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Colorado Hays and Fodders.

ALFALFA—TIMOTHY—NATIVE HAY—CORN FODDER—SORGHUM—SALT BUSH.

DIGESTION EXPERIMENTS

—BY—

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DIGESTION EXPERIMENTS WITH SOME COLORADO HAYS AND FODDERS.

BY WM. P. HEADDEN.

Some years ago, while making a study of the alfalfa plant and again on extending the work to a study of alfalfa and some other hays, I was surprised at the scarcity of data upon the digestibility of the various hays that I was endeavoring to study. The results of the experiments that I succeeded in finding were not only few in number but not concordant. Further, they were made with hays which could scarcely be compared with those that I was studying and under different conditions from those which obtain here.

It is accepted as a fact among us, whether justly so or not, that alfalfa or lucerne hay as grown and made in this state is scarcely excelled by any other hay for the purposes of milk-producing and fattening, for which it is used in large quantities. It is also probably true that the alfalfa grows as well under our conditions and makes as good a quality of hay as in any other locality in this country and perhaps in the world. It is for such reasons that it seemed to me desirable to make some experiments to determine anew the digestion coefficients of alfalfa hay produced here. It is true that these had been previously determined by my immediate predecessor, Dr. O'Brine, using steers to experiment with, but I wished to extend the experiments to include some other fodders. I deemed it desirable that still others should be added, because the accumulated data on this subject is neither extensive nor concordant. I therefore present the results of some experiments on the digestibility of some Colorado grown fodders, using sheep as our experimental animals.*

In Bulletin No. 39, I tried to set forth some of the differences between hays made from leguminous plants and the grasses. I have this problem in view in these experiments also, but rather incidentally, the principal purpose of this bulletin being to give the results of our attempts to determine the digestion coefficients

*I wish to acknowledge the patient, faithful, cheerful, and interested service rendered by my assistants in the prosecution of this work. Some of my results being unusually low led to frequent repetitions as a matter of precaution. Some of the work too has been disagreeable, but my assistants have at all times done it willingly. It is with pleasure that I make this acknowledgment.

of some of our fodders, either because of their present importance or because of their possible interest to stockmen and feeders.

It may not be amiss to state some of the more salient differences between the leguminous hays and those made from grasses. The leguminous hays contain a larger portion soluble in water and alcohol by about 10 per cent than the native hay, the amount of hemicellulose, cellulose like constituents reacting with phloroglucin, is much larger in the leguminous hays than in the native hays. These two facts may account for the greater sensitiveness that the leguminous hays show to the effects of moisture. I have seen alfalfa badly discolored by a heavy dew. These facts, too, may indicate even greater differences than we at present realize. The extractive as well as the nitrogenous substance are probably quite different, which is also certainly true among the grasses as well.

The leguminous hays are as a class sensitive to the action of water and inclined to heat readily. Under our Colorado conditions the action of water is often wholly avoided and the hay has a bright green color and a marked pleasant odor. One would expect such hay to be more uniform in quality and superior to that made in states where it is difficult to cut and cure the hay without its being more or less damaged by rains or heavy dews.

I do not know to what extent the quality of the hay affects its digestion coefficients, but alfalfa hay is certainly sensitive to the action of even a slight amount of moisture in the form of rain or dew. I have but little data conveying any idea of how sensitive it is or of the character of the changes produced in it. I have had opportunity to study but one sample in any detail; in this case I do not know what percentage of the original hay was washed out, the hay did not heat; it was simply cut at one of those inopportune periods when it rains every few hours even in Colorado. The total rainfall during this wet period was 1.76 inches. The hay which escaped the rain contained 26.46 per cent crude fibre; that which was exposed to it contained 38.83 per cent, the former contained 18.71 per cent protein the latter 11.01. The nitrogen free extract, which includes the hemicelluloses was reduced about five per cent. These statements and figures may serve both to justify and explain my statement that legume hay, especially alfalfa, is very sensitive to the action of moisture and fermentation. In the case of brennheu, the fermentation seems to make it more palatable to cattle. I have never heard of this effect having been produced in the case of hays made from grasses, this, however, may be the case, but I have not met with any statement to this effect. The large portion of the legume hays soluble in water and easily fermentable accounts for their rapid deterioration when exposed to excessive moisture and heat. The amount

dissolved by alcohol and cold water from alfalfa hay is about 36 per cent, while the same menstruua dissolve only 27 per cent from native hay and 28 from timothy.

In the case of native hay, the results will doubtlessly vary with the different amounts of the various grasses which make up the hay. A hay consisting of blue stem principally will differ from one made up of a mixture of grasses, and probably still more from one consisting largely of sedges. This consideration should not be lost sight of when any statement concerning a native hay is made, for the statement may be based upon results obtained in experiments with a hay very different from the one the reader may have in mind. The mixture of grasses represented by the term native hay, is indicated by the sample used in Bulletin 39, in which we find the following: *Andropogon scoparius*, *Carex marcida*, *Elymus canadensis*, *Panicum virgatum*, *Sporobolus asperifolius*, *Sporobolus cryptandrus*, *Poa tennuifolio*, *Andropogon furcatus*, *Chrysopogen avenacrus*, *Calamovilfa longifolio*, *Agropyron tenerum*, and *Bouteloua oligostachya*. This mixture represented an excellent sample of this class of hay, but results obtained with it can only in a measure be applied to another hay representing a different mixture of grasses, i. e., to one consisting almost wholly of blue stem, *Agropyron tenerum*, or rushes and sedges.

I recognize the necessity of having a representative sample of hay, even when the hay is composed exclusively of one plant, which is the case in the alfalfa hay, and for this reason alone I make the following statements:

The sample of alfalfa hay used was furnished by the Farm Department. The practice is, when possible, to cut the alfalfa before it is more than in half bloom, and this hay was probably cut when the alfalfa was in this condition, but the analysis agrees better with the composition of a hay cut at a later period, i. e., when in full bloom or even past this stage. The hay was not first class hay.

The results obtained with this sample were so exceptional, especially in regard to the ether extract or fat, that the analytical work was repeated in the case of the hay and the feces of sheep No. 3. The principal weakness in my data lies in the sample of hay itself, which is quite normal in its composition except in regard to the amount of ether extract or so called fat that it contains, of which there is even a little less than I have heretofore found in the stems or in hay made from plants in full seed. The protein, 13.12 per cent, is a shade low, and the crude fibre 41.05 per cent, a trifle high for really good alfalfa hay, but they are not abnormal enough to justify their rejection. The ether extract, however, being less than one half the amount usually found in

average samples of alfalfa hay is open to serious doubt. The feces voided by sheep feeding on this hay are, on the other hand quite as rich in ether extract as those of sheep which had been feeding on much better hay.

The case presents itself to me in the following light, as it will probably present itself to others, i. e., if the feces of two sets of sheep feeding on the same kind of hay show practically the same amount of the ether extract, we ought to find a corresponding agreement in the amount of ether extract in the respective hays, provided the digestive processes have acted upon them in the same manner and degree. But we do not find this to be the case, and I view the discrepancy as of such importance that I consider it my duty to reject this series of experiments with alfalfa hay or to give the results obtained and a fuller account of the study made in our endeavor to find the error, or some explanation for the results obtained. I shall give the series with all results as found and then an account of the work done.

The digestion coefficient for the ether extract seems to be the only one concerning which any serious question can be raised. The coefficient obtained being negative cannot be used, but it seems to me that there must be some facts indicated by this result, for, though the agreement of the coefficients found is very poor, they agree in their general purport, i. e., they are all three negative. The hay seems to have undergone some change which lessened the amount of ether extract in the hay, but in passing through the digestive processes it appears to have been rendered soluble again. This can scarcely be the case. The excess is more likely due to ether soluble substances in the feces which are not furnished by the undigested portions of the hay.

The sheep used in the first four series of experiments were wethers between three and four years old.

The fodders used were corn fodder, native hay, timothy hay and alfalfa hay.

The animals were fed for a period of twelve days and the feces collected during the last five days.

CORN FODDER.

Fodder Fed.—Sheep No. 3.

Weight of fodder received in five days, 5395.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.*	Extract.
7.02	11.11	1.36	8.66	32.37	39.48

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5016.27	599.38	73.37	467.20	1746.36	2129.95

**Orts, air dried, weighed 606.0 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.71	24.18	1.28	8.36	31.25	28.28

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
565.34	146.53	7.76	50.66	189.37	171.38

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5016.27	599.38	73.37	467.20	1746.36	2129.95
Less orts	565.34	146.53	7.76	50.66	189.37	171.38
Consumed	4450.93	442.85	65.61	416.54	1556.99	1958.57

Feces.

Air dried feces weighed 1965.5 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.11	13.73	1.86	10.89	24.22	42.20

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1825.75	269.86	36.56	214.04	478.04	829.34

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	4450.93	442.85	65.61	416.55	1556.99	1958.57
Voided	1825.75	269.86	36.56	214.04	478.04	829.34
Digested	2625.18	172.99	29.05	202.51	1078.95	1129.23
Co-efficients or percentages digested	**58.98**	**39.06**	**44.28**	**48.62**	**69.30**	**57.66**

*Fibre is used throughout these tables for crude fibre, and extract for nitrogen free extract.

**Orts is the portion left by the animal.

CORN FODDER.

Fodder Fed—Sheep No. 5.

Weight of fodder received in five days, 5395.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.02	11.11	1.36	8.66	32.37	39.48

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5016.27	599.38	73.37	467.20	1746.36	2129.95

Orts, air dried, weighed 453.5 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.02	23.07	1.56	8.70	30.47	29.18

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
421.65	104.62	7.07	39.45	138.18	132.33

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5016.27	599.38	73.37	467.20	1746.36	2129.95
Less orts	421.65	104.62	7.07	39.45	138.18	132.33
Consumed	4594.62	494.76	66.30	427.75	1608.18	1997.62

Feces.

Air dried feces weighed 1978.5 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.76	14.43	1.83	11.66	24.19	40.13

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1825.00	285.50	36.20	230.69	478.59	793.97

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	4594.62	494.76	66.30	427.75	1608.18	1997.62
Voided	1825.00	285.50	36.20	230.69	478.59	793.97
Digested	2769.62	209.26	30.10	197.07	1129.59	1203.65
Co-efficients or percentages digested	**60.28**	**42.29**	**45.40**	**46.07**	**70.24**	**60.25**

CORN FODDER.

Fodder Fed.—Sheep No. 10.

Weight of fodder received in five days, 5395.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.02	11.11	1.36	8.66	32.37	39.48

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5016.27	599.38	73.37	467.20	1746.36	2129.95

Orts, air dried, weighed 500.50 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.33	18.89	1.40	10.03	30.00	34.35

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
473.82	94.55	7.01	50.21	150.12	167.96

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5016.27	599.38	73.37	467.20	1746.36	2129.95
Less orts	473.82	94.55	7.01	50.21	150.12	167.96
Consumed	4542.45	504.83	66.36	416.99	1596.24	1961.99

Feces.

