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AGRICULTURAL EXPERIMENT STATION

**Digestion Trial With Two Jersey Cows on
Full Ration and on Maintenance**

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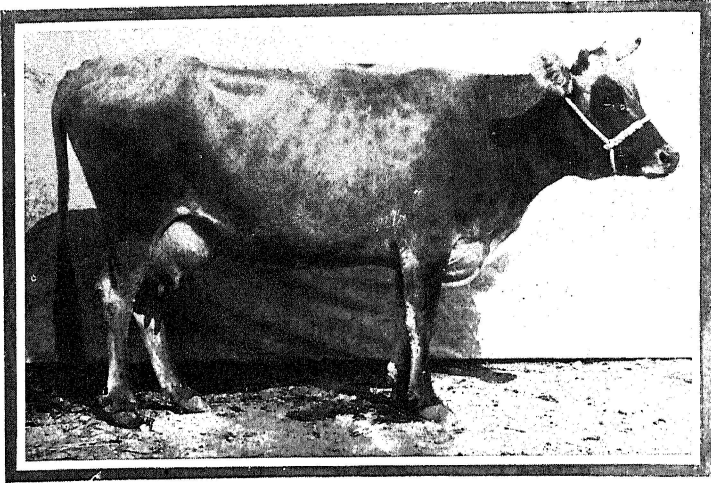
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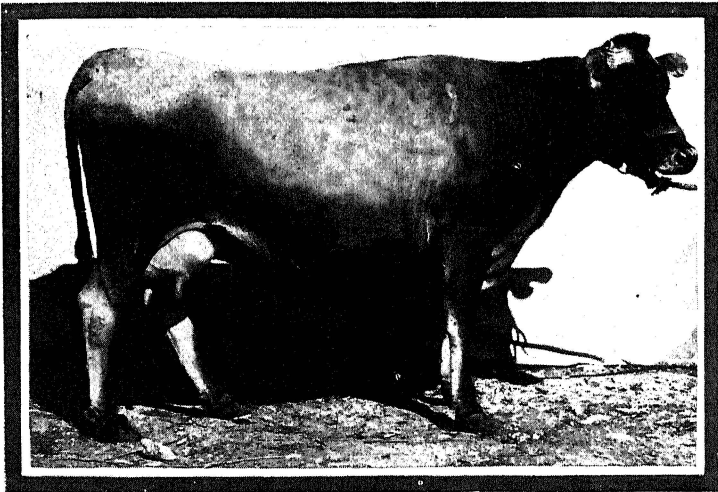
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NO. 27, PEDRO'S RAMAPOSA 181160



NO. 62, PEDRO'S ELF 197242

A DIGESTION TRIAL WITH TWO JERSEY COWS ON FULL RATION AND ON MAINTENANCE.

C. H. ECKLES.

In the course of an investigation already reported¹ digestion trials were conducted with two Jersey cows covering a period of 10 days when on full rations and again when on maintenance. These cows were registered animals known as Pedro's Ramapose 181160 and Pedro's Elf 197242. Table I gives data regarding the history of these animals.

TABLE I.

	No. 27	No. 62
Date of birth.....	Sept. 4, 1902	May 11, 1903
Age at first calving.....	29 mo.	18 mo.
Lbs. Milk first lactation period.....	4552	878
Lbs. fat first lactation period.....	238.8	44.1
No. days in milk.....	337	131
Lbs. milk second lactation period.....	7174	3189
Lbs. fat second lactation period.....	377	114.8
No. days in milk.....	365	232
Lbs. milk third lactation period.....	8522	3188
Lbs. fat third lactation period.....	469.9	169.3
No. days in milk.....	365	321

The first digestion trial covered 10 days beginning December 27, 1907. The chemical work was done under the direction of Dr. P. F. Trowbridge, of the Department of Agricultural Chemistry.

