basis for the belief that beef cattle on low protein roughage should have supplemental protein daily, or at least every other day, the results of these trials show no detrimental effects from 4 and 6-day intervals of feeding range cows. A 1960-61 trial with yearling heifers at this station resulted in winter losses of 2, 8 and 26 lb. per head during a 137-day wintering period for 2, 4 and 6-day intervals of feeding. This may reflect the more critical requirement for protein by the young, growing heifer.

It was observed that cows fed their allowance of cottonseed meal pellets at 6-day intervals required more than a day to clean up the supplement. No difficulty with digestive disturbances, scouring, or founder was observed. Perhaps the larger amount of supplement given at one time permitted the smaller and more timid cows to obtain an equal share of the supplement offered. Differences in grazing patterns could not be determined, since the cows were in adjacent pastures and those fed at 4 and 6-day intervals tended to come to the feeding area whenever the Lot 1 cows were being caked.

SUMMARY

Feeding the same average daily amount of protein supplement (cottonseed meal pellets) to range beef cows at 2, 4 or 6-day intervals showed no adverse effect from lengthening the feeding intervals as reflected in body weight change during the winter, or birth and weaning weights of the calves. The trial is being repeated. For stocker cattle and cows up to calving, it appears that some use can be made of a lengthened feeding interval where difficult terrain or labor are factors, providing the procedure is in line with good management practices.

Barley for Grazing and Fattening Cattle In Oklahoma

L. S. Pope, O. F. Harper, D. F. Stephens and George Waller

Milo and barley are the two most important feed grains for fattening cattle in Oklahoma. In most years, they supply more than 75% of all the feed grain available for livestock. Most of the milo (grain sorghum) is produced in the western ⅓ of the state, while barley is grown chiefly in the central belt. With barley, there is added advantage from the winter pasture and the relatively cheap gain which can be obtained with stocker calves. This can significantly reduce the cost of a yearling feeder. Rolled barley can be used to supplement cattle on small grain pasture, or to "warm up" cattle before the fattening period.

New and improved varieties of barley, which are more winter hardy and provide better grazing, have been developed at the Oklahoma Station over the past few years. The increase in barley production is reflected in acreage and yield data from the U.S.D.A., as shown in Figures 1 and 2 for Oklahoma during the past 9 years.

Barley vs. Milo for Fattening Steers

New methods of processing (i.e. steam rolling) to increase its bulk, together with its fibrous seed coat, have given barley a further advantage for fattening cattle. The rolled grain not only serves as the chief

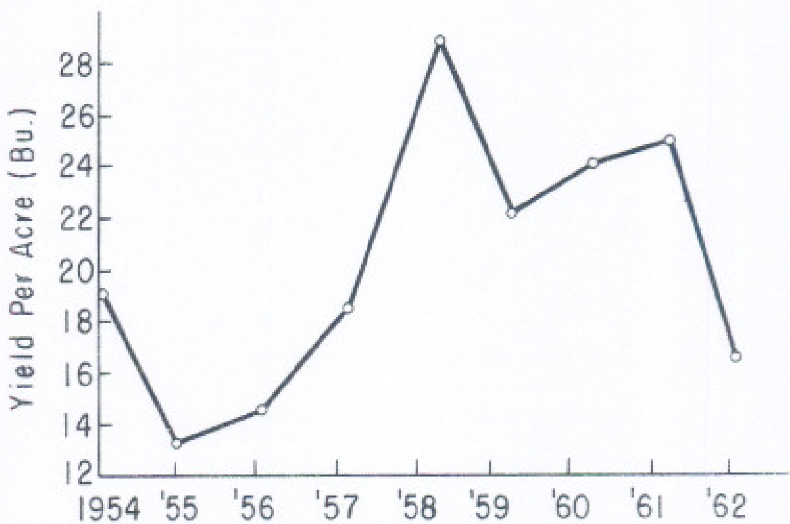

Figure 1. Oklahoma Barley Acreage harvested, 1954-62.

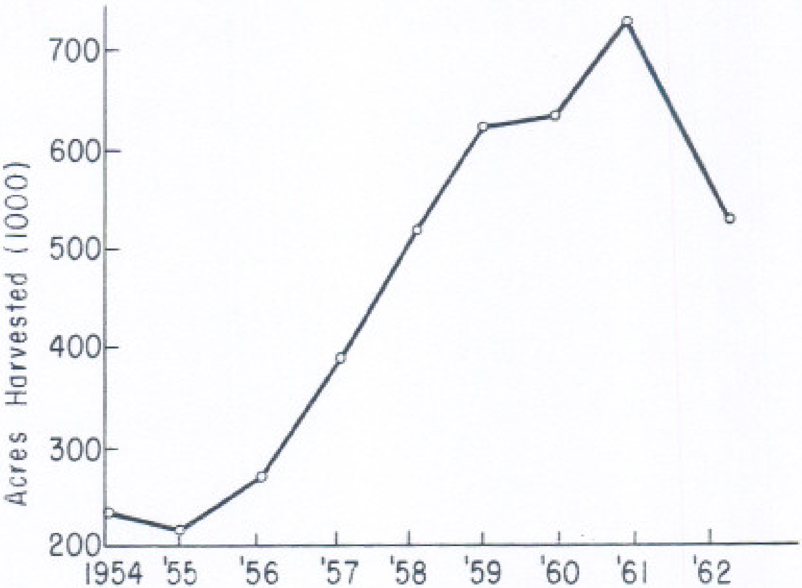

Figure 2. Oklahoma Barley Yield produced, 1954-62.

source of energy for fattening, but also substitutes for much, if not all, of the bulk required. Hence barley may "pencil out" to have a much higher feeding value than shown in past trials when both of these factors are considered.

Experiments at this station and at Arizona have indicated that barley may have more feeding value than grain sorghum for fattening steers, presumably because of the greater availability of starch in the barley kernel. Elsewhere in the report is a comparison of corn, milo and barley when each was fed in ground form, and in rations equalized in fiber and other nutrients. Note the improved efficiency with barley. In recent Arizona tests, it was shown that nearly 25% of the starch in milo passed through fattening cattle vs. only 8% of the barley starch.[1] Results of several feeding trials at Arizona show that barley is superior to milo in terms of feedlot performance and efficiency of gain.

Similar results are available from a 1960-61 test conducted at the Ft. Reno station. Three lots of yearling steers were fattened on either rolled milo or rolled barley (see Table 1). There was a slight advantage in rate of gain for barley and about 94% less barley was required per cwt. gain. When credit was given to barley for the "roughage" effect it induced in the ration (i.e., 2 lb. cottonseed hulls were necessary in the milo ration to provide equal fiber) it appeared that rolled milo was less than 90% of the value of rolled barley.

[1]Cadena, *et. al.*, Ariz. F. Day Rpt., 1962

Table 1.—Comparison of Steam Rolled Milo vs. Barley in Equal Fiber Rations for Fattening Yearling Steers.[1]

Ration	Rolled Milo, Supplement, 2# C.S. Hulls	Rolled Barley, Supplement
No. steers	27	25
Av. daily gain, 154 days	2.35	2.49
Av. daily grain intake	14.7	14.7
Feed required per cwt. gain, lb.		
Grain	625	590
Supplement	79	75
C.S. Hulls	115	36[2]
Av. carcass yield, %	61.2	60.7
Av. carcass grade score[3]	2.85	3.04
Relative value of milo compared to barley, %		
Based on grain/cwt.—	94.4	
Based on value of grain + roughage replaced—	89.0	

[1] Av. of results from 3 lots fed each ration
[2] Small amount of cottonseed hulls fed first 4 weeks of test
[3] 3 = Top Good, 4 = Low Choice

As with all grains, barley may vary in yield and chemical composition, depending on soil fertility, climate, and variety. This results in considerable variation in nutrient content, as is illustrated by the chemical analysis of 7 samples of feed grade barley used at Ft. Reno during the past 3 years (see Table 2). Of most importance is the variation in crude protein and fiber; the latter being a reflection of plumpness of kernel or test weight. Other studies also indicate a variation in trace mineral content.

Acre Yield of Beef From Barley

What can we expect in terms of "yield of beef per acre" from barley, if we consider both its winter pasture potential and the feedlot gains possible from feeding the grain?

Table 2.—Variation in Chemical Composition of 7 Samples of Barley.

Percent Composition	Low Sample	High Sample	Average
Dry Matter	90.2	93.0	91.4
Ash	2.32	2.68	2.54
Crude Protein	9.94	14.73	11.66
Ether Extract	1.25	2.64	1.78
Crude Fiber	4.38	7.01	5.53
N-Free Extract	67.21	73.62	69.90
Calcium	.03	.12	.07
Phosphorus	.29	.39	.32

Results of winter grazing trials with barley pasture at the Ft. Reno station during the fall and early winter of 1962-63 give some indication of expected performance. Obviously, the amount of winter gain possible with stocker cattle grazing barley will vary widely from year to year depending on weather conditions, and age or condition of the cattle. Barley forage is not the most palatable of our small grains, but intake appears to be satisfactory when grazed in pure stands.

One hundred, weaner, Hereford steer calves were purchased from the Schultz ranch near Shattuck in early October for use later in feeding trials. The calves were allowed to recover from the effects of weaning and were branded for individual identification. In late October, they were placed on 50 acres of excellent barley pasture (Rogers variety) with an adjacent 100-acres of dead grass and milo stubble. A mineral mix of 2 parts salt and one part bone meal was available, free choice. The performance for the 101-day period of winter grazing is shown below:

Number of steers pastured	100
Days on pasture	101
Av. initial weight, lb.	470
Av. final weight, lb.	560
Av. daily gain	0.9
Gain per acre of barley, lb.	120

The gain per acre credited to barley was calculated as ⅔ of the total gain per steer, with the remainder credited to other feed.

It can be seen that grazing barley pasture at the rate of 2 steers per acre (plus additional dry feed) for 101 days resulted in 0.9 lb. gain per head or 120 lb. per acre. Growth of barley pasture in December and January was retarded due to extremely cold weather, hence, the results obtained might be considered below average for good winter pasture and a longer grazing period. Nevertheless, cheap gains on barley pasture reduced the cost of yearling feeders by 4.5¢ per lb., based on an initial cost of 28¢ per lb.

Feedlot Performance From Barley

From the results of 5 feeding trials conducted at the Ft. Reno station during the past three years, we can gain some idea of what might be expected in terms of the value of barley for fattening cattle. In all trials, an "all-barley and supplement" type feeding program was employed. Table 3 summarizes the overall results of 5 experiments, which were designed to test different supplements to barley rations. Age of cattle, average initial and final weights, days on feed, barley required per cwt. gain and the quality of carcass produced are shown. While there was considerable variation between different groups of experimental cattle, it appears that about 6.5 lb. of steam rolled barley was necessary to produce a lb. of gain—plus additional supplement and a small amount of roughage during the first 30-40 days while the cattle are being started on feed.

