4-1-1956

Feeding Value of Early, Medium and Late Cut Prairie Hay

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BULLETIN 457 APRIL 1956

feeding value

EARLY-, MEDIUM-, AND LATE-CUT PRAIRIE HAY

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Contents

Summary

1—Protein content of prairie hay decreased with maturity of the grasses at time of harvest. The range in protein content of the hay in these experiments was from a high of 7.88 percent for early-cut hay to a low of 3.51 for late-cut hay.

2—Winter feeding trials conducted over a 3-year period at three locations showed calves can be wintered to gain 0.75 to 1.0 pound daily when fed about a full feed of prairie hay and enough soybean meal pellets to give approximately 10 percent total protein in the ration. Gains of this range were obtained with hay varying widely in protein content when this method of protein supplementation was used. Also the rations were about equal in digestible protein and total digestible nutrients.

3—Equalization of the protein content of the rations resulted in variations of less than 1 pound to more than 2 pounds of soybean meal pellets being fed per calf daily. This illustrates the importance of harvesting prairie hay early to obtain the greatest feeding value.

4—While the stage of maturity of prairie hay when harvested is indicative of its probable protein content, there is enough variability to make average analyses of limited value. An analysis for protein would be advisable, especially when a minimum amount of supplement is to be fed. The approximate amounts of protein supplement needed with hay of various protein contents are given in table 11. Here comparative values of hay of different protein content may be estimated.

5—Calves fed an early-cut hay without additional protein supplementation appeared thrifty and healthy at the end of the winter feeding period. This ration resulted in the lowest winter feed cost per head, but the rate of gain was low and the cost per 100 pounds of gain was more expensive than when some protein supplement was fed.

6—Apparent digestibility of protein increased with increases of protein in the rations. Total dry matter in early-cut hay was more digestible than in late-cut hay, when fed alone or with equal amounts of protein supplements containing various levels of protein. The greater amount of protein supplement as used in the feeding trials appears necessary to obtain the highest feeding value from the low-protein hay. The same general results were obtained with calves and lambs, but lambs digested both protein and total dry matter of most rations better.

7—The phosphorus content of the hay decreased with maturity of the grasses at time of harvest. Most of the phosphorus values, even for early-cut hay, were below the recommended minimum allowance for cattle. Therefore, adequate phosphorus supplementation appears important with rations of the type used in these experiments. The results of calcium analyses do not indicate any particular need for special calcium supplementation, especially when supplements such as bone meal and dicalcium phosphate supply the needed phosphorus.

Feeding Value of early-, medium-, and late-cut *Prairie Hay*

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Prairie hay makes up a major part of the harvested feeds that are fed to cattle and sheep in many areas of South Dakota. A large number of animals are also grazed most of the winter on the matured and standing grass in the range area of the state.

Chemical analysis of samples cut from various areas of the state, reflecting the extremes in harvesting dates (June to October), show this hay varies from more than 10 to less than 4 percent protein. Stage of maturity when harvested was found to have a big effect on the protein and phosphorus content. The amount of these two nutrients as well as the feeding value in general were reduced considerably with advancing maturity.

Yield of dry matter also decreases as the cutting date is delayed beyond the heading stage. Results of experiments in which these observations were made appear in bulletin 405 of the South Dakota Agricultural Experiment Station.

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Acknowledgements: The work reported in this bulletin was supported in part by a grant-in-aid from Swift and Company, Chicago. The authors are also grateful to J. G. Ross, Agronomist, and J. K. Lewis, Assistant Animal Husbandman, for the estimated botanical composition of the hay; and to Frank Whetzal, Albert Dittman, and Wade Pringle, superintendents at the Range Field Station, Cottonwood; North Central Substation, Eureka; and Central Substation, Highmore, respectively, for supervision of the feeding trials.

Results from Previous Work

The previous work (bulletin 405) on feeding value of prairie hay was designed to determine the effect of time of harvest on chemical composition and feeding value. Three stages of maturity selected for harvesting were heading (early), seed ripe (medium), and mature and weathered after frost (late). The stage of maturity of the dominant species was used to determine the cutting date. Early-cut hay was usually harvested about the first half of July, medium-cut during the latter part of August, and late-cut during late September or early October.

The first two cutting dates represent rather typical periods for hay put up before or after small grain harvest. The last one would be the extreme in late harvesting of hay and yields a feed that is similar to that consumed by cattle and sheep on winter range.

Several samples of hay from the vicinity of the Range Field Station, Cottonwood; the North Central Substation, Eureka; and the Central Substation, Highmore were analyzed to determine the effect of stage of maturity on the chemical composition and feeding value of the hay. A compilation of several of these analyses is shown in table 1.

The data in table 1 show a serious decline in the protein and phosphorus content of the hay as it matured. Other nutrients did not change appreciably. Both protein and phosphorus are expensive portions of livestock rations, and any loss means a reduction in the value of the hay.

When hay alone was fed to steer calves in digestion trials, apparent digestibility of protein, fat, fiber, and nitrogen-free extract decreased with each successive stage of cutting. The decrease was much

Table 1. Average Chemical Composition (Percent) of Prairie Hay Cut at Three Stages of Maturity (1947, 1948, 1949, and 1950)

	Stage of Maturity		
	Early	Medium	Late
Number of samples	36	34	35
Dry matter	91.25	91.61	91.02
Crude protein	7.43	6.11	4.94
Ether extract (fat)	2.66	3.24	3.35
Crude fiber	29.23	29.64	30.30
Nitrogen-free extract	43.11	43.91	43.50
Ash	8.82	8.71	8.93
Calium*	0.29	0.31	0.32
Phosphorus*	0.19	0.13	0.09
Total digestible nutrients†	44.12	41.06	37.89
Digestible protein†	3.17	1.87	0.46

*Different samples than those for the other analyses.
†Calculated from digestion coefficients presented in S. Dak. Agr. Expt. Sta. bul. 405, 1951.

greater for protein than for the other nutrients. Calculated total digestible nutrients and digestible protein are presented in table 1. Early-cut hay contained more digestible nutrients and digestible protein than the other cuttings. The differences in digestible protein were especially great. Late-cut hay furnished a very small amount of digestible protein for the cattle when fed without protein supplementation.

Supplementing the hay rations with 1 pound each of soybean meal and oats resulted in considerable improvement in digestibility of the rations. With this rate of supplementation, there was little difference in the rations containing the early- or medium-cut hay. However, digestibility of the late-cut hay ration was still lower than the other two. Feeding trials with the supplemented hay gave the largest gain with the early- and the smallest with the late-cut hay.

Objectives of This Experiment

Results of the earlier work on chemical composition, digestion trials, and feeding trials pointed to the need for a greater amount of protein supplement to be fed with the hay harvested in late stages of maturity. The large acreage of hay to be harvested and work pressure from other sources, such as small grain harvest, usually results in hay varying widely in cutting dates. The protein content of the hay will also vary quite widely. Feeding a protein supplement at the same rate with all hay results in overfeeding of the supplement with hay high in protein. Such a method of feeding may also result in underfeeding of the supplement with low-protein roughage.

The purpose of the research reported in this publication was to demonstrate the importance of using the protein content of prairie hay as an index for determining its feeding value. The value of high-quality roughage with a high protein content has been emphasized for a long time.

Recently a number of experiments have been conducted to determine the feeding value and best ways of utilizing so called low-quality roughages. These low-quality roughages may be crop residues (straw, corn cobs, corn stalks) or hay that has matured before harvesting or has undergone severe weather damage.

