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COMPOSITION AND DIGESTIBILITY OF CORN-FODDER AND CORN STOVER.

[For explanations of technical terms and information concerning the uses of food constituents the reader is referred to the appendix to Bulletin No. 43]

In each of the following series of experiments four grade shorthorn steers were employed. They are designated in this Bulletin as No. 1, No. 2, No. 3, and No. 4. They were about two years old and weighed at the beginning and close of the experiments as follows:

TABLE 1. WEIGHT OF STEERS IN POUNDS.

Date.	Steer No. 1.	Steer No. 2.	Steer No. 3.	Steer No. 4.	Average.
February 22, 1897	1018	1038	904	1112	1018
March 27, 1897	1000	1015	885	1126	1007

In general the methods of feeding, collecting, sampling, and analyzing were the same as reported in Bulletin No. 43.

Each experiment was conducted for a period of ten days, after one week of preliminary feeding. Two composite samples were made of feed, of refuse, and of dung from each steer, one set of samples being for a period of four days and the other for a period of six days. Data were thus obtained for determining the digestibility of the foods by each steer for those two consecutive periods, as well as for the full period of ten days.

Digestibility of Corn-Fodder.

In a former series of digestion experiments the digestibility of corn-fodder was studied, but, as stated in the report of that work (Bul. 43, p. 198), the results obtained were not entirely satisfactory. The most probable source of error was found to be the more or less imperfect mastication of the grain by the individual steers. Other slight errors

Table 2. Number of Pounds (both Fresh and Dry) of Corn-fodder Fed, of Refuse, and of Dung, for each Steer; and also the Percentage Composition of the Dry Matter.

	Date.	Amounts, pounds.		Composition of dry matter, percentages.				
	1897.	Fresh substance.	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
Each Steer.								
Feed ..	Feb. 23–26.....	65.25	53.770	5.13	8.11	2.15	20.44	64.17
Feed ..	Feb. 27–March 4 ..	99.25	81.481	5.09	7.90	2.03	21.15	63.83
Steer No. 1.								
Refuse.	Feb. 23–26.....	10.48	7.516	6.21	5.15	.93	38.87	48.84
Refuse.	Feb. 27–March 4 ..	17.91	13.013	6.32	5 23	1.05	38.68	48.72
Dung..	Feb. 24–27.....	81.72	13.833	12.02	15.26	2.29	18.19	52.24
Dung..	Feb. 28–March 5 ..	127.18	22.327	11.36	14.69	2.65	17.74	53.56
Steer No. 2.								
Refuse.	Feb. 23–26.....	21.45	16.983	3.46	9.40	3.21	13.91	70.02
Refuse.	Feb. 27–March 4 ..	29.49	23.189	3.22	8.90	2.91	17.21	67.76
Dung..	Feb. 24–27.....	58.89	10.995	13.68	13.28	1.27	20.93	50.84
Dung..	Feb. 28–March 5 ..	100.78	17.739	13.62	13.48	1.38	21.46	50.06
Steer No. 3.								
Refuse.	Feb. 23–26.....	9.77	7.082	6.84	6.51	1.28	33.97	51.40
Refuse.	Feb. 27–March 4 ..	14.02	10.056	5.91	6.08	1.24	36.34	50.43
Dung..	Feb. 24–27.....	87.64	15.865	11.75	13.88	2.82	20.66	50.89
Dung..	Feb 28–March 5 ..	128.73	23.714	11.52	13.39	2.80	21.91	50.38
Steer No. 4.								
Refuse.	Feb. 23–26.....	14.67	10.858	6.11	5.94	1 19	35.05	51.71
Refuse.	Feb. 27–March 4 ..	21.38	15.873	6.19	5.66	1.07	37.45	49.63
Dung..	Feb. 24–27.....	76.56	14.142	11.88	16.89	2.43	14.88	53.92
Dung..	Feb. 28–March 5 ..	123.33	23.428	11.33	14.38	2.33	15.61	56.35

were evidently caused by irregularities in voiding the dung, and by imperfect methods for obtaining uniform samples of the corn-fodder.