Air dried feces weighed 2115.50 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.43	12.63	1.63	10.36	27.11	41.82

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1979.36	267.19	34.48	219.11	573.57	884.85

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	4542.45	504.83	66.36	416.99	1596.24	1961.99
Voided	1979.36	267.19	34.48	219.11	573.57	884.85
Digested	2563.09	237.64	31.88	197.88	1022.67	1077.14
Co-efficients or percentages digested	**56.43**	**47.08**	**48.04**	**47.46**	**64.07**	**54.90**

Average Coefficients, as Given by the Three Sheep.

	Dry Matter.	Ash.	Fat.	Protein.	Crude Fibre.	N. Free Extract.
Sheep No. 1	**56.43**	**47.08**	**48.04**	**47.46**	**64.07**	**54.90**
Sheep No. 2	**60.28**	**42.29**	**45.40**	**46.07**	**70.24**	**60.25**
Sheep No. 3	**58.98**	**39.06**	**44.28**	**48.62**	**69.30**	**57.66**
Average	**58.56**	**42.84**	**45.91**	**47.38**	**67.87**	**57.60**

The corn fodder used was a dent corn, sown broadcast and cut quite immature; some of the plants were in silk, but no corn was formed on the ears. The fodder was about eight months old when fed.

NATIVE HAY.

Fodder Fed.—Sheep No. 2.

Weight of fodder received in five days, 5380.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.23	7.33	2.05	7.36	35.78	41.70

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5044.88	394.35	110.29	394.32	1924.10	2243.22

Orts, air dried, weighed 429.0 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.85	8.77	1.70	7.21	38.17	38.29

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
403.91	37.62	7.29	30.93	163.72	164.21

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5044.88	394.35	110.29	394.32	1924.10	2243.22
Less orts	403.91	37.62	7.29	30.93	163.72	164.21
Consumed	4640.97	356.73	103.00	363.39	1760.38	2079.01

Feces.

Air dried feces weighed 1832.5 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.06	10.16	2.68	7.11	35.93	39.06

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1721.50	186.12	49.11	130.21	658.47	715.71

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	4640.97	356.73	103.00	363.39	1760.38	2079.01
Voided	1721.50	186.12	49.11	130.21	658.47	715.71
Digested	2919.47	170.61	53.89	233.18	1101.91	1363.30
Co-efficients or percentages digested	**62.91**	**47.82**	**52.32**	**67.47**	**62.59**	**65.57**

NATIVE HAY.

Fodder Fed.—Sheep No. 5.

Weight of fodder received in five days, 5380.0 grains.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.23	7.33	2.05	7.36	35.78	41.70

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5044.88	394.35	110.29	394.32	1924.10	2243.22

Orts, air dried, weighed 553.5 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.30	8.34	1.53	6.98	38.31	38.54

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
518.63	46.16	8.47	38.63	212.02	213.35

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5044.88	394.35	110.29	394.32	1924.10	2243.22
Less orts	518.63	46.16	8.47	38.63	212.02	213.35
Consumed	4526.25	348.19	101.82	355.69	1702.08	2029.87

Feces.

Air dried feces weighed 1968.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.58	10.46	2.74	7.68	32.43	40.14

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1838.59	205.82	53.92	151.12	638.23	789.91

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	4526.25	348.19	101.82	355.69	1702.08	2029.87
Voided	1838.59	205.82	53.92	151.12	638.23	789.91
Digested	2687.66	142.37	47.90	204.57	1063.85	1239.96
Co-efficients or percentages digested	**59.38**	**40.89**	**47.14**	**57.51**	**62.50**	**61.08**

NATIVE HAY.

Fodder Fed.—Sheep No. 10.

Weight of fodder received in five days, 5380.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.23	7.33	2.05	7.36	35.78	41.70

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5044.88	394.35	110.29	394.32	1924.10	2243.22

Orts, air dried, weighed 433.5 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.09	6.44	0.96	5.37	36.98	44.16

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
407.10	27.91	4.16	23.27	160.31	191.43

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5044.88	394.35	110.29	394.32	1924.10	2243.22
Less orts	407.10	27.91	4.16	23.27	160.31	191.43
Consumed	4637.78	366.44	106.13	371.05	1763.79	2051.79

Feces.

Air dried feces weighed 2130.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.48	10.14	2.90	7.37	33.97	39.14

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1991.96	215.91	61.77	156.91	723.52	833.61

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	4637.78	366.44	106.13	371.05	1763.79	2051.79
Voided	1991.96	215.91	61.77	156.91	723.52	833.61
Digested	2645.82	150.53	44.36	214.14	1040.27	1218.18
Co-efficients or percentages digested	**57.05**	**41.24**	**41.80**	**57.71**	**58.98**	**59.37**

The Average Coefficients found for Native Hay.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 2	**62.91**	**47.82**	**52.53**	**67.47**	**62.59**	**65.57**
Sheep No. 5	**59.38**	**40.89**	**47.14**	**57.51**	**62.50**	**61.08**
Sheep No. 10	**57.05**	**41.24**	**41.80**	**57.71**	**58.98**	**59.37**
Average	**59.78**	**43.32**	**47.09**	**60.90**	**61.36**	**62.01**

Jordan and Hall give a blue joint under meadow grasses. I do not know whether this is our blue joint or not, but for this they give the following coefficients:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Maximum	68.6	48.7	52.3	70.2	72.4	68.6
Minimum	39.9	10.0	37.0	56.5	36.5	43.2
Average	54.3	29.4	44.7	63.4	54.5	55.9

This blue joint is probably *Calamagrostis canadensis*, while our blue stem is *Agropyron tenerum*. I know of no data on this subject applicable to our native hay, unless the comparison be made under the very broad head of meadow hay, which is, perhaps, a little too broad.

The native hay used in this experiment was purchased in the market as "upland hay." It was said to have been cut on the farm of Mr. Gilkison and was composed largely of blue joint *Agropyrum tenerum*.

I do not think that the coefficients of digestion of this class of hay have been determined, at least I can find none.

Such hay is cut from the bottom lands along the water courses, or where water courses have been and the supply of moisture is both greater and more constant than in the higher ground. It can scarcely be compared with Eastern meadow hay, though such a comparison would, in a measure, be justified.

TIMOTHY HAY.

Fodder Fed.—Sheep No. 3.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.58	7.21	1.43	7.45	40.71	36.52

Fodder Constituents Fed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
	5166.19	398.77	79.08	411.91	2251.31	2019.18

Orts, air dried, weighed ooo grams.

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5166.19	398.77	79.08	411.91	2251.38	2019.18

Feces.

Air dried feces weighed 2349.50 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.07	11.10	2.49	7.45	41.85	32.04

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2230.35	260.71	58.51	175.03	983.22	752.71

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5166.19	398.77	79.08	411.91	2251.38	2019.18
Voided	2230.35	260.71	58.51	175.03	983.22	752.71
Digested	2935.84	138.06	20.57	236.88	1268.16	1266.47
Co-efficients or percentages digested	**56.83**	**34.62**	**26.01**	**57.51**	**56.33**	**62.72**

TIMOTHY HAY.

Fodder Fed.—Sheep No. 4.

Weight of fodder received in five days, 5530.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.58	7.21	1.43	7.45	40.71	36.52

Fodder Constituents Fed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Orts, air dried, weighed 000 grams.	5166.19	398.77	79.08	411.91	2251.31	2019.18

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5166.19	398.77	79.08	411.91	2251.31	2019.18

Feces.

Air dried feces weighed 2275.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.46	10.31	2.23	7.48	42.00	31.48

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2091.19	235.42	50.73	170.11	955.41	716.11

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5166.19	398.77	79.08	411.91	2251.31	2019.18
Voided	2091.19	235.42	50.73	170.11	955.41	716.11
Digested	3075.00	161.35	28.35	241.80	1295.97	1303.07
Co-efficients or percentages digested	**59.52**	**32.94**	**35.85**	**58.70**	**57.56**	**64.53**

TIMOTHY HAY.

Fodder Fed.—Sheep No. 8.

Weight of fodder received in five days, 5530.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.58	7.21	1.43	7.45	40.71	36.52

Fodder Constituents Fed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Orts, air dried, weighed 65.0 grams.*	5166.19	398.77	79.08	411.91	2251.38	2019.18

Analysis of Orts.

Analysis incomplete.

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
	13.91	1.30	8.82		

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5166.19	398.77	79.08	411.91	2257.38	2019.18
Less orts		13.91	1.30	8.82		
Consumed	5166.19	384.86	77.78	403.09	2251.38	2019.18

Feces.

Air dried feces weighed 2567.5 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.98	9.77	2.06	6.45	43.93	30.80

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2388.21	250.71	51.50	165.62	1127.11	790.71

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5166.19	384.86	77.78	403.09	2251.38	2019.18
Voided	2388.21	250.71	51.50	165.62	1127.11	790.71
Digested	2777.98	134.15	26.28	237.47	1124.27	1228.47
Co-efficients or percentages digested	**53.77**	**34.86**	**33.79**	**58.91**	**49.94**	**60.79**

*The moisture and crude fibre determinations in this sample of orts were omitted, which introduces a slight error into the co-efficients obtained.

Average Digestion Coefficients for Timothy Hay.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 3	56.83	34.62	26.01	57.51	56.33	62.72
Sheep No. 4	59.52	32.94	35.85	58.70	57.56	64.53
Sheep No. 8	53.77	34.86	33.79	58.91	49.94	60.79
Average	56.71	34.14	31.88	58.37	54.61	62.80

The average coefficients obtained are well within the range found by other experimenters, with the exception of the coefficient of digestion for the fat or ether extract, which is far below the coefficient given for fat in timothy hay cut before or in bloom, and even lower than the minimum given for fat, 34.6, in timothy hay cut past bloom. The digestion coefficient of crude fibre is lower than the minimum given for timothy hay cut before or in bloom, but above the maximum for timothy cut after bloom. The digestion coefficient for the fat is markedly low. The same fact is observable in the results obtained for the digestion coefficient of fat in corn fodder. The native hay gives us a higher coefficient for the digestibility of the fat or ether extract than is given for blue joint, a meadow grass common in the East; but as already noted, the Eastern blue joint and the Western blue stem are different grasses, and their digestion coefficients may not be the same, in fact, are probably not the same, and my only justification in comparing them is the very general one that they each constitute a meadow hay.

We will have to take up the question of the digestion coefficient of fat in a subsequent paragraph, after we have set forth the results obtained with alfalfa hay.

The timothy hay used was purchased in the Denver market, it had been grown in the mountains, had been cut in early bloom and well cured. It was as good a sample as we could hope to procure either in the market or by growing it on the Station farm.

ALFALFA HAY.

Fodder Fed.—Sheep No. 4.

Weight of fodder received in five days, 5470.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.23	9.63	0.80	13.12	41.05	30.17

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5183.88	526.72	43.76	717.63	2245.23	1650.34

Orts, air dried, weighed 000 grams.

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5183.88	526.72	43.76	717.63	2245.23	1650.34

Feces.