The cows were about three months in milk at the time and practically at their maximum production. The digestion trial was carried out in the usual manner. The grain and hay ration for each day for each animal for the entire period was weighed out at the

¹Research Bulletin No. 2, Mo. Exp. Station.

beginning and a sample taken of each constituent of the ration. It is not possible to do this with the silage since it will not keep outside the silo. For this reason the silage was weighed out from the silo at each feeding and a composite sample for chemical analysis made by taking a small portion at random from each feed and placing it in a tight glass jar in which sufficient chloroform had been placed to prevent spoiling. The cows were kept in the barn and watered in the manner to be followed during the digestion trial for a week preceding, in order that they might be accustomed to the routine.

Three attendants were provided for each cow, working in 8 hour shifts to collect the dung and urine. A common grain shovel was used for the former and a tin vessel about the size of an ordinary milk pail with a wooden handle was used for collecting the urine. None of the excreta was lost during the 10 days covered by the digestion trial.

Table 2 gives the ration received daily by the two animals.

TABLE 2.
RATION FED PER DAY.
Digestion Trial on Full Ration.

	No. 27		No. 62	
	Lbs.	Kilos	Lbs.	Kilos
Alfalfa Hay.....	9.0	4.082	6.0	2.585
Silage.....	35.0	15.875	22.0	10.115
Corn.....	6.28	2.857	4.0	1.814
Bran.....	3.14	1.406	2.0	.907
Oilmeal.....	1.57	.726	1.0	.454

This was the same ration as used throughout the entire investigation of which the digestion trial was one part. It consisted of alfalfa hay of the best quality, corn silage made from well matured corn, and a grain mixture of corn meal 4 parts, wheat bran 2 parts and oilmeal 1 part. The ration of both animals was made up in the same proportion with the only difference being the quantity given which had been adjusted during the several weeks preceding to maintain the cows at uniform weight. It will be noted that No. 27 re-

ceived considerably more than No. 62 which is accounted for by her larger production of milk.

Table 3 gives the chemical analysis and tables 4 and 5 give the amounts of the several constituents in the ration received by the two cows.

TABLE 3.

PERCENTAGE COMPOSITION OF DAILY RATION.
 Digestion Trial December 27, 1907 to January 5, 1908.
 NO. 27 AND NO. 62.

	Dry Matter	Ash	Nitrogen	Protein	Crude Fibre	Nitrogen free Extract	Fat
Alfalfa Hay.	94.16	8.225	2.030	12.68	36.350	35.33	1.560
Silage.	29.29	1.812	.319	1.99	7.082	17.58	.825
Corn.	85.04	1.193	1.275	7.97	1.897	69.99	3.993
Bran.	89.51	6.668	2.328	14.55	8.487	55.05	4.749
Oilmeal.	90.89	5.343	5.498	34.36	7.975	36.47	6.736
Refused.	94.53	7.013	1.461	9.13	41.673	34.77	1.943

TABLE 4.

COMPOSITION OF DAILY RATION FED NO. 27.
 Weights in grams.

	Am't Fed	Dry Matter	Ash	Nitrogen	Protein	Crude Fibre	Nitrogen free Ext.	Fat
Alfalfa Hay.	4082.0	3843.6	335.74	82.86	517.88	1483.81	1442.17	63.68
Corn Silage..	15875.0	4649.7	287.66	50.64	316.50	1124.27	2789.83	130.97
Corn.	2857.0	2429.5	34.08	36.43	227.69	54.20	1999.61	114.08
Bran.	1406.0	1258.5	93.75	32.73	204.56	119.33	774.00	66.67
Oilmeal.	726.0	659.8	38.79	39.93	249.50	57.90	264.77	48.90
Total.	24946.0	12841.1	790.02	242.59	1516.13	2839.51	7270.38	424.30
Refused.	73.2	69.1	5.13	1.06	6.68	30.50	25.45	1.42
Total Rat'n.	24872.8	12772.0	784.89	241.53	1509.45	2809.01	7224.93	422.88

TABLE 5.
COMPOSITION OF DAILY RATION FED NO. 62.
Weights in grams.