Table 3.—Summary of 5 Barley Feeding Trials at Ft. Reno, 1960-63[1]

Age of cattle	Fall Calves			Yearlings	
Trial number	1[2]	3[2]	5	2[2]	4
No. steers/experiment	36	40	48	36	40
Av. days on feed	199	206	205	146	164
Av. weight, lb.					
Initial	523	573	516	690	633
Final	997	996	997	1082	1052
Total gain	474	423	481	392	419
Av. daily gain, lb.	2.38	2.05	2.35	2.69	2.37
Barley intake/cwt./day, lb.	2.1	1.9	1.8	1.9	1.8
Feed required/cwt. gain, lb.					
Barley	655	668	579	625	646
Supplement	87	96	103	76	86
C.S. Hulls[3]	59	67	28	48	58
Carcass data:					
Av. yield, %	60.9	63.2	60.5	61.4	62.4
Grade score[4]	3.2	3.1	3.7	3.6	3.3

[1] Trials 1, 3 and 5 were fall and winter feeding tests; trials 2 and 4 were conducted in spring and summer.

[2] Implanted with 24 mg. stilbestrol at the start of the experiment.

[3] Small quantity of C.S. hulls used in starting cattle on feed.

[4] Carcass grade score based on 3= Top Good; 4= Low Choice. Yield based on final Ft. Reno shrunk weight and hot carcass weight less 2%.

If we value the gains at 22¢ per lb. (current market for Good-to-Choice slaughter cattle) and consider the total gain from pasture as well as that which might result from feeding 25 bu./acre barley in the fattening phase, it can be calculated that barley would yield about 305 lb. of weight gain per acre, at a value of $67.10. Yields in excess of 40 bu./acre have been obtained at Ft. Reno. On this basis, we can calculate 415 lb. or $91.30 return per acre. Depending on the market, it may be possible to obtain more financial return from grazing and feeding barley than selling a cash crop of grain. The above results are believed to be conservative in terms of winter gain and yields for many areas.

They do not, however, take into account the variation in pasture than can be expected, nor the time, labor, capital and risk involved in feeding cattle, as well as the market fluctuations, cost of preparation, and small amount of supplement and roughage required to effectively use barley, all which should be considered.

Success with "all-barley" type rations depends on many factors. Close attention is necessary. Cattle should be self-fed and the roughage reduced from 50% to zero over 3-4 weeks. Considerable scouring and looseness may occur as the last portion of roughage is withdrawn. Barley should be well crimped to increase its bulk. A well-balanced supplement is the key to success with barley feeding — especially the trace mineral picture. Considerable stiffness and founder may occur among barley-fed cattle. In the above experiments involving 200 cattle, 6%

of the steers were foundered and 3.5% were observed to be somewhat stiff. However, many "stiff" cattle continue to gain, and will grade satisfactorily upon slaughter. Generally, barley-fed cattle have been firm and well covered with outside fat, but with less marbling than desired.

Summary

Increased interest has developed in barley for winter grazing and fattening cattle on the grain. Much of the future for barley depends on the wheat program now under consideration, and barley is less winter hardy than wheat and subject to more freeze out. However, it appears to have promise in many areas where winter pasture can be combined with a feedlot program in the production of finished beef. Yields per acre in terms of weight gain from winter grazing and later fattening program appear to be the neighborhood of 300-400 lb., depending on the growth of winter pasture and yield of barley. Additional items such as labor, supplement, risk and investment should be considered.

The Influence of Slaughter Weight and Limited Feed Intake During Finishing Carcass Merit in Swine

J. C. Hillier, Marvin Heeney and Melvin Bradley

It is well established that carcass traits in swine are high to moderately high in heritability. That economically important carcass traits can be changed significantly through selection, over a period of several years, if modern selection practices are followed and modern aids to selection employed to the fullest. Changes are being made in the direction of both younger and leaner pork and such changes are taking place at an increasing rate, particularly where the producer has the desire to market a superior product. However, a visit to any packer's cooler will reveal that there is a need for a very rapid change in market hogs in the direction of less backfat and increased muscling.

While genetic progress is being made toward a more desirable lean to fat ratio there are forces working against the full expression of this genetic improvement. These forces include more rapid gains as produced by the greater use of rations that are more nearly correct from a nutritional standpoint, less exercise and more nearly ideal temperature conditions as found in modern confinement housing, and the use of feed additives which tend to promote health and thus more

Table 1:—The Influence of Slaughter Weight on Dressing Percentage

Slaughter Weight		150	159	175	180	200	210	215	225	240
Reference No.										
Okla. (1961)	1	70.0		70.6		71.3			70.7	
Okla. (1962)	2					71.2			71.5	
Wallace (1960)	3	70.6			70.8		71.7			72.6
Varney (1962)	4		70.4					71.8		
Cahill	5	75.6					77.6			
Fields (1961)	6		71.4						71.8	
Av.		72.1	70.7	70.6	70.8	71.2	74.6	71.8	71.3	72.6

*Off feed 24 hours before slaughter—no adjustment.

The degree to which hogs tend to become fatter with increased weight is indicated in Table 2. These data indicate that there are distinct fattening patterns associated with breeding groups. This is in agreement with the works of DePope and Whatley (1956) which showed distinct differences among lines in their tendency to fatten, particularly at weights above 170 pounds.

Increases in loin area associated with slaughter weight are shown in Table 3. There is a tendency for the yield of lean cuts, as a percentage of the live weight, to decrease as slaughter weight increases. This is shown in Table 4. No doubt this trend is closely associated with the tendency for the hogs to lay down fat at an increasing rate as they become heavier. The type of hog used will have a good deal to do with the weight at which the highest yield of lean cuts is obtained. The addition of inter and intra muscular fat and the addition of exterior fat to the point of trimming, will increase these lean cut yields, for such fat remains on and within the cut. Up to the point that more fat is being trimmed off than left on cuts increased finish increases lean cut yield.

Table 2:—The Influence of Slaughter Weight on Backfat Thickness

Slaughter Weight		150	159	175	180	200	210	215	225	240
Reference No.										
Okla. (1961)	1	0.99		1.02		1.15			1.24	
Okla. (1962)	2					1.20			1.45	
Wallace (1960)	3	1.13			1.27		1.48			1.52
Varney (1962)	4		1.10					1.50		
Cahill	5	1.40					1.70			
Fields (1961)	6		1.14						1.52	
Av.		1.17	1.12	1.02	1.27	1.17	1.59	1.50	1.40	1.52

Table 3:—The Influence of Slaughter Weights on Loin Area

Slaughter Weight	150	159	175	180	200	210	215	225	240
Reference No.									
Okla. (1961) 1	3.36		3.98		4.41			4.24	
Okla. (1962) 2					4.12			4.33	
Wallace (1960) 3	3.43			3.85		4.07			4.45
Varney (1962) 4		3.66					4.16		
Cahill (1960) 5	---					---			
Fields (1961) 6		3.61						4.39	
Av.	3.39	3.63	3.98	3.85	4.26	4.07	4.16	4.32	4.45

Table 4:—The Influence of Slaughter Weight on Percentage Lean Cuts of Live Weight

Slaughter Weight	150	159	175	180	200	210	215	225	240
Reference No.									
Okla. (1961) 1	39.8		40.6		41.3			40.0	
Okla. (1962) 2					38.8			38.2	
Wallace (1960) 3	38.0			37.8		36.6			35.8
Varney (1962) 4		39.6					38.0		
Cahill (1960) 5	39.3					37.8			
Fields (1960) 6		39.2					38.5		
Av.	39.0	39.4	40.6	37.8	40.0	37.2	38.2	39.1	35.8

The weight of ham associated with live weight is indicated in Table 5. These figures indicate that modern meat type hogs slaughtered at 215 pounds or heavier are producing hams that are heavier than the consumer desired as reported by Fields *et al.* (1961).

Table 5:—The Influence of Slaughter Weight on Weight of Trimmed Ham

Slaughter Weight	150	159	175	180	200	210	215	225	240
Reference No.									
Okla. (1961) 1	11.8		14.1		16.2			17.6	
Okla. (1962) 2					15.3			16.7	
Wallace (1960) 3	10.7			12.9		14.4			16.45
Varny (1962) 4		12.10					15.56		
Cahill (1960) 5	---					---			
Fields (1961) 6		12.15					16.22		
Av.	11.2	12.12	14.1	12.9	15.7	14.4	15.99	17.1	16.45

Restricting Feed Intake

Any scheme for the limiting of feed intake for pigs in an effort to improve leanness should provide adequate nutrients for maximum bone and muscle growth with a small excess of energy to store as fat. High fiber, low energy rations have been tested as a means of improving the carcass qualities of swine.

Crampton, *et al.* (1954) found that restricting the feed to reduce daily gain from 1.7 to 1.3 pounds and extending the feeding period by 17 days reduced the backfat and increased the percentage of grade A carcasses significantly. Hochstetler, *et al.* (1959) studied the effect of varying levels of fiber from different sources upon growth and carcass characteristics of swine. Rations containing from 3 to 8 percent fiber were used. The general response of the pigs was to increase feed consumption as the fiber content of the ration increased, so that daily TDN intakes were not in direct relation to the TDN levels of diets. In general dressing percent was reduced and the yield of lean cuts on the carcass basis increased with the increasing of fiber content.

The effect of limited feeding of corn and pasture was tested by Jordon, *et al.* (1956). The feeding of 50 to 70 percent of a full feed of corn seemed to be the most desirable level for the improvement of leanness in the carcass without seriously reducing rate of gain. Dressing percent reduced markedly with the reduced levels of corn fed. Merkel *et al.* (1958) found that the feed consumption per hundred pounds of gain was increased by restricting the digestible nutrients of the ration. Differences between treatments were not significant when the crude fiber of the ration was less than 10 percent. High fiber levels in the diet tended to reduce dressing percent.

Hillier, *et al.* (1951) found that the dilution of an ordinary swine ration with 20 percent ground prairie hay reduced rate of gain about 30 percent and increased the feed required per unit of by 60 percent. Carcasses from hogs fed the high fiber ration had 0.30 inches less backfat and were calculated to have a value of $0.86 more per hundred than carcass from hogs fed the regular ration. Because of the low dressing percentage of the pigs on the bulky ration the on-foot values of the two groups were the same.

In general the feeding of bulky rations has given the following results as compared to the feeding of rations of normal energy and fiber content; 1. Increased daily feed intake, 2. Reduced feed efficiency, 3. Reduced dressing percentage, 4. Reduced rate of gain, 5. Improvement in the lean to fat ratio, and 6. Greater feed and labor costs. Merkel, *et al.* (1953, 1958). Recently Thrusher, *et al.* (1962) fed rations varying from 62 to 78% TDN. Improvements in carcass values were more than offset in increased feed costs where low energy rations were used.

Because of the generally unsatisfactory results obtained where ordinary rations have been diluted with higher fiber feed, attention has been turned to limiting the daily intake of rations of ordinary TDN value (70-76%).