Air dried feces weighed 2340.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.21	10.30	3.06	9.44	44.23	26.76

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2194.63	241.07	71.60	220.80	1034.10	626.11

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5183.88	526.72	43.76	717.63	2245.23	1650.34
Voided	2199.63	241.07	71.60	220.81	1034.10	626.11
Digested	2989.25	285.65	—27.84	496.82	1211.13	1024.23
Co-efficients or percentages digested	**57.66**	**54.23**	**—63.61**	**69.08**	**54.43**	**62.06**

ALFALFA HAY.

Fodder Fed.—Sheep No. 3.

Weight of fodder received in five days, 5470.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.23	9.63	0.80	13.12	41.05	30.17

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5183.88	526.72	43.76	717.63	2245.23	1650.34

Orts, air dried, weighed 000 grams.

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5183.88	526.72	43.76	717.63	2245.23	1650.34

Feces.

Air dried feces weighed 2832.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.26	11.12	3.27	9.27	44.00	26.08

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2654.68	315.03	92.63	262.65	1246.19	738.82

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5183.88	526.72	43.76	717.63	2245.23	1650.30
Voided	2654.68	315.03	92.63	262.65	1246.19	738.82
Digested	2529.20	211.69	—48.87	454.98	999.04	911.52
Co-efficients or percentages digested	**49.56**	**40.19**	**—111.67**	**63.40**	**44.49**	**55.23**

ALFALFA HAY.

Fodder Fed.—Sheep No. 8.

Weight of fodder received in five days, 5470.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.23	9.63	0.80	13.12	41.05	30.17

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
5183.88	526.72	43.76	717.63	2245.23	1650.30

Orts, air dried, weighed 1522.0 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.44	11.12	0.84	12.44	36.48	32.68

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1423.98	169.24	12.78	189.34	555.23	497.33

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	5183.88	526.72	43.76	717.63	2245.23	1650.34
Less orts	1423.98	169.24	12.78	189.34	555.23	497.39
Consumed	3759.90	357.48	30.98	528.29	1690.00	1152.95

Feces.

Air dried feces weighed 2044.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.99	10.00	2.99	8.38	46.00	26.64

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1921.57	205.40	61.11	171.22	940.22	544.55

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3759.90	357.48	30.98	528.29	1690.00	1152.95
Voided	1921.57	205.40	61.11	171.22	940.22	544.55
Digested	1838.33	152.08	—30.13	357.07	749.78	608.40
Co-efficients or percentages digested	**48.89**	**42.57**	**—97.26**	**67.59**	**44.36**	**52.77**

Average Digestion Coefficients for Alfalfa Hay.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 3	**49.56**	**40.19**	Negative **111.67**	**63.40**	**44.49**	**55.23**
Sheep No. 4	**57.66**	**54.23**	Negative **63.61**	**69.08**	**54.43**	**62.06**
Sheep No. 8	**48.89**	**42.54**	Negative **97.26**	**67.59**	**44.36**	**52.77**
Averages	**52.04**	**45.65**	Negative **90.85**	**66.69**	**47.76**	**56.69**

The maximum, minimum and average coefficients of digegestion as given by Jordan and Hall are as follows:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Maximum	60.2	40.9	54.0	77.0	49.0	71.8
Minimum	57.0	38.0	48.4	68.8	43.3	64.0
Average	58.9	39.5	51.0	72.0	46.0	69.2

The experiments on which the quoted data were based were made, one by Utah Experiment Station, using two steers; one by the New York Experiment Station, using a cow; one by the Colorado Station, using two steers. Additional experiments which have appeared since the compilation of Jordan and Hall was made are, so far as I have been able to find, the following:

Kansas Station, Bulletin 103.—Steers.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
First cutting, plants in bloom	59.40	63.49	60.00	78.52	46.10	75.31
Second cutting, 50 per cent. of plants in bloom	58.29	56.41	30.39	75.14	50.44	71.99
Third cutting, plants in full bloom	60.03	60.90	51.65	76.70	50.63	75.24

Minnesota Station, Bulletin 80.—Steers.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Alfalfa hay	65.84	51.40	55.88	75.38	57.57	71.86

Ontario Agricultural College and Experimental Farm Report, 1898.—Sheep.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
First cutting	58.6	——	48.8	73.4	39.1	71.8
Second cutting	56.2	——	50.4	72.8	37.7	70.1
Third cutting	51.3	——	44.1	64.4	37.1	64.0

Utah Station.—Bul. 54.—Steers.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
60.16	40.85	50.57	70.30	45.67	71.80

These give for alfalfa hay, first cutting, taking the Minnesota and Utah samples as such, the following:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Average alfalfa hay	61.00	51.58	53.81	74.40	47.11	72.49
Average all cuttings	58.73	56.61	48.97	73.33	45.54	71.41

My average results are lower than the averages of other experimenters, but are within the bounds of probability, with the exception of the fat or ether extract, which in my series is negative, and we assume, tentatively only, that the results are erro-

neous, even though the three sheep give the same result, i. e., a negative one. The natural explanation would be to attribute it to some error, and as the result is common to the three sheep, the error, if any has been made, must be a fundamental one, and would seem to lie in the determination of the fat or ether extract in the hay itself. The hay used was first cutting hay, furnished by the Farm Department, probably cut when the plants were in early to half bloom, as it is our custom to cut the alfalfa when in this condition, though the analysis corresponds to much later cut hay.

The results in the case of the ether extract being so remarkable, the analytical work, though already done in duplicate, was repeated in the case of the hay and the feces of sheep No. 3. The principal weakness in my data lies in the sample of hay, the composition of which shows nothing unusual except a very small amount of fat, ether extract, which is even less than I have heretofore found in the stems alone or in hay made from plants that were in full seed.

This extremely low percentage of fat almost forbids the use of the coefficient obtained for it in this series of experiments.

The crude protein, 13.12 per cent, is a shade low, and the crude fibre, 41.05 per cent, a little too high for prime, first cutting alfalfa hay. But they are so well within the range found for these constituents in alfalfa hay that they cannot justly be made the subject of adverse comment. The fat, however, being less than one-half the amount usually found in good alfalfa hay, is open to the gravest doubts. The feces of the sheep fed on this hay are, on the other hand, quite as rich in ether extract as the feces of other sheep fed with a much better alfalfa hay. The average ether extract found in the feces of this series of experiments, and being the average of fifteen determinations, is 3.10 per cent, while the average percentage of ether extract found in the feces of three other sheep, likewise based upon fifteen determinations, is 3.09 per cent.

It would seem that if the feces of two sets of sheep, to which the same kind of hay had been fed, contained the same amount of ether extract (fat), we ought to find a corresponding agreement in the amounts contained in the hay feed, provided that the digestion processes had acted upon them in the same manner and degree ; but we do not find this to be the case, as will appear more fully in the statement of a subsequent series of experiments. I therefore feel it to be incumbent upon me either to reject this series or to make a somewhat full record of the study made, which I shall do as briefly as possible. It would be easier to do the former and to use only such results as are in harmony with other experiments which are considered as altogether reliable, and the number of which add materially to their conclusiveness.

The hay was passed through a cutter and the sample taken by Professor W. W. Cooke, who was at the time Professor of Agriculture at this institution, and by him delivered to me. The hay was discolored to a degree which might be produced by its being exposed to a heavy dew or a light rain. An analysis of it indicated it to be at least a fair quality of hay, the only thing attracting attention being the very unusually low percentage of ether extract or fat.

Two things were possible in our results: We might have obtained too low results in our analysis of the hay, or those obtained for the fat in the feces might have been too high, and it is conceivable that both determinations might have been wrong, even though the former was made in duplicate and the latter was the average of five closely agreeing determinations. The analysis of both the hay and the feces were repeated without changing the results. It was then thought the alfalfa being very rich in chlorophyll, the coloring matters might have accumulated in the feces and possibly, having been rendered more readily soluble in ether, might account for a part of the discrepency between our results and those of others. The hay and feces of sheep Nos. 3, 4 and 8 were resampled, the samples carefully dried in hydrogen and extracted with petroleum ether, boiling from 35 deg. to 50 deg. Petroleum ether of this boiling point dissolved about 50 per cent as much out of both hay and feces as the anhydrous ether. The petroleum ether Bp. 35 deg.–50 deg., dissolved 1.78, 1.97 and 1.78 per cent from the feces, whereas the anhydrous ether dissolved 3.64, 3.62 and 3.62 per cent. The petroleum extract had a yellowish green color and it was evident that there was some coloring matter present which was freely soluble in this menstruum.

An attempt to separate the fatty acids and in this manner to eliminate the question of coloring matters and bile products, gave unsatisfactory results.

We next tried a higher boiling petroleum, 50 deg.–60 deg. We found this much more difficult to work with than the lower boiling petroleum, and further, that it yielded a much higher percentage of extract, in one instance falling only 0.10 per cent below the ether and in no instance more than 1 per cent less than the ether. After extracting five samples with petroleum Bp. 50 deg.–60 deg., we abandoned it and had recourse to alternate extraction with petroleum Bp. 35 deg.–50 deg. and anhydrous ether, also treating same samples in reverse order. As a result of this treatment we found that samples treated with ether yield but little, 0.07 per cent average of three trials, to petroleum Bp. 35 deg.–50 deg., while those treated with petroleum Bp. 35 deg.–50 deg. yield 0.90 per cent to the ether. At first I supposed that this difference was due to chlorophyll soluble in ether, but insol-

uble in the petroleum; subsequent attempts to separate the coloring matters from these extracts, though very unsatisfactory in themselves, indicate that this assumption was not wholly justified. The coefficient of digestion for the fat, petroleum extract, was negative, as in the case of the ether extract—showing over twice as much fat in the feces as was ingested with the hay; the negative coefficient for the ether extract being 111.67 and for the petroleum 110.8.

The next thing suggesting itself was that the excess of substances extracted from the feces by the ether might be due to biliary products, and we sought for cholesterine and bile pigments. We did not obtain satisfactory crystallizations of cholesterine, but we did obtain a good Petenkofer reaction. This is hardly to be wondered at, as this substance occurs so generally distributed within the body. We obtained fairly good reactions for bile pigments, and were it not for the presence of other substances which might have produced the reactions observed, one would be justified in asserting that they were present. As the matter stands, however, I am very doubtful about the actual presence of bile pigments, and I am very fully convinced that this class of products do not furnish the explanation for the excessive amount of extract in the feces. By excessive is here meant relative to the amount in the hay feed.

We attempted to determine the chlorophyll in these extracts; the results were, as was to be foreseen, unsatisfactory, but indicated that from 30 to 35 per cent of the extract consists of chlorophyll and related substances. The petroleum extract was not colorless, but contained a considerable quantity of coloring matter. This coloring matter was also soluble in ether, for when the sample was first extracted with ether, and then with petroleum, the latter remained colorless. The large amount of coloring matter in alfalfa gave us trouble in other operations; for instance, we found it necessary to use lead and copper salts jointly in obtaining a colorless solution from an alcoholic extract of alfalfa hay.