	Amt. Fed	Dry Matter	Ash	Nitro- gen	Pro- tein	Crude Fibre	Nitro- gen free Extract	Fat
Alfalfa Hay.....	2585.0	2434.0	212.62	52.48	328.00	939.65	913.28	40.33
Corn Silage... ..	10115.0	2962.6	183.28	32.27	201.69	716.34	1778.21	83.45
Corn.....	1814.0	1542.6	21.64	23.13	144.56	34.41	1269.62	72.43
Bran.....	907.0	811.8	60.48	21.11	131.94	76.98	499.30	43.07
Oilmeal... ..	454.0	412.6	24.26	24.96	156.00	36.21	165.57	30.58
Total.....	15875.0	8163.6	502.28	153.95	962.19	1803.59	4625.98	269.86
Refused... ..	60.7	57.4	4.26	.89	5.54	25.30	21.11	1.18
Total Ration..	15814.3	8106.2	498.02	153.06	956.65	1778.29	4604.87	268.68

Tables 6 and 7 record the amount of milk by milkings for each animal and the totals.

TABLE 6.
YIELD OF MILK AND FAT.
NO. 27.

Date	A. M.			P. M.		
	Lbs. Milk	Per cent Fat	Lbs. Fat	Lbs. Milk	Per cent Fat	Lbs. Fat
Dec. 26.....	.....	.....	.....	12.2	6.0	.7320
27.....	13.7	5.8	.7946	12.4	5.4	.6696
28.....	15.0	5.1	.7650	12.1	4.4	.5324
29.....	16.1	5.0	.8050	11.9	5.6	.6664
30.....	15.2	4.8	.7296	11.3	5.3	.5989
31.....	15.7	4.3	.6751	11.2	5.7	.6384
Jan. 1.....	15.0	5.4	.8100	12.1	5.1	.6171
2.....	14.3	5.1	.7293	12.3	5.3	.6519
3.....	14.3	5.2	.7436	11.7	5.5	.6435
4.....	15.0	5.7	.8550	11.1	4.6	.5106
5.....	15.5	5.2	.8060	.....	.....	.....
	149.8	5.14	7.7132	118.3	5.29	6.2608

TABLE 7.
 YIELD OF MILK AND FAT.
 NO. 62.

Date	A. M.			P. M.		
	Lbs. Milk	Per cent Fat	Lbs. Fat	Lbs. Milk	Per cent Fat	Lbs. Fat
Dec. 26.....				6.1	5.4	.3294
27.....	7.0	5.6	.3920	5.9	5.0	.2950
28.....	5.2	3.1	.1612	8.1	5.8	.4988
29.....	7.7	6.0	.4620	5.6	5.2	.2912
30.....	7.4	4.9	.3626	6.8	4.7	.3196
31.....	7.0	5.6	.3920	6.4	5.6	.3584
Jan. 1.....	7.1	5.1	.3621	5.9	5.0	.2950
2.....	7.2	5.0	.3600	6.2	4.8	.2976
3.....	7.4	5.5	.4070	6.1	4.9	.2989
4.....	6.9	4.6	.3174	5.8	5.5	.3190
5.....	7.2	5.6	.4032	.....	.....	.....
	70.1	5.16	3.62	63.4	5.2	3.30

Table 8 gives the chemical composition of the milk of each cow and the total of each constituent in both pounds and kilos.

TABLE 8.
 COMPOSITION OF MILK.
 NOS. 27 AND 62.

	Percentage Composition		Constituents in Lbs. and Kilos			
	No. 27	No. 62	No. 27		No. 62	
			Lbs.	Kilos	Lbs.	Kilos
Total Milk.....			268.1	120.61	133.5	60.55
Total Nitrogen.....	.63	.64	1.69	.76	.85	.39
Total Protein.....	4.02	4.08	10.78	4.85	5.45	2.47
Fat.....	5.10	5.10	13.67	6.15	6.81	3.09
Sugar.....	5.20	5.20	13.94	6.27	6.94	3.15
Ash.....	.77	.81	2.06	.93	1.08	.49

Table 9 records the daily weights of dung and of urine for each animal and in table 10 is found the result of the analyses.

