BULLETIN NO. 47. SEPTEMBER, 1897.

OREGON AGRICULTURAL EXPERIMENT STATION.

CHEMICAL-AGRICULTURAL DEPARTMENTS.

THE RELATIVE DIGESTIBILITY

OF

CHEAT AND CLOVER.

BY

G W. SHAW, Chemist, and H. T. FRENCH, Agriculturist.

The Bulletins of this Station are sent free to all residents of Oregon who request them.

AGRICULTURAL COLLEGE PRINTING OFFICE
G. B. KEADY, PRINTER.
1897.

BOARD OF REGENTS.

J. T. APPERSON, President ..... *Oregon City*
W. E. YATES, Secretary ..... *Corvallis*
J. K. WEATHERFORD, Treasurer ..... *Albany*
WM. P. LORD, Governor ..... *Salem*
H. R. KINCAID, Secretary of State ..... *Salem*
G. M. IRWIN, Supt. Public Instruction ..... *Salem*
WM. M. HILLEARY, Master State Grange ..... *Turner*
T. W. DAVENPORT ..... *Silverton*
W. P. KEADY ..... *Portland*
WALLIS NASH ..... *Portland*
BENTON KILLIN ..... *Portland*
JONAS M. CHURCH ..... *La Grande*
SAMUEL HUGHES ..... *Forest Grove*

COMMITTEES.

EXECUTIVE.

SAMUEL HUGHES, Chairman, W. E. YATES, Secretary, J. T. APPERSON, WILLIAM M. HILLEARY, BENTON KILLIN.

FINANCE.

BENTON KILLIN, WM. M. HILLEARY, J. M. CHURCH

AGRICULTURE AND CHEMISTRY.

BENTON KILLIN, WILLIAM M. HILLEARY.

HORTICULTURE AND ENTOMOLOGY.

SAMUEL HUGHES, J. K. WEATHERFORD.

MECHANICS AND HOUSEHOLD ECONOMY.

J. K. WEATHERFORD, SAMUEL HUGHES, WALLIS NASH.

LITERARY DEPARTMENT AND LIBRARY.

WALLIS NASH, T. W. DAVENPORT.

ADVERTISING AND PRINTING.

W. P. KEADY, W. E. YATES.

BUILDINGS AND GROUNDS.

W. E. YATES, J. M. CHURCH.

FARMERS' INSTITUTES.

J. K. WEATHERFORD, W. E. YATES.

OFFICERS OF THE STATION.

THOMAS M. GATCH, A. M., Ph. D. ..... *President and Director*
H. T. FRENCH, M. S. ..... *Agriculturist*
G. W. SHAW, Ph. D. ..... *Chemist*
A. B. CORDLEY, B. S. ..... *Entomologist*
MOSES CRAIG, M. S. ..... *Botanist*
GEO. COOTE ..... *Horticulturist*

RELATIVE DIGESTIBILITY OF CHEAT AND CLOVER HAY.

Much controversy has arisen over the comparative value of Cheat hay. Cheat has long been considered a valuable hay-producing plant throughout the Willamette valley. That it grows well there is little doubt. Many farmers report a yield of three to four tons per acre, and even greater yields are often mentioned. The average yield is about 2½ tons per acre. This portion of the State seems to be the natural habitat for several wild species of *Bromus;* and owing to the certainty with which Cheat may be grown, and the uncertainty which attends the efforts of the farmer in growing other varieties of grasses, it is not strange that Cheat should be retained so tenaciously.

Cheat is a very hardy plant, easily withstanding such vicissitudes of climate as are likely to prevail throughout a large portion of Western Oregon. On low, flat, heavy soil, where water is too abundant during the winter months for other grasses to thrive, Cheat will make a very good growth. It would not be easy to find a grass that can surpass Cheat under these conditions. On the higher portions of the land, or on land which is fairly well drained, there are other varieties of grasses and clovers which may be grown successfully, and which will give much better results when fed to stock.

The question upon which this report is intended to throw more light is not a question of *growing* Cheat, but rather its value as compared with Clover, when fed to cattle.

It is a common practice at present to feed Cheat to dairy cows as well as to all other kinds of stock; and it is with a view of discouraging its growth for dairy stock especially that these facts are presented.