In the following work special precautions were taken to avoid these possible sources of error. In order to obtain uniform samples for feeding and for analysis the ears were all separated from the stover. To avoid as far as possible imperfect mastication of the grain the ears were

ground to corn and cob meal. The stover was run through a cutting machine. To reduce the error due to irregularities in voiding the dung, the length of time occupied by the experiment proper was extended to

TABLE 3. NUMBER OF POUNDS OF EACH NUTRIENT IN THE CORN-FODDER FED, IN THE REFUSE, AND IN THE DUNG, DURING A PERIOD OF FOUR DAYS; AND ALSO THE DIGESTION CO-EFFICIENTS.

	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
STEER NO. 1.						
Corn-fodder fed.....	53.770	2.757	4.361	1.157	10.993	34.502
Amounts refused.....	7.516	.467	.387	.070	2.922	3.670
Amounts eaten.....	46.254	2.290	3.974	1.087	8.071	30.832
Dung excreted.....	13.833	1.663	2.111	.316	2.517	7.226
Amounts digested	32.421	.627	1.863	.771	5.554	23.606
Per cent. digested	**70.09**	**27.38**	**46.88**	**70.93**	**68.81**	**76.56**
STEER NO. 2.						
Corn-fodder fed.....	53.770	2.757	4.361	1.157	10.993	34.502
Amounts refused.....	16.982	.587	1.596	.546	2.363	11.890
Amounts eaten.....	36.788	2.170	2.765	.611	8.630	22.612
Dung excreted.....	10.995	1.504	1.461	.139	2.302	5.589
Amounts digested	25.793	.666	1.304	.472	6.328	17.023
Per cent. digested	**70.11**	**30.69**	**47.16**	**77.25**	**73.33**	**75.28**
STEER NO. 3.						
Corn-fodder fed.....	53.770	2.757	4.361	1.157	10.993	34.502
Amounts refused.....	7.082	.485	.461	.091	2.406	3.639
Amounts eaten.....	46.688	2.272	3.900	1.066	8.587	30.863
Dung excreted.....	15.865	1.864	2.202	.447	3.278	8.074
Amounts digested	30.823	.408	1.698	.619	5.309	22.789
Per cent. digested	**66.02**	**17.96**	**43.54**	**58.07**	**61.83**	**73.84**
STEER NO. 4.						
Corn-fodder fed.....	53.770	2.757	4.361	1.157	10.993	34.502
Amounts refused.....	10.858	.663	.644	.129	3.805	5.617
Amounts eaten.....	42.912	2.094	3.717	1.028	7.188	28.885
Dung excreted.....	14.142	1.681	2.389	.344	2.105	7.623
Amounts digested	28.770	.413	1.328	.684	5.083	21.262
Per cent. digested	**67.04**	**19.72**	**35.73**	**66.54**	**70.72**	**73.61**

ten days. Tables 2, 3, and 4 give the essential data of the experiments with corn-fodder.

Considering the fact that corn-fodder is really not a single uniform food, but a combination of grain and stover, the results obtained are

very satisfactory. Table 5 gives a general summary of the digestion coefficients as obtained from each animal for periods of four days, six days, and also for ten days, together with the averages for each period.

TABLE 4. NUMBER OF POUNDS OF EACH NUTRIENT IN THE CORN-FODDER FED, IN THE REFUSE, AND IN THE DUNG, DURING A PERIOD OF SIX DAYS; AND ALSO THE DIGESTION COEFFICIENT.