The question of the coloring matters was not prosecuted further and was considered to this extent only because of their direct disturbing influence upon our fat determinations and indirectly upon some of our work due to the color imparted to the solutions, making it difficult to observe the reactions or to determine when the end had been reached.

In all of this we have been unable to find any explanation of the fact that this series of experiments gives us no digestion coefficient for the ether extract in alfalfa hay. I have canvassed all of the analytical difficulties which have occurred to me as possibly being capable of furnishing even a suggestion of an explanation, the analysis of the hay and also those of the feces have been repeated several times by different operators and with great

care. The results are so constant that they preclude any mistake in the analytical work. To convey an idea of the care with which my assistants worked and the concordant results obtained, I may be permitted to give some of them: Ether extract in alfalfa hay, 0.783, 0.835, 0.785, 0.812 and 0.750, after resampling and prolonged drying in hydrogen. Ether extract in the only sample of orts left by the sheep was 0.827, 0.850. The results obtained in the analysis of the feces were equally satisfactory.

The only suggestion remaining is that the hay used in this experiment had suffered some change which affect the solubility of the "ether extract" in this remarkable manner, i. e., reducing it to about one-half the amount to be expected in good alfalfa hay, this hay showing 0.80 per cent, while the next sample experimented with contained 1.62 per cent and was likewise first cutting but in much better condition. The orts show the same relation; the orts in this series show an average of 0.83 per cent ether extract, in the next one to be given 1.22 per cent. Of the three sheep used only one left any portion of its fodder, and I am inclined to consider it an accident that the fat in the hay and orts in this one sample are so nearly the same. The feces, on the other hand, do not show this difference, but are very similar in the percentage of ether extract yielded.

As already stated, the feces from this hay containing only 0.80 per cent ether extract yielded as the average of fifteen determinations made on the feces of three sheep 3.10 per cent, while the feces from another alfalfa hay yielded as the average of the same number of determinations made on the feces of three other sheep 3.09 per cent. One thing is evident, i. e., that however changed the hay may have been, this change did not affect the amount of ether extract appearing in the feces.

There are no facts that I know of to justify us in assuming that oxidation would diminish the solubility of the fats in alfalfa hay, even if slightly damaged by rain or dew, as this may have been. Beyond this I cannot conceive by what cause the fat in this hay could have been so reduced, and I am still less able to apprehend what changes could have taken place within the animal to restore an apparently *normal* amount of ether extract to the feces.

It is almost certain that the ether extract consists of soluble fecal matter, the amount of which is not dependent upon the amount of ether extract in the hay, and the coefficient obtained is of but little value.

It is generally accepted as a fact that the determination of the coefficient of digestion of fat, especially when only small amounts are fed, is at best unsatisfactory. This is applicable in the case of hays and fodders in which the amount of fat or ether

extract is small. In the case here presented the largest amount of ether extract consumed in the five days during which the feces were collected was 43.76 grams, a little less than an ounce and a half. This is a small quantity, but concerning the result there is no room for questions, it is not doubtful, for we find in the feces 92.63 grams of fat or ether extract—more than twice the amount consumed, and we find almost exactly the same ratio if we take the petroleum extract, i. e., 23.52 grams consumed and 48.99 grams voided in the feces. All uncertainty in regard to the coefficient disappears in this markedly negative result. While I am unable to give any explanation, satisfactory or otherwise, for this anomalous result, except as already suggested, I cannot, in fairness, do otherwise than publish the results obtained.

I see but one question which can still be raised, i. e., the character of the sample itself. The experience of Professor Cooke as a chemist and his own interest in the experiment ought to be a sufficient guaranty of its fairness. The fact that the one sample of orts obtained in the experiment gives the same amount of ether extract that the sample of hay gave is remarkable, for sheep, when they have the opportunity, eat the leaves of alfalfa in preference to the stems, and the fact that this hay had been chopped would in no way preclude the animals leaving the stems in preference to a mixture of leaves and stems. The analysis, as already intimated, suggests a sample of hay which had been cut when passed full bloom, but by what process the ether extract in the feces has been rendered so large is not apparent.

SECOND SERIES.

It was my intention to extend the work with the preceding hays and fodders to include a study of the alcoholic and aqueous extracts together with several other points which appear to me interesting and possibly of considerable value. The doubts which gathered about the alfalfa hay and the anamalous results obtained decided me to take up another series of experiments. I accordingly obtained other sheep and repeated the work *de novo*. I was the more willing to do this, as it would increase the number of experiments made and the number of animals experimented with, both of which are desirable factors in this kind of work, besides there is a scarcity of experiments to determine the coefficients of some of the fodders with which I wished to experiment. Some of the conditions, too, under which the experiments were conducted were made more favorable. The comfort of the animal was better provided for and the spring season was chosen instead of the summer.

It further seemed advisable to extend the experiments to include sorghum fodder raised without irrigation and one of our na-

tive salt bushes, *Atriplex argentea*, because they are of importance to the eastern section of the state, which is largely devoted to grazing. The cattlemen find it desirable to have some fodder to feed during severe storms, as by doing so they avoid during the late winter and spring the loss of cattle, which are already somewhat reduced by the scanty supply of grass and the exposures of the season. Owing to the climatic conditions prevailing in this section it would be a boon if some of the native plants could be used for fodder when dried. As the salt bush mentioned, *Atriplex argentea*, has been used for this purpose, I included it in our experiment. In regard to the sorghum fodder, two things are to be considered; first, it is necessary to grow it without irrigation and with but little rainfall; the average rainfall of Cheyenne Wells is 15.90 inches; second, the plants will not grow rankly and the fodder would not be used until the latter part of winter or some time during the spring, by which time it is claimed that sorghum fodder will have deteriorated very materially. But even under these conditions one would judge sorghum fodder to be preferable to hay made from the Russian thistle or some of the salt bushes.

The Sub-station at Cheyenne Wells experimented with the growing sorghum for this purpose. The cultural problems lie entirely beyond my province. The sample of sorghum fodder used was grown by this Sub-station, cut when only a few of the plants were advanced enough to mature seed, shocked and preserved in shock until the following spring. The sample was leafy and of an excellent color, and whatever the changes this fodder may have suffered due to its having stood in shock, exposed to the weather of an eastern Colorado winter, it is still representative of the very best sorghum fodder that the people of this section can hope to obtain.

The second series of experiments include the following: Alfalfa hay, native hay, timothy hay, corn fodder, sorghum fodder and salt bush hay.

The sheep used in these experiments were wethers about one year old, so-called Mexican lambs, and represented the stock fed by feeders in this valley. The sheep were rather under-sized but healthy and hardy. They were gentle and their stalls were light and airy, so arranged that we could close them nights and during severe weather. The water given them to drink was heated to from 14 deg. to 20 deg. C., and in cold weather to from 35 deg. to 40 deg., usually to about 30 deg. During this series of experiments the sheep received a small allowance of salt, except with the salt bush hay. The weights of the sheep were taken on the morning of the day the experiments began, before feeding, and on the morning of the day they were turned out of the stalls twelve hours after the last feed.

ALFALFA HAY.

Fodder Fed.—Sheep No. 4.

Weight of fodder received in five days, 4450.5 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.75	11.77	1.62	15.03	30.28	35.55

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4106.00	533.23	72.01	668.12	1346.10	1580.27

Orts, air dried, weighed 320.7 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.32	20.74	1.22	14.93	32.44	25.35

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
323.60	66.51	3.91	47.88	104.03	81.29

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4106.00	523.23	72.01	668.12	1346.10	1580.27
Less orts	323.60	66.51	3.91	47.88	104.03	81.29
Consumed	3782.40	456.72	68.18	620.24	1242.07	1498.98

Feces.

Air dried feces weighed 1485.20 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.68	13.37	3.09	10.99	39.95	25.92

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1386.00	198.51	45.89	163.25	593.34	384.92

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3782.40	456.72	68.18	620.24	1242.07	1498.98
Voided	1386.00	198.51	45.89	163.25	593.34	384.92
Digested	2396.40	258.21	22.29	456.99	648.76	1114.06
Co-efficients or percentages digested	**63.64**	**56.54**	**32.61**	**73.68**	**52.23**	**74.32**

Weight of sheep at beginning of experiment 46.0 pounds.
Weight of sheep at end of experiment 49.0 pounds.

ALFALFA HAY.

Fodder Fed.—Sheep No. 5.

Weight of fodder received in five days, 4450.5 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.75	11.77	1.62	15.03	30.28	35.55

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4106.00	523.23	72.01	668.12	1346.1	1580.27

Orts, air dried, weighed 436.7 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.52	22.10	1.32	19.12	24.44	27.50

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
412.60	96.51	5.76	83.44	106.73	120.01

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4106.00	523.23	72.01	668.12	1346.10	1580.27
Less orts	412.60	96.51	5.76	83.44	106.73	120.01
Consumed	3693.40	426.72	66.25	564.68	1239.37	1460.26

Feces.

Air dried feces weighed 1426.7 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.73	11.77	3.06	10.46	41.72	26.26

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1130.69	167.94	43.65	149.22	595.25	374.61

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3693.40	426.72	66.25	564.68	1239.37	1460.26
Voided	1130.69	167.94	43.65	149.22	595.25	374.61
Digested	2562.71	258.78	22.60	415.48	644.12	1085.65
Co-efficients or percentages digested	**69.39**	**60.64**	**34.11**	**75.58**	**51.97**	**74.35**

Weight of sheep at beginning of experiment 46.0 pounds.
Weight of sheep at end of experiment 49.0 pounds.

ALFALFA HAY.

Fodder Fed.—Sheep No. 6.

Weight of fodder received in five days, 4450.5 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
7.75	11.77	1.62	15.03	30.28	35.55

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4106.00	523.23	72.01	668.12	1346.10	1580.27

Orts, air dried, weighed 229.3 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.45	22.02	1.12	16.78	30.73	23.90

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
216.81	50.49	2.57	38.48	70.46	43.53

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4106.00	523.23	72.01	668.12	1346.10	1580.27
Less orts	216.81	50.49	2.57	38.48	70.46	43.53
Consumed	3889.19	472.74	69.52	629.64	1275.64	1536.74

Feces.

Air dried feces weighed 1718.6 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.82	12.15	3.12	10.86	40.34	26.83

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1601.36	208.83	53.62	186.21	693.31	461.12

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3889.19	472.74	69.52	629.64	1275.64	1536.74
Voided	1601.36	208.83	53.62	186.21	693.31	461.12
Digested	2287.83	263.91	15.91	443.42	582.33	1075.62
Co-efficients or percentages digested	**58.83**	**55.83**	**22.85**	**70.36**	**45.65**	**69.99**

Weight of sheep at beginning of experiment 42.0 pounds.
Weight of sheep at end of experiment 45.0 pounds.