The question of profit is determined more largely if possible, in dairying, than in any other branch of farming, by a proper knowledge of the food supply. It is not a question of quantity altogether, but of quality, and a proper combination of food constituents to produce the best results. The dairy cow is a delicately wrought machine which must not be over worked in consuming a large amount of material that is not needed, in order to get a sufficient supply of that which is essential in the production of milk.

When Cheat is fed to dairy cows the creamery man complains of a lack of milk supply, and this fact implies that the farmer is simply *keeping* his cows without getting proper returns from them. Much is said in these days regarding the yield of butter fat as an indicator of the value of a cow in the dairy; but it is not altogether just to the cow to apply the test before we have learned how to feed her properly. While the food, under normal conditions, will not materially change the per cent. of butter fat in milk, it will materially change the total yield by increasing the flow of milk.

It would not be right to discourage the growth of Cheat unless there is something better with which to replace it. Over a large portion of the

Willamette valley, where Cheat is now grown, Clover can be grown successfully. This has been thoroughly demonstrated on the Experiment Station farm, and we have seen the same results obtained on other farms in this portion of the State.

The two factors entering into the value of a foodstuff are its composition and its digestibility. The first factor is determined by chemical analysis alone. The second is determined either by actual trials with animals, or with artifical digestion fluids made to correspond closely with the digestive fluids of the body. The digestible matter for most of the common cattle foods has been determined by feeding animals for a stated period upon food whose composition has been previously determined by analysis. The material so used is weighed and the excreta of the animal carefully collected, weighed and analyzed.

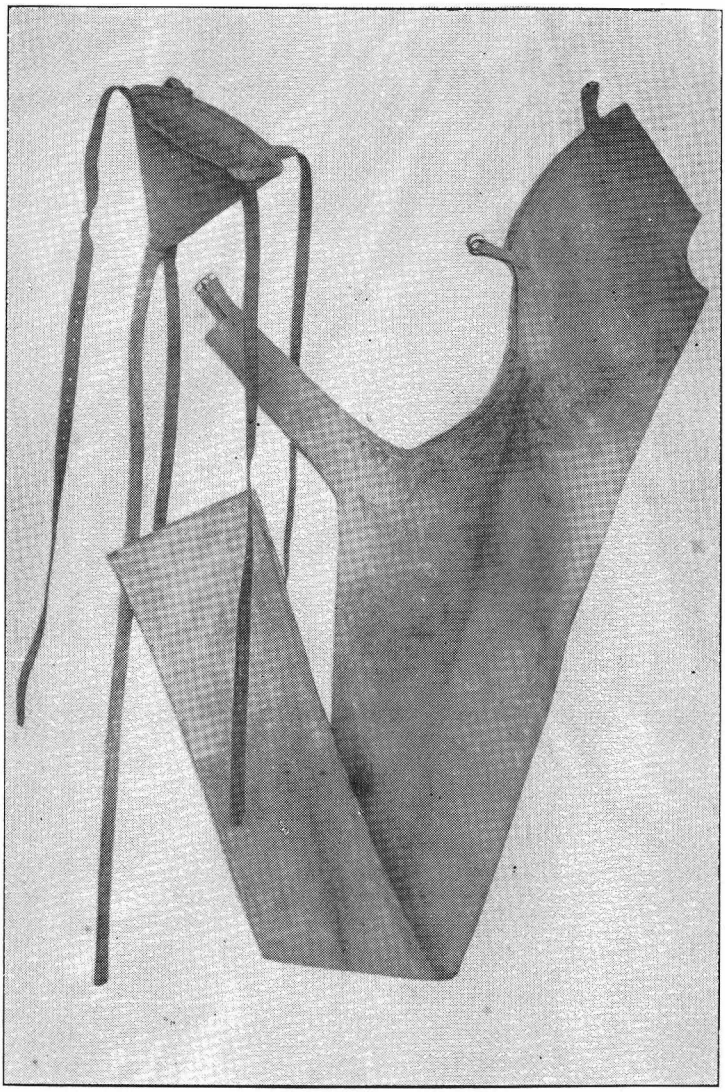
The solid excretum is simply that material which has escaped the action of the digestive fluids, or the indigestible matter. From its analysis, and that of the food eaten, can be calculated the amount of the food digested.

The per cents of the various nutrients that can be digested by an animal are called the *digestion co-efficients.*

Thus it is seen that chemical analysis is the first and last step in rendering intelligible the results of feeding experiments. It is absolutely essential to a proper understanding of the material used in rations, if we desire to feed economically. It is the foundation upon which the whole system of rational feeding rests. The object of the following experiment; from the chemical standpoint, was to determine the digestion co-efficients of Cheat (*Bromus secalinus*) hay, and to compare its digestibility with that of Red Clover (*Trifolium pratense*) when fed to the same animal.

