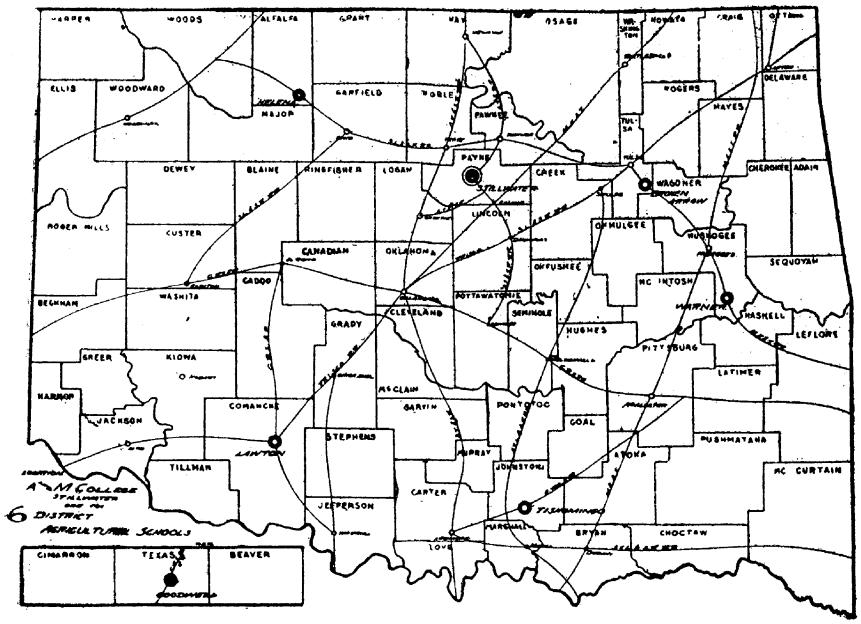
OKLAHOMA
AGRICULTURAL EXPERIMENT
STATION

BULLETIN NO. 90 NOVEMBER, 1910

A STUDY OF BERMUDA GRASS

PART I.—CULTIVATION AND VALUE
PART II.—CHEMICAL COMPOSITION
PART III.—DIGESTION EXPERIMENTS

CHEMISTRY



LOCATION OF THE A. & M. COLLEGE AND THE SIX SCHOOLS OF AGRICULTURE

STILLWATER, OKLAHOMA

A. & M. COLLEGE PRINTING DEPARTMENT

STATE BOARD OF AGRICULTURE

(Ex-Officio Board of Regents)

HON. J. P. CONNORS, *President*	Canadian
HON. DAN DIEHL, *Vice President*	Gotebo
HON. R. F. WILSON, *Treasurer*	Valliant
HON. J. C. ELLIOTT	Pauls Valley
HON. EWERS WHITE	McLoud
HON. FRANK IKARD	Chickasha
HON. J. W. L. CORLEY	Howe
HON. A. C. COBB	Wagoner
HON. O. A. BREWER	Helena
HON. GEORGE H. HINDS	Westville
HON. FRANK L. HAYMES	Broken Arrow

STATION STAFF

JAMES A. WILSON, B. Agr.	*Director*
B. C. PITTUCK, B. S.	*Assistant Director*
L. L. LEWIS, M. S., D. V. M.	*Veterinarian and Bacteriologist*
W. A. LINKLATER, B. S. A.	*Animal Husbandman*
ROY C. POTTS, B. S.	*Dairyman*
C. E. SANBORN, M. A.	*Entomologist*
CHAS. K. FRANCIS, Ph. D.	*Chemist*
N. O. BOOTH, B. S.	*Horticulturist*
O. O. CHURCHILL, B. S.	*Agronomist*
A. H. WRIGHT, B. S.	*Assistant Agronomist*
R. O. BAIRD, B. S.	*Assistant Chemist*
A. L. LOVETT, B. S.	*Assistant Entomologist*
J. L. MCKEOWN	*Financial Secretary*
W. W. EVANS	*Farm Superintendent*
LULA TOURTELLOTTE	*Clerk*

VISITORS ARE CORDIALLY WELCOMED AT ALL TIMES.