The Average Co-efficients.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 4	**63.64**	**56.54**	**32.61**	**73.68**	**52.23**	**74.32**
Sheep No. 5	**63.69**	**60.64**	**34.11**	**73.58**	**51.97**	**74.35**
Sheep No. 6	**58.83**	**55.83**	**22.85**	**70.36**	**45.65**	**69.99**
Average	**63.95**	**57.67**	**29.86**	**72.54**	**49.93**	**72.89**

If we do not include the coefficient 22.85 found for the fat in the experiment with sheep No. 6, we would still have only 33.34 as the average for sheep Nos. 4 and 5, which is still very much lower than has been found by any other experimenter for any cutting of alfalfa hay. A very little of the hay used in these experiments was slightly mouldy, the rest of the hay was in prime condition and the sample was fair. The highest average coefficient which we find for the fat or ether extract is 33.34, and that actually found for the three sheep is 29.86, while the highest individual coefficient is 34.11. All that has been said concerning the care taken to eliminate analytical errors in the first series of experiments with alfalfa, applies to this, and we believe that we have succeeded in eliminating them.

CORN FODDER.

Fodder Fed.—Sheep No. 1.

Weight of fodder received in five days, 3896.2 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
8.21	9.53	1.55	4.62	29.85	46.24

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
3576.37	371.22	60.36	179.91	1162.12	1802.14

Orts, air dried, weighed 818.6 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.79	8.49	1.28	2.49	35.02	45.93

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
763.02	69.49	10.47	20.38	286.61	375.91

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	3576.37	371.22	60.36	179.91	1162.12	1802.14
Less orts	763.02	69.49	10.47	20.38	286.61	375.91
Consumed	2813.35	301.73	49.89	159.53	875.51	1426.23

Feces.

Air dried feces weighed 1400.3 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.73	12.63	1.12	7.16	30.16	42.20

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1306.06	176.82	19.74	100.22	422.33	590.94

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	2813.35	301.73	49.89	159.53	875.51	1426.23
Voided	1306.06	176.82	19.74	100.22	422.33	590.94
Digested	1507.29	124.91	30.15	59.31	453.18	835.29
Co-efficients or percentages digested	**53.58**	**41.39**	**60.43**	**37.18**	**51.76**	**57.16**

Weight of sheep at beginning of experiment 47.0 pounds.
Weight of sheep at end of experiment 49.0 pounds.

CORN FODDER.

Fodder Fed.—Sheep No. 2.

Weight of fodder received in five days, 3896.2 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
8.21	9.53	1.55	4.62	29.85	46.24

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
3576.37	371.22	60.36	179.91	1162.12	1802.14

Orts, air dried, weighed 995.6 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.72	7.66	1.30	2.59	35.01	46.72

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
928.7	76.26	12.94	25.78	348.52	465.12

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	3576.37	371.22	60.63	179.91	1162.12	1802.14
Less orts	928.70	76.26	12.94	25.78	348.52	465.12
Consumed	2647.67	294.96	47.42	154.13	813.60	1337.02

Feces.

Air dried feces weighed 1230.4 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.67	13.26	1.19	7.83	29.20	42.00

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1148.34	163.12	14.64	96.34	359.21	516.71

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	2647.67	294.96	47.42	154.13	813.60	1337.02
Voided	1148.34	163.12	14.64	96.34	359.21	516.71
Digested	1499.33	131.84	332.77	57.79	454.39	820.31
Co-efficients or percentages digested	**56.63**	**44.70**	**69.11**	**37.49**	**55.85**	**61.35**

Weight of sheep at beginning of the experiment 46.0 pounds.
Weight of sheep at end of experiment 47.0 pounds.

CORN FODDER.

Fodder Fed.—Sheep No. 3.

Weight of fodder received in five days, 3896.2 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
8.21	9.53	1.55	4.62	29.85	46.24

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
3576.37	371.22	60.36	179.91	1162.12	1802.14

Orts, air dried, weighed 800.0 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.47	7.22	1.26	2.63	37.19	45.23

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
748.24	57.76	10.08	21.04	297.55	362.83

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	3576.37	371.22	60.36	179.91	1162.12	1802.14
Less orts	748.24	57.76	10.08	21.04	297.55	362.83
Consumed	2828.13	313.46	50.28	158.87	864.57	1439.31

Feces.

Air dried feces weighed 1220.2 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.76	14.17	1.29	7.90	26.56	43.32

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1137.72	172.94	15.74	95.73	324.01	528.51

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	2828.13	313.46	50.28	158.87	864.57	1439.31
Voided	1137.73	172.94	15.74	95.73	324.01	528.51
Digested	1690.41	140.52	34.54	63.14	540.56	910.80
Co-efficients or percentages digested	**59.77**	**44.83**	**68.69**	**33.45**	**62.52**	**63.28**

Weight of sheep at beginning of experiment 48.5 pounds
Weight of sheep at end of experiment 49.0 pounds.

Average Digestion Co-efficients of Corn Fodder.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 1	**53.58**	**41.30**	**60.43**	**37.18**	**51.76**	**57.16**
Sheep No. 2	**56.63**	**44.70**	**69.11**	**37.49**	**55.85**	**61.35**
Sheep No. 3	**59.77**	**44.83**	**68.69**	**33.45**	**62.52**	**63.28**
Average	**56.66**	**43.64**	**66.08**	**36.04**	**56.71**	**60.60**

The fodder used in the preceding experiments was obtained from the Farm Department. It was cut August 20, stood in shock until November 22, when it was hauled in and stacked, where it remained till March 10. The fodder was bright, prime fodder. The corn was a variety of dent, and was mature enough to have a few ears so far developed that the corn hardened up while in shock. All of the ears and nubbins were husked out. The corn had been seeded thinly in drills. The ratio of the leaves to the stems was 2-1. The fodder was cut fine, from one-fourth to one-half inch long. The orts consisted wholly of stalks, as the sheep ate all the leaves. We did not succeed in inducing the sheep to eat all the stems, even when they had been ground in a drug mill and moistened.

Jordan and Hall give as maximum, minimum and average digestion coefficients for dent and flint corn fodder (mature):

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Maximum	72.7	52.9	82.0	67.6	79.8	81.2
Minimum	59.8	6.6	64.7	37.9	42.8	63.4
Average	68.2	30.6	73.9	56.1	55.8	72.2

The same authors give the maximum, minimum and average coefficients for dent and flint cornfodder, immature, as:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Maximum	69.8	57.4	79.5	70.5	74.6	74.0
Minimum	52.3	17.7	57.3	24.1	46.1	59.2
Average	63.9	37.2	72.2	51.7	66.0	66.2

The coefficients obtained for our three individual sheep agree very well indeed, but our averages are quite different from those given in the compilation cited. Neglecting the ash and considering the other results, we have the following exhibit of facts relative to the digestibility of corn fodder, with which many experi-

ments have been made, the most of them by Eastern experimenters, and naturally under Eastern conditions.

My first series of experiments gave the following results—corn fodder immature:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 1	56.43	47.08	48.04	47.46	64.07	54.90
Sheep No. 2	60.28	42.29	45.40	46.07	70.24	60.25
Sheep No. 3	58.98	39.06	44.28	48.62	69.30	57.66
Average	**58.56**	**42.84**	**45.91**	**47.38**	**67.87**	**57.60**

Second series. Corn fodder, grown thinly in drills and mature enough to ripen a few ears:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 1	53.58	41.39	60.43	37.18	51.76	57.16
Sheep No. 2	56.63	44.70	69.11	37.49	55.85	61.35
Sheep No. 3	59.77	44.83	68.69	33.45	62.52	63.28
Average	**56.66**	**43.64**	**66.08**	**36.04**	**56.71**	**60.60**

The coefficients obtained for the individual sheep in the respective series agree as well as could be expected, and while the two series vary greatly, as it is proper that they should, all of the conditions under which the experiments were made being different in every respect. Still the results have a common feature when compared with the results recorded by all other American experimenters, i. e., they are uniformly low. This is, perhaps, most fairly shown by taking the averages, but, as will be noticed upon mere inspection, I might take the minima given by others and my result would still be comparatively low, but, as suggested, the averages may be fairer.

The averages found in Jordan and Hall, "The Digestibility of American Feeding Stuffs," are for dent and flint corn fodder:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Immature	63.9	37.20	72.2	51.7	66.0	66.2
Mature	68.2	30.60	73.9	56.1	55.8	72.2
My first series	58.6	42.84	45.9	47.4	67.9	57.6
My second series	56.7	43.64	66.1	36.0	56.7	60.6

In only one instance does the average found for any of the constitnents given exceed the average given by Jordan and Hall, i. e., the coefficient found for crude fibre. With this exception my coefficients are all low. I will take up this point later, but will remark that in spite of the low coefficients obtained, the animals were gaining flesh, as the three made an aggregate gain of three and a half pounds in the five days. The ration fed was not, in my opinion, such as to permit any unusual portion of it to pass the animal without having been fully acted on by the digestion processes. The amount of dry matter consumed was 2.7 per cent. of the animal's weight, a ratio which is by no means excessive.

TIMOTHY HAY.

Fodder Fed Sheep No. 1.

Weight of fodder received in five days, 4440. grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.49	9.37	2.99	5.62	31.54	43.99

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4151.88	416.03	132.72	249.54	1400.26	1923.64

Orts, air dried, weighed 1269.6 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
4.99	6.97	1.48	5.83	33.20	47.53

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1206.25	88.49	18.79	74.01	421.52	603.42

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4151.88	416.03	132.72	249.54	1400.26	1923.64
Less orts	1206.25	88.49	18.79	74.01	421.52	603.42
Consumed	2945.63	327.54	113.93	175.53	978.74	1320.22

Feces.

Air dried feces weighed 1549.9 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.79	7.84	2.28	5.92	37.26	39.91

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1444.67	121.59	35.33	91.75	577.41	618.52

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	2945.63	327.54	113.93	175.53	978.74	1320.22
Voided	1444.67	121.59	35.33	91.75	577.41	618.52
Digested	1500.96	205.95	78.60	83.78	401.33	702.70
Co-efficients or percentages digested	**50.96**	**62.88**	**68.99**	**47.73**	**41.00**	**53.23**

Weight of sheep at beginning of experiment 47.5 pounds.
Weight of sheep at end of experiment 48.0 pounds.
Daily consumption of dry matter equalled 2.7 per cent of the animals weight.

TIMOTHY HAY.

Fodder Fed Sheep No. 2.

Weight of fodder received in five days, 4440.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.49	9.37	2.99	5.62	31.54	43.99

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4151.88	416.03	132.72	249.54	1400.26	1923.64

Orts, air dried, weighed 1329.4 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.78	6.71	2.14	7.93	37.44	40.00

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1232.53	89.20	28.44	105.45	497.74	531.72

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4151.88	416.03	132.72	249.54	1400.26	1923.64
Less orts	1232.53	89.20	28.44	105.45	497.74	531.72
Consumed	2919.35	326.83	104.28	144.09	902.52	1391.92

Feces.