TABLE 9.

WEIGHTS OF DUNG AND URINE DIGGESTION TRIAL ON FULL RATION.

Date	No. 27		No. 62	
	Weight of fresh dung Kilos	Weight of fresh urine Kilos	Weight of fresh dung Kilos	Weight of fresh urine Kilos
Dec. 27, 1907.....	30.245	8.092	12.854	4.632
Dec. 28, 1907.....	28.011	9.702	15.559	4.390
Dec. 29, 1907.....	30.110	7.159	14.591	4.642
Dec. 30, 1907.....	35.608	8.511	14.599	5.440
Dec. 31, 1907.....	32.728	6.666	14.153	4.626
Jan. 1, 1908..	29.935	8.993	15.044	4.451
Jan. 2, 1908..	31.572	7.589	14.313	4.990
Jan. 3, 1908.....	28.801	6.643	13.973	4.404
Jan. 4, 1908..	26.638	8.607	14.637	5.376
Jan. 5, 1908..	28.237	8.482	14.963	4.648
Average.	30.182	7.999	14.469	4.760

TABLE 10.

ANALYSES OF DUNG AND URINE DIGESTION TRIAL ON FULL RATION.

	Composite Sample		Average of Daily Samples	
	No. 27	No. 62	No. 27	No. 62
Dung				
Dry Matter.....	14.95	19.44	.....	.....
Moisture.....	85.05	80.56	.....	.....
Nitrogen.....	0.33	0.417	0.322	0.425
Protein.....	2.062	2.606	2.013	2.576
Fat.....	0.463	.0746	.....	.....
Crude Fibre.....	4.298	5.666	.....	.....
Ash.....	1.574	2.029	.....	.....
N. free Ex.....	6.552	8.393	.....	.....
Urine				
Dry Matter.....	7.16	8.03	.....	.....
Moisture.....	92.84	91.97	.....	.....
Nitrogen.....	0.799	1.024	0.783	1.036

The nitrogen was determined separately in both dung and urine daily. A composite sample of each was made by placing an amount equal to 1 part in 50 of the total in an air tight jar with sufficient chloroform added to prevent fermentation. The jars were kept in a temperature of about 5° C. The nitrogen determinations of both urine and dung in the composite sample agrees closely with the averages of the daily analyses.

Tables 11 and 12 give the total amounts of the different nutrients consumed, the amount excreted in the dung and the per cent digested. It will be noted here that while there is some difference regarding the digestibility of the different constituents the average figure was almost exactly the same for both animals.

TABLE 11.
SUMMARY RESULTS AVERAGED BY DAYS.
NO. 27.
Weights in grams.

	Consumed	Excreted in Dung	Per cent Digested
Protein.....	1509.44	622.51	58.75
Fat.....	422.88	139.74	66.95
Crude Fibre.....	2809.01	1297.22	53.82
Nitrogen-free Extract.	7224.93	1977.53	72.62
Total.....	11966.26	4037.00	66.27

TABLE 12.
SUMMARY OF RESULTS AVERAGED BY DAYS.
NO. 62.
Weights in grams.

	Consumed	Excreted in Dung	Per cent Digested
Protein.....	956.65	377.13	60.58
Fat.....	268.68	107.94	59.82
Crude Fibre.....	1778.30	819.81	53.89
Nitrogen-free Extract.	4604.87	1214.38	73.62
Total.....	7608.50	2519.26	66.95

Table 13 gives a comparison of the per cent of the several constituents actually digested and the amount that would be digested according to the average digestion coefficients as given by Jordan.¹

¹The Feeding of Animals, p. 427.

TABLE 13

COMPARISON OF AVERAGE AND ACTUAL DIGESTION COEFFICIENTS.

NO. 27 AND NO. 62.

On Full Ration.

	Protein		Crude Fibre		Nitrogen free Extract		Fat	
	Average	Actual	Average	Actual	Average	Actual	Average	Actual
No. 27... ..	70.2	58.75	53.9	53.82	76.6	72.62	78.0	66.95
No. 62.....	70.2	60.58	53.9	53.89	76.6	73.62	78.0	59.82

Using average figures No. 27 should have digested 70.81 per cent of the ration while she digested 66.27 as found by trial.