One thing in common with these feeds is a low protein content. Their place in a livestock feeding program will depend largely upon their price in relation to high-quality roughages and the amount and cost of protein supplements needed.

Composition of the Hay

Botanical Composition

The botanical composition of the hay harvested during the 3 years of this experiment is shown in table 2. The estimates for the 1950 hay were made in the field before the hay was cut. None were made for any of the late cuttings or for the medium cutting at Highmore. Estimates of the botanical composition of the 1951 and 1952 hay were made from samples taken during the feeding trials. An attempt was made to get all three cuttings at each location from fields as uniform as possible.

Table 2. Estimated Percentage of the Major Plant Species in Hay Harvested at the Three Substations

	1950			1951			1952		
	Early	Medium	Late	Early	Medium	Late	Early	Medium	Late
Cottonwood*									
Western wheatgrass	80	85	—	98	95	95	69	88	85
Green needlegrass	12	10	—	—	—	—	8	—	—
Bluegrass (Poa sp.)	7	2	—	—	—	—	—	—	—
Blue grama	—	—	—	trace	trace	—	10	7	9
Goatsbeard	—	—	—	—	—	—	10	2	3
Eureka*									
Western wheatgrass	10	10	—	75	22	65	32	45	40
Green needlegrass	25	30	—	10	15	15	8	6	5
Needle-and-thread	25	25	—	3	10	—	16	7	7
Kentucky bluegrass	30	15	—	—	—	—	4	1	2
Blue grama	—	—	—	1	trace	—	2	1	2
Big and little bluestem	7	10	—	8	5	10	1	15	20
Prairie junegrass	1	5	—	1	5	—	4	1	3
Cudweed sagewort	trace	5	—	—	5	7	10	6	4
Prairie cordgrass	—	—	—	—	20	—	—	—	—
Goatsbeard	—	—	—	—	—	—	1	3	3
Highmore*									
Western wheatgrass	50	—	—	59	20	75	42	40	42
Green needlegrass	10	—	—	8	15	—	4	10	5
Needle-and-thread	20	—	—	30	10	—	10	16	16
Kentucky bluegrass	10	—	—	—	20	10	29	22	18
Blue grama	trace	—	—	trace	3	—	—	trace	5
Big and little bluestem	—	—	—	—	—	—	—	—	trace
Prairie junegrass	—	—	—	—	3	—	trace	—	1
Annual bromegrass	8	—	—	—	15	trace	1	trace	—
Cudweed sagewort	trace	—	—	—	1	—	1	trace	1
Red threeawn	—	—	—	—	10	—	trace	—	—

*Numerous minor species were present at Eureka and Highmore in amounts generally less than 1 percent for any one species. The hay from the Cottonwood area contained a much smaller number of the minor species.

Differences in botanical composition of the three cuttings for any one year at a substation were not great, except at Cottonwood in 1952, Highmore in 1951, and Eureka in 1951. The variation between years was greater at Eureka and Highmore than at Cottonwood. The hay was cut from different areas in the vicinity of the substations. Hay had been harvested from these areas the previous year.

The general botanical composition of the hay indicates a similar type of hay at Eureka and Highmore. Hay from the Cottonwood area contained a higher percentage of western wheatgrass and generally less green needlegrass than at Eureka and Highmore. Kentucky bluegrass and needle-and-thread were often present in large amounts at Eureka and Highmore but were absent in the hay from the Cottonwood area. A much greater number of minor species were present in the hay from Eureka and Highmore.

Chemical Composition

Chemical composition of the hay used in the feeding trials is shown in table 3. The protein values for the Cottonwood hay are lower in most instances than those given in table 1 for hay cut at a similar stage of maturity. They are also lower than those for Eureka and Highmore in these trials. The protein content of the Cottonwood early-cut hay was rather low in two of the years even though harvesting was done about the middle of July. The 1950 hay was rained on after cutting and before baling, and the 1952 hay took some heavy rain in the field after it was baled.

Early- and medium-cut hay fed at the Eureka substation are about average in protein for these stages of cutting. The late-cut hay is above average for hay harvested after frost, but each year this stage of cutting was made after a good killing frost.

In two of the trials at Highmore, the protein content of the early- and medium-cut hay was approximately the same. A poor growth was made in the spring but late rains stimulated growth, and the medium-cut hay was not typical for hay cut in late August. Nearly twice as much yield was obtained from the medium cutting than from the early one in 1952. Weather conditions will influence the yield of hay cut at different times of the year and they should be considered when determining the best time to harvest hay.

Calcium and phosphorus content of the hay was determined in the last two trials. Recommended calcium requirements for cattle range from 0.15 percent for mature nonpregnant animals to 0.37 percent for young growing stock. Corresponding recommended phosphorus levels are 0.15 to 0.28 percent.

Calcium in the hay analyzed approached or exceeded the higher level given. The phosphorus values ranged from 0.04 to 0.21 percent with most of them falling below the recommended minimum allowance for cattle. These analyses show the importance of providing adequate phosphorus supplementation. This is most important when the hay has

Table 3. Chemical Composition of the Hay Fed in the Feeding Trials (10 Percent Moisture Basis)

	Crude Protein %	Crude Fiber %	Ether Extract %	Nitrogen-Free Extract %	Ash %	Calcium %	Phosphorus %
Cottonwood							
Early-cut hay							
1950	6.46	26.31	3.14	42.89	11.20	—	—
1951	7.88	27.99	2.31	43.60	8.22	0.33	0.20
1952	6.48	30.97	3.07	39.40	10.08	0.51	0.12
Av.	6.94	28.42	2.84	41.97	9.83	0.42	0.16
Medium-cut hay							
1950	5.85	28.42	4.27	42.98	8.48	—	—
1951	4.49	29.05	3.27	45.71	7.48	0.35	0.21
1952	5.50	30.90	2.49	41.94	9.17	0.41	0.10
Av.	5.28	29.46	3.34	43.54	8.38	0.38	0.155
Late-cut hay							
1950	5.22	28.01	4.51	41.30	10.96	—	—
1951	3.69	31.58	3.18	41.68	9.87	0.35	0.11
1952	3.55	30.30	3.46	43.71	8.98	0.54	0.10
Av.	4.15	29.96	3.72	42.23	9.94	0.455	0.105
Eureka							
Early-cut hay							
1950	6.78	30.23	2.72	42.34	7.93	—	—
1951	7.83	26.81	2.88	43.93	8.55	0.32	0.17
1952	7.45	27.14	3.11	43.97	8.33	0.51	0.14
Av.	7.35	28.06	2.90	43.42	8.27	0.42	0.16
Medium-cut hay							
1950	5.80	27.55	3.60	44.88	8.17	—	—
1951	6.06	27.05	3.46	45.19	8.24	0.36	0.05
1952	6.24	27.84	3.23	44.02	8.67	0.49	0.11
Av.	6.03	27.48	3.43	44.70	8.36	0.42	0.08
Late-cut hay							
1950	5.04	29.13	3.47	45.23	7.13	—	—
1951	5.78	27.67	3.40	46.91	6.24	0.42	0.04
1952	5.34	27.62	3.46	45.10	8.48	0.49	0.10
Av.	5.39	28.14	3.44	45.75	7.28	0.45	0.07
Highmore							
Early-cut hay							
1950	7.05	28.73	2.25	44.02	7.95	—	—
1951	7.59	27.27	2.76	44.70	7.68	0.32	0.06
1952	6.96	30.36	2.84	41.76	8.08	0.39	0.14
Av.	7.20	28.79	2.62	43.49	7.90	0.36	0.10
Medium-cut hay							
1950	7.17	27.97	3.52	44.05	7.29	—	—
1951	5.65	30.31	1.95	44.06	8.03	0.32	0.05
1952	6.93	26.96	3.64	44.60	7.87	0.33	0.13
Av.	6.58	28.41	3.04	44.24	7.73	0.32	0.09
Late-cut hay							
1950	5.65	29.01	3.52	44.62	7.20	—	—
1951	3.51	33.08	2.94	43.12	7.35	0.35	0.07
1952	5.11	27.15	4.13	44.91	8.70	0.35	0.11
Av.	4.76	29.75	3.53	44.21	7.75	0.35	0.09

been cut late. Even early-cut hay may be low in phosphorus.