It seemed the more essential to set forth the results thus contrasted since after the publication of Bulletin 39 numerous persons—some evidently not having read the bulletin—made extravagant statements as to what the author claimed. Now the fact is that the writer never did assert that the hay in question was "worthless," for such a statement would be far from the truth. What he *did intentionally* imply was that Cheat did not favorably compare with several other grasses there named, either from the standpoint of a food or in economy of production. Cheat, and even straw, can be made the basis of a ration, but it is certainly poor economy to feed a hay of low food value when there are others much better which can be had; and it is still more wasteful, as well as crude and unscientific, to feed either this or any other coarse food alone, when the advantages to be gained by properly balanced rations are so clearly set forth in the literature of the day, and are so well recognized by the most eminent feeders of the country.

The details of the feeding were as follows: A three year old Short Horn grade steer was selected for the experiment. The animal was placed in a stall arranged in such a manner that the excreta could be collected without loss. The apparatus used was that recommended by Professor Armsby, of Pennsylvania. It is shown in the accompanying illustration. The apparatus was found well adapted to the work. The preliminary feeding began on February 17, 1896, and continued till March 2d, during which time



the animal was fed in the same manner as during the actual digestion period. During the last four days of this time the harness was adjusted to the steer, and the conditions made identical with those of the digestion period.

The hay was cut as for ordinary feeding, and after being thoroughly mixed, was weighed into rations, and a sample of each placed in an air tight bottle and brought to the laboratory for analysis. The first of the prepared rations was fed to the steer on March 2d, at 5 p. m., and the experiment ended at 5 p. m., March 8th. The water, as well as the food, given to the animal was carefully weighed. The amounts of each consumed, together with the weight of excreta, and the weight of the animal are given in Tables I and II. It is somewhat interesting to note the fact that the animal voided 58 per cent more urine during the Clover experiment than when fed on the Cheat. During the same time he drank 20 per cent. more water. The samples of dung were brought to the laboratory where they were reduced to an air-dried condition, and after being ground till the entire material would pass through a one-millimeter sieve, were preserved in air-tight bottles till analyzed.

TABLE I—CHEAT.

Dates.	*Food eaten.....*	*Water drunk.....*	*Weight of urine*	*Weight of solid excreta.....*	*Weight of animal.....*
	Pounds	Pounds	Pounds	Pounds	Pounds
March 3	16	37	11¾	29⅛	1006
March 4	16	40½	7	35	1012
March 5	16	28¼	3¼	30¾	1002
March 6	16	44	8	34	1007
March 7	16	32½	8¾	37¼	1008
March 8	16	33	9	32½	1006
Total	96	215¼	47¾	199½	.....

TABLE II—CLOVER.

Dates.	*Food eaten.....*	*Water drunk.....*	*Weight of urine*	*Weight of solid excreta.....*	*Weight of animal.....*
	Pounds	Pounds	Pounds	Pounds	Pounds
March 23	15	21	19	30	988
March 24	15	70	22¾	28	993
March 25	15	40	18½	33½	991
March 26	15	49½	16	36	992
March 27	15	42½	18½	32	991
March 28	15	47	18½	31	992
Total	90	270	113¼	190½	.....

The composition of the two hays was as follows:

TABLE III.

Material.	*Clover.*		*Cheat.*	
Water	4.27	Dry matter.	7.00	Dry matter.
Dry matter	95.73		93.00	
Ether Extract	3.35	3.50	1.95	2.09
Protein	14.84	15.50	6.06	6.52
Crude Fibre	28.83	30.11	31.80	34.19
Nitrogen-free Extract	40.20	41.12	44.10	47.43
Ash	8.50	8.77	9.09	9.77
Total dry matter	95.73	100.00	93.00	100.00

For a full description of the terms above employed the reader is referred to Bulletin 39, but for the sake of reference the following resume is here inserted:

Protein, albumenoids, and nitrogenous matter mean the same thing, and are represented by the white of an egg, lean meat and the gummy part of wheat. Other things being equal, that food has the highest food value which is the richest in digestible protein. The function of this class of bodies is that of muscle forming. The term *Ether Extract* in the case of grains might well be expressed by the word fat, which is frequently used, but in the case of grasses and other coarse foods there is also included coloring matter and certain gums. *Crude fibre* is a term used to express the more woody parts of the plant, and is well represented by paper and cotton fibre. It is closely allied to starch, and with the next group belongs to the class of carbohydrates. The *Nitrogen-free Extract* is best represented by such bodies as sugar and starch, which together with the Ether Extract and Fibre serve to form animal fat and heat.