The publications of this Station are sent free to residents of Oklahoma on request. All communications should be addressed, not to individuals or departments, but to the

EXPERIMENT STATION, Stillwater, Oklahoma.

PREFACE

Two bulletins have been published by the Oklahoma Agricultural Experiment Station on Bermuda grass, but these have treated the subject in a somewhat different way than set forth here.

The previous publications have called attention to the grass, methods of planting and uses. In this bulletin some of the earlier statements have been repeated and where advisable the subject matter covered in more detail, owing to the fact that the former bulletins are out of print and a continued demand for the information.

The chemical analyses of a series of experiments with Bermuda grass, covering a period of three years, are reported here together with the results of a digestion trial. This data substantiates the statement made in 1902, that Bermuda grass is the best pasture grass for Oklahoma.

CHARLES K. FRANCIS, *Chemist.*

A STUDY

OF

BERMUDA GRASS

BY

CHAS. K. FRANCIS
R. O. BAIRD

PART I

THE CULTIVATION AND VALUE OF BERMUDA GRASS

Name and Description.—Bermuda grass was first described by Carl von Linne in 1753 who classified it, but it was not known by its present scientific name, **Capriola Dactylon,** until 1891 when Kuntze reclassified the grasses.* This grass has a number of other names such

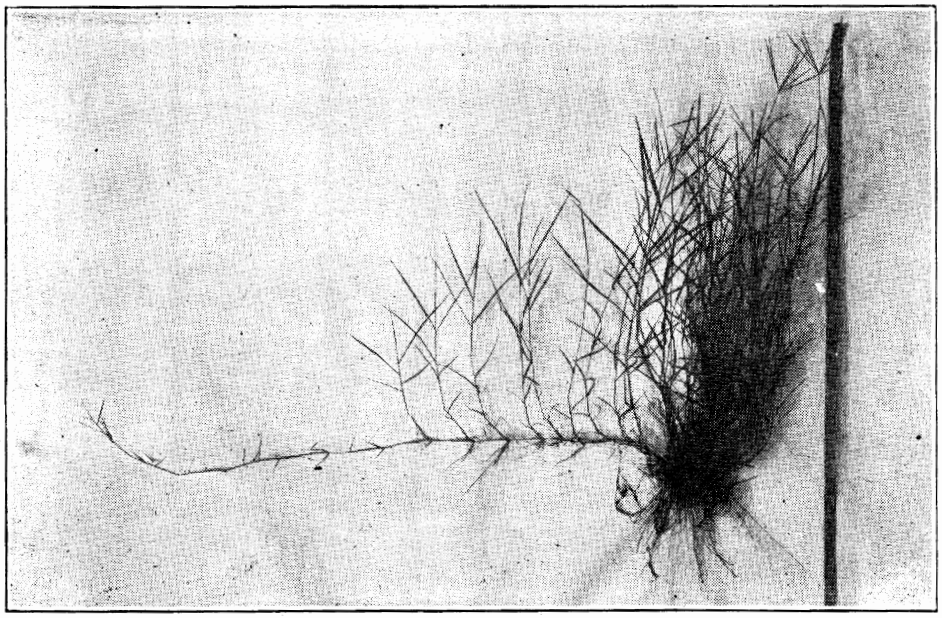


Fig. 1.—BERMUDA GRASS, SHOWING CHARACTER OF THE PLANT.

as Dog's-tooth grass, Scotch grass, Wire grass, Bahama grass, Indian-couch grass. It is claimed that Bermuda grass is the same as the Sacred Durva grass of the Hindoos, celebrated in the sacred vedas as the shield of India in the absence of which cattle would die.**

*Illus. Flora. Britton and Brown I, 175; 1896.
**Grasses. Shaw; p. 111, 1903.