These analyses do not indicate any particular need for calcium supplementation. Since most phosphorus supplements, such as bone meal and dicalcium phosphate, contain even more calcium than phosphorus, it does not appear that any special consideration need be given to calcium supplementation with this hay.

Winter Feeding Trials

Feeding trials with calves were conducted from 1950 to 1953 at the Range Field Station, Cottonwood; the North Central Substation, Eureka; and the Central Substation, Highmore. All the animals used in the Cottonwood trials and some of those at Highmore were good quality Hereford steer and heifer calves from the Experiment Station breeding herd. Hereford steer and heifer calves of similar quality were purchased from local auction markets for Eureka and for the remaining needs at Highmore.

The calves were obtained from 2 to 4 weeks before being put on the experimental rations. They were vaccinated against blackleg and sprayed for lice one or more times during the trials. Dehorning was not done until the close of the trials in the spring.

A good quality prairie hay was fed from the time the calves arrived at the substations until they were put on the experimental rations. They were given a small amount of oats the first day, and the amount was increased gradually to about 1 pound per calf daily. As soon as the calves were consuming the oats readily, they were started on a small amount of soybean meal pellets. The oats were gradually replaced with soybean meal pellets until the calves were getting only pellets. This change-over was completed before the trials started except in the 1950-51 trial at Eureka.

The experimental rations consisted of hay from the local area, harvested at three stages of maturity to provide hay varying in protein content. The hay was supplemented with soybean meal pellets to equalize the protein content in all rations. All soybean meal pellets fed were 41 percent protein (expeller process), except 44 percent protein (solvent process) pellets were fed in the 1952-53 trials at Cottonwood.

A level of 10 percent total protein was selected as a desirable amount based on previous work at this station and the recommended digestible protein requirements for wintering calves to gain 0.75 to 1.0 pound daily. Satisfactory and fairly uniform gains were obtained at about this level of protein, and it was used throughout the 3 years of the feeding trials (1950-53). One lot of calves was also fed early-cut hay without protein supplement in each trial at Cottonwood and in the 1952-53 trials at Eureka and Highmore.

The three stages of maturity selected for harvesting corresponded to the stages used in the earlier work already mentioned and will be referred to here as early, medium, and late. Samples of hay were taken from the field shortly before harvesting or from the windrows just ahead of the baler for protein analysis.

Protein contents from these analyses were used to determine the amount of soybean meal pellets to feed with each hay. A small sample of hay was taken from each bale throughout the feeding trials and composited for chemical analyses. The analyses from the two methods of sampling were quite similar, and the analyses of the feeding trial samples were used in calculating the protein content of the rations fed. Since moisture content of hay from these stations has been quite variable at different times of the year, the chemical composition has been calculated on a 10 percent moisture basis.

Hay was fed in amounts that would be cleaned up without undue wastage, and the amount of soybean meal pellets fed was adjusted to give the desired amount of protein. Common salt was fed free choice as well as a mixture of 1 part common salt and 3 parts bone meal. Water was provided in tanks in the lots at Cottonwood and Highmore. At Eureka the calves were turned into an adjacent lot for water once daily. The calves had access to a shed open to the south and an outside exercise lot. The hay was fed in the shed and the pellets in bunks in the exercise lot. Both hay and pellets were fed twice daily.

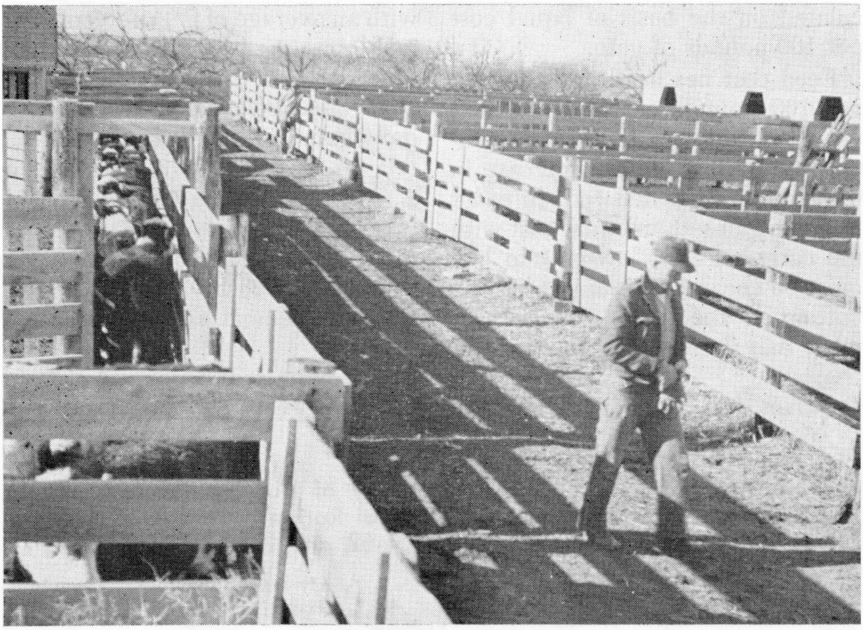
Cottonwood Trials

Both steer and heifer calves were used in all the Cottonwood feeding trials. Their average initial weight was approximately 350 pounds each year during the experiment. Eight calves per lot were fed in 1950-51 and 1951-52, with two and three steers per lot, respectively, in the two trials. Ten calves were started in each lot (either three or four steers) in the 1952-53 trial. In the latter trial, one calf died in lot 2 and one in lot 4 shortly after being put on the experiment. No other death losses occurred here.

The calves were fed hay according to appetite. The amount of protein supplement was regulated by a previously prepared feeding schedule to control the amount of protein in each ration at about 10 percent.

Each year one lot of calves also was fed early-cut hay without any supplement. The total protein levels of the supplemented rations were slightly lower than the 10 percent level, but the gains of the calves were within the expected range for the type of rations fed. It was expected that daily gains of 0.75 to 1.0 pound would be obtained. In 2 of the 3 years, the average daily gain for each lot of calves fed hay and soybean meal pellets ranged from 0.90 to 1.0 pound.

Results of the three trials have been combined and are presented in table 4. Average daily gains for the 3 years were nearly equal for the calves fed hay with different protein content but supplemented with soybean meal pellets to give about equal amounts of total protein in the rations.



Corrals and working chute at the Range Field Station, Cottonwood. The building to the left is the scale house. This arrangement permits use of the chute without the cattle having to cross the scale unless so desired.

Hay consumption shows little if any difference in palatability of the hay fed in the different lots when supplemented in the manner used in this experiment. The experiment shows that similar rates of gain that are satisfactory for wintering calves can be obtained with native prairie hay, predominantly western wheatgrass, of different protein content by proper protein supplementation.