	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
STEER NO. 1.						
Corn-fodder fed.....	81.481	4.150	6.437	1.655	17.236	52.003
Amounts refused.....	13.013	.822	.681	.138	5.034	6.338
Amounts eaten.....	68.468	3.328	5.756	1.517	12.202	45.665
Dung excreted.....	22.327	2.536	3.281	.591	3.961	11.958
Amounts digested.....	46.141	.792	2.475	.926	8.241	33.707
Per cent. digested.....	**67.39**	**23.80**	**43.00**	**61.04**	**67.54**	**73.81**
STEER NO. 2.						
Corn-fodder fed.....	81.481	4.150	6.437	1.655	17.236	52.003
Amounts refused...	23.189	.746	2.064	.674	3.992	15.713
Amounts eaten.....	58.292	3.404	4.373	.981	13.244	36.290
Dung excreted.....	17.739	2.415	2.391	.245	3.808	8.880
Amounts digested.....	40.553	.989	1.982	.736	9.436	27.410
Per cent. digested.....	**69.57**	**29.05**	**45.32**	**75.03**	**71.25**	**75.73**
STEER NO. 3						
Corn-fodder fed.....	81.481	4.150	6.437	1.655	17.236	52.003
Amounts refused	10.056	.594	.612	.125	3.655	5.070
Amounts eaten.....	71.425	3.556	5.825	1.530	13.581	46.933
Dung excreted.....	23.714	2.732	3.176	.665	5.196	11.945
Amounts digested.....	47.711	.824	2.649	.865	8.385	34.988
Per cent. digested.....	**66.80**	**23.17**	**45.48**	**56.54**	**61.74**	**74.55**
STEER NO. 4.						
Corn-fodder fed	81.481	4.150	6.437	1.655	17.236	52.003
Amounts refused.....	15.873	.982	.898	.171	5.945	7.877
Amounts eaten.....	65 608	3.168	5.539	1.484	11.291	44.126
Dung excreted.....	23.428	2.655	3.368	.546	3.656	13.203
Amounts digested.....	42.180	.513	2.171	.938	7.635	30.923
Per cent. digested.....	**64 29**	**16.19**	**39.19**	**63.21**	**67.62**	**70.09**

For comparison the average of the four determinations of the digestibility of corn-fodder made in 1895 are also given.

It is observed that, by grinding the ears of corn-fodder to corn and cob meal previous to feeding, the digestibility of the ration is much in-

creased. The digestibility of the total dry matter is increased from 61.5 to 67.5 per cent., making a net increase of 6 per cent. This gain is chiefly in the protein and carbohydrate extract, the digestibility of the protein being increased 6.1 per cent. and that of the carbohydrate extract 8.4 per cent. These two nutrients constitute more than 90 per cent. of the total dry matter of the corn kernel. The experimental data here given confirm the suggestion made in Bulletin No. 43, page 200, that the individual differences in the ability of different animals to digest ordinary corn-fodder are due principally to the more or less incomplete mastication of the kernels.

TABLE 5. DIGESTION COEFFICIENTS FOR CORN-FODDER.

Duration of experiment.	Animals employed.	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
Four days	Steer No. 1	70.1	27.4	46.9	70.9	68.8	76.6
	Steer No. 2	70.1	30.7	47.2	77.3	73.3	75.3
	Steer No. 3	66.0	18.0	43.5	58.1	61.8	73.8
	Steer No. 4	67.0	19.7	35.7	66.5	70.7	73.6
Average of four trials		**68.3**	**23.9**	**43.3**	**68.2**	**68.7**	**74.8**
Six days	Steer No. 1	67.4	23.8	43.0	61.0	67.5	73.8
	Steer No. 2	69.6	29.1	45.3	75.0	71.3	75.5
	Steer No. 3	66.8	23.2	45.5	56.5	61.7	74.8
	Steer No. 4	64.3	16.2	39.2	63.2	67.6	70.1
Average of four trials		**67.0**	**23.1**	**43.3**	**64.0**	**67.0**	**73.5**
Ten days	Steer No. 1	68.5	25.3	44.6	65.2	68.1	74.9
	Steer No. 2	69.8	29.7	46.0	75.9	72.1	75.4
	Steer No. 3	66.5	21.1	44.7	57.2	61.8	74.3
	Steer No. 4	65.4	17.6	37.8	64.6	68.8	71.5
Average of four trials		**67.5**	**23.4**	**43.3**	**65.7**	**67.7**	**74.0**
Average of four trials made in 1895		61.5	19.4	37.2	72.4	66.0	65.6

As the value of corn-fodder as a food-stuff is governed by its digestibility it follows that by grinding the ears to corn and cob meal the value of corn-fodder is increased about 10 per cent., that is, to each 61.5 pounds of digestible matter in ordinary corn-fodder 6 pounds of digestible matter are added by grinding the ears. As the ears constitute only about one-half of the edible portion of corn-fodder (52 per cent. in these experiments), it follows that the nutritive value of ear corn is increased nearly 20 per cent. by grinding. By reference to Bulletin No. 43, page 205, it will be seen that the nutritive value of shelled corn for hogs is increased nearly 10 per cent. by grinding.