Bermuda grass is a branching plant which puts out creeping stems or runners that have been known to grow over 12 feet in a single season. At short intervals along the stems nodes or joints form. Wherever these nodes touch the ground roots grow and in a few days a young plant is formed which is independent of the mother plant. When this grass is compared with grasses similar in appearance it will be noted that two to four leaves grow from each node of the Bermuda grass while the others support but one. Truly, an average of THREE BLADES OF GRASS GROW WHERE BUT ONE GREW BEFORE.

Pasture.—This grass is without doubt the best pasture grass grown in the Southern States, and is especially adapted to the climatic conditions of Oklahoma. It will grow on almost any kind of soil, but, like any other plant, will produce the best yields on rich ground. Bermuda grass will not grow in cold weather, and turns greenish brown in winter, but with a minimum rainfall will remain green in Oklahoma from April to October.

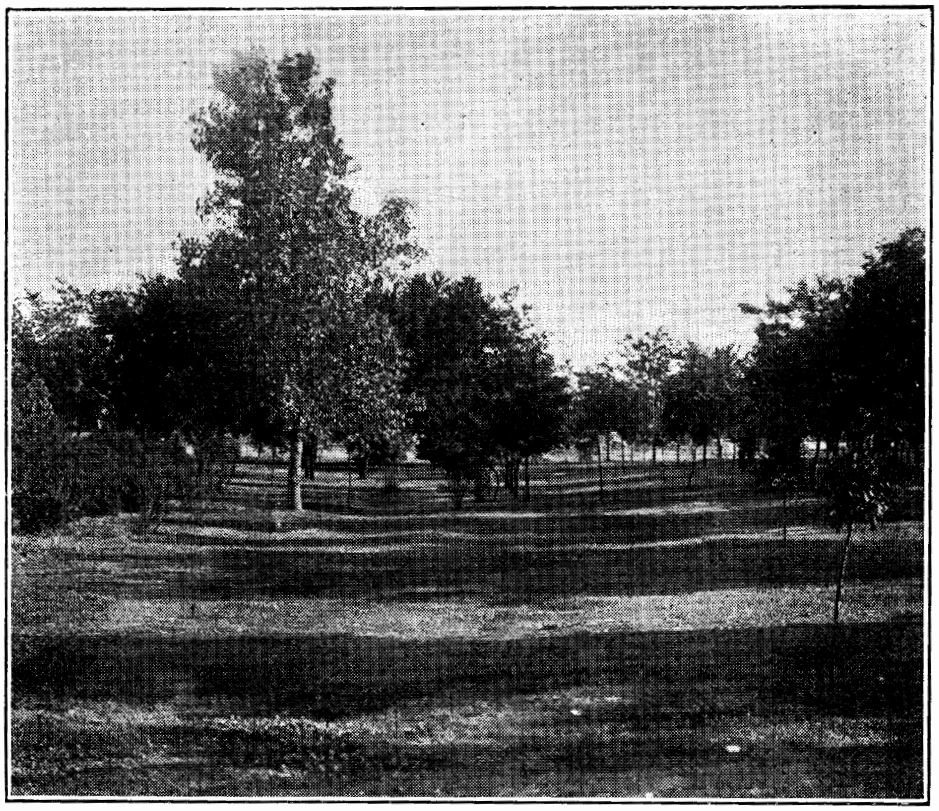


Fig. 2.—BERMUDA LAWN WITH TREES.

Lawns.—It has no equal in the South for lawns, as it will continue to grow when the heat is the greatest, provided it is supplied with water occasionally. A dry spell will not kill it, simply retard the growth. It will not do well in the shade and should not be planted beneath trees.

Feed.—The chemical composition of Bermuda hay shows it to rank very high as a cattle food in comparison with other hays. This point will be considered in detail in Part II of this bulletin.

Prevents Washing.—Lands well covered by Bermuda grass will not wash to any extent as the thick mat of grass and roots form a covering which is but little affected by running water.