The major difference between the three rations was in the amount of protein supplement required. A daily average of only 1.14 pounds of soybean meal pellets was needed with the early-cut hay, 1.60 pounds with the medium-cut hay, and 2.08 pounds with the late-cut hay. Such an increase in the amount of protein supplement obviously increases the cost of wintering calves.

Total feed cost per head for the winter and cost per 100 pounds of gain have been calculated and presented in table 4. The prices per ton used in these calculations were $20 for all hay and $100 for soybean meal pellets. These represent about average prices during the time of the experiment. Present feed cost may be calculated by applying current local prices of hay and supplement to the feed requirements shown in table 4. Using the above prices for early-cut hay and soybean meal, the values for the hay lower in protein content have been calculated on the basis of equal cost per 100 pounds of gain.

Feed cost per head and the cost per 100 pounds of gain increased with a lowering in the protein content of the hay and an increase in the amount of pellets fed. In order to make gains at an equal cost with the early-cut hay, low-protein hay must be cheaper as indicated at the bottom of the table. This adjustment may be made if hay is purchased.

Calves fed early-cut hay alone with an average of 6.94 percent protein consumed slightly more hay than calves fed this hay with soybean meal pellets but the average daily gain was only 0.45 pound.

A comparison of this lot with lot 2 shows that each 100 pounds of protein supplement fed to the calves in lot 2 saved 967 pounds of hay in producing each 100 pounds of gain. The supplement fed in lot 2 resulted in a considerable reduction in the cost of 100 pounds of gain over the 3-year period.

Table 4. Feeding Results with Prairie Hay of Varying Protein Content Supplemented to Equalize Protein in Total Ration (Average of 3 Years, Cottonwood 1950-51, 1951-52, and 1952-53)

	Early-Cut Hay Alone	Early-Cut Hay + Protein Supplement	Medium-Cut Hay + Protein Supplement	Late-Cut Hay + Protein Supplement
Lot number	1	2	3	4
Total no. calves	26	25	25	26
Av. no. days fed	140	140	140	140
Av. initial wt., lbs.	352	351	352	350
Av. daily gain, lbs.	0.45	0.84	0.87	0.86
Av. daily ration, lbs.				
Hay fed	12.5	12.4	12.2	12.0
Hay consumed	11.4	11.1	11.1	10.8
Soybean meal pellets	—	1.14	1.60	2.08
Feed per 100 pounds gain, lbs.				
Hay fed	2779	1473	1396	1397
Soybean meal pellets	—	135	183	242
Av. protein content of hay, %*	6.94	6.94	5.28	4.15
Av. protein content of ration fed, %	6.94	9.9	9.5	9.7
Supplement per ton of hay fed, lbs.	—	183	262	346
Feed cost per head, $†	17.54	25.40	28.32	31.44
Feed cost per 100 pounds gain, $	27.79	21.48	23.11	26.07
Value per ton of hay for equal cost of gains, $‡	15.46	20.00	17.66	13.43

*Based on 10 percent moisture in hay.

†Feed prices per ton: hay, $20; soybean meal pellets, $100.

‡Based on results and feed prices of this trial, giving early-cut hay a value of $20 per ton when fed with protein supplement.

In two of the trials, the early-cut hay contained only about 6.5 percent protein and the gains of the calves fed hay alone was 0.30 and 0.39 pound. Each 100 pounds of the protein supplement saved 1,260 pounds of hay for each 100 pounds of gain in these two trials.

In the other trial, the hay contained 7.88 percent protein and the rate of gain for calves fed hay alone was 0.65 pound daily. Only 683 pounds of hay were saved for each 100 pounds of the supplement fed in this trial. The results of this one trial indicate that a satisfactory winter gain for calves may be obtained with hay alone that contains about 8 percent total protein. Unless the protein supplement was rather high-priced in relationship to hay (100 pounds costing more than 683 pounds of the hay with 7.88 percent protein), cost of the gains would be cheaper when using some protein supplement.

Eureka Trials

Ten calves were fed in each lot in the feeding trials at the Eureka substation. The average initial weight was about 425 pounds in 1950-51, 460 pounds in 1951-52, and about 380 pounds in 1952-53. An equal number of steers and heifers were used in the first trial, three heifers in the second one, and only steers in the last trial. One calf was removed from the experiment in the late-cut hay lot in 1950-51 and one died in the medium-cut hay lot in 1951-52. The number of days these two calves were on experiment was included in the results. This accounts for the fractional number of calves shown for these lots in table 5.

Feeding and management practices at Eureka were similar to those used in the Cottonwood feeding trials. A similar level of total protein was planned, but the 10 percent level was slightly exceeded at this substation. The average rate of gain was slightly higher than at Cottonwood which may be due to the higher level of protein in the rations.

The differences in rate of gain during the 3 years of this experiment were small and the results have been combined and presented in table 5. As in the Cottonwood feeding trials, the rate of gain was nearly equal for the calves fed hay differing in protein content but supplemented with soybean meal pellets to give approximately the same amount of protein in the total rations.

The medium-cut hay appeared slightly more palatable. Needle-and-thread was often a major species in the hay from Eureka and there were generally some needles present in the early-cut hay.

Even with the lower hay consumption, the lot of calves fed early-cut hay made gains nearly equal to those of the other lots. Although the botanical composition of the hay differed considerably from the Cottonwood hay (table 3), similar results were obtained with the rate of protein supplementation used.

Feed cost has been calculated using the same feed prices as in the trials at Cottonwood. Feed cost per head for the winter and per 100 pounds of gain were similar for the two stations with each kind of hay.

Using the early-cut hay as the base, medium-cut hay had a similar value at the two stations. Late-cut hay was worth slightly more in relation to the other two at Eureka than at Cottonwood due to its slightly higher protein content.

Early-cut hay was also fed without protein supplement in the 1952-53 feeding trial. The results obtained with the early-cut hay in this trial are shown in the last two columns of table 5. The hay contained 7.45 percent protein and the calves fed the hay without supplement gained 0.55 pound per head daily. Calves fed this hay with an average of 1.33 pounds of soybean meal pel-

Table 5. Feeding Results with Prairie Hay of Varying Protein Content Supplemented to Equalize Protein in Total Ration (Average of 3 Years, Eureka 1950-51, 1951-52, and 1952-53)

				1952-53 Trial Only	
	Early-Cut Hay + Protein Supplement	Medium-Cut Hay + Protein Supplement	Late-Cut Hay + Protein Supplement	Early-Cut Hay + Protein Supplement	Early-Cut Hay Alone
Lot number	2	3	4	2	1
Total no. calves	29.8*	30	29.7*	9.8*	10
Av. no. days fed	140	140	140	140	140
Av. initial wt., lbs.	424	423	420	379	379
Av. daily gain, lbs.	0.92	0.98	0.97	1.04	0.55
Av. daily ration, lbs.					
Hay fed	12.2	12.8	12.7	12.0	13.0
Hay consumed	10.0	10.9	10.4	9.8	10.7
Soybean meal pellets	1.18	1.66	2.03	1.33	—
Feed per 100 pounds gain, lbs.					
Hay fed	1332	1308	1303	1145	2356
Soybean meal pellets	128	169	208	128	—
Av. protein content of hay, %†	7.35	6.03	5.39	7.45	7.45
Av. protein content of ration fed, %	10.5	10.2	10.4	10.8	7.45
Supplement per ton of hay fed, lbs.	192	258	320	—	—
Feed cost per head, $‡	25.29	29.48	31.94	26.10	18.20
Feed cost per 100 pounds gain, $	19.72	21.53	23.[illegible]3	17.85	23.56
Value per ton of hay for equal cost of gains, $§	20.00	17.23	14.31	20.00	15.15

*One calf removed from lot 2 in 1950-51 and one died in lot 4 in 1951-52. The number of days these calves were on the experiment was included in the results for these lots.