The figures for No. 62 by average coefficients is 70.79 while by trial the figure was 66.95.

On Maintenance.

	Protein		Crude Fibre		Nitrogen free Extract		Fat	
	Average	Actual	Average	Actual	Average	Actual	Average	Actual
No. 27.....	69.4	67.32	52.7	55.33	74.6	82.12	77.0	73.17
No. 62.....	68.7	65.54	53.8	52.06	75.4	80.99	76.7	73.92

When on maintenance No. 27 digested 73.79 per cent and No. 62 72.19 per cent of the entire ration. The average digestion coefficient for the same ration are 69.1 for No. 27 and 69.7 for No. 62.

The first half of the table gives this comparison for the digestion trial made while the cows were on full ration and the second half for the digestion trial made for the same animals when on maintenance. The columns headed "Average" is the digestion coefficient of this ration calculated by applying average figures of digestibility to the data given in Tables 4 and 5. The columns headed "Actual" gives the coefficient of digestion as actually determined for No. 27 and No.62. When the cows were on full ration it will be noted the coefficient was decidedly lower for both cows than the average with the exception of the crude fibre. The data for the second digestion trial indicates

the same cows on a maintenance ration of the same composition as in the first were able to show a coefficient of digestibility fully as high as the averages ordinarily used. This seems to indicate the depression in the digestion coefficient with both animals when on the full ration was due to the amount of the ration consumed. When both were on maintenance No. 27 had on the whole a higher digestion coefficient than No. 62 while on a full ration the reverse was true. That is, on a full ration when No. 27 was consuming 50% more feed than No. 62 her coefficient of digestion was lower, while when both were dry and farrow she was able to digest a slightly higher per cent of her food. The general tendency of the digestion trials carried on at this Experiment Station with steers by Dr. P. F. Trowbridge the results of which have not as yet been published also indicate that the plane of nutrition has a decided influence on the digestion coefficient.

Since most of the digestion trials upon which the average digestion coefficients are based were made with animals at or near maintenance conditions it is not surprising that animals on full ration are not able to make as good use of the food as those on a lower plane of nutrition. While the results given are entirely too few upon which to base a conclusion it at least is justifiable to raise the question if the digestion coefficients for use in making calculations regarding the feeding of dairy cows should not be determined by using cows that are producing large quantities of milk and for this reason are receiving a heavy ration rather than by making use of coefficients of digestibility from trials with steers under maintenance conditions.

Table 14 gives the nitrogen balance. The outgo of nitrogen in milk, urine and dung agrees closely with that taken in by the food in both animals.

TABLE 14.
DAILY NITROGEN BALANCE.
Weights in grams.

	No. 27	No. 62
Dung.....	99.60	60.34
Urine.....	63.90	48.74
Milk.....	76.00	39.00
Total.....	239.50	148.08
Consumed in Feed.....	241.53	153.06

DIGESTION TRIAL ON MAINTENANCE

Abuut 13 months later, a digestion trial was again made with the same two cows. This time they were dry and farrow. The trial lasted 10 days beginning January 28, 1909. No. 62 had been on maintenance 150 days and No. 27, 90 days at the beginning of this trial. Data regarding the maintenance period is given in detail in another part of this publication. The ration fed the animals was the same as given when in milk at the time of the first trial. The same grain mixture was used and practically the same ratio between the grain, hay and silage was maintained. For each pound of grain, each cow consumed, she also received one pound of alfalfa hay and four pounds of silage. The amount given was of course such as was found by trial during the preceding months to be necessary for maintenance.

Table 15 gives the ration fed and Table 16 the chemical composition of each constituent of the ration.

TABLE 15.

RATION FED PER DAY, DIGESTION TRIAL ON MAINTENANCE.