As stated above the indigestible matter constitutes the dung. This was collected during the period of the experiment, weighed and analyzed.

TABLE IV—THE STEER VOIDED AS DUNG.

	Dry Matter.
Of the clover hay, 190.5 lbs.	32.37 lbs.
Of the cheat hay, 199.7 lbs.	49.10 lbs.

The *water-free dung* showed the following composition:*

TABLE V.

	Clover.	*Cheat.*
Ether Extract	4.51	2.56
Protein	15.40	6.89
Crude Fibre	33.32	33.24
Nitrogen-free Extract	32.24	13.47
Ash	14.53	43.84
Total.	100.00	100.00

* The nitrogen was corrected for metabolic nitrogen according to the method suggested by Dr. Jordan in Annual Report of Maine Station, 1888.

From the above figures, computing the ingredients of the dung excreted during the experiment, we have:

TABLE VI.

	Clover.	*Cheat.*
Ether Extract	1.46	1.26
Protein	4.98	3.38
Crude fibre	1 .78	16.22
Nitrogen-free Extract	10.52	21.58
Ash	4.70	6.66
Total	32.37	49 10

These figures represent the indigestible matter. It is evident, then, that if these be subtracted from the figures representing the ingredients eaten, we shall obtain the amounts digested.

TABLE VII—SHOWING DIGESTIBILITY OF CLOVER HAY.

Material.	*Dry Matter.*	*Ether Extract.*	*Protein.*	*Crude Fibre.*	*Nitrogen-free Extract.*	*Ash.*
In 90 lbs. clover hay	86.15	3.02	13.35	25.94	36.29	7.55
In 190.5 lbs. clover dung	32.37	1.46	4.98	10.78	10.52	4.70
Amounts digested, lbs	53.78	1.56	8.37	15.16	25.77	2.85

TABLE VIII—SHOWING DIGESTIBILITY OF CHEAT HAY.

Material.	*Dry Matter.*	*Ether Extract*	*Protein.*	*Crude Fibre.*	*Nitrogen-free Extract.*	*Ash.*
In 96 lbs. cheat hay	89.28	1.86	5 81	30.52	42.37	8.72
In 199.7 lbs. cheat dung	49.10	1.27	3.38	16.22	21 58	6.66
Amounts digested, lbs	40.18	60	2.43	14.30	20.72	2.06

The following table shows the comparative digestibility of the constituents in each food stuff used in the experiment:

TABLE IX—DIGESTION CO-EFFICIENTS.

	Clover.	*Cheat.*
Dry Matter	62	45
Ether Extract	55	32
Protein	63	42
Crude Fibre	59	46
Nitrogen-free Extract	71	49
Ash	37	23

Computing the nutritive ratio* for each, as determined by the experiment, it is is found to be:

For clover hay. 1: 5.3
For cheat hay 1:15.0

The chemical analysis shows that Cheat contains a larger per cent. of indigestible woody fiber than Clover, and less than half as much protein or flesh formers. In carbohydrates, or those substances which go largely to keep up animal heat, the Cheat is better provided than the Clover. This to a certain extent explains why the Cheat gives such favorable results in keeping stock animals, or those which are being kept over winter. In the fat contained the Cheat is not nearly as well provided as the Clover.

The nutritive ratio is rather wide—that is there is a large proportion of carbohydrates to the protein, or flesh forming substances—there being 15 of the former to one of the latter. It is not economical to require the animal functions to take care of so much crude fiber in order to obtain a sufficient supply of nitrogenous material. It is cheaper to supply the deficiency by a better balanced ration. This might be done by feeding liberally with bran oil meal, pea meal, or cotton seed meal, but in feeding these concentrated foods the expense is materially increased. The best results will be obtained when we feed in the coarse food as nearly a complete, or balanced, ration as possible.

*Found by multiplying the Ether Extract by 2½, adding to the product the Crude Fibre and Nitrogen-free Extract, and dividing by the Protein. It expresses the relation between the carbohydrates and the protein.