†Based on 10 percent moisture in hay.

‡Feed prices per ton: hay, $20; soybean meal pellets, $100.

§Based on results and feed prices of this trial, giving early-cut hay a value of $20 per ton when fed with protein supplement.

One lot of calves at the North Central Substation, Eureka. Note the V-bottom feed bunk—desirable for feeding a small amount of pellets. The pellets roll to the center and each calf appears to have a better chance of getting its share.

lets daily gained 1.04 pounds per day. In this trial, 100 pounds of soybean meal pellets saved 946 pounds of hay in producing 100 pounds of gain.

The unsupplemented lot of calves was in a healthy and thrifty condition and had a low feed cost per head in comparison to the supplemented lot. However, the protein supplement resulted in a considerable saving in cost and hay per 100 pounds of gain. Feeding hay of this protein content (7.45 percent) without a protein supplement does not appear economical under any ordinary price relationships between hay and protein supplement.

Highmore Trials

Feeding trials at the Highmore substation were conducted in a manner similar to the other substations. Six steer and four heifer calves were started in each lot in the 1950-51 and 1951-52 trials. Ten steer calves were used in the trial conducted in 1952-53. The approximate average initial weights for the three trials were 430, 350, and 410 pounds, respectively. Results of these trials are presented in table 6.

Rate of gain was lower than at the other two substations. There was also more variation between years and between the kinds of hay. However, the averages for the medium- and late-cut hay were the same for the 3-year period.

Results of the lot fed the early-cut hay during 1951-52 have been omitted from the table. This hay contained about 30 percent needle-and-thread, and it was cut before the needles had fallen. The needles were very thick in the hay.

One lot of calves was fed the hay for 112 days, and during this period they lost an average of 0.24 pound daily per calf. Hay consumption averaged only 5.7 pounds daily per calf. This lot of calves was then given a ration similar to that fed the calves receiving the medium-cut hay. During a 43-day period they made an average daily gain of 1.72 pounds. This indicates that the previous poor performance was due to the large amount of needles in the hay.

When needle-and-thread is present in amounts large enough to cause trouble, either the hay should be cut before the needles appear or after they have fallen. Generally, yield of hay will not be great enough to harvest before the needles appear. Harvesting should be delayed until they fall, even though this procedure will result in a lower nutritive value for the hay.

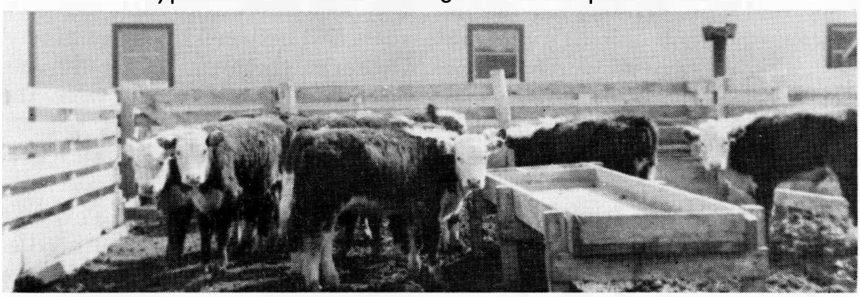
In the two trials included in table 6 in which the early-cut hay was fed, the protein content of the hay was nearly the same as for the medium-cut hay (table 3). The gains of the calves were less than for the medium-cut hay in both trials.

More recent feeding trials at the Highmore substation have been conducted in which an early-cut prairie hay has been fed supplemented with soybean meal pellets to give about 10 percent protein in the total ration. In two trials, the rate of gain has been 0.93 and 1.17 pounds per calf daily.

The early-cut hay harvested in 1950 also has been fed during the winters of 1953-54 and 1954-55 after storage. It was supplemented in the same manner (actually less protein supplement being used) as in the 1950-51 trial. The rates of gain were 0.89 and 0.74 pound per calf daily, respectively, in comparison to 0.61 pound in the 1950-51 trial. These results indicate that the poor showing of the early-cut hay lot shown in table 6 was probably due to factors other than poor utilization of the hay by the calves.

Rate of gain for the lot of calves fed the medium-cut hay and an average of 1.04 pounds of soybean meal pellets was the same as for the

One lot of calves at the Central Substation, Highmore. This lot represents typical calves used throughout the experiments.



lot fed the late-cut hay and 1.61 pounds of the soybean meal pellets. This is less protein supplement than fed at the other substations with hay of similar maturity, and the amount of hay fed was also less. The average protein content of the rations was close to the levels used at Cottonwood. The lower amounts of hay and pellets consumed probably were largely responsible for the lower rate of gain than at the other substations.

Calves fed the late-cut hay consumed less hay but made the same average gain as those fed the medium-cut hay. This resulted in less hay required per 100 pounds of gain. However, the greater amount of soybean meal pellets resulted in

Table 6. Feeding Results with Prairie Hay of Varying Protein Content Supplemented to Equalize Protein in Total Ration (Average of 3 Years, Highmore 1950-51, 1951-52, and 1952-53)

				1952-53 Trial Only	
	Early-Cut Hay + Protein Supplement	Medium-Cut Hay + Protein Supplement	Late-Cut Hay + Protein Supplement	Early-Cut Hay + Protein Supplement	Early-Cut Hay Alone
Lot number	2	3	4	2	1
Total no. calves	20*	29	29	10	10
Av. no. days fed	126	122	122	140	140
Av. initial wt., lbs.	419	400	391	411	411
Av. daily gain, lbs.	0.59	0.69	0.69	0.58	0.11
Av. daily ration, lbs.					
Hay fed	11.2	11.3	10.3	12.0	12.1
Hay consumed	10.1	10.5	9.4	10.7	10.5
Soybean meal pellets	1.05	1.04	1.61	1.21	—
Feed per 100 pounds gain, lbs.					
Hay fed	1891	1636	1498	2063	11,065
Soybean meal pellets	177	151	233	208	—
Av. protein content of hay, %†	7.00	6.58	4.76	6.96	6.96
Av. protein content of ration, %	9.8	9.5	9.7	9.9	6.96
Supplement per ton of hay fed, lbs.	187	185	311	—	—
Feed cost per head, $‡	20.71	20.14	22.37	25.25	16.94
Feed cost per 100 pounds gain, $	27.76	23.91	26.63	—	—
Value per ton of hay for equal cost of gains, $§	—	20.00	11.33	—	—

*Only two years, 1950-51 and 1952-53, are included in the results for this lot.
†Based on 10 percent moisture in hay.
‡Feed prices per ton: hay, $20; soybean meal pellets, $100.
§Based on results and feed prices of this trial, giving medium-cut hay a value of $20 per ton when fed with protein supplement.

a considerable increase in the protein supplement required per 100 pounds of gain.

Feed cost has been calculated in the same manner as in tables 4 and 5. The medium-cut hay ration was the cheapest in cost per head and per 100 pounds of gain. During the 2 years shown for the early-cut hay in table 6, its protein content was about the same as for the medium-cut hay. Therefore, the value per ton of hay for equal cost of gains has been calculated only for the late-cut hay using the medium as the base for this calculation. The difference between the two is greater than at the other substations. This is due to the rather small amount of protein supplement fed with the medium-cut hay.