Kind of Soil Necessary.—As stated in a previous paragraph Bermuda grass does well even on poor soil. It will grow on soils which are so exhausted that they will no longer produce other crops at a profit. It will do best on a rich bottom alluvial soil. It is better adapted to sandy lands than to stiff clays, but will grow in the latter if it once gets a good stand.

Planted on sandy soil Bermuda grass is valuable in preventing wind action, but it is necessary to get the grass set in light shifting soil early in the spring so that a good growth may be obtained before the dry season.

Grown on Alkali Soils.—Bermuda grass does not seem to be as easily killed by alkali as other crops. This Station has an excellent pasture of it on land which contains so much alkali that other crops cannot be grown there.

Preparation of Soil and Planting.—The best method of preparing the soil is similar to that followed for corn or cotton, and the method of planting similar to that employed in putting in potatoes or tobacco. Have the land as clean and rich as possible and in good mechanical condition. Fall and winter plowing and frequent harrowings together with a dressing of manure will be found worth while.

Seed Not Satisfactory.—Experience has shown that Bermuda grass seed is low in germinating power and expensive, costing from 50c to $1.25 per pound. The plants from seed are very tender and grow slowly, so they are easily injured and choked back or killed by weeds. The grass from seed freezes back in winter and often does not begin to grow until May. Small tracts or lawns may be seeded when roots or pieces of sod are not to be obtained. The seed may be sown broadcast or, preferably, in drills.

Planting from Sod.—The most practical method of planting Bermuda grass is to set out portions of the sod on the prepared land early in March and not later than June tenth. The earlier the planting the better, provided there is no frost in the ground.

The following method has been recommended by this Station in a previous bulletin,* which is now out of print:

Method "A".—After the land has been prepared furrows about six inches deep should be made with a single shovel plow. The furrows

*Okla. Agr. Exp. Sta. Bull. 70; 1906.

should be about six inches apart and pieces of sod about two inches square dropped every eighteen inches. Cover these, either by using the foot as the sod is dropped, or a hoe or a double-shovel plow. The depth of covering will depend upon the condition of the soil; if it is dry a thicker covering may be given than if it is wet. It will not be advisable to cover with a harrow. The small amount of labor thus saved will be more than offset by the delay in getting a good stand of grass.

When but a limited amount of Bermuda grass roots, from which the dirt has been shaken, is available, the preparation of the soil should be the same. But the roots must be planted with more care than the sod, and the soil must be well packed about them with a roller, or tamped. It is desirable to have a little of the root exposed to the air. This is not necessary when the sod is planted; it may be completely covered.

The following methods have also been suggested:*

Method "B".—In the fall while breaking the land with a turning plow, drop small pieces of sod in every third furrow behind the plow, one to two feet distant, the next furrow slice being made to cover these. Then sow rye on the land and in the spring graze down to aid in removing the shade from the crop and to firm the land. Horses and sheep should not be thus grazed while the grass is setting, because they bite off too many of the creeping stems and thus prevent the grass from spreading.

Method "C".—In the light furrows made between the rows of corn when ready to be laid by, drop several pieces of the sod one to two feet apart and cover with a plank leveler, such as may be run between the rows of corn.

Method "D".—In making a new pasture where the land is more or less covered with broom sage, sassafras, etc., pieces of sod may be dropped into shallow holes made with a hoe and the earth pressed down with the foot. The holes should be from three to six feet apart. The closer they are the more rapidly will the grass get possession of the land. Help the grass along as much as possible by cutting down the sassafras and other objectionable growth, or grazing according to conditions and the season of the year. This method is adapted to the planting of large areas of run down land when it is desired to change them into pastures at a minimum expenditure of labor.

Hay.—Bermuda grass should be cut for hay just before the tops break out, because after the plant blossoms the lower leaves fall off and the upper portion dries. The grass should be cured the same day that it is mowed. On account of the fineness of the grass it is necessary to use a fine fork for handling it.

*Grasses, Shaw, p. 121.