Digestibility of Corn Stover.

By *corn stover* is meant corn-fodder less the ears; that is, the stalks with tassels, leaves, and husks, the ears only having been removed. The stover used in these experiments was run through a cutting machine be-

Table 6. Number of Pounds (both fresh and dry) of Corn Stover fed, of Refuse, and of Dung, for each Steer, and also the percentage composition of the Dry Matter.

	Date.	Amounts, pounds.		Composition of dry matter, percentages.				
	1897.	Fresh substance.	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
Steer No. 1.								
Feed....	March 16–19....	63.50	51.936	8.64	6.40	1.04	33.53	50.39
Feed....	March 20–25....	93.00	75.730	8.38	6.36	.99	33.71	50.56
Refuse..	March 16–19....	26.11	19.121	6.85	5.05	.94	38.45	48.71
Refuse..	March 20–25....	33.22	25.128	6.05	4.72	.88	39.58	48.77
Dung....	March 17–20....	79.57	13.559	18.40	10.73	1.21	21.87	47.79
Dung....	March 21–26....	127.10	21.239	17.85	10.65	1.25	22.23	48.02
Steer No. 2.								
Feed....	March 16–19 ...	64.00	52.345	8.64	6.40	1.04	33.53	50.39
Feed....	March 20–25....	90.00	73.094	8.38	6.36	.99	33.71	50.56
Refuse..	March 16–19....	27.66	20.853	6.67	5.24	.91	38.46	48.72
Refuse..	March 20–25....	33.08	25.358	6.12	4.84	.91	39.38	48.75
Dung....	March 17-20....	70.70	12.793	17.99	11.06	1.09	20.98	48.88
Dung....	March 21–26....	103.10	18.940	18.67	11.41	1.27	19.89	48.76
Steer No. 3.								
Feed....	March 16–19....	64.25	52.549	8.64	6.40	1.04	33.53	50.39
Feed....	March 20–25....	95.00	77.154	8.38	6.36	.99	33.71	50.56
Refuse..	March 16–19....	25.53	19.469	6.98	5.48	.85	37.62	49.07
Refuse..	March 20–25....	32.69	25.137	6.35	4.91	.85	38.65	49.24
Dung....	March 17–20....	77.83	14.490	16.08	9.73	1.06	24.75	48.38
Dung....	March 21–26....	117.63	21.830	16.30	10.12	1.14	23.85	48.59
Steer No. 4.								
Feed....	March 16–19....	63.00	51.527	8.64	6.40	1.04	33.53	50.39
Feed...	March 20–25....	96.00	77.966	8.38	6.36	.99	33.71	50.56
Refuse..	March 16–19....	25.19	18.166	6.75	5.01	.87	37.97	49.40
Refuse..	March 20–25....	31.25	23.143	5.98	4.33	.85	39.28	49.56
Dung....	March 17-20....	95.96	13.922	19.19	10.84	1.10	20.77	48.10
Dung....	March 21–26....	165.31	23.600	17.97	11.07	1.10	21.88	47.98

fore it was fed. The essential data from the experiments with corn stover appears in Tables 6, 7, and 8.

Table 9 gives a general summary of the digestion coefficients for corn stover as obtained from each animal for periods of four days, six days, and ten days, and also the average of the four trials for each period. The results obtained are in close agreement with all of the

principal constituents. For comparison the digestibility of corn stover by cattle as determined by the Pennsylvania Experiment Station is given in Table 10 (See Pa. Exp. Sta. Bul. No. 3).