Early-cut hay was fed without any protein supplement in the 1952-53 trial. The hay contained 6.96 percent protein, but the rate of gain was much lower than in the feeding trials at the other substations with hay which was even lower in protein. These calves all came through the winter in a healthy condition but were rather thin. Wintering calves on hay alone of this protein content results in a low cost per head but is rather expensive in terms of cost per 100 pounds of gain.

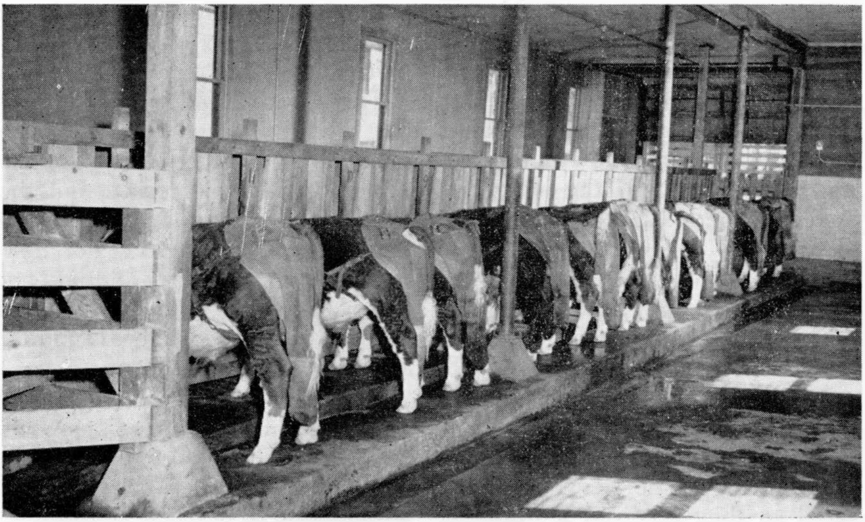
1950-51 Digestion Trials

Digestion trials with the Cottonwood hay were conducted in conjunction with the 1950-51 feeding trials to obtain more information on the nutritive value of the hay cut at different stages of maturity and varying in protein content. The total collection method was used to determine the digestibility of the rations, and the steers were equipped with harnesses and collection bags.

Procedure Followed

Steer calves similar to those in the feeding trials were used. They were fed a ration of good quality prairie hay and about 1 pound of oats for approximately 2 months before being given the experimental rations. During this time they were dehorned, sprayed, vaccinated for blackleg, and trained for digestion work.

After the calves were well trained for digestion work, they were given the experimental rations. A suitable period of time was allowed to determine the approximate feed intake on hay alone. The feed offered each animal was adjusted according to the consumption of the early-cut hay. The amount of feed offered was set at 430 grams twice daily per 100 pounds of body weight. The initial rate of feeding was used throughout the trials. In the supplemented rations, the amount of soybean meal pellets (41 percent protein, expeller process) necessary to give the desired protein level was included as a part of the above rate and the hay was reduced accordingly. The calves had free access to two mineral supplements and block salt. One of the mineral supplements was composed of dicalcium



Calves on digestion trials, fastened for feeding. Feces are collected in the canvas bags.

phosphate with 10 percent salt and the other one was bone meal with 10 percent salt.

Feed offered was weighed to the nearest grain at each morning and afternoon feeding. The calves were fastened in stanchions for about 3 hours for each feeding and then turned into a paved inside exercise lot where they had free access to water and mineral supplement. No bedding was used.

The importance of rather complete feed consumption was realized, but this is not possible with low-protein prairie hay without seriously restricting the amount offered. Therefore, feed intake was regulated as stated and any refused hay was weighed and samples saved for chemical analysis for the same nutrients as in the hay fed. The refused nutrients were deducted from those offered to determine the amount of each consumed.

The hay was fed as taken from the bales, and a small sample from each bale was saved for chemical analysis to determine the amount of the various nutrients offered. There was some variation in the chemical composition between collection periods. Since only a few bales of each hay were fed during a collection period, the analyses used for determining the nutrients offered were those made on the hay sampled during each collection period. A representative sample from the entire lot of soybean meal pellets was taken at the begining of the trials. The chemical composition of this sample was used to determine the nutrients offered from the protein supplement during all periods.

The feces were weighed twice daily and a small sample saved for analyses to determine the amount of nutrients excreted. Daily samples during the collection periods were composited, preserved with thymol, and refrigerated until the end of the collection periods.

Early-, Medium-, and Late-Cut Hay Comparisons

One series of digestion trials was conducted in which the hay was fed without supplementation. This series consisted of three collection periods with two steer calves receiving each hay. The steers were rotated so they received a different hay during each collection period. Ten- to 12-day preliminary periods were used to overcome the effects of the previous rations. The preliminary period was followed by a 7-day collection period. This series of digestion trials was followed by a similar one in which the steers were fed each hay with soybean meal pellets.

Digestion coefficients have been calculated from the results of this trial and are presented in table 7. These values represent the percentage difference between the intake in the feed and the outgo in the feces, or that consumed which is apparently absorbed and available for productive purposes.

Hay Without Protein Supplement

When hay was fed without protein supplementation, consumption decreased with a lowering of the protein content of the ration. The amounts shown as consumed when the soybean meal pellets were fed are about the same as offered, since consumption was essentially complete during this phase of the trial.

There was a tendency for apparent digestibility of the unsupplemented rations to decrease as the protein content decreased, but the changes were small except for protein. Results show the major deficiency in the medium- and late-cut hay was protein. Late-cut hay was also lower in digestible dry matter and total digestible nutrients.

Hay With Protein Supplement

Digestibility of protein and ether extract was considerably improved with each kind of hay when supplemented with soybean meal pellets. With the rate of supplementation used, digestibility of crude protein was higher for the medium- and late-cut hay rations than for the ration with early-cut hay. The protein content of the dry matter consumed was 11.0 percent for the medium- and late-cut hay rations but only 10.2 for the one with early-cut hay. This difference in protein content probably accounts for the lower apparent digestibility of protein with the early-cut hay ration.

Digestibility of the crude fiber and nitrogen-free extract in the early-cut hay ration did not appear to be affected by supplementation. However, there appeared to be a slight increase in digestibility of the nitrogen-free extract but a decrease in crude fiber with the greater amount of protein supplement in the medium- and late-cut hay rations. Dry matter digestibility and total digestible nutrients in the three rations varied only slightly.

Table 7. Results of 1950-51 Digestion Trials with Early-, Medium-, and Late-Cut Prairie Hay (Averages for Six Steer Calves)

	Hay Alone			Hay and Supplement		
	Early	Medium	Late	Early	Medium	Late
Average daily ration consumed, dry basis, lbs.						
Hay	8.8	8.3	7.9	8.1	7.5	7.5
Soybean meal pellets	—	—	—	0.75	1.15	1.28
Total dry matter	8.8	8.3	7.9	8.85	8.65	8.78
Protein	.69	.53	.44	.90	.95	.97
Percent protein in ration	7.8	6.4	5.6	10.2	11.0	11.0
Av. % digestible (digestion coefficients)						
Dry matter	52.87	51.47	47.96	51.87	52.24	52.20
Crude protein	39.53	35.43	23.83	52.76	60.23	56.30
Ether extract	36.67	33.36	33.52	46.01	43.88	45.37
Crude fiber	67.45	65.60	64.15	65.12	60.84	60.31
Nitrogen-free extract	54.69	55.76	52.27	54.28	58.02	56.02
Total digestible nutrients	50.64	51.20	48.60	51.22	52.30	51.24

Results indicate that the method of supplementation used is an effective way to supplement rations containing prairie hay differing in the amount of protein. When different amounts of high-protein supplements were fed to equalize the protein level, digestibility of the three rations and total digestible nutrients were quite similar. This method of feeding adds a greater amount of a high-energy supplement to the low-protein hay rations. However, the digestibility data indicate that a greater amount is needed with the low-protein hay.