Air dried feces weighed 1549.7 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.35	6.72	2.06	5.48	39.75	39.64

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1451.30	104.13	31.92	84.92	616.02	614.21

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	2919.35	326.83	104.28	144.09	902.52	1391.92
Voided	1451.30	104.13	31.92	84.92	616.02	614.21
Digested	1468.05	222.70	72.36	59.17	286.50	777.71
Co-efficients or percentages digested	**50.28**	**68.14**	**69.39**	**41.06**	**31.94**	**55.87**

Weight of sheep at beginning of experiment 48.0 pounds.
Weight of sheep at end of experiment 47.5 pounds.
Daily consumption of dry matter equalled 2.7 per cent of the animals weight.

TIMOTHY HAY.

Fodder Fed Sheep No. 3.

Weight of fodder received in five days, 4440.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.49	9.37	2.99	5.62	31.54	43.99

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4151.88	416.03	132.72	249.54	1400.26	1923.64

Orts, air dried, weighed 1893.7 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.26	6.66	1.62	6.11	38.13	42.22

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1794.10	126.15	30.67	115.72	722.01	799.55

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4151.88	416.03	132.72	249.54	1400.26	1923.64
Less orts	1794.10	126.15	30.67	115.72	722.01	799.55
Consumed	2357.78	289.88	102.02	123.82	678.25	1124.09

Feces.

Air dried feces weighed 1208.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.00	8.19	2.57	6.02	36.34	41.08

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1135.52	98.93	31.04	72.72	438.91	496.22

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	2357.78	289.88	102.05	123.82	678.25	1124.09
Voided	1135.52	98.93	31.04	72.72	438.91	496.22
Digested	1222.26	190.95	71.01	51.10	239.34	627.87
Co-efficients or percentages digested	**51.84**	**65.87**	**69.58**	**41.27**	**35.29**	**55.86**

Weight of sheep at beginning of experiment 47.0 pounds.
Weight of sheep at end of experiment 46.0 pounds.
Daily consumption of dry matter equalled 2.2 per cent of animals weight.

Average Digestion Co-efficients for Timothy Hay.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 1	**50.96**	**62.88**	**68.99**	**47.73**	**41.00**	**53.23**
Sheep No. 2	**50.28**	**68.14**	**69.39**	**41.06**	**31.94**	**55.87**
Sheep No. 3	**51.84**	**65.87**	**69.58**	**41.27**	**35.29**	**55.86**
Average	**51.03**	**65.63**	**69.32**	**43.35**	**36.08**	**54.99**

The hay fed was not the same as in the former experiment. The sheep were younger and of a different breed, and the conditions of air, sunlight and general attention to the comfort of the animal were more favorable than in the former experiment. All of these facts should be taken into consideration in comparing the results. As both samples of hay were obtained in the Denver market, I cannot be more than morally certain that they were of about the same age, but I really entertain no doubt on this point. If we may judge by the amount of orts left, the hay used in the first experiment was more palatable to the sheep than that used in the second. The total amount of orts left by the three sheep in the first experiment was 60 grams, while they aggregated 4493.0 grams in the second.

The individual taste of one of the sheep was very marked in the second series, as it seemingly ate none of the timothy heads, all of which seemed pretty mature.

I will restate the results obtained in the first experiment that the differences may be the more easily observed:

The Digestion Co-efficients of Timothy Hay, First Series.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 3	56.83	34.62	26.01	57.51	56.33	62.72
Sheep No. 4	59.52	32.94	35.85	58.70	57.56	64.53
Sheep No. 8	53.77	34.86	33.79	58.91	49.94	60.79
Average	56.71	34.14	31.88	58.37	54.61	62.80

Jordan and Hall give the digestion coefficients for timothy hay before or in bloom as follows:

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Maximum	65.7	48.2	60.8	60.4	62.1	71.8
Minimum	55.9	41.8	51.5	51.1	56.6	57.4
Average	60.7	44.2	58.4	56.8	58.8	64.3
Timothy hay past bloom.						
Average	53.4	30.3	51.9	45.1	47.1	60.4

The coefficient found for the fat or ether extract in the second series seems to be an exception, being much higher than the maximum given by Jordan and Hall for this constituent of the hays, but the coefficients found for the three sheep are in much closer agreement than we usually find to be the case in this work. With this exception we find in both series a very marked tendency toward lower coefficients than other experimenters have found—a result which was specifically mentioned in connection with the coefficients found for corn fodder.

NATIVE HAY.

Fodder Fed Sheep No. 4.

Weight of fodder received in five days, 4394.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.13	10.64	3.13	6.98	31.38	42.74

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4168.56	467.54	137.53	306.71	1388.12	1878.23

Orts, air dried, weighed 839.5 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.22	9.84	3.05	6.09	31.34	44.46

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
795.68	82.60	25.60	51.12	263.01	373.23

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4168.56	467.54	137.53	306.71	1388.12	1878.23
Less orts	795.68	82.60	25.60	51.12	263.01	373.23
Consumed	3372.88	384.94	111.93	255.59	1125.11	1505.00

Feces.

Air dried feces weighed 1643.8 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.03	12.92	5.12	5.78	27.99	42.16

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1544.68	212.31	84.16	95.01	406.19	693.04

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3372.88	384.94	111.93	255.59	1125.11	1505.00
Voided	1544.68	212.31	84.16	95.01	406.19	693.04
Digested	1828.20	172.61	27.74	160.58	664.92	812.96
Co-efficients or percentages digested	**54.20**	**44.88**	**22.10**	**62.83**	**59.09**	**54.02**

Weight of sheep at beginning of experiment 50.0 pounds.
Weight of sheep at end of experiment 50.5 pounds.
Daily consumption of dry matter equalled 3.0 per cent of the animals weight.

NATIVE HAY.

Fodder Fed Sheep No. 5.

Weight of fodder received in five days, 4394.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.13	10.64	3.13	6.98	31.38	42.74

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4168.56	467.54	137.53	306.71	1388.12	1878.23

Orts, air dried, weighed 954.5 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.06	7.69	2.99	5.41	33.32	45.53

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
906.21	73.40	28.53	51.63	318.01	434.51

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4168.56	467.54	137.53	306.71	1388.12	1878.23
Less orts	906.21	73.40	28.53	51.63	318.01	434.51
Consumed	3262.35	394.14	109.00	255.08	1070.11	1443.72

Feces.

Air dried feces weighed 1766.4 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.91	13.42	5.17	5.48	28.12	41.90

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1642.09	237.02	91.32	96.79	496.78	740.14

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3262.35	394.14	109.00	255.08	1070.11	1443.72
Voided	1642.09	237.02	91.32	96.79	496.78	740.14
Digested	1620.26	157.12	17.68	158.29	573.33	703.58
Co-efficients or percentages digested	**46.60**	**39.76**	**16.22**	**62.06**	**53.58**	**48.74**

Weight of sheep at begining of the experiment 50.0 pounds.
Weight of sheep at the end of the experiment 50.5 pounds.
Daily consumption of dry matter equalled 2.9 per cent of the animals weight.

NATIVE HAY.

Fodder Fed Sheep No. 6.

Weight of fodder received in five days, 4394.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.13	10.64	3.13	6.98	31.38	42.74

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4168.56	467.54	137.53	306.71	1388.12	1878.23

Orts, air dried, weighed 803.3 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.23	9.93	2.60	6.09	31.40	44.65

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
761.29	79.76	20.88	48.93	252.22	358.62

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4168.56	467.57	137.53	306.71	1388.12	1878.23
Less orts	761.29	79.76	20.88	48.93	252.22	358.62
Consumed	3407.27	387.78	116.65	257.78	1135.90	1519.61

Feces.

Air dried feces weighed 1783.0 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.96	12.41	5.02	5.48	29.29	41.84

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1676.78	221.21	89.50	97.71	522.26	746.01

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3407.27	387.78	116.73	257.78	1135.90	1519.61
Voided	1676.78	221.21	89.50	97.71	522.26	746.01
Digested	1730.49	166.57	27.23	160.07	613.64	773.60
Co-efficients or percentages digested	**50.79**	**42.95**	**23.33**	**62.09**	**54.02**	**51.09**

Weight of sheep at the beginning of the experiment 45.0 pounds.
Weight of sheep at the end of the experiment 47.5 pounds.
Daily consumption of dry matter equalled 3.3 per cent of the animals weight.

The Average Digestion Co-efficients for Native Hay.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 4	**54.20**	**44.84**	**22.10**	**62.83**	**59.09**	**54.02**
Sheep No. 5	**46.60**	**39.76**	**16.22**	**62.06**	**53.58**	**48.78**
Sheep No. 6	**50.79**	**42.95**	**23.33**	**62.09**	**54.02**	**51.09**
Average	**50.53**	**42.52**	**20.55**	**62.33**	**55.56**	**51.30**

I have stated in connection with the first series of experiments that I know of no data really applicable to this, which we designate as native hay.

The coefficients found for these two hays with which I have experimented agree fairly well, with the exception of those found for the ether extract, which are very far apart. The hays were composed of different grasses and were grown in localities twenty-two miles apart. The average coefficients found in the first series of experiments were as follows:

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
59.78	43.32	47.09	60.90	61.36	62.01

This hay seems to have been a decidedly more digestible one than that used in the second series. The grass constituting the greater part of that used in the second experiment was Colorado blue stem, *Agropyron tenerum*.

SORGHUM FODDER.

Fodder Fed Sheep No. 1.

Weight of fodder received in five days, 4441.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.75	8.17	1.55	5.80	23.26	55.47

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4185.68	371.21	68.83	258.51	1055.45	2019.45

Orts, air dried, weighed 482.3 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.37	10.19	1.29	4.97	28.43	48.75

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
457.95	38.95	4.93	19.00	108.61	186.31

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4185.68	371.21	68.83	258.51	1055.45	2019.45
Less orts	457.95	38.95	4.93	19.00	108.61	186.31
Consumed	3727.73	332.26	63.70	239.51	946.84	1833.14

Feces.

Air dried feces weighed 1698.8 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.80	11.46	1.28	8.48	28.16	43.82

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1583.24	194.61	21.74	144.02	478.34	744.47

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3727.73	332.26	63.70	239.51	946.84	1833.14
Voided	1583.24	194.61	21.74	144.02	478.34	744.47
Digested	2144.49	137.65	41.96	95.49	468.50	1088.67
Co-efficients or percentages digested	**57.53**	**41.43**	**65.87**	**39.87**	**49.38**	**59.39**

Weight of the sheep at the beginning of the experiment 53.5 pounds.
Weight of the sheep at the end of the experiment 50.5 pounds.
Daily consumption of dry mattr equalled 3.1 per cent of the animals weight.

SORGHUM FODDER.

Fodder Fed Sheep No. 2.

Weight of fodder received in five days, 4441.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.75	8.17	1.55	5.80	23.26	55.47

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4185.68	371.21	68.83	258.51	1055.45	2019.45

Orts, air dried, weighed 890.8 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
8.09	8.35	1.25	4.55	25.14	52.62

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
818.74	74.38	11.13	40.53	223.92	468.73

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4185.68	371.21	68.83	258.51	1055.45	2019.45
Less orts	818.74	74.38	11.13	40.53	223.92	468.73
Consumed	3366.94	296.83	57.70	217.98	732.53	1550.72

Feces.