What is really desired is to feed a level and quality of protein as well as minerals and vitamins necessary for maximum bone and muscle growths but to limit the daily energy intake. Thus protein-energy ratios come into the picture. In work at this station pigs limited to a definite daily intake starting at 175 pounds were slaughtered at 200 and 225 pounds. Feed efficiency was not changed but lean cut yield as a percentage of live weight was increased about one percent.

Becker, *et al.* (1962) limited one group of pigs to 70 percent of a full feed and another to daily intake of five pounds for the period from 114 pounds to slaughter weight. Restriction to 70 percent of a full feed improved feed efficiency by 11 percent, reduced gain 20 percent, (10 days longer to market) and increased the yield of lean cuts by 0.8 percent. Thrasher, *et al.* (1962) limited the intake of a corn-soy ration to 85 and 90 percent of a full fed. Both degrees of limitation reduced the rate of gain and backfat thickness and increased lean cut yield, however, the feed per unit of gain and feed costs was slightly higher in the limited fed groups. Becker, *et al.* (1963) restricted pigs on a corn-soy type ration to 85 and 70 percent of a full feed. On 85 percent of a full feed feed efficiency was maintained while lean cut yield was increased slightly. At 70 percent of a full feed feed efficiency was also improved.

Energy Protein Ratios

Noland and Scott (1960) fed three levels of protein, 12, 16 and 20 percent each at three levels of energy. Carcasses from pigs fed the 1200 calorie ration were fatter than pigs fed the 950 and 1050 calorie ration. Pigs fed the 16 and 20 percent protein rations produced longer and leaner carcasses than those fed the 12 percent protein rations.

Wagoner, *et al.* (1963) fed rations containing from 950 to 1640 calories per pound in combination with protein levels of 13, 19 and 25 percent. Increased protein level resulted in decreased carcass backfat thickness. This may be partially due to decreased feed consumption in the higher energy diets. Increasing energy levels increased the dressing percent. There was no significant inter actions of protein and energy observed in any of the measurements taken. This was interpreted to mean that no serious deficiency of energy or protein existed.

When the protein level is altered in a mixed ration, it is generally done by increasing or decreasing the amount of supplemental protein. Indirectly the amino acids balance is also changed. Kropf, *et al.* (1959) checked the influence of amino acid balance as well as protein level. Providing a poor amino acid balance reduced rate of gain, daily feed intake, and feed efficiency significantly. Carcasses from pigs given the poor amino acid balance tended to be lower in protein and higher in fat than those produced on a better balance of amino acid. Under the conditions of this trial the feeding of a 12 percent protein diet of good amino acid balance did not lower rate of gain or efficiency, cut did tend to produce a fatter carcass than the 16 percent protein ration.

In most studies concerning protein energy ratios protein quality varied as the energy content of the ration changed. Clawson, *et al.* (1962) used rations containing graded levels of from 10 to 18% protein formulated so that a similar ratio of amino acids was maintained in all diets.

Feed efficiency was more closely associated with energy level in the diet than with calorie-protein ratio. As the energy and protein increased in diets of a constant calorie-protein ratio, feed per pound of gain was consistently decreased. The carcass measurements were not significantly influenced by ration treatment, although there was a tendency for both higher energy and lower protein levels to produce fatter carcasses.

Summary

The easiest and most effective means of altering the composition of a pork carcass, from a pig of a given genetic make-up, in the direction of greater leanness, is to slaughter at a lighter weight. A weight of 200 pounds, rather than the present average slaughter weight of about 230 pounds, seems to fit the needs of most interests. These considerations include the lowest feed cost, including breeding herd cost, per pound of hog marketed; maximum conversion of feed to lean pork; optimum size wholesale and retail cuts, and consumer acceptability of the products.

The feeding of low energy rations will produce leaner pork but at the cost of lower dressing percent and increase feed cost as well as increased labor. Limiting the daily intake of a normal energy ration, starting at about 150 pounds and continuing to a slaughter weight, will improve the lean to fat ratio in a carcass and may or may not improve feed efficiency. Lean cut yield as a percentage of live weight may be improved as much as five to eight percent, however such savings are not likely to occur under anything less than ideal environmental conditions.

Even with the most modern equipment it is difficult to limit feed in the amounts and to the individuals desired. In most cases limited feeding will mean increased costs. The financial success of a program of limited feeding will depend on the recognition of increased value at the market.

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Steam Heated (Pregelatinized) Milo For Fattening Beef Calves

L. S. Pope, O. F. Harper and George Waller

Since milo is the chief feed grain for fattening cattle in the Southwest, methods of improving its nutritive value are of major concern. With fattening cattle, fully 75% of the total feed cost is represented by cost of grain alone. Hence, it is of prime importance to determine the best method of preparation of a grain such as milo. Small increases in efficiency of using grain in a fattening ration can greatly improve profits.

Traditionally, cattle feeders have considered milo (grain sorghum) to be only about 90% the value of corn. More recent research, which is discussed elsewhere in this publication, suggests that in certain types of rations, milo has less feeding value than barley.

One of the reasons that milo may be of less energy value to the ruminant is that the dense and compact kernel, with its outer layer of flinty starch, is less subject to methods of processing, or to bacterial and other digestive enzymes in the paunch and small intestine.

If so, one possibility for improving milo might be to increase the availability of its starch to rumen micro-organisms or digestive enzymes. A method was studied involving the steam heating of ground milo until it was almost completely gelatinized, i.e., the envelope containing the starch granules (which may constitute 65% or so of the grain) was broken down to permit easy access to enzymes and more rapid digestion. Attempts to improve milo with steam heat by passing it through the chamber of a pelleting mill were reported in 1962[1]

Procedure

Through the cooperation of Grain Products, Inc., Dodge City, Kansas, it was possible to obtain two differently processed grain sorghums. One was in the ground, but otherwise natural state, while the other had been passed through a special tube or steam chamber and heated to such a degree that it was almost completely gelatinized. A maximum temperature of approximately 270° F was achieved by steam heat and mechanical extrusion through the dies to form the expanded pellets. Actual cooking time in the 180-270° F range was estimated to be about 10 seconds. In addition to gelatinization of starch, considerable denaturation of protein and possible alteration of fat may have occurred. This "expanded" milo came out in small, hard cubes and was re-ground to the same physical state as the ground, but untreated, milo.

Two lots, each containing 12 light, weaner, Hereford steer calves, were selected from the Experiment Station herd and self-fed rations containing the differently processed grains.

[1] See Okla. Agr. Expt. Sta. Mis. Pub. MP-67, p. 113.

Initially, the ration contained (%): ground milo, 56; wheat bran, 7.5; cottonseed meal, 3.7; urea, 0.8; trace mineralized salt, .75; dicalcium phosphate, .75; molasses, 5.3 and cottonseed hulls, 25.

At the mid-point of the trial, the rations were modified slightly and made to contain (%) ground milo, 55; cottonseed meal, 9; dehydrated alfalfa meal, 5; urea, 1; molasses, 3; cottonseed hulls, 26; calcium carbonate and salt, each 0.5. Vitamin A was added to both rations to supply at least 3,000 I.U./cwt., and an antibiotic was added during the first 60 days of the trial. A free-choice mineral mix of 2 parts salt and one part steamed bone meal was available to both lots.

Initial and final shrunk weights (16 hours off feed and water) were recorded, as well as 28-day intermediate weights. Following the completion of the 127-day feeding trial, the calves were reversed to the opposite ration for about 10 days to study their pattern of feed intake on the opposite milo treatment.

Data were obtained from two rumen-fistulated steers fed the normal or treated milo rations as described for the group-fed calves during the last part of the feeding trial. Collections of rumen ingesta and fluid were made twice on each steer while on each ration. Through the cooperation with the Dairy Department, analyses were made for volatile fatty acids and pH of the rumen fluid.

Results

Chemical composition of rations fed and results of the 127-day feeding trial are summarized in Table 1. Calves fed the steam-heated milo gained less than those fed the untreated milo. A marked difference was apparent in feed intake, with the ration containing the cooked milo consumed at much lower levels than that containing untreated milo. However, feed efficiency was only slightly different for the two rations.

The cause of this depression in feed intake, and the slower rate of gain which resulted, poses an interesting problem. It is unlikely that it was caused by changes in odor and flavor resulting from the cooking process, and both grains were fed in the same particle size. More likely a faster rate of fermentation or output of acid from in the rumen of calves fed the gelatinized milo may have adversely affected feed intake. Preliminary results on volatile fatty acid production in the rumen showed no consistent pattern between the untreated milo and the gelatinized milo rations. It was noted that calves of Lot 1 consumed 1.6 lb. less per head per day of the cooked milo ration when the treatments were reversed during a 10-day period following the feeding trial.

These results do not support research at Maryland and elsewhere that steam-heating grain corn improves rate and efficiency of grain. Possibly, grains differ in response to steam heating due to the nature and chemistry of the starch they contain.

Table 1.—Effect of Steam Heated (Gelatinized) Milo for Fattening Beef Calves

Lot Number and Milo Treatment	Lot 1 Normal Ground Milo	Lot 2 Pregelatinized Ground Milo
No. steers per lot*	12	12
Av. weights, lb.		
Initial	497	459
Final	870	776
Total gain—127 days	373	317
Av. daily gain, lb.	2.46	2.25
Av. daily feed intake, lb.	16.84	15.33
Feed required per cwt. gain, lb.	685	681
Chemical composition of ration, % as fed		
Dry matter	91.46	91.83
Ash	3.27	3.78
Crude protein	14.43	14.60
Ether extract	3.01	1.53
Crude fiber	11.96	12.54
N-free extract	58.79	59.38

* One steer removed for respiratory infection in Lot 1 early in the trial and is not included in data. One steer in Lot 2 bloated severely during last 28-day period and data during this period is not included.

Summary

Steam-heating ground milo, so as to gelatinize its starch, resulted in lowered feed intake and reduced daily gains of calves self-fed rations containing 55% of the treated grain. Feed efficiency was not greatly affected by heat treatment. Complete degradation of starch in the milo kernel does not appear to improve its feeding value for fattening cattle.

Factors Affecting Milk Production of Range Beef Cows

L. S. Pope, L. Smithson, D. F. Stephens, D. O. Pinney and M. Velasco

The quantity of milk available for the calf has long been recognized as one of the most important factors affecting weaning weights. It is known, for example, that two-year-old heifers wean about 80 lb. lighter calves than they will at maturity. In any herd, some beef cows appear to be better mothers and milkers than others, and consistently wean off heavier calves.

The amount of milk produced by a beef cow depends on many factors, such as: available feed, time of calving relative to spring grass, age, condition, and inherent producing ability. Unfortunately, little emphasis has been placed on milk production in many range herds. Many of the factors that influence milk production among range cows are poorly understood.

During the past three years, milk production data have been obtained on more than 300 range beef cows, in both fall- and spring-calving herds. While the data have been collected primarily to study the effects of winter feed on milk production, during both the winter and the following summer on grass, a number of interesting observations can be made as to the importance of milk to the growing calf, and the factors that influence milk production of beef cows.