In our experiments with Bermuda grass we made a cutting as often as possible, but on a large scale the number of cuttings will of course be influenced by the condition of the grass and the weather. Certainly two cuttings may be made, and in some cases as many as seven or eight. Each crop will run from half a ton to over two tons per acre.

Improving by Cultivation and Fertilizer.—After four or five seasons Bermuda grass may become so thickly sod bound as to hinder further growth. Then it is advisable to revive the plants by plowing and harrowing. Follow the harrowing with a drag or roller to smooth off the surface. An occasional tearing up of the pasture will materially improve the quality and quantity of the grass.

Fig. 3.—BERMUDA HAY.

It is perfectly reasonable to assume that in a few years after planting the grass will be improved by an application of fertilizer. For this purpose a dressing of nitrate of soda is suggested, eighty to a hundred pounds per acre should be ample. This may be previously mixed with dry rich soil to facilitate thorough distribution.

Bermuda grass does not enrich the soil in the same way that clover does, but its roots and the mat-like character of the sod are favorable to earth worms. It is a well known fact that earth worms appreciably improve a soil in which they live. The improvement on the composition of the soil effected by Bermuda grass is caused by humus added. That is to say, it aids in the formation of more plant food through the effect of its decaying leaves, etc., upon the insoluble mineral matter in the ground.

PART II

CHEMICAL COMPOSITION OF BERMUDA GRASS

The data reported here was obtained from a series of analyses extending over three years. The Bermuda grass examined was grown on the campus of the Oklahoma A. & M. College.

So far as possible, the grass was cut every Saturday afternoon during the spring and summer. For the three years this made an average season of 17 weeks. The grass was cut with an ordinary hand lawn-mower, fitted with a canvas basket to collect the grass.

The following tables show the percentage composition of the Bermuda hay. Each sample represents a different cutting. The results are arranged to correspond with the order of the cutting each year.

TABLE I

Composition of Bermuda Hay First Year After Planting

Sample Number	Water	Ash	Protein	Fiber	Nitrogen-free Extract	Fat*	Yield in Pounds Per Acre
4362	7.99	9.72	18.66	21.67	39.42	2.54	615
4370	7.66	9.93	22.84	19.73	36.69	3.15	265
4381	7.30	10.33	20.17	20.96	38.32	2.92	366
4383	7.51	9.45	20.17	20.28	39.61	2.98	252
4384	7.34	9.71	19.07	20.45	40.46	2.97	246
4385	7.84	7.67	19.47	21.41	40.73	2.88	159
4388	7.55	7.97	19.55	22.02	39.76	3.15	378
4390	7.33	8.64	21.00	22.12	38.02	2.89	307
4419	7.18	9.27	19.95	21.52	39.22	2.86	293
4421	7.51	9.12	17.85	23.75	40.00	1.77	297
4422	7.45	8.76	18.34	23.08	40.24	2.13	404
4424	7.46	9.65	17.46	22.50	40.70	2.23	377
4425	7.24	9.78	17.50	21.50	41.15	2.88	225
4442	7.20	10.11	17.46	22.36	41.01	1.86	276
4447	7.30	8.81	19.16	21.40	41.22	2.11	152
4454	6.87	8.38	18.59	21.83	42.43	1.90	175
4459	7.09	7.77	16.54	21.37	45.52	1.81	44
4483	7.06	9.29	14.17	20.30	47.30	1.88	84

*Ether-extract.