The average digestibility of the total dry matter is 62.0 per cent,

TABLE 7. NUMBER OF POUNDS OF EACH NUTRIENT IN THE CORN STOVER FED, IN THE REFUSE, AND IN THE DUNG, DURING A PERIOD OF FOUR DAYS; AND ALSO THE DIGESTION COEFFICIENTS.

	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract
STEER NO. 1.						
Corn stover fed.....	51.936	4.486	3.326	.542	17.413	26.169
Amounts refused.....	19.121	1.309	.965	.180	7.353	9.314
Amounts eaten.....	32.815	3.177	2.361	.362	10.060	16.855
Dung excreted.....	13.559	2.495	1.455	.163	2.965	6.481
Amounts digested.....	19.256	.682	.906	.199	7.095	10.374
Per cent. digested....	**58.68**	**21.47**	**38.37**	**54.97**	**70.53**	**61.55**
STEER NO. 2.						
Corn stover fed.....	52.345	4.521	3.353	.546	17.550	26.375
Amounts refused	20.853	1.390	1.092	.189	8.019	10.163
Amounts eaten	31.492	3.131	2.261	.357	9.531	16.212
Dung excreted.....	12.793	2.302	1.415	.140	2.684	6.252
Amounts digested.....	18.699	.829	.846	.217	6.847	9.960
Per cent. digested	**59.38**	**26.48**	**37.42**	**60.78**	**71.84**	**61.44**
STEER NO. 3.						
Corn stover fed.....	52.549	4.539	3.365	.548	17.618	26.479
Amounts refused	19.469	1.359	1.068	.166	7.324	9.552
Amounts eaten.....	33.080	3.180	2.297	.382	10.294	16.927
Dung excreted.....	14.490	2.329	1.410	.153	3.586	7.012
Amounts digested.....	18.590	.851	.887	.229	6.708	9.915
Per cent. digested	**56.20**	**26.76**	**38.62**	**59.95**	**65.16**	**58.58**
STEER NO. 4.						
Corn stover fed..	51.527	4.451	3.299	.538	17.275	25.964
Amounts refused	18.166	1.226	.910	.158	6.897	8.975
Amounts eaten.....	33 361	3.225	2.389	.380	10.378	16.989
Dung excreted.....	13.922	2.672	1.509	.153	2.892	6.696
Amounts digested.....	19.439	.553	.880	.227	7.486	10.293
Per cent. digested.....	**58.27**	**17.15**	**36 84**	**59.74**	**72.13**	**60.59**

as determined by the Pennsylvania experiments, while our result gives 58.2 per cent. The average of both is 60.1 per cent. Of the several constituents of the dry matter, the ash, protein, and carbohydrate extract gave higher digestion coefficients in the Pennsylvania experiments, while the fat and fiber show higher coefficients in our results.

TABLE 8. NUMBER OF POUNDS OF EACH NUTRIENT IN THE CORN STOVER FED, IN THE REFUSE, AND IN THE DUNG, DURING A PERIOD OF SIX DAYS; AND ALSO THE DIGESTION COEFFICIENTS.

	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
STEER NO. 1.						
Corn stover fed.....	75.530	6.333	4.807	.747	25.461	38.182
Amounts refused	25.128	1. 519	1.186	.222	9.945	12.256
Amounts eaten.....	50.402	4.814	3.621	.525	15.516	25.926
Dung excreted.....	21.239	3.791	2.263	.266	4.721	10.198
Amounts digested.....	29.163	1.023	1.358	.259	10.795	15.728
Per cent. digested.....	**57.86**	**21.25**	**37.50**	**49.33**	**69.57**	**60.66**
STEER NO. 2.						
Corn stover fed.....	73.094	6.128	4.652	.723	24.640	36.951
Amounts refused.....	25.358	1.553	1.228	.230	9.987	12.360
Amounts eaten.....	47.736	4.575	3.424	.493	14.653	24.591
Dung excreted.....	18.940	3.536	2.161	.240	3.767	9.236
Amounts digested.....	28.796	1.039	1.263	.253	10.886	15.355
Per cent. digested.....	**60.32**	**22.71**	**36.89**	**51.32**	**74.29**	**62.44**
STEER NO. 3.						
Corn stover fed.....	77.154	6.469	4.910	.763	26.009	39.003
Amounts refused.....	25.137	1.595	1.235	.213	9.714	12.380
Amounts eaten.....	52.017	4.874	3.675	.550	16.295	26.623
Dung excreted.....	21.830	3.558	2.210	.248	5.206	10.608
Amounts digested.....	30.187	1.316	1.465	.302	11.089	16.015
Per cent. digested.....	**58.03**	**27.00**	**39.86**	**54.91**	**68.05**	**60.15**
STEER NO. 4.						
Corn stover fed.....	77.966	6.537	4.962	.771	26.282	39.414
Amounts refused.....	23.143	1.384	1.003	.197	9.091	11.468
Amounts eaten.....	54.823	5.153	3.959	.574	17.191	27.946
Dung excreted.....	23.600	4.241	2.613	.260	5.163	11.323
Amounts digested.....	31.223	.912	1.346	.314	12.028	16.623
Per cent. digested.....	**56.95**	**17.17**	**34.00**	**54.70**	**69.97**	**59.48**