Procedure

Estimates of dairy milk production were obtained from differences in body weight of suckling calves during two nursing periods at 12-hour intervals, following a preliminary period to establish the base time. Chute and scale facilities were designed to permit rapid handling of calves in small groups (6 to 10 head) before and immediately after nursing. Calves were separated from the cows 12 hours before the initial nursing and during the next two periods. Cows were fed prairie hay and had water available. The scales were graduated to the nearest ¼ lb., and the records show a rather high degree of accuracy in obtaining weights. Such a procedure made it possible to obtain frequent estimates on large number of cows.

The calves were weighed before and after nursing, as rapidly as possible, and data on any calves which showed excretory loss were discarded. It has been determined from more detailed studies with identical-twin cows at Stillwater that the calf obtains more milk from nursing the beef cow than can be obtained by hand-milking. Also, the cow is in the proper state for optimum lactation while nursing the calf. A disadvantage of the nursing procedure is that it is not possible to obtain samples of milk for chemical analysis. Other stations have employed different techniques for collecting milk production data. One method involves the injection of a hormone which causes the "let down" of milk. With any method, it is probable that the estimates obtained are conservative and that cows actually produce more out in the pasture.

Milk production records were obtained on two-year-old heifers as well as mature cows under a spring-calving program. Other studies included fall-calving cows. In one experiment, it was possible to collect milk production data on the same females for two consecutive years. Results of the first estimate may be somewhat in error if the young calves were unable to completely nurse out the cows. Similarly, the accuracy of the last sampling is probably influenced by the reduced milk flow of the cow and heavier weights of the calves. It is believed that the records obtained between two to five months of age are reasonably accurate, and estimates of the repeatability of low or high performance suggest that this is true.

Results

1. **Difference in milk production among individual cows.** Since numerous studies on weaning weights of calves from different cows show a rather consistent pattern between low and high producers in the same herd, it is not surprising that milk production data also exhibit the same trend. Data on the 7-month lactation pattern of the top and bottom cows which were on the same wintering regimes and of the same age are shown in Figure I. Note that the better producing cows averaged 8.4 lbs. more milk per day, as determined from seven estimates taken during the summer of 1962. Sex corrected weaning weights (210 days) of their calves were 70 lbs. heavier than for the low producers.

2. **Relationship of milk yield to calf gain.** In both fall- and spring-calving herds, it has been possible to express mathematically the relationship (correlation) between the amount of milk produced by the cow and the average daily gain of her calf. This has been determined at various intervals during lactation, and shows some difference between spring vs. fall calving, since the fall-dropped calf is much more dependent for growth on the dam's milk.

Table I shows some of the correlation coefficients that have been obtained in spring-calving herds. From these, it is possible to calculate the percent of the variation in calf gain which can be accounted for by differences in milk production of their dams (correlation squared). Note that the correlations are much higher early in life of the calf, with values in excess of .8 up to three months of age. After the third month, the correlations decline sharply, and often become slightly negative as the calf depends less on milk and more on other feed for gain. From birth to weaning, as much as 50% of the variation in calf gain can be accounted for by differences in milk production of their dams.

With such correlations between milk yield and calf gain, it is apparent that as we select for heavier weaning weights we also favor heavier milk production, especially if the selection is made early in the calf's life.

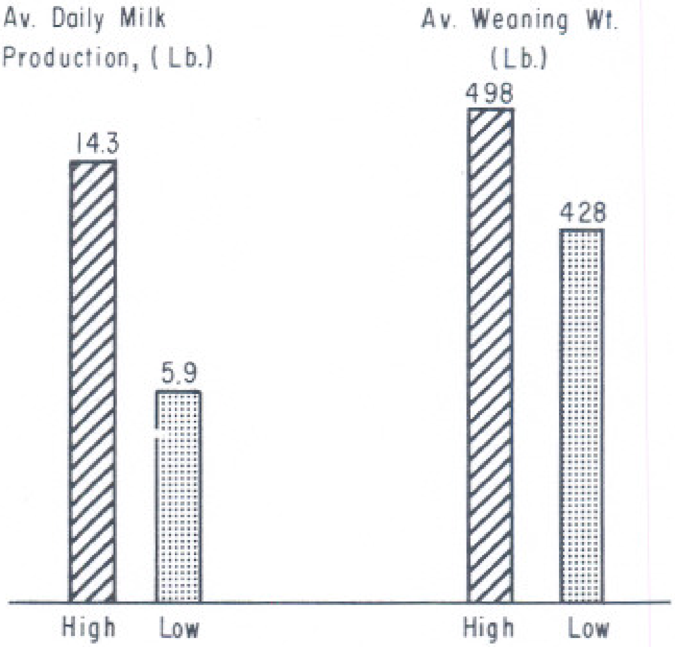

Figure 1. Average Daily Milk Production (5 Estimates) and Weaning Weights of Calves from 6 High and 6 Low Producers at Ft. Reno.

3. **Effect of winter feed level on milk production.** Graphs presented in Figures II and III show dramatically the shape of the milk production curve for spring and fall calving cows, as influenced by winter feed levels. This is one of the most dramatic and important factors influencing milk production. Fall-calving cows fed poorly during the winter give less milk than those fed more liberally (see Figure II). With cows calving in February and March, this effect of poor winter feed conditions carries into the following summer, even though the cow is on good pasture. Such a carryover effect is apparent in Figure III. This substantiates the common practice of dairymen to build up the cow shortly before each lactation. This is necessary for the development of proper secretory tissue, and must precede each succeeding lactation, otherwise milk yields suffer. Cows fed poorly up to calving may not recover and milk as well as those well-fed before parturition. Preparation for milk production must begin, therefore, before calving and especially during the last 6 weeks.

Are the depressing effects of low feed levels early in life permanent as far as the beef female is concerned? Some indication of this can be obtained from data on milk production of spring-calving cows that had function of body weight ($W^{.73}$), this factor was calculated for each of 49 cows, using an average of spring and summer weights. When correlated with average milk production for the summer, a value ____ was obtained.

It is apparent from the above data that, regardless of the means of expressing body size or weight, there appears to be little or no relationship between size at 4 years of age and milk production, within the two groups of cows. Among cows that are well-developed for their age, there seems to be little association between body size and milk production. Both large and small cows in the above group appeared to be able to lactate to their inherent capacity for production, while on summer grass. This poses a fundamental question as to the optimum size of a range beef cow, in line with most economical and profitable production.

8. **Are current feeding standards adequate for lactating beef cows?** From the body weights of a beef cow, and with some idea of probable production, it is possible to utilize the data available on dairy females and apply this to different weights and production levels among beef cows. Thus, it is possible to estimate whether or not our current standards (Morrison or NRC) are adequate for the lactating beef female. Such data have been calculated in Table III, using an estimated value of 3.5% for butterfat.

It appears that the digestible protein allowance may be seriously low for cows producing 25 lbs. of milk a day, especially with body weights in excess of 1,100 lbs. TDN standards appear adequate for all but the heavier, high producing beef cows. Calcium requirements appear to exceed current standards for the high producers, but this may

Table 3.—Comparison of Calculated Nutrient Requirements Based on Body Weight and Milk Production vs. Current Recommended Allowances (lb./day)[1]

Nutrients or Mineral	Digestible Protein	TDN	Calcium	Phosphorus
900 lb. Cow				
15# milk/day	1.28	11.7	.053	.046
25# milk/day	1.74	14.7	.075	.062
1,100 lb. Cow				
15# milk/day	1.40	13.1	.057	.050
25# milk/day	1.86	16.1	.079	.066
Current Recommendations for 900-1,100 lb. beef cows nursing calves	1.2-1.4	12-15	.066	.053

[1]Assuming 3.5% butterfat; calculated values based on requirements of dairy cows (Morrison, *Feeds and Feeding*, 22nd Ed., Appendix Table III).

not be critical since excess quantities are available in most roughages and pasture. Phosphorus is apparently ample, or nearly so, for most weights and levels of production.

Summary

Estimates of milk production on more than 300 range beef cows, representing both spring and fall-calving herds, were analyzed to determine some of the factors that influence milk production. A wide individual difference in milk production among cows was observed. Milk production was highly correlated with daily gain of calves, accounting for 50 to 80% of the variation observed in calf gains to three months of age. Data on 49 four-year-old cows were analyzed to determine the effects of birth date, sex, and birth weight of calf on milk production. Time of calving in relation to the first sample had an important bearing on the first milk production estimate. Male calves and those with heavier birth weights were associated with a slight increase in milk production of the dam. Body size of the beef cow had little bearing on milk production, and fall body weights were negatively associated. Milk production was found to be a highly repeatable trait, hence good or poor producers tend to repeat their performance in relation to other cows in the herd. The feed level prior to and during lactation had a marked influence on milk yields.

The Comparative Value of Corn, Milo and Barley Rations For Fattening Calves

Robert Totusek, Dwight Stephens, Lowell Walters and G. R. Waller

Sorghum grain is the principal high energy feed available for fattening cattle in the Southwest. Barley has been an increasingly abundant grain in recent years and has been extensively used in cattle fattening rations by the small feeder in particular. Even more sorghum grain and barley may be available for beef rations in future years. Corn, which consistently produces good results and is the standard grain to which others are compared, is often used as the grain in cattle fattening rations in the eastern portion of the state.

Although considerable research has been done on the relative feeding value of grains, many of the previously reported feeding trials involved hand-feeding and often high concentrate rations. Furthermore, most of the comparisons have been with rations which contained constant levels of protein supplement and roughage, with the kind of grain as the only variable and no allowance made for differences in chemical composition of the grain as a basis for determining the amount of protein supplement and roughage fed. One objective of this experiment was to compare corn, milo, and barley under the following conditions:

(1) In a self-fed high roughage (about 40%) type of ration.

(2) In rations equivalent in protein, energy and fiber.

Another objective of this experiment was to compare simple rations containing corn or milo or barley to a ration containing a greater variety of feeds (eight) which has consistently produced excellent results when fed to bulls and steers on rate-of-gain tests at the Ft. Reno Livestock Experiment Station. This ration was first reported by Chambers, *et al.* in the 1956 Feeders Day Report. It has the following makeup:

	%
Corn-and-cob meal	35.0
Whole Oats	10.0
Wheat Bran	10.0
Cottonseed Meal	10.0
Molasses	5.0
Cottonseed hulls	20.0
Ground alfalfa hay	10.0
	100.0

The above ration, hereafter called the test ration, has proved to have several merits. Calves can be allowed free access to the ration immediately when placed in the feedlot without suffering digestive disturbances and can therefore be started on feed with a minimum of health problems and labor. (It is a relatively high roughage ration with a concentrate to roughage ratio of approximately 60:40). The ration promotes a rapid rate of gain, yet there has been little difficulty with founder, bloat, urinary calculi, and cattle "going off feed". Whether this particular ration has any special merits not explained merely by its chemical composition and physical balance has been a matter of speculation. Most cattle feeders use at least three or four ingredients in the ration and believe that cattle tend to "stay on feed" better during a long feeding period if the ration contains an even greater variety of feeds. Little experimental evidence on this point is available.