	No. 27		No. 62	
	Lbs.	Kilos	Lbs.	Kilos
Alfalfa Hay.....	3.2	1.451	2.8	1.270
Silage.....	12.8	5.806	11.2	5.080
Corn.....	1.83	.830	1.6	.726
Bran.....	.91	.415	.8	.363
Oilmeal.....	.46	.207	.4	.181

TABLE 16.

PERCENTAGE COMPOSITION OF RATION FED, DIGESTION TRIAL ON MAINTENANCE.

NO. 27 AND NO. 62.

	Dry Matter	Ash	Nitrogen	Protein	Crude Fibre	N. free Extract	Fat
Alfalfa Hay.	94.21	8.960	2.250	14.06	32.97	35.84	2.380
Silage.	30.192	1.869	.227	1.42	7.00	18.23	1.676
Corn.	94.07	1.190	1.415	8.84	2.03	78.24	3.770
Bran.	90.285	7.293	2.335	14.59	10.25	53.50	4.645
Oilmeal.	93.45	5.540	5.440	34.00	8.03	38.57	7.310

Tables 17 and 18 give the total amounts of each constituent of the ration received by the two cows.

TABLE 17.

COMPOSITION OF RATION, TEN DAYS DIGESTION TRIAL ON MAINTENANCE.

NO. 27.

Weights in grams.

	Dry Matter	Ash	Nitrogen	Protein	Crude Fibre	N. free Extract	Fat
Alfalfa. ...	13674.49	1300.53	326.58	2040.79	4785.56	5202.14	345.45
Silage	17529.49	1085.13	131.80	824.44	4064.17	10584.25	973.08
Corn.	7807.20	98.72	117.39	733.38	168.41	6493.92	312.77
Bran.	3743.04	302.35	96.80	604.87	424.94	2218.00	192.57
Oilmeal ...	1937.13	114.84	112.77	704.79	166.45	799.52	151.53
Total.	44691.55	2901.57	785.34	4908.27	9609.53	25297.86	1975.40

TABLE 18.

COMPOSITION OF RATION, TEN DAYS DIGESTION TRIAL ON MAINTENANCE.

NO. 62.

Weights in grams.

	Dry Matter	Ash	Nitro- gen	Protein	Crude Fibre	N. free Extract	Fat
Alfalfa... ..	11965.14	1137.96	285.76	1786.00	4187.35	4551.86	302.27
Silage.....	15338.14	949.49	115.32	720.75	3556.14	9261.20	851.44
Corn.....	6827.04	86.36	102.69	641.81	147.33	5678.19	273.60
Bran.....	3276.17	264.64	84.73	529.56	371.94	1941.35	168.55
Oilmeal... ..	1695.56	100.52	98.70	616.88	145.69	699.81	132.63
Total.....	39102.05	2538.97	687.20	4295.00	8408.45	22132.41	1728.49

Table 19 gives the weights of dung and urine by days.

TABLE 19.
Weight in pounds.

Date	No. 27		No. 62	
	Weight of fresh dung Kilos	Weight of fresh urine Kilos	Weight of fresh dung Kilos	Weight of fresh urine Kilos
Jan. 29, 1909	6.996	3.683	6.732	3.842
Jan. 30, 1909..	7.471	3.279	5.765	3.847
Jan. 31, 1909..	5.419	2.950	4.851	4.079
Feb. 1, 1909.....	5.905	3.205	4.472	3.742
Feb. 2, 1909.....	6.025	3.609	4.789	3.021
Feb. 3, 1909.....	7.017	3.377	5.073	3.160
Feb. 4, 1909.....	6.528	3.667	5.200	3.163
Feb. 5, 1909.....	6.364	3.277	6.649	3.942
Feb. 6, 1909.....	6.777	3.743	6.010	3.586
Feb. 7, 1909.....	7.765	4.348	6.149	4.305
Average.	6.627	3.514	5.569	3.669

The excreta was handled in the same manner as described for the first trial. Only composite samples were taken in this case since the analyses of the daily and of the composite samples had been found in the first trial to check closely. The analyses of the composite samples of dung and urine is found in Table 20.

TABLE 20.