TABLE 9. DIGESTION COEFFICIENTS FOR CORN STOVER.

Duration of experiment.	Animals employed.	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
Four days	Steer No. 1	58.7	21.5	38.4	55.0	70.5	61.6
	Steer No. 2	59.4	26.5	37.4	60.8	71.8	61.4
	Steer No. 3	56.2	26.8	38.6	60.0	65.2	58.6
	Steer No. 4	58.3	17.2	36.8	59.7	72.1	60.6
Average of four trials		**58.1**	**23.0**	**37.8**	**58.9**	**69.9**	**60.5**
Six days	Steer No. 1	57.9	21.3	37.5	49.3	69.6	60.7
	Steer No. 2	60.3	22.7	36.9	51.3	74.3	62.4
	Steer No. 3	58.0	27.0	39.9	54.9	68.1	60.2
	Steer No. 4	57.0	17.7	34.0	54.7	70.0	59.5
Average of four trials		**58.3**	**22.2**	**37.1**	**52.6**	**70.5**	**60.7**
Ten days	Steer No. 1	58.2	21.3	37.9	51.6	70.0	61.0
	Steer No. 2	60.0	24.2	37.1	55.3	73.3	62.0
	Steer No. 3	57.3	26.9	39.4	57.0	66.9	59.5
	Steer No 4	57.5	17.5	35.1	56.7	70.8	59.9
Average of four trials		**58.2**	**22.5**	**37.4**	**55.2**	**70.3**	**60.6**

TABLE 10. DIGESTION COEFFICIENTS FOR CORN STOVER.

Duration of experiment.	Animals employed.	Dry matter.	Ash.	Protein.	Fat.	Fiber.	Carbohydrate extract.
Ten days	Steer No. 1	62.0	41.9	49.7	50.5	67.4	64.2
	Steer No. 2	62.4	42.6	49.7	48.1	68.3	64.4
Average of two trials		**62.2**	**42.3**	**49.7**	**49.3**	**67.9**	**64.3**
Ten days	Steer No. 1	62.4	48.9	54.8	54.3	64.9	64.5
	Steer No. 2	61.1	46.2	52.8	55.8	65.2	62.5
Average of two trials		**61.8**	**47.6**	**53.8**	**55.1**	**65.1**	**63.5**
Average for twenty days		**62.0**	**45.0**	**51.8**	**52.2**	**66.5**	**63.9**

SUMMARY.

When the ears are ground to corn and cob meal, corn-fodder shows a higher percentage of digestibility than any other common coarse food stuff, the digestibility of the dry matter being 8 per cent. higher than timothy hay and 14 per cent. higher than clover hay (see Bulletin No. 43, page 205).

The total digestibility of corn-fodder is increased 6 per cent. by grinding the ears to corn and cob meal previous to feeding; while the value of the ears alone is increased nearly 20 per cent. by grinding.

In both its composition and digestibility corn stover closely resembles timothy hay, and the edible portion of the stover has a nutritive value fully equal to that of timothy.

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