Procedure

The Calves

Eighty Hereford calves of known ancestory and with an average of approximately 7 months and an average weight of about 460 lbs. were obtained from the Experiment Station herds. They were divided into eight lots primarily on the basis of sire and weight, with the heavier calves assigned to Lots 1-4 and the lighter calves to Lots 5-8. The four lots in each of the two replicates were also comparable in average initial age and grade.

The feeding period was from October 19, 1961, to May 3, 1962, a period of 196 days. Initial and final weights were on a shrunk basis, with the calves allowed no access to feed or water for 16 hours. At the conclusion of the feeding period the calves were shipped to Oklahoma City for slaughter. Carcass data were obtained after a 48 hour chill.

The Rations

Four rations were fed, and their typical makeup is given in Table 1. The four rations—test, corn, milo and barley—were fed to Lots 1 through 4, and also to Lots 5 through 8, respectively. Each ration then was fed to two lots of calves, one lot in the replicate of heavier calves, and one lot in the replicate of lighter calves.

The chemical composition of the test ration, corn, milo and barley is given in Table 2. These analyses, along with those of other feeds used, served as the basis for the formulation of rations. The test ration contained 12.3% crude protein and 16.9% crude fiber, and was estimated to contain 63.0% total digestible nutrients (TDN). The rations containing corn, milo and barley were accordingly formulated to contain equivalent levels of protein, fiber, and TDN. All rations contained 10.0% alfalfa and 7.5% molasses, while the levels of grain, cottonseed meal and cottonseed hulls in the corn, milo and barley rations were varied to control ration composition in terms of protein, fiber and TDN as indicated necessary by chemical analyses. The feed ingredients of the test ration remained constant throughout the feeding period.

All rations were self-fed throughout the trial. A mineral mixture of equal parts salt and ground limestone was offered free-choice at all times. Water (heated in winter) was readily available, and an ample area of both open shed and outside pen was provided for each lot. Feeds which were ground were prepared with a hammer mill, using the following sized screens: Shelled corn, ear corn and alfalfa hay—1½ inch, milo—5/16 inch, and barley—½ inch.

Table 1.—Ingredient Makeup of Rations (Percent)[1]

Feed	Ration			
	Test	Corn	Milo	Barley
Corn-and-cob meal	32.5	---	---	---
Corn, ground	---	39.0	---	---
Milo, ground	---	---	39.2	---
Barley, ground	---	---	---	44.2
Oats, whole	10.0	---	---	---
Wheat bran	10.0	---	---	---
Cottonseed meal	10.0	13.5	13.8	11.8
Molasses	7.5	7.5	7.5	7.5
Cottonseed hulls	20.0	30.0	29.5	26.5
Alfalfa hay, ground	10.0	10.0	10.0	10.0

[1] Composition of rations was varied during the feeding trial as indicated necessary by chemical analyses of different batches of feed.

Table 2.—Chemical Composition of Test Ration and Grains (Percent)

	Dry Matter	Crude Protein	Crude Fiber	N-Free Extract	Ether Extract	Ash
Test Ration	91.1	12.3	16.9	52.8	3.4	4.5
Corn	90.0	9.2	1.3	73.6	4.3	1.5
Milo	89.7	8.7	1.5	74.0	3.8	1.7
Barley	90.2	10.7	4.4	70.3	2.2	2.6

Results

Feedlot Performance

Gain and feed data are summarized in Table 3, with each figure for each ration actually representing 20 calves in two lots. The results within each of the two replicates were remarkably similar. The four lots of calves on the four different rations in each of the two replicates ranked in identical order in rate of gain, feed intake and feed efficiency, and differences were of the same magnitude. This certainly justified confidence in the results, and on this basis the data for the two lots on each ration were combined.

All 20 calves on the test ration completed the trial. Previous observations have indicated that cattle fed this ration have a low mortality from common feedlot disorders. Only one calf was lost on the corn ration (prolapsed rectum) and this was probably due to an anatomical defect rather than to ration effect. Losses on the milo ration (one from bloat, one from urinary calculi) and on the barley ration (two from urinary calculi) could be more logically attributed to the ration. Although definite conclusions regarding losses from disease require a larger number of observations than was possible in this one experiment, the results do agree with the experience of many feeders. Losses from urinary calculi on milo rations are especially troublesome in certain areas.

The rate of gain of the calves as a group was excellent, especially considering the initial age and weight of the calves, the bulkiness of the ration, the length of the feeding period, and the fact that stilbestrol was not used. Average daily gains produced by the test ration and the corn ration were almost identical (2.55 vs. 2.54 lb.). Gains of the milo calves were only slightly (.07 lb.) lower while the barley calves gained considerably (.2 lb.) more slowly than the corn group. The lower rate of gain on the barley ration was probably due at least in part to low feed consumption. Feed intake on the barley ration was 7 and 14% lower than on the corn and milo rations, respectively.

The most efficient gains were made on the corn ration. The barley ration was essentially as efficient (less than 1% more feed required per 100 lb. gain), the test ration was slightly less efficient (4.5% more feed required) and the milo ration was much less efficient (10.8% more feed required—91 lb. more per 100 lb. gain) than the corn ration. The milo was palatable and was consumed in greater quantity than any of the rations, but it produced a lower rate of gain and was consequently less efficient than the corn ration. This poor feed utilization is typical of milo rations.

Slaughter and Carcass Information

Information concerning the dressing percent and carcass characteristics of the calves is given in Table 4. Average chilled carcass weights largely reflect differences in liveweight of the calves, plus a slightly lower dressing percentage in the case of the barley calves. The test ration and corn ration groups had identical dressing percentages, with the milo calves only slightly lower.

Differences in quality grade, trimmed retail cut yield, ribeye area, and fat covering were small, but for the most part were in the same

Table 3.—Feedlot Performance of Steer Calves Fed Various Grain Rations (196 days)

Lot No. Ration	1 & 5 Test	2 & 6 Corn	3 & 7 Milo	4 & 8 Barley
No. calves completed test	20	19[1]	18[1]	18[1]
Av. initial wt. lb.[2]	460	460	462	462
Av. final wt. lb.[2]	961	958	944	921
Av. daily gain, lb.	2.55	2.54	2.47	2.34
Av. daily feed intake, lb.	22.4	21.3	23.0	19.8
Feed per cwt. gain, lb.	877	839	930	846

[1] One calf was removed from Lot 2 due to prolapsed rectum, one calf died in Lot 3 due to bloat, and one calf was removed from Lot 7 due to urinary calculi. These calves are not included in the data. Two calves were removed from Lot 4 two days before the end of the feeding period due to urinary calculi but are included in the data.

[2] Initial and final weights were taken after a 16 hour shrink without feed and water.

Table 4.—Slaughter and Carcass Information of Calves Fed Various Grain Rations.

Lot No. Ration	1 & 5 Test	2 & 6 Corn	3 & 7 Milo	4 & 8 Barley
Carcass Weight (chilled), lb.	593	591	580	556
Dressing %[1]	61.7	61.7	61.4	60.4
Quality Grade[2]	10.2	10.0	9.6	9.8
Trimmed Retail Cut Yield, %[3]	48.4	48.5	48.8	49.1
Ribeye Area, sq. in.[4]	11.1	10.9	10.8	10.6
Av. Fat Over Ribeye, in.[5]	.65	.61	.59	.56

[1] Calculated on basis of shrunk Ft. Reno live weight and chilled carcass weight.

[2] U.S.D.A. quality grade converted to following numerical designations: 15—high prime, 14—average prime, 13—low prime, 12—high choice, 11—average choice, 10—low choice, 9—high good, 8—average good, 7—low good.

[3] Calculated as follows: % of carcass as boneless trimmed retail cuts from the four major wholesale cuts = 51.34 − 5.78 (fat thickness) − .462 (% kidney fat) + .740 (ribeye area) − .0093 (carcass weight).

[4] Determined by measurement on tracings of the ribeye.

[5] Average of three measurements determined on tracings of the ribeye.

order as the rate of gain. This is logical since faster gaining cattle tend to be fatter and consequently will show more marbling and yield less of the trimmed retail cuts than comparable cattle on a ration which produces slower gains. Faster gaining cattle also produce heavier carcasses with larger ribeyes.

Summary and Discussion

Considering both feedlot performance and carcass merit, the test ration and corn ration produced very comparable results and were superior to the milo and barley rations. The milo ration resulted in a slightly lower rate of gain and carcass grade, and much poorer feed efficiency, while the barley ration produced slightly lower carcass grade and dressing percentage, and a considerably lower rate of gain than the corn ration.

No comparative figures summarizing the value of the grains and rations as determined in this experiment are reported here. Prices of both cattle and feed change, so the most meaningful financial comparisons would result by applying current prices to the results of this experiment.

Milo is often the most economical grain in this area in spite of its poor feed efficiency. It is similar to corn in composition. The reason for its poor utilization is not known but research concerning this problem is now in progress and additional research is being planned for the future.

The relatively good feed efficiency of the barley ration may be somewhat misleading. About 15 additional days would have been required for the barley cattle to reach the same weight as the corn cattle, and considerably more feed would have been required for the additional 40 pounds gain. Barley is probably better suited to high concentrate rations which will benefit from its high fiber content than to high roughage rations of the type fed in this experiment.

It should be recognized that the composition of feeds will vary, and in some instances grains will have different relative values than those observed in this experiment.

Fattening Cattle on "All-Concentrate" Rations Based on Steam-Rolled Milo

L. S. Pope, L. E. Walters, G. Waller and W .D. Campbell

Due to the high cost of roughage relative to grain, there has been a significant shift toward the use of high-energy rations in large commercial feedlots. Increased quantities of grain are now available for fattening cattle in the Southwest. When the costs of harvesting, transporting and processing roughage are considered, together with its lower net energy value for fattening steers, roughage has become more costly than grain in the typical Southwest ration.

Obviously, if large amounts of good roughage such as corn or sorghum silage can be produced under irrigation and handled mechanically, it is usually more profitable to feed as much of it as possible. However, where all feeds must be purchased and delivered to the feedlot, it becomes a different story. The general trend in the Southwest has been toward increased production of grain, and greater use of this grain in fattening more cattle.

Feeding experiments with rolled barley, rolled oats, or corn-and-cob meal, all of which have considerable fiber and bulk in the hull or cob portion, show that when these concentrates are properly supplemented, they can be fed as the sole ration for fattening cattle. On the other hand, milo differs considerably from these concentrates as it has less than ⅓ the fiber content of barley, and nearly 15% more weight per unit volume. Few attempts have been made to feed "all-milo and supplement" type rations to fattening cattle, although North Carolina and Georgia researchers have successfully fed ground corn-and-supplement rations.

Results are now available from two trials in which steamed-rolled milo and supplement constituted the entire ration. This was compared to a conventional fattening ration containing 25% cottonseed hulls as the roughage. A third trial is now in progress in which some of the factors that influence or regulate the feed intake of fattening cattle on "all-milo and supplement" rations are being studied.