COMPOSITION OF DUNG AND URINE DIGESTION TRIAL ON MAINTENANCE.

	Composite Sample	
	No. 27	No. 62
Dung		
Dry Matter.....	18.998	20.837
Moisture.....	81.002	79.163
Nitrogen.....	0.387	0.424
Protein.....	2.419	2.650
Fat.....	0.799	.807
Crude Fibre.....	6.473	7.217
Ash.....	2.487	2.630
Nitrogen free Extract.....	6.82	7.531
Urine		
Nitrogen.....	1.523	1.360

The nitrogen balance as given below shows a reasonably close agreement.

	Weights in Grams No. 27	Weights in Grams No. 62
Dung.....	25.65	23.61
Urine.....	53.52	49.90
Total.....	79.17	73.51
Consumed in Feed.....	78.53	68.7

Tables 21 and 22 give a summary of the results of this digestion trial.

TABLE 21.

SUMMARY OF DIGESTION TRIAL ON MAINTENANCE.

NO. 27.

	Consumed Grams	Excreted in Dung		Per cent Digested
		Per cent	Weight Grams	
Protein.....	4908.27	2.419	1604.19	67.32
Fat.....	1975.40	.799	529.92	73.17
Crude Fibre.....	9609.53	6.473	4293.08	55.33
N. free Ex.....	25297.86	6.82	4523.23	82.12
Total.....	41791.06	.....	10950.42	73.79

TABLE 22.

SUMMARY OF DIGESTION TRIAL ON MAINTENANCE.

NO. 62.

	Consumed Grams	Excreted in Dung		Per cent Digested
		Per cent	Weight Grams	
Protein.....	4295.0	2.65	1480.25	65.54
Fat.....	1728.49	.807	450.78	73.92
Crude Fibre.....	8408.45	7.217	4031.34	52.06
N. free Ex.....	22132.41	7.531	4206.18	80.99
Total.....	36564.35	.....	10168.55	72.19

The second column, headed per cent, in both tables refers to the composition of the dung, the weights of which are found in Table 19. The third column is the weight of the constituents excreted and the fourth column the per cent digested. No. 27 shows a higher

per cent of each constituent digested with an average of 7.5 more for the entire ration when on maintenance. No. 62 also has digested a larger per cent of each constituent and an average of 5.24 per cent higher when on maintenance.

Table 23 is included as a matter of interest. It gives the amount of water consumed daily by each cow while on full ration producing and again when dry and on maintenance. It illustrates the increased demands for water by the cow in milk and consuming a large ration.

TABLE 23.

WATER CONSUMED DURING DIGESTION TRIALS.

Weights in Pounds.

Day	No. 27		No. 62	
	First	Second	First	Second
1.....	94	0	68	23
2.....	82	0	30	0
3.....	77	20	37	0
4.....	81	23	43	28
5.....	82	17	30	17
6.....	82	15	46	0
7.....	73	20	32	30
8.....	77	18	46	18
9.....	65	17	40	0
10.....	60	17	29	12
Average.....	77.3	14.7	40.1	12.8

SUMMARY AND CONCLUSIONS.

Complete data is given of a digestion trial made with two Jersey cows when at the maximum yield of milk and repeated with the same animals when dry and on maintenance. The ration used was the same in both trials except in quantity.

When on full ration the per cent digested was lower with both animals and for each constituent of the ration than the average figures in common use.

The cow which received the most liberal ration digested 66.27 per cent of the entire ration. According to the digestion coefficients in common use she should have digested 70.81 per cent. The same cow on maintenance digested 73.79 per cent of the ration. The average figures for the same ration are 69.1 per cent. The second cow receiving about 50 per cent less feed, during the trial when in milk digested 66.95 per cent of the ration. On maintenance the same animal digested 72.19. According to the average figures in use she should have digested 70.79 per cent in the first trial and 69.7 for the second.

These results suggest that the average digestion coefficients in use are somewhat high as applied to cows producing large quantities of milk which requires a heavy ration and that accurate figures for this purpose should be obtained from experiments with cows in milk.