Air dried feces weighed 1502.1 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.42	11.15	1.47	8.38	28.18	44.40

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1405.65	167.41	22.08	125.81	423.35	666.91

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3366.94	296.83	57.70	217.98	732.53	1550.72
Voided	1405.65	167.41	22.08	125.81	423.35	666.91
Digested	1961.29	129.42	35.62	92.17	309.18	883.81
Co-efficients or percentages digested	**58.22**	**43.60**	**61.73**	**42.28**	**42.21**	**56.99**

Weight of the sheep at the beginning of the experiment 49.5 pounds.
Weight of the sheep at the end of the experimnt 47.0 pounds.
Daily consumption of dry matter equalled 3.0 per cent of the animal's weight.

SORGHUM FODDER.

Fodder Fed Sheep No. 3.

Weight of fodder received in five days, 4441.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.75	8.17	1.55	5.80	23.26	55.47

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
4185.68	371.21	68.83	258.51	1055.45	2019.45

Orts, air dried, weighed 375.6 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
8.26	10.54	1.27	4.70	24.76	50.47

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
344.58	39.58	4.77	17.65	92.99	185.22

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	4185.68	371.21	68.83	258.51	1055.45	2019.45
Less orts	344.58	39.58	4.77	17.65	92.99	185.22
Consumed	3841.10	331.63	64.06	240.86	962.46	1834.23

Feces.

Air dried feces weighed 1648.4 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.66	11.57	1.44	8.69	28.77	41.07

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
1550.61	169.81	21.14	127.61	422.42	608.93

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	3841.10	331.63	64.06	240.86	962.46	1834.23
Voided	1550.61	169.81	21.14	127.61	422.42	608.93
Digested	2290.49	161.82	42.92	113.25	540.04	1225.30
Co-efficients or percentages digested	**59.63**	**48.80**	**67.00**	**47.02**	**56.11**	**66.86**

Weight of the sheep at the beginning of the experiment 56.0 pounds.
Weight of the sheep at the end of the experiment 53.0 pounds.
Daily consumption of dry matter equalled 3.0 per cent of the animal's weight.

Average Co-efficients for Sorghum Fodder.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 1	**57.53**	**41.43**	**65.87**	**39.87**	**49.38**	**59.39**
Sheep No. 2	**58.22**	**43.60**	**61.73**	**42.28**	**42.21**	**56.99**
Sheep No. 3	**59.63**	**48.80**	**67.00**	**47.02**	**56.11**	**66.80**
Average	**58.46**	**44.61**	**64.87**	**43.06**	**49.23**	**61.06**

There are but few recorded experiments upon the digestibility of sorghum fodder. The following is quoted by Jordan and Hall from the publications of the North Carolina Station—two experiments with sorghum fodder (pulled from Back African and Collier canes):

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
First, with goat	59.89	17.64	47.14	59.46	64.88	62.53
Second, with cow	66.29	41.31	46.25	62.20	75.88	66.55

There is a record of two experiments by the Texas Station, but the fodder was cut in dough state and fed green. This fact would make but little difference, provided the fodder was cut at the same period of development and the fodder retained its feeding qualities unmodified by keeping, especially when exposed to alternations of freezing and warm weather. These experiments were made with cows and gave the following results:

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
73.3	43.8	81.6	56.7	75.0	78.2
73.1	39.5	81.3	51.1	74.0	78.7
Average 73.2	41.6	81.4	53.4	74.5	78.3

The coefficients are very varying, but represent different fodders. I used one cut in the latter part of September and kept, as the most of our fodders are kept, in shock until used. The time of my experiment also corresponded to that at which this fodder would be used, so the results represent as nearly as possible the value of this fodder to the stockmen of the eastern part of the state. Considering that the North Carolina experiments were made with pulled fodder, blades and tops, while mine were made with the whole plant, it seems that the results obtained in my experiments

have really lost nothing of their general value, from the fact that the experiments were made with regard to special conditions.

I am inclined to doubt the claim which is sometimes urged against this fodder, that it changes rapidly, losing its feeding qualities. One must admit, however, that the coefficients given by the Texas Station experiments show a much higher degree of digestibility than either those of the North Carolina Station or my own. My experiments show that a large amount of dry matter was eaten per thousand of live weight, i. e., 30 to 31 pounds. The animals ate it freely enough, but each of the animals lost weight while feeding upon it. The aggregate loss was 7.5 pounds in five days; so that neither the coefficients found nor the weights of the animals at the end of the experiments indicate any great value for such sorghum fodder.

The animals fed upon it well, as the amount left as orts as well as the large amount of dry matter consumed indicate, and, so far as we could observe, they suffered no inconvenience from their being kept upon it as an exclusive diet for 12 days.

The variety of sorghum was Minnesota Early Amber, grown on sandy loam; sown May 10, cut September 15, stood in shock until following March. Weight of crop not given.

SALT BUSH. Atriplex Argentea.

Fodder Fed Sheep No. 4.

Weight of fodder received in five days, 6422.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.32	19.28	1.46	9.73	27.33	36.38

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
6080.38	1238.62	93.76	624.82	1755.75	2368.23

Orts, air dried, weighed 1547.0 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.24	15.61	1.07	7.23	39.57	30.28

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract
1450.47	241.41	16.55	111.82	612.12	468.43

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	6080.38	1238.62	93.76	624.82	1755.75	2368.23
Less orts	1450.47	241.41	16.55	111.82	612.12	468.43
Consumed	4629.91	997.21	77.21	513.00	1143.67	1899.80

Feces.

Air dried feces weighed 2655.1 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.53	10.53	1.32	6.27	40.44	34.91

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2481.78	279.51	35.04	166.41	1073.14	926.81

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	4629.91	997.21	77.21	513.00	1143.67	1899.80
Voided	2481.78	279.51	35.04	166.41	1073.14	926.81
Digested	2148.13	717.70	42.17	346.59	70.53	972.99
Co-efficients or percentages digested	**46.40**	**71.97**	**54.62**	**67.56**	**6.02**	**51.21**

Weight of the sheep at the beginning of the experiment 52.0 pounds.
Weight of sheep at the end of the experiment 50.0 pounds.
Daily consumption of dry matter equalled 3.9 per cent of the animal's weight.

SALT BUSH. Atriplex Argentea.

Fodder Fed Sheep No. 5.

Weight of fodder received in five days, 6422.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.32	19.28	1.46	9.73	27.33	36.38

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
6080.38	1238.62	93.76	624.82	1755.75	2368.23

Orts, air dried, weighed 761.0 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.84	13.96	1.16	7.18	40.17	31.69

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
716.56	106.23	8.83	54.63	305.61	241.11

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	6080.38	1238.62	93.76	624.82	1755.75	2368.23
Less orts	716.56	106.23	8.83	54.63	305.61	241.11
Consumed	5363.82	1132.39	84.93	570.19	1450.14	2127.12

Feces.

Air dried feces weighed 3102.1 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
6.36	10.18	1.37	6.49	38.66	37.01

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2904.89	315.71	42.50	201.34	1227.48	1148.11

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5363.82	1132.39	84.93	570.19	1450.14	2127.12
Voided	2904.89	315.71	42.50	201.34	1227.48	1148.11
Digested	2458.93	816.68	42.43	368.85	222.66	979.01
Co-efficients or percentages digested	**45.84**	**72.12**	**49.95**	**64.69**	**15.35**	**46.03**

Weight of sheep at the beginning of the experiment 58.0 pounds.
Weight of sheep at the end of the experiment 52.0 pounds.
Daily consumption of dry matter equalled 4.1 per cent of the animal's weight.

SALT BUSH. Atriplex Argentea.

Fodder Fed Sheep No. 6.

Weight of fodder received in five days, 6422.0 grams.

Analysis of Fodder.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.32	19.28	1.46	9.73	27.33	36.38

Fodder Constituents Fed, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
6080.38	1238.62	93.76	624.82	1755.75	2368.23

Orts, air dried, weighed 870.1 grams.

Analysis of Orts.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.57	14.88	0.99	6.42	42.32	29.82

Fodder Constituents Contained in the Orts, in Grams.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
821.46	129.41	8.61	55.86	368.24	259.41

Fodder Constituents Consumed, in Grams.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Fed	6080.38	1238.62	93.76	624.82	1755.75	2368.23
Less orts	821.46	129.41	8.61	55.86	368.24	259.41
Consumed	5258.92	1109.21	85.15	568.96	1387.51	2108.82

Feces.

Air dried feces weighed 2979.6 grams.

Analysis of Feces.

Moisture.	Ash.	Fat.	Protein.	Fibre.	Extract.
5.58	10.87	1.36	6.34	40.61	35.24

Fodder Constituents Voided.

Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
2813.48	326.62	40.49	188.71	1369.10	1049.27

Fodder Constituents Digested.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Consumed	5258.92	1109.21	85.15	568.96	1387.51	2108.82
Voided	2813.48	326.62	40.49	188.71	1369.10	1049.27
Digested	2445.44	782.50	44.66	380.25	48.41	1059.55
Co-efficients or percentages digested	**46.50**	**70.55**	**52.45**	**66.83**	**3.49**	**50.24**

Weight of the sheep at the beginning of the experiment 47.5 pounds.
Weight of the sheep at the end of the experiment 47.0 pounds.
Daily consumption of dry matter equalled 4.9 per cent of the animal's weight.

The Average Co-efficients of Salt Bush. Atriplex argentea.

	Dry Matter.	Ash.	Fat.	Protein.	Fibre.	Extract.
Sheep No. 4	**46.40**	**71.97**	**54.62**	**67.56**	**6.02**	**51.21**
Sheep No. 5	**45.84**	**72.12**	**49.95**	**64.69**	**15.35**	**46.03**
Sheep No. 6	**46.50**	**70.55**	**52.45**	**66.83**	**3.49**	**50.24**
Average	**46.25**	**71.55**	**52.34**	**66.36**	**8.29**	**49.16**

No data on the subject of the fodder value of the native salt bushes have come to my knowledge, so there are no results with which to compare these obtained with *Atriplex argentea.*

This salt bush is not to be mistaken for the Australian salt bush, *Atriplex semibaccata*, which plant differs materially from *Atriplex argentea.* The Australian salt bush has, I believe, been recommended by the California Station as a forage plant in alkali soils. I have made two preliminary tests with this plant, with results showing it to be better as it grows with us than the native silvery salt bush, but not a real good fodder. It probably would be a good plant for trial in the eastern part of the state where this silvery one grows. The Australian salt bush is an annual with us, which seeds itself abundantly.

The average digestion coefficients as found in these experiments with the silvery salt bush present some rather striking features. The coefficient for the dry matter is low, but it is evident that this must be the case when we observe that the crude fibre, constituting over one-quarter of the weight of the hay, is so good as indigestible.