Procedure

Preliminary results of Trial I were reported previously.[1] Complete results are available for the 193-day feeding trial, in which one lot of 10 steer calves was fed a conventional fattening ration containing 24% cottonseed hulls and 8% dehydrated alfalfa meal. The percent concentrates were: steam rolled milo, 50; C.S. meal, 9; molasses, 8; cottonseed hulls, 24; salt and calcium carbonate, 1; and vitamin A premix, .05. The experimental lot of 10 calves received an "all-concentrate" ration containing (by percent): steam rolled milo, 74; dehydrated alfalfa meal, 8; molasses, 8; cottonseed meal, 9; calcium carbonate and salt, 1, and vitamin A, .05.

Both groups were self-fed their respective fattening rations. The roughage in the "all-concentrate" ration was gradually reduced over a 6-week period, in a stepwise fashion. The cattle were maintained on concrete pens and bedded twice weekly with straw. Shrunk weights were taken at the start and completion of the trial, and carcass data were obtained upon slaughter at Oklahoma City. One-half the calves in each lot were implanted with 24 mg. stilbestrol.

Trial II, was conducted during the summer of 1962 with 3 lots of 7 or 8 yearling steers each. The steers were fed 112 days on either a

[1] See Oklahoma Agr. Expt. Sta. MP-64, p. 88.

Table 1.—Feeding All-Concentrate Rations Based on Steam Rolled Milo (Trial I)

Ration Fed	Normal 68% Concentrates 8% Dehyd.Alf. Meal 24% Cottonseed hulls	All-Concentrate 92% Concentrates 8% Dehyd. Alf.
No. steers/treatment	10	9[1]
Av. weights, lb.		
Initial	460	460
Final	886	896
Total gain—193 days	426	436
Av. daily gain, lb.	2.20	2.26
Av. daily feed intake, lb.	19.6	17.5
Feed required/cwt. gain, lb.	891	774
Feed cost per cwt. gain, $	19.60	18.58
Carcass and slaughter data:		
Dressing percentage	59.7	61.6
Marbling	Small	Moderate
USDA grades		
Choice		3
Good	9	6
Standard	1	

[1] Data on one steer in all-concentrate lot removed after 70 days for urinary calculi not included.

"normal" fattening ration with 25% cottonseed hulls, or one of two all-concentrate mixtures, using cottonseed meal or urea as supplemental protein (nitrogen). The composition of the mixtures fed is shown in Table 2. Note that it was possible to formulate rations to include 85 to 90% rolled milo.

The yearling steers were allotted to treatment on the basis of previous treatment, shrunk weight and feeder grade. Steers in Lots 2 and 3 were gradually advanced to the "all-concentrate" diet by stepwise removal of cottonseed hulls (25% initially) over a 4-week period. The cattle were fed in concrete-paved pens, bedded with sand. The area around the pens was treated to kill grass and weeds.

Trial III is now in progress to study some of the factors that influence appetite or feed intake when highly concentrated rations are fed. It is well recognized that cattle drop off in feed intake as the proportion of concentrate in the ration is increased.

To investigate some of the factors that regulate the feed intake of fattening cattle, a series of trials have been initiated. Preliminary results are available from the first experiment. Thirty yearling steers were purchased from the Daube Ranch near Ardmore in late September and divided into 5 uniform groups of 6 each. The steers were self-fed 5 fattening mixtures, formulated to differ in content of roughage, source of energy, or density (weight per unit volume). The rations fed, their relative densities and the estimated caloric value of each are shown in Table 3.

Table 2.—Ration Composition, Feedlot and Carcass Data on Steers Fed All-Concentrate Rations (Trial II)

Ration Designation Lot Number	Normal 1	All-Concentrate With C.S. Meal 2	All-Concentrate With Urea 3
Ration composition, %			
Steam rolled milo	58	85.5	89.5
Dehyd. Alf. meal	5	5	5
Cottonseed meal	8	5	--
Urea	--	--	1
Molasses	3	3	3
C.S. hulls	25	--	--
Salt	.5	.5	.5
Calcium carbonate	.5	1.0	1.0
Vit. A premix	.05	.05	.05
Cost per ton of feed delivered, $	53.00	55.00	54.00
Feedlot performance:[1]			
Av. daily gain, lb.	2.57	2.49	2.51
Av. daily feed intake, lb.	26.2	21.6	19.9
Feed per cwt. gain, lb.	1019	867	793
Feed cost per cwt. gain, $	27.01	23.85	21.41
Slaughter and carcass data:			
Dressed carcass wt., lb.	645	661	659
Dressing percentage	60.5	62.8	62.6
USDA carcass grade			
Choice	2		3
Good	5	8	5

[1] Seven steers in Lot 1, 8 each in Lots 2 and 3.

Lot A steers were fed a conventional fattening ration, with 30% cottonseed hulls. Lot B steers were gradually advanced from this to the "all-concentrate" mix without cottonseed hulls.

To increase the caloric content of the ration, 5% stabilized animal tallow replaced an equal quantity of milo in the mix fed Lot C. As a means of increasing the density of the "normal" fattening ration, 500 lb. of fine sand was added to each ton of the mixture fed Lot D. In order to study the effect of bulk *per se,* an inert material (polyethylene resin, Du Pont) replaced cottonseed hulls in the ration fed steers of Lot E.

The steers have been on test approximately 150 days and will continue on trial to observe any abnormalities that may result from the rations being tested. Upon slaughter, a close inspection will be made of the rumen and digestive tract. Results to date are presented.

Results

Value of "All-Concentrate" Rations Based on Steam-Rolled Milo. The results of Trial I, where 50% vs. 74% steam-rolled milo rations were compared, are shown in Table 1. Calves fed the 74% milo, "all-concentrate" ration gained slightly faster, consumed 2.1 lb. less feed per day, and required 87% less feed per cwt. gain than those receiving the

Table 3.—Ration Composition, Density and Net Energy Value of Rations Fed (Trial III)

Ration Designation	A	B	C	D	E
Ration composition, %[1]					
Steam rolled milo	51.4	83.9	45.9	Same	Same
Cottonseed meal	8.0	5.0	8.0	as A	as B
Dehyd. Alf. meal	5.0	5.0	5.0	plus	plus
Urea	1.5	1.5	1.5	500 lb.	400 lb.
Molasses	3.0	3.0	3.0	sand	inert
Stabilized animal tallow	--	--	5.0	per	bulk
Cottonseed hulls	30.0	--	30.0	ton	per
Salt	0.5	0.5	0.5		ton[2]
Calcium carbonate	0.5	1.0	0.5		
Increased weight per unit volume compared to Ration A, %[3]	--	37.0	—2.0	20.0	6.0
Net energy/cwt., Therms[4]	60.78	72.38	65.12	48.62	60.07
Av. daily gain, lb. (148 days)	2.50	2.56	3.15	2.90	2.95

[1] All mixtures supplied 30,000 I.U. vitamin A and 3 gm. trace mineral per steer daily.
[2] Polyethylene resin, Du Pont, used as filler.
[3] Based on weight per bushel unit; av. of 3 estimates.
[4] Calculated from Morrison's *Feeds and Feeding*, 22nd Ed., appendix Table 2.

conventional fattening ration. Carcass grade and yield data indicate that calves on the "all-concentrate" diet were fatter. Using feed prices current at the time of the experiment, it required $1.02 less to produce 100 lb. gain on the "all-concentrate" diet.

The calves in this 193-day trial were maintained in concrete paved lots, bedded with straw once or twice weekly. They appeared to show no greater desire for bedding than cattle fed rations with 24% cottonseed hulls. Some scouring and looseness was observed in the "all-concentrate" lot early in the trial, but became progressively less as the trial advanced. No founder was observed.

A decline in feed intake, which is characteristic on very concentrated rations, occurred when the "all-concentrate" ration was fed. This trend has been consistently observed in concentrate-to-roughage experiments, both at this station and elsewhere. Such a decline in feed consumption often prevents the feeder from increasing the daily energy intake by raising the grain level in the ration. The reasons for this reduced intake may be the result of a "ceiling" on caloric intake, or to other factors which are not understood, such as the density of the ration or rate of fermentation in the digestive tract. Thus, the factors which affect feed intake of cattle on fattening rations need further investigation.

Results of Trial II, which was conducted during the summer of 1962 with three lots of yearlings steers, are shown in Table 2. One lot was fed a normal ration with 25% cottonseed hulls. Two different "all-concentrate" diets were employed, one with cottonseed meal as the source of supplemental protein, and the other with urea replacing cottonseed meal. The composition of rations fed, the cost per ton

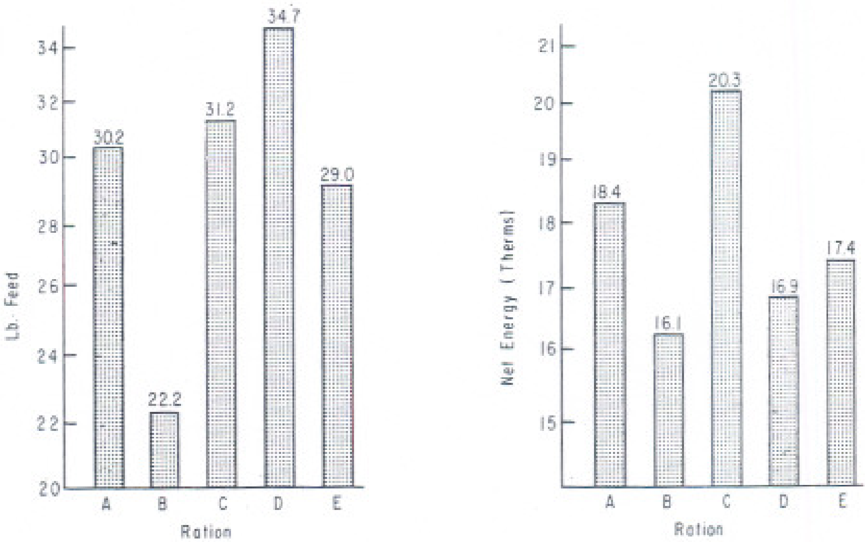

Figure 1.—Average Daily Feed and Eenergy Intake of Steers in Trial III.

delivered, average daily gains, feed efficiency and carcass grades have been summarized in Table 2.

Note that in Lots 2 and 3 it was possible to increase steam rolled milo to 85.5% or 89.5% of the ration. Such levels of milo are higher than those commonly employed in swine rations. The calculated net energy content of the rations fed indicate a much higher energy value per lb. for the two "all-concentrate" diets.

Results of the 112-day feeding test show little difference in average daily gains, but a marked reduction in feed intake and feed required per cwt. gain when the "all-concentrate" rations were fed. Daily feed intake was reduced 17% in Lot 2, and 24% in Lot 3, as compared to the Lot 1. Corresponding reductions in feed required per cwt. gain were 15% and 22% for Lots 2 and 3, respectively.