1951-52 Digestion Trials

The early-cut hay harvested at Cottonwood in 1951 was higher and the late-cut hay lower in protein than that harvested in 1950 (table 3). These two cuttings varied from nearly 8 to less than 4 percent protein, air-dry basis. They were used in digestion trials to determine the effects of different levels of protein on digestibility of rations composed largely of an early-cut, high-protein prairie hay and a late-cut, low-protein hay. The digestion trials were conducted in a similar manner as described for the 1950-51 trials, but both calves and lambs were used.

Procedure Followed

Eight Hereford steer calves and eight western wethers were used as the experimental animals. Handling of the calves prior to the beginning of the experiment was similar to the other digestion trials. The calves weighed 475 pounds and the lambs about 90 pounds initially. The lambs were fed a ration composed of a full feed of good quality prairie hay and about one-fourth pound of oats for approximately 6 weeks prior to the start of the experiment. During this time, they were sheared, dusted to control ticks, and drenched with phenothiazine to control internal parasites.

Four calves and four lambs were fed the early-cut hay and four of each were fed the late-cut hay. The hay was chopped to facilitate feeding and reduce sorting by the animals.

To compare the digestibility of the rations by the calves and lambs, they were fed equal amounts according to body weight. The base for the rate of feeding was 10 pounds of air-dry feed twice daily per 1,000 pounds of body weight. The feed for each animal was calculated from this base, considering that the feed capacity was proportional to three-fourths power of body weight ($W^{0.75}$). This method gives a greater amount of feed per unit of weight for the smaller animals; for example, an 80-pound lamb gets more than one-tenth as much feed as an 800-pound steer. These calculations were made for the initial rate of feeding.

After the first digestion period, small but uniform increases were made in the amount of feed offered during each succeeding period, since the animals were gaining in weight. Only hay was fed during periods 1 and 6. In each of the other periods, 15 percent of the air-dry ration was composed of one of the supplements containing various levels of protein.

The composition of the supplements fed with the hay is shown in table 8. Soybean meal, 41 percent protein (expeller process), was the high-protein ingredient used to obtain increasing levels of protein in the supplements in periods 3, 4, and 5. Different proportions of ground whole oats and oat hulls were used to regulate the content in calculated total digestible nutrients to approximately the same as that for oats fed in period 2. Approximately equal calcium and phosphorus levels in the different supplements were obtained by varying the amount of dicalcium phosphate. Bone meal with 10 percent salt and plain salt were also offered free choice.

Table 8. Ingredients and Protein Content of Supplements Fed in 1951-52 Digestion Trials

	Digestion Period					
	1*	2	3	4	5	6*
Ground whole oats	—	98.4	62.5	32.4	—	—
Ground oat hulls	—	—	5.0	9.8	15.0	—
Soybean meal	—	—	31.5	57.0	84.6	—
Dicalcium phosphate	—	1.6	1.0	0.8	0.4	—
Percent protein, dry basis	—	13.26	21.84	27.44	36.64	—

*Hay alone.

The supplements were mixed for each period and samples taken for chemical analysis at time of mixing. Hay was sampled during each collection period. An additional analysis was made for moisture of the feeds as fed to calculate the amount of dry matter offered.

There was some variation in the composition of the hay between periods. The percent digested (digestion coefficient) was calculated using an average analysis of the hay for all periods and using the analysis for each individual period. Final results were essentially the same, and the digestion coefficients reported for these digestion trials have been calculated using the chemical analysis for the individual periods.

Level of Protein Comparisons

Results of the digestion trials with steers are reported in table 9 and those with lambs in table 10. Feed and feces were analyzed for only moisture, protein, and ash. Digestibility of dry matter, organic matter, and protein appeared to be sufficient for these comparisons.

The hay consumption shown in tables 9 and 10 represents rather complete consumption of the early-cut hay offered to both the calves and lambs. The differences in the amount of early- and late-cut hay consumed were due to more of the late-cut hay being refused. Increasing the protein level of the ration through supplementation brought about improvement in consumption of the late-cut hay rations.

The early-cut hay rations were eaten in adequate amounts even without the supplement. The lower consumption of the early-cut hay in period 5 by both calves and lambs was due to a high moisture

Table 9. Digestibility by Steer Calves of High- and Low-Protein Hay When Supplemented to Obtain Various Levels of Protein in Total Ration

Digestion Period	Av. Daily Ration Consumed, Lbs. Hay	Av. Daily Ration Consumed, Lbs. Supplement	% Protein in Ration	Av. % Digestible (Digestion Coefficients) Protein	Organic Matter	Dry Matter
Early-cut prairie hay (Av. for 6 calves. Value on moisture-free basis)						
1	9.72	—	9.12	50.1	61.1	57.2
2	8.34	1.49	9.82	60.5	65.7	62.0
3	8.94	1.59	12.18	65.2	61.2	57.6
4	9.26	1.65	13.40	63.0	61.0	56.0
5	8.50	1.74	15.66	71.8	59.5	55.1
6	11.18	—	9.54	51.9	61.2	56.6
Late-cut prairie hay (Av. for 6 calves. Values on moisture-free basis)						
1	6.37	—	3.82	5.3	45.9	41.2
2	7.01	1.50	5.58	39.6	49.6	45.5
3	7.86	1.60	7.90	49.2	48.7	44.5
4	8.51	1.66	8.30	47.3	48.3	43.8
5	8.98	1.75	9.67	59.3	48.7	44.5
6	8.37	—	4.38	16.4	45.3	40.9

Table 10. Digestibility by Lambs of High- and Low-Protein Hay When Supplemented to Obtain Various Levels of Protein in Total Rations

Digestion Period	Av. Daily Ration Consumed, Lbs. Hay	Supplement	% Protein in Ration	Av. % Digestible (Digestion Coefficients) Protein	Organic Matter	Dry Matter
Early-cut prairie hay (Av. for 6 lambs. Values on moisture-free basis)						
1	2.58	—	9.15	55.5	59.0	55.5
2	2.25	0.41	9.86	62.6	62.7	59.4
3	2.31	0.43	12.30	68.8	61.6	58.8
4	2.43	0.45	13.43	68.2	62.0	58.8
5	1.95	0.47	16.14	71.6	59.9	56.5
6	2.67	—	9.31	60.7	61.9	58.5
Late-cut prairie hay (Av. for 6 lambs. Values on moisture-free basis)						
1	1.79	—	3.72	−1.1	42.2	38.6
2	1.81	0.40	5.59	39.8	50.6	46.5
3	2.10	0.44	7.96	55.0	51.9	48.5
4	2.24	0.45	8.41	54.6	50.8	47.5
5	2.31	0.47	9.94	60.5	51.2	47.5
6	2.03	—	4.20	21.8	47.1	44.0

content of the early hay which resulted in a lower amount of dry matter being offered. The amount fed was eaten with very little waste.

Apparent digestibility of protein increased with increases in protein in the ration for both early- and late-cut hay for both species. Lambs digested the protein in the rations with early-cut hay better than did the steers except at the highest level of protein (period 5). This condition was true with the late-cut hay except that the steers had slightly higher digestion coefficients for protein with the unsupplemented ration in period 1. However, this was reversed in period 6 when the hay was again fed without supplement.