The coefficient found for the nitrogen free extract is also low, but approaches the coefficients found for this constituent in hays, being, in fact, higher than in some of them. The ash in this plant is very abundant and its coefficient of digestion, 71.55,

is very high. The effect of this fodder upon the animals was very marked. The animals seemed to suffer no inconvenience, they looked as bright and contented as usual and chewed their cuds freely. There was no laxative, but a very marked diuretic action observed. I regret that I was not provided with facilities for collecting the urine. It would be interesting to know the amount voided and its nitrogen content. The water drunk daily by the same sheep varied from 1.5 to 4.5 pounds when fed native hay and a little salt, but this amount of water was increased to 10.5 to 15.0 pounds when they were fed on the salt bush and salt was withheld. Sheep No. 5 drank from 1.5 to 3.0 pounds of water when fed on native hay, but drank from 12 to 14 pounds daily when fed on the salt bush; but No. 6 drank the maximum quanties of water, from 13 to 15 pounds. There is no proof that the excessive amount of urine voided was due to the specific action of any substance contained in the plant, and it seems rather more probable that the large amount of saline matter taken into the system, 782.59 grams, a trifle over five ounces daily, provoked an intense thirst, as indicated by their drinking from three to eight times the amount of water usually drank by these individual animals, which flooded the system and had to be voided.

The weather at the time, the first week in June, was fine, the temperature of the water drank 13 deg.–14 deg. C.

Had the weather been cold and stormy and the water which the animal drank very cold, the results would have been less favorable than those observed. It must be kept in mind that this hay was put up for the purpose of feeding it to animals, already reduced in flesh and vitality, to take them over stormy periods. The general result of the experiment is not encouraging.

Some of the fodder constituents, the protein, for instance, show a comparatively good coefficient and there is a fair amount of it contained in the fodder. The same is true of the nitrogen free extract. The coefficient for the fat is good and compared with other plants there is a fair amount of it, but these good features of the salt bush as a fodder plant are offset by this thirst provoking and diuretic effect, whether the latter is consequent upon the former or not. I omit the composition of the ash in the hay and the feces, but may take it up in a later bulletin.

This bulletin is already longer than I desired it to be, and as each set of experiments summarizes itself I will not recapitulate the results here.

This bulletin will be followed very shortly by another, in which I shall take up some subjects omitted in this, i. e., the digestibility of the various extracts, alcoholic, aqueous, etc., together with the digestibility of the pentosans occurring in these fodders.

All of these hays and fodders have been cured and preserved

under Colorado conditions, and the animals used were the average grade of sheep fattened by the hundred thousand in this valley. Our results are as representative of our fodders and conditions as they can be made.

The coefficients found are not only lower than those usually given, but are lower than those given by investigators experimenting under very similar conditions. I have exercised every care to obtain correct results, and I believe that the coefficients of our fodders actually have a lower value than is usually given for the same fodders elsewhere.

Our fodders are seldom preserved under cover, but in stacks or shocks out of which they usually come as green, bright, attractive looking hays and fodders. They have, however, been exposed to our changes of temperature, our dry air and continuously strong light.

I believe that the results recorded in this bulletin are very close to the facts and would tentatively suggest that the coefficients of digestion for our hays and fodders are lower than the coefficients shown by the same fodders elsewhere. I do not know the reason for this, but believe that the manner of preserving the fodders, together with our climatic conditions, may account for it.

SUMMARY.

The average coefficients of digestibility found for corn fodder—a variety of dent corn—sown thickly and cut quite immature were: Dry Matter, 58.56; Ash, 42.84; Fat, 45.91, Protein, 47.38; Crude Fibre, 67.87; Nitrogen Free Extract, 57.60. The average coefficients given by Jordan and Hall for the immature fodder are: Dry Matter, 63.9; Ash, 37.2; Fat, 72.2; Protein, 51.7; Crude Fibre, 66.0; Nitrogen Free Extract, 66.2.

The second experiment with corn fodder, dent corn, drilled thinly in rows, cut August 20, some ears matured corn which were husked out before cutting to be fed, gave the following: Dry Matter, 56.66; Ash, 43.64; Fat, 66.08; Protein, 36.04; Crude Fibre, 56.71; Nitrogen Free Extract, 60.60. Jordan and Hall give the following coefficients for dent and flint corn (mature): Dry Matter, 68.2; Ash, 30.6; Fat, 73.9; Protein, 56.1; Crude Fibre, 55.8; Nitrogen Free Extract, 72.2.

It will be noticed that our coefficients are lower than the quoted ones, which are averages.

The average coefficients obtained for alfalfa hay in the first series of experiments were: Dry Matter, 52.04; Ash, 45.65; Fat, 90.85; Protein, 66.69; Crude Fibre, 47.76; Nitrogen Free Extract, 56.69.

The sample of hay used in this experiment contained an unusually low percentage of ether extract, 0.80, and was not a first-class hay, neither was it a decidedly inferior hay.

The second experiment in which a prime, first cutting hay was used gave the following: Dry Matter, 63.95; Ash, 57.67; Fat, 29.86; Protein, 72.54; Crude Fibre, 49.93; Nitrogen Free Extract, 72.89. The animals used in the first experiment were mature sheep probably 4 years old; those used in the second were young sheep, so-called Mexican lambs, about 1 year old.

The average digestion coefficients of first cutting alfalfa hay, which I obtain by using all the data available at this time, not including my own, are: Dry Matter, 61.00; Ash, 51.58; Fat, 53.81; Protein, 74.40; Crude Fibre, 47.11; Nitrogen Free Extract, 72.49.

There is here a substantial uniformity except in the case of the coefficient for the fat or ether extract, which we hold to be of little or no value, which is emphasized by the extreme results obtained in the first series of experiments. See remarks at conclusion of first series of experiments.

We mean to indicate by the negative sign that there was 90.85 per cent. more fat, ether extract, in the feces than in the hay eaten.

Native hay is seldom composed of the same mixture of grasses even if cut from the same ground, but in different years. It is therefore difficult to obtain comparable samples.

We obtained for a sample grown in the neighborhood of Fort Collins the following coefficients: Dry Matter, 59.78; Ash, 43.32; Fat, 47.09; Protein, 60.90; Crude Fibre, 61.36; Nitrogen Free Extract, 62.01; and for another sample grown in the Box Elder Valley about 23 miles north of the Poudre Valley the following: Dry Matter, 50.53; Ash, 42.52; Fat, 20.55; Protein, 62.33; Crude Fibre, 55.56; Nitrogen Free Extract, 51.30. The hay used in the second series of experiments seems to have been a decidedly less digestible one than that used in the first experiment; it represented a different mixture of grasses, the former consisting largely of Colorado blue stem.

Jordan and Hall give for meadow hay, with which our "native hay" is possibly more nearly comparable than with any other fodder, the following: Dry Matter, 54.3; Ash, 29.4; Fat, 44.7; Protein, 63.4; Crude Fibre, 54.5; Nitrogen Free Extract, 55.9.

Timothy hay is grown in large quantity in some of our mountainous districts and is of superior quality. We obtained as digestion coefficients for this hay, in the first series: Dry Matter, 56.71; Ash, 34.14; Fat, 31.88; Protein, 58.37; Crude Fibre, 54.61; Nitrogen Free Extract, 62.80. In the second series: Dry Matter, 51.03; Ash, 65.63; Fat, 69.32; Protein, 43.35; Crude Fibre, 36.08; Nitrogen Free Extract, 54.99.

These samples differed as much from one another as any two samples which we might purchase in the market would be likely to differ, as the second was purchased two years subsequent to the first and both would be properly classed as prime timothy hay.

Jordan and Hall gave the average digestion coefficients for timothy hay before and in bloom as: Dry Matter, 60.7; Ash 44.2; Fat, 58.4; Protein, 56.8; Crude Fibre, 58.8; Nitrogen Free Extract, 64.3. For timothy hay past bloom: Dry Matter, 53.4; Ash, 30.3; Fat, 51.9; Protein, 45.1; Crude Fibre, 47.1; Nitrogen Free Extract, 60.4.

The differences are marked in some instances but the agreement is as great as we have any right to expect.

The native hays are highly esteemed as feed for horses, commanding the same price in the market as timothy hay. If there is any choice the native hay receives the preference, while both are prefered before alfalfa, especially for livery and road animals. The results with the sheep are interesting in this connection. The fodders were fed alone, there was no mixed ration, but the sheep made a gain of 3 pounds each when fed alfalfa, the timothy scarcely maintained their weight, one sheep gained ½ pound, one sheep lost ½ pound and one lost 1 pound. The native hay makes a somewhat better showing as a fodder for sheep, two sheep gained ½ pound each, while the third one gained 2½ pounds in five days.

The result which will appeal to the public as most striking, so far as a digestion experiment can be depended upon to indicate the value of a fodder, is that obtained with the corn fodder. This fodder was not shredded, but simply cut as fine as we could conveniently cut it with a hand cutter, neither was it prepared in any manner, being fed dry, and yet the sheep showed a gain of 2 pounds, 1 pound and ½ pound respectively in the five days and the dry matter consumed per 100 weight of animal was less than of the other fodders.

The average digestion coefficients found for sorghum is for a fodder held until the spring of the year. The question which I had in mind when I undertook this particular experiment was what can our ranchmen in the eastern part of the state grow as a fodder to feed their cattle during the severe storms of late winter and spring when it is often necessary to tide the animals over trying periods. Sorghum promises to yield them as much fodder under their conditions as any other forage plant. The fodder, if it is used at all, must be shocked and kept till late winter or spring. It might have greater value if fed in the fall or early winter, but the experiments with it gave disappointing results so far as its feeding value was concerned, the sheep losing 3, 2.5 and 3 pounds respectively in five days.

The average digestion coefficients obtained were: Dry Matter, 58.46; Ash, 44.61; Fat, 64.87; Protein, 43.06; Crude Fibre, 49.23; Nitrogen Free Extract, 61.06.

There are but few recorded digestion experiments with sorghum fodder. An experiment with a goat gave the following: Dry Matter, 59.88; Ash, 17.64; Fat, 47.14; Protein, 59.46; Crude Fibre, 64.88; Nitrogen Free Extract, 62.51.

The salt bush atriplex argentea used by ranchmen in the eastern part of the state yields digestion coefficients as follows: Dry Matter, 46.25; Ash, 71.55; Fat, 52.34; Protein, 66.36; Crude Fibre, 8.29; Nitrogen Free Extract, 49.16.

These coefficients, that for crude fibre and consequently that for the dry matter excepted, are quite favorable, but as a fodder for sheep it is a failure if the weights of the sheep after their 12 days feeding on salt bush can be relied upon. The sheep were weighed at the beginning and end of their last 5 days feeding on this fodder, when we found that they had lost ½, 2 and 6 pounds respectively in this time.

This fodder provoked an intense thirst, the animals drinking from 10½ to 15 pounds of water a day and voiding an immense amount of very ill-smelling urine.

These same animals drank from 1½ to 4½ pounds of water daily when fed on other fodders.

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