Dressing percentage data indicate a fatter carcass or higher yield from feeding the "all-concentrate" rations, although the trend in carcass grade was inconsistent. This was due to small differences in marbling among the treatments. No abnormalities of the rumen wall were observed upon slaughter in any of the cattle. Using current feed prices, it was possible to reduce the cash outlay for 100 lb. gain by $4.16 and $5.60 for Lots 2 and 3, respectively, vs. Lot 1. This illustrates the potential of high-grain rations when all feed must be purchased and roughage is costly relative to grain.

Again, the trend toward lowered feed consumption on the "all-concentrate" rations was observed. With high-energy rations, it appears that urea may be used to reduce costs and increase the level of grain in the ration.

Factors Affecting Feed Intake of Fattening Cattle. A trial is now in progress in which some of the factors that influence feed intake are being studied. Specifically, the effect of additional calories, the density of the ration, and the role of bulk *per se,* are being investigated. Five lots of 6 yearling steers each are being used in a preliminary trial to gain some insight into the factors responsible for feed intake, and to test rations that can be used in future studies on the problem. The different formulas, and their energy and density values are shown in Table 3.

Data on feed and energy intake are presented graphically in Figure 1 for the first 148 days of the trial. Note that as the energy level of the ration was increased by removal of the roughage (Lot A vs. B) the feed intake declined, although the net energy intake was less affected. When fat was added to the ration to provide a higher caloric content (Lot C vs. A), feed intake was little affected, while the actual caloric intake was increased. This suggests that additional calories as fat may be consumed at a higher level by ruminants than additional calories taken in as carbohydrate.

Where the ration was made more dense in Lot D, so as to weigh more per unit volume, an increase in feed intake was obtained over the Lot A basal diet. Energy consumption was slightly less, but it appeared that the steers were attempting to consume more of the heavier ration to attain the same energy intake as Lot A. Such a trend is also apparent from the results with Lot E steers, where the addition of an inert material (polyethylene resin) to the "all-concentrate" formula fed Lot B increased average daily feed intake. Again, feed intake appeared to be limited by the caloric content of the total diet, not by its weight or density.

From a practical standpoint, the results with Lots A and E point up the low energy value of cottonseed hulls for fattening cattle, which appears to be mostly a "filler" for fattening cattle.

Summary

Calves and yearlings fattened on "all-concentrate" rations based on steam-rolled milo, properly supplemented, gained as rapidly as those fed conventional fattening rations with 25% cottonseed hulls. Further a marked saving was possible in total feed required per cwt. gain, and in feed cost. Cattle fattened on the all-concentrate diet had a higher dressing percentage, but no consistent advantage in carcass grade. Preliminary results indicate that the caloric content of the diet is a more important factor controlling feed intake of fattening cattle than bulk or density of the ration.

Intraruminal Vitamin A for Fattening Beef Calves

Robert Totusek, Dwight Stephens and Lowell Walters

Vitamin A supplementation of beef cattle rations has increased tremendously during the past two years, especially in the case of fattening cattle. The increase in this practice has occurred because: (1) Reported instances of vitamin A deficiency have increased in frequency, (2) Several recent experiments have indicated a benefit from vitamin A supplementation of rations presumed adequate in carotene, and (3) Synthetic vitamin A is now relatively cheap. Vitamin A can be administered in several ways. It can be added to the ration, administered orally in large doses or injected into the muscle or rumen in large doses.

It has been shown that such large doses are stored by the animal and gradually utilized. For example, a million I.U. injected into the rumen of a steer will provide sufficient vitamin A for about 70 days. One advantage of a method of administration such as intraruminal injection is that it offers a means of assuring adequate and immediate vitamin A intake for every animal. This may be desirable, for example, when cattle are brought into the feedlot from a situation suspected to be sub-optimum in vitamin A. One experiment station has reported that large intraruminal doses of vitamin A resulted in increased marbling in the carcass. The purpose of this experiment was to determine the influence of intraruminally injected vitamin A on the gain and carcass merit of fattening calves.

Procedure

A group of Angus heifer calves (35 head) and two groups of Angus steer calves (47 and 32 head) were available for this experiment, and were designated Groups A, B, and C respectively. Most of the calves were dropped in February, March and April of 1962 and were being progeny tested for feedlot gain during the winter of 1962-63.

The sires of the calves were known and it was possible to assign equal numbers of calves by each sire to each treatment. This was considered a very desirable feature since marbling is known to be highly heritable and one objective of this experiment was to determine the effect of intraruminal vitamin A on marbling.

Group A heifers and Group B steers were calved in the same herd, and were not creep fed. Each of these two groups was divided into three treatment groups for vitamin A—none, one million I.U., or 2 million I.U. per calf. Group C steers were from a separate herd, and had been creep fed. Since the limited number of calves per sire in this group made it unfeasible to divide each progeny group into three treatment groups, only two vitamin A treatment levels, none and one million I.U., were imposed.

Calves which received vitamin A were given two intraruminal injections at the levels indicated, one 28 and another 120 days after the

Table 1.—Effect of Intraruminal Vitamin A on Daily Gain and Carcass Merit of Fattening Calves, by Groups

Group and Vitamin A Treatment[1]	No. of Calves	140 Days lb.	Last 56 Days lb.	Dress-[2] ing %	Marbling[3] Score	Carcass[4] Grade	Ribeye[5] Area Sq. In.	Fat[5] Thick-ness In.
Group A—Heifers								
No Vit. A	12	2.09	1.67	62.5	13.4	10.0	9.06	.79
1 Million I.U.	12	2.09	1.66	61.7	12.9	9.6	9.24	.76
2 Million I. U.	11[6]	2.13	1.78	61.2	14.2	9.8	9.40	.71
Group B—Steers								
No Vit. A	16	2.41	2.12	61.2	14.6	10.0	9.82	.69
1 Million I.U.	15	2.49	2.16	61.3	12.8	9.7	9.83	.73
2 Million I.U.	16	2.60	2.14	61.9	12.8	9.6	9.92	.69
Group C—Steers								
No Vit. A	16	2.43	1.99	62.3	15.2	10.4	9.83	.86
1 Million I.U.	16	2.37	1.92	62.6	15.8	10.5	9.79	.85

[1]Those calves which received vitamin A were given two injections directly into the rumen, each at the level indicated, 140 and 48 days before the conclusion of the fattening period.

[2]Dressing percent was calculated on the basis of shrunk Ft. Reno live weights and chilled carcass weights.

[3]Marbling scores based on a possible range of 1 to 26, from devoid (1-2-3) to very abundant (34-35-36).

[4]9=high good, 10= low choice, 11=average choice.

[5]Ribeye area and fat thickness were determined on tracings.

[6]One heifer died due to a respiratory infection midway through the trial.

beginning of the feeding trial, or 140 and 48 days before the conclusion of the trial. The ration, which was self-fed, was the standard Ft. Reno test ration, composed of 32.5% corn-and-cob meal, 10% whole oats, 10% wheat bran, 10% cottonseed meal, 7.5% molasses, 20% cottonseed hulls, and 10% ground alfalfa hay. A mineral mixture of equal parts salt and bonemeal was available free-choice. The steers were fed in two lots and the heifers in two lots. It was not possible to obtain feed intake and feed efficiency data.

Initial weights were 441, 484, and 571 lb. for Groups A, B and C respectively, and were similar for vitamin A treatment levels within each group. Initial and final weights were taken after a 16-hour shrink without feed and water. Carcass information was obtained following a 72-hour chill.

Results and Discussion

The effect of the intraruminal administration of vitamin A within each group of calves in indicated in Table 1. Vitamin A at the one million I.U. level had little influence on rate of gain. Differences in gain between calves which received no vitamin A and those which received one million I.U. were small and inconsistent. Calves which received two million I.U. of vitamin A gained considerably more than those which received no vitamin A in Group B, but essentially the same in Group A. The only advantage in gain at the one million I.U. level compared to no vitamin A, also occurred in Group B. The reason for this possible difference in response among the groups is not obvious.

The added gain in group B was not accompanied by an increase in carcass grade, marbling score or fatness. Furthermore, it seems that if vitamin A nutrition had been a problem under the conditions of this experiment, there would have been some response to vitamin A at the one million I.U. level in the other two groups.

Differences in dressing percent, marbling, carcass grade, ribeye area, and fat thickness were small and apparently not influenced by vitamin A administration. There would be little reason to anticipate a vitamin A effect upon several of the carcass traits, but marbling and carcass grade were of particular interest, and were not affected by vitamin A in this experiment.

Table 2 presents a summary in which calves in the three groups are combined on the basis of treatment. This summary further emphasizes the general lack of effect from vitamin A administration, but the possible added gain at the two million I.U. level is still apparent.

Table 2.—Summary of the Effect of Intramural Vitamin A on Daily Gain and Carcass Merit of Fattening Calves

Vitamin A Treatment	No. of Calves	Daily Gain: 140 Days lb.	Daily Gain: Last 56 Days lb.	Dressing %	Marbling Score	Carcass Grade	Ribeye Area Sq. In.	Fat Thickness In.
Comparison I[1]								
No Vitamin A	28	2.28	1.93	61.7	14.1	10.0	9.50	.73
1 Million I.U.	27	2.31	1.94	61.4	12.9	9.6	5.57	.74
2 Million I.U.	27	2.41	2.00	61.7	13.3	9.7	9.72	.70
Comparison II[2]								
No. Vitamin A	44	2.33	1.95	62.0	14.5	10.2	9.61	.78
1 Million I.U.	43	2.33	1.93	61.8	14.0	10.0	9.65	.78

[1]Comparison I is a summary of no vitamin A vs. 1 million I.U. vs. 2 million I.U. in groups A and B.

[2]Comparison II is a summary of no vitamin A vs. 1 million I.U. in Groups A, B and C.

Summary

Two intraruminal injections of either one or two million I.U. of vitamin A each during the feeding period were largely without influence on gain and carcass merit of fattening calves. In one comparison calves injected twice with one million I.U. gained slightly more, and those injected twice with two million I.U. gained considerably more than those calves which received no vitamin A. The significance of these differences in view of the lack of response to vitamin A in the other comparisons is not known. Vitamin A had no apparent influence on any of the carcass traits measured, including marbling and carcass grade. Obviously, vitamin A administration might be of considerably more value in other situations and with other rations than was true in this experiment. Apparently the ration fed in this experiment (which contained 10% good quality alfalfa hay) and/or the body storage of the calves provided enough vitamin A to largely meet the needs of the calves.

Bermuda Grass and Prairie Hays for Wintering Beef Cattle

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The use of bermuda grass for summer grazing, as well as for the production of hay, has increased sharply in Oklahoma. An advantage for bermuda grass is its ability to withstand heavy grazing and to respond to heavy fertilization where rainfall is adequate. Increased amounts of bermuda grass hay are now available, and chemical analyses indicate a high protein content (9 to 13%) depending on the stage of growth when harvested and soil fertility.