The low apparent digestibility of the protein in the late-cut hay ration without protein supplementation and even when supplemented at the low protein levels would result in very little protein being available to the calves and lambs. The protein content of the late-cut hay rations in period 5 was close to the same as that for the early-cut hay rations in period 2 (about 9.8 percent). The digestion coefficients for protein of the rations with the two kinds of hay were close to the same for both calves and lambs. This suggests that digestibility of protein was about the same when the protein levels of the rations were about equal.

Digestibility of dry matter and organic matter in the early-cut hay ration did not appear to be improved by supplementation. Replacing 15 percent of the late-cut hay with oats brought about a considerable improvement in digestibility of organic matter and dry matter by both calves and lambs.

Further increases in the protein content of the ration, but with 15 percent of the ration composed of the supplement, resulted in no additional improvement in digestibility of these two fractions. These results indicate that a greater amount of high-energy supplement is needed with the late-cut hay for it to be about equal to early-cut hay in feeding value. This was the method of supplementation used in the feeding trials and the 1950-51 digestion trials.

Discussion

The results of these trials have shown that similar rates of gain can be obtained by supplementing the hay with a high-protein supplement (soybean meal pellets in these experiments) at different rates to give an equal amount of protein in the rations. A level of 10 percent total protein was used and the gains were quite satisfactory for maintaining calves in a thrifty and healthy condition during the winter.

Equalization of the protein content of the rations resulted in variations in some of the trials of less than 1 to over 2 pounds of the soybean meal pellets being fed per head daily. This obviously results in a lower value for the lower protein hay, and costs of winter gains may be increased considerably when such hay is considered to have the same value per ton as high-protein hay.

Since the protein and also phosphorus content decreases with maturity of the hay, harvesting early saves the greatest amount of these two nutrients. Both are expensive portions of the ration and a high content of them in the hay gives it a greater value. The calcium content of the hay appears to be high enough to need no special consideration in winter supplementation, especially when such ingredients as bone meal and dicalcium phosphate are used to supply the needed phosphorus.

Early-cut hay with a protein content from 6.46 to 7.88 percent was fed alone in five feeding trials. The calves were apparently healthy but rather thin at the end of the trials. This method gave the lowest feed cost per head but was more expensive in cost per 100 pounds of gain than the same hay fed with a protein supplement. This practice probably should be considered only when hay is plentiful and cheap in relationship to high-protein supplements, and when a more liberal feeding program will be followed before the calves are sold.

Although not tried in these experiments, no doubt a similar rate of gain could have been obtained by feeding less hay with some protein supplement. At times it may be desirable to winter at a low rate of winter gain and a low cost per head for winter feed. Whether it will be more economical to use only hay or feed less hay with some protein supplement will depend on the protein content of the hay and the price of hay and supplement.

Digestion trials showed that apparent digestibility of protein decreased with a lowering of the protein content in the hay. Digestibility of dry matter and total digestible nutrients were slightly lower with the late-cut, low-protein hay. When rations composed of hay varying in amount of protein were supplemented with soybean meal to equalize the protein level at about 10.0 percent, air-dry basis, the rations appeared quite similar in apparent digestible protein and total digestible nutrients.

Other digestion trials, in which equal amounts of supplements containing various levels of protein were fed with early- and late-cut prairie hay, showed that apparent digestibility of protein increased with higher levels of protein. Protein digestibility in the late-cut hay rations was lower than in the early-cut hay rations in each period with about equal amounts of the same supplement but with less protein in the total ration. However, when the protein content of the two supplemented rations was nearly the same (late-cut hay, period 5, and early-cut hay, period 2), protein digestibility was about equal. This was true for either steers or lambs. The results indicate that level of protein in these rations had a major effect on apparent digestibility of protein.

Digestibility of dry matter and organic matter in the early-cut hay ration did not appear to be influenced by the rate of supplementation used. However, replacing 15 percent of the late-cut hay with the supplements brought about some improvement in digestibility of dry matter and organic matter by both calves and lambs (approximately 5.6 percent protein, dry basis).

Further increases in protein level, but with the same amount of supplement, did not result in any additional improvement in digestibility of the total ration. Digestibility of the late-cut hay rations was lower than the early-cut hay ones with this rate of supplementation. This shows the need for a greater amount of supplementation with low-protein hay as was used in the feeding trials and the 1950-51 digestion trials.

These experiments did not include any work to determine the protein requirements for wintering beef calves for gains of 0.75 to 1.0 pound daily. Most feeding standards give the protein requirements of cattle as digestible crude protein. Those of the National Research Council recommend that the ration for a 500-pound beef calf should contain 6.0 percent digestible crude protein and 54 percent total digestible nutrients for gains of about 1 pound daily. The digestibility data from these experiments indicate that a ration with prairie hay and high-protein supplement to give 10 percent total protein, air-dry basis, will about meet these recommendations. Good results were obtained with this level of feeding with hay varying considerably in protein content.

Stage of maturity when harvested affects the protein content of hay. The time hay is harvested is indicative of its probable protein content. However, there is enough variability to make an average analysis of limited value. Therefore, an analysis for protein would be advisable, especialy when a minimum amount of supplement is to be fed.

A suggested rate of supplementation, for use when the protein content of prairie hay is known, is presented in table 11. The second column gives the amount of high-protein supplement needed per pound of hay fed. The total amount of supplement needed per day may be calculated by multiplying the total hay fed by the value opposite the appropriate protein content. The amount of high-protein supplement per ton of hay is shown in the last column. These values may be used to estimate the difference in value of hay of variable protein content. This table gives 134 pounds as the amount of supplement needed with a ton of hay containing 8 percent protein. If the hay had only 6 percent protein, then 266 pounds of supplement would be needed per ton of hay. The difference in amount of high-protein supplement is 132 pounds.

The approximate difference in the value per ton of the two as indicated from the results of these experiments is the value of the 132 pounds of high-protein supplement. If it costs $70 per ton (3.5 cents per pound), the difference in value per ton would be $3.62 for hay varying only two percentage units in protein. Any current price per pound may be applied to give values suitable to local and present conditions.

It should be realized that environmental and animal variations will have an influence on performance and that the results will not always be the same with the method of feeding recommended here. It should be pointed out also that the results herein were obtained only with prairie hay which was harvested during the previous season. While the comparative values of

Table 11. Suggested Rate of Protein Supplementation with Prairie Hay of Various Protein Content for Wintering Calves for Gains of 0.75 to 1.0 Pound Daily

Protein Content of Hay, Air Dry Basis, %	Amount of High-Protein Supplement (Approximately 40%) Per Pound of Hay, lbs.	Per Head Daily*, lbs.	Per Ton of Hay, lbs.
10.0	0	0	0
9.0	0.033	0.4	66
8.0	0.067	0.8	134
7.0	0.100	1.2	200
6.0	0.133	1.6	266
5.0	0.167	2.0	334
4.0	0.200	2.4	400

*Approximate amount when on a full feed of 12-13 pounds of hay daily. A small amount of oats in addition to the protein supplement is advisable the first two or three weeks when getting calves on feed.

hay (table 11) with different protein content are based on work with winter rations for calves, these values should indicate the comparative values of prairie hay, varying in protein content, in other types of cattle rations. Calves fed for a more liberal rate of gain would require slightly more protein and mature cows would require slightly less protein than was used in these feeding trials.