Despite its high protein content, experiments to date show that bermuda grass hay can be improved for wintering cattle by feeding a supplement. As a roughage, bermuda grass appears to differ considerably from prairie hay. Experiments have been conducted during the past three years to determine the best supplement (protein or energy) needed to increase the value of bermuda grass hay. Digestion trials have been conducted to determine the availability of the protein and carbohydrate fractions of the roughage. Wintering trials with beef cows have been conducted to determine the need for additional protein with prairie hay as the roughage.

Results of Previous Tests

In a preliminary trial, conducted in 1960-61, weaner calves were fed bermuda grass hay containing 13% crude protein. They failed to gain as well as those fed prairie hay plus 1.4 lb. of cottonseed meal per head daily (51 lb. less in 87 days). When calves were fed the bermuda grass hay supplemented with 1.4 lb. cottonseed meal, gains were improved. This indicated that additional supplement was required, despite its high protein content.

In a further test conducted in 1961-62, bermuda grass and prairie hays were again compared. Calves fed prairie hay were supplemented with 1.25 lb. cottonseed meal per head daily, while those on bermuda hay were either given no supplement, or fed 1.25 lb. ground corn per head daily for additional energy. In a 93-day test, calves fed prairie hay plus cottonseed meal gained an average of 66 lb., vs. only 23 lb. for those on bermuda grass hay alone. However, when 1.25 lb. ground corn was added as a daily supplement to the bermuda grass hay, gains were increased to 67 lb. per head. The data from this trial suggest that bermuda grass hay can be effectively supplemented with energy-rich feeds, and it is then equal to prairie hay plus a protein supplement.

Results of Current Trials

Growth and digestibility trials have been conducted with bermuda grass hay, supplemented with protein and energy, as compared to prairie hay and the same supplements. Digestion trials with steers have been conducted to study the availability of nutrients in prairie hay from fertilized and unfertilized meadows, and from bermuda grass hay. In addition, two lots of beef females have been wintered on prairie hay, at two different levels of protein supplement.

Trial I. Sixty, weaner, Hereford heifer calves were allotted to six groups of 10 calves each on the basis of shrunk weight and source. They were fed either prairie or bermuda grass hays, *ad lib.*, in small traps, with the following supplements per head daily:

Prairie Hay:
Lot 1—No supplement
Lot 2—1.25 lb. cottonseed meal per head daily
Lot 3—1.25 lb. ground corn per head daily

Bermuda Grass Hay:
Lot 4—No supplement
Lot 5—1.25 lb. cottonseed meal per head daily
Lot 6—1.25 lb. ground corn per head daily

The amount of cottonseed meal added to the ration of calves fed prairie hay in Lot 2 was calculated to meet the requirement for digestible protein. An energy-rich supplement (ground corn) was used in Lots 3 and 6, since previous studies suggested a benefit from additional energy as well as protein with bermuda grass hay. All calves had access to a mineral mixture of 2 parts salt and one part steamed bone meal, free choice. The chemical composition of the two hays are shown in Table 1.

Unfortunately, the amount of bermuda grass hay was sufficient for only a 68-day trial. At this time, final weights were taken on the bermuda grass hay lots, while those on prairie hay were continued on test. Calves on the prairie hay rations were continued on test for 139 days to gain further information on the relative effects of protein and energy supplements with this roughage over a longer period.

Trial II. Twelve, yearling Hereford steers were selected from the Experiment Station herd and used in digestion trials. A 7-day collection period, preceded by a 14-day preliminary period, was followed with 6 observations on each of the following treatments:

Ration A—Prairie hay, unfertilized, cut in late June

Ration B—Prairie hay, from fertilized meadow (40 lb. N per acre), cut in late June

Ration C—Prairie hay, unfertilized, cut in late June plus S.B. meal

Ration D—Bermuda hay fertilized (40 lb. N per acre), cut in July

Complete results of the digestion trial are not available, but the digestion coefficients for crude protein have been determined.

Trial III. Two groups of beef females, each containing 14 mature cows and 7 bred yearling heifers, were placed in small traps at the Lake Carl Blackwell Experimental range and fed prairie hay, *ad lib.* The females were allotted to test in early November on the basis of body weight, age and source. Females in Lot 1 received 1.0 lb. cottonseed meal per head daily up to calving (Feb. 16) and 2.0 lb. per head thereafter until April 2. Females in Lot 2 received no supplement to calving, and 1.0 lb. per head daily to April 2. Data obtained include winter gain or loss of body weight to calving, birth date and weights of calves, and spring weights of cows taken on April 2.

Results

Chemical composition of the prairie and bermuda grass hay used in heifer feeding trials at Lake Blackwell is shown in Table 1. As in past years, the bermuda grass hay analyzed much higher than prairie hay in crude protein (10.22 vs. 4.18%). Assuming a 60% digestibility, it is apparent that such hay should meet the minimum digestible protein requirement of 450 lb. heifer calves, if 10 lb. per day were consumed (0.6 lb. per day from the hay vs. a requirement of 0.7 lb.)

Results of the heifer feeding trial utilizing the two hays are summarized in Table 2. Unfortunately, sufficient hay was not available to conduct a complete trial with bermuda grass, and it was necessary to terminate this phase of the test after 68 days.

With prairie hay as the roughage, the deficiency of protein was striking when no supplement was fed. Calves fed the unsupplemented hay consumed 3.0 lb. less hay per head daily, and lost 115 lb. from fall to spring (139 days). Supplementing this roughage with 1.25 lb. cottonseed meal resulted in 43 lb. average gain. Supplementing with an energy-rich feed, such as 1.25 lb. ground corn per head daily, was of only slight value when protein was lacking. Prairie hay supplemented with 1.25 lb. of cottonseed meal resulted in a digestible protein intake approaching the minimum requirement for calves of this weight.

Results from supplementing bermuda hay were less clear cut. Both corn and cottonseed meal appeared to give a slight increase in gain; the best performance was obtained when 1.25 lb. of cottonseed meal was fed. However, even the protein supplemented bermuda grass hay was not equal to the prairie hay plus cottonseed meal. From this limited comparison and results of earlier tests, it appears that supplementing bermuda grass with cottonseed meal gives less response than with prairie

Table 1.—Chemical Composition of Hays Used in Feeding Trials (%).

	Prairie Hay	Bermuda grass Hay
Dry matter	92.00	91.00
Ash	8.47	8.32
Crude protein	4.18	10.22
Ether extract	1.90	1.84
Crude fiber	30.01	30.49
N-free extract	55.44	49.13

Table 2.—Growth Trials With Weaner Heifer Calves Fed Prairie or Bermuda Grass Hays.

	Prairie Hay			Bermuda Hay		
Ration fed	No Supple.	1¼ lb. CSM	1¼ lb. Corn	No Supple.	1¼ lb. CSM	1¼ lb. Corn
No. heifers per lot	10	10	10	10	10	10
68-day results (lb.):						
Av. initial wt.	448	448	448	448	448	448
Av. final wt.	418	490	415	443	468	452
Total gain	—30	+42	—33	—5	+20	+4
Av. hay intake/day				8.1	8.1	8.1
139-day results (lb.):						
Av. final wt.	333	483	356			
Total gain	—115	+35	—92			
Av. hay intake/day	8.9	11.9	8.9			

hay. This would be logical if the protein in bermuda grass meets the minimum requirement of the calves.

Results of the digestion trial are incomplete, but coefficients of digestibility for crude protein have been calculated. These are:

Unfertilized prairie hay (no supplement) = 41.2%
Fertilized prairie hay (no supplement) = 47.6%
Unfertilized prairie hay plus 0.85 lb. S.M. Meal = 53.3%
Bermuda grass hay (no supplement) = 63.8%

It is apparent that both nitrogen fertilization and the addition of a small amount of soybean meal improved the digestion of crude protein in prairie hay rations. However, unsupplemented bermuda grass hay had the highest digestion coefficient for crude protein of any of the rations compared. This is further indication of less need for additional protein when bermuda grass hay is fed, and helps explain the response obtained from the corn supplement.

Results shown in Table 3 with beef heifers wintered on prairie hay, and supplemented at two levels with cottonseed meal, again demonstrate the advantage for a small amount of additional protein. A sharp weight loss (56 lb. per head to calving) resulted when pregnant heifers were fed prairie hay with no protein supplement. In contrast, the addition of only 1.0 lb. of cottonseed meal per head daily to the prairie hay ration of Lot 2 increased hay consumption by 7.0 lb per head, and resulted in a gain of 57 lb. to calving.

The "appetizing" effect from feeding a protein supplement with low quality roughage is well illustrated in these data. In terms of energy (TDN) intake, the small amount of cottonseed meal, by virtue of the TDN it supplied and the improved feed intake which resulted, increased the daily TDN per heifer by nearly 4 lb. This beneficial effect from adding a protein supplement to a deficient diet emphasizes the importance of balancing such rations for this nutrient. By virtue of a

Table 3.—Two Levels of Protein Supplement to Prairie Hay for Wintering Pregnant 2 & 3-Year-Old Heifers

Supplement	Lot 1 None to calving, 1 lb./day to spring	Lot 2 1 lb./day to calving 2 lb./day to spring
No. heifers per lot[1]	21	21
Average weights, lbs.		
Initial, 11/9/62	777	782
To calving, 2/16/63	720	840
To spring, 4/2/63[2]	634	782
Average gain to calving, lbs.	—56	+57
Average loss, calving to spring[2]	86	58
Average birth date, March	3/16	3/18
Average birth weight	67	69
Average hay intake/day, lbs.	11.4	18.4

[1]Each lot contained 14 two-year-old and 7 yearling bred heifers.
[2]Includes only those heifers that had calved by April 2 (9 in each lot).

small amount of protein supplement, hay intake was increased from approximately 1.4 lb. to 2.0 lb. per 100 lb. of body weight. This results from an increased bacterial activity in the rumen, a faster breakdown of the fibrous feed and more rapid clearance from the rumen. Such effects have recently been demonstrated in British studies using hays of different qualities.

Results available to April 2 for heifers that had calved show a further advantage for increasing the level of cottonseed meal to 2.0 lb. per head daily after calving in Lot 2. Prairie hay, with about 4% crude protein, is therefore inadequate for the young beef female. It can be calculated to supply only .24 lb. per head daily of digestible protein, as compared to a requirement of 0.8 lb. daily. The intake of digestible protein from a combination of prairie hay and 1.0 lb. cottonseed meal up to calving, and 2.0 lb. after calving, proved adequate. Both values are slightly below presently accepted standards.

Summary

Earlier trials have indicated that weaner calves on bermuda grass hay respond to both protein and energy supplements. Results of digestion trials show that the bermuda grass hay (which analyzed nearly 10% crude protein) had a higher digestibility of crude protein (64%) than unsupplemented prairie hay (41%), nitrogen fertilized prairie hay or prairie hay supplemented with soybean meal. Results of winter feeding trials with weaner heifers and pregnant young cows show a distinct need for additional protein prairie hay. Bermuda grass hay appears to respond slightly to both protein and energy supplements (cottonseed meal and corn), but is not equal to prairie hay supplemented with additional cottonseed meal. It appears that lack of available protein is not the limiting factor in improving bermuda grass hay for beef cattle.