TABLE II

Composition of Bermuda Hay Second Year After Planting

Sample Number	Water	Ash	Protein	Fiber	Nitrogen-free Extract	Fat	Yield in Pounds Per Acre
4631	6.79	9.50	18.65	20.68	42.13	2.25	114
4637	6.75	8.51	17.06	20.83	44.73	2.12	48
4643	6.42	9.98	16.25	21.51	43.07	2.77	53
4653	6.73	7.94	13.19	24.52	45.28	2.34	93
4658	6.57	7.23	11.98	24.77	47.04	2.41	117
4661	6.54	7.45	11.19	26.91	45.65	2.26	149
4666	6.72	7.22	12.16	26.78	44.83	2.29	146
4695	6.69	7.68	10.94	26.03	46.61	2.05	81
4700	6.40	6.56	11.51	25.85	46.70	1.98	108
4702	6.29	8.02	10.81	25.10	47.90	1.88	91
4709	6.06	8.22	10.31	25.85	47.67	1.89	86
4711	6.07	8.92	10.03	26.64	46.33	2.01	74
4714	6.33	7.71	9.59	26.24	48.45	1.68	77
4722	6.54	7.67	8.72	26.15	49.02	1.90	62
4726	6.65	7.99	8.75	25.24	48.57	1.80	58
4727	6.77	7.91	9.36	24.49	49.73	1.74	45

TABLE III

Composition of Bermuda Hay Third Year After Planting

Sample Number	Water	Ash	Protein	Fiber	Nitrogen-free Extract	Fat	Yield in Pounds Per Acre
4849	10.84	5.94	17.21	20.70	43.90	1.41	128
4850	10.71	6.22	17.24	21.05	42.61	2.17	102
4853	10.70	6.29	14.88	21.02	44.96	2.15	62
4861	10.55	5.81	11.81	25.23	45.00	1.60	355
4873	9.56	5.65	12.33	23.65	46.37	2.44	161
4878	10.50	5.72	12.17	24.97	44.16	2.48	77
4881	10.60	7.19	12.51	24.46	43.03	2.21	31
4894	10.54	6.86	8.40	27.45	45.15	1.60	180
4908	10.25	6.61	9.37	24.28	47.57	1.92	176
4930	11.00	7.11	9.23	25.73	45.47	1.46	85
4944	11.46	6.57	10.06	25.00	45.21	1.70	78
4980	11.74	6.92	9.76	25.59	44.53	1.46	46
5005	11.15	6.70	10.32	24.80	45.03	2.00	154

Probably the most remarkable fact to be noticed in the preceding tables is the high percentage of protein. This is especially marked in the first year, where the second cutting shows a protein content of over 22 per cent. But there is a gradual decrease toward the end of the season. The yield of hay for the first season was 5850 pounds per acre, with an average of 18.17 per cent protein.

The second year was hot and very dry, so that many crops were total failures. For this year there was a decided drop in the percentage of protein. The loss may be noted in almost every cutting as the season advanced. The yield of hay was 1635 pounds per acre, containing an average of 11.91 per cent protein.

Conditions for crops were very much better during the third year, but the quality of the hay was found to be about the same as that examined in the preceding year. The tendency to lose protein with the advance of summer was again noted. The yield in hay was 1667 pounds per acre. The average per cent of protein was 11.94. The relationships mentioned above are shown in Fig. 4, in which the percentages of protein have been reduced to a dry basis in order to avoid the variables introduced through the different amounts of water contained in the samples. These curves show at a glance, the quantity of protein found in Bermuda hay throughout the experiment.

The wide difference in quality and quantity of the hay made early each season and that made later may be compared with other crops under like conditions. Samples of Kafir fodder were analyzed every week from May 12 to August 17. The decrease in protein was from 22.77 per cent. on May 12 to 6.82 per cent on August 17.* Three cuttings of alfalfa show variations as follows: Cut June 3 contained 20.50 per cent protein; cut June 10, 17.81 per cent; cut June 24, 12.87 per cent. Another variety of alfalfa decreased in protein as follows: First cutting, 31.25 per cent; second, 26.25; third, 22.62; fourth, 18.25; fifth, 16.56.** The amounts of protein mentioned above are in all cases expressed in terms of the water-free substance. It is perfectly natural to reason that the young plants would contain a higher percentage of

*Okla. Exp. Sta. Bull. 37, 1899.
**Minn. Agr. Exp. Sta. Bull. 80, pp. 162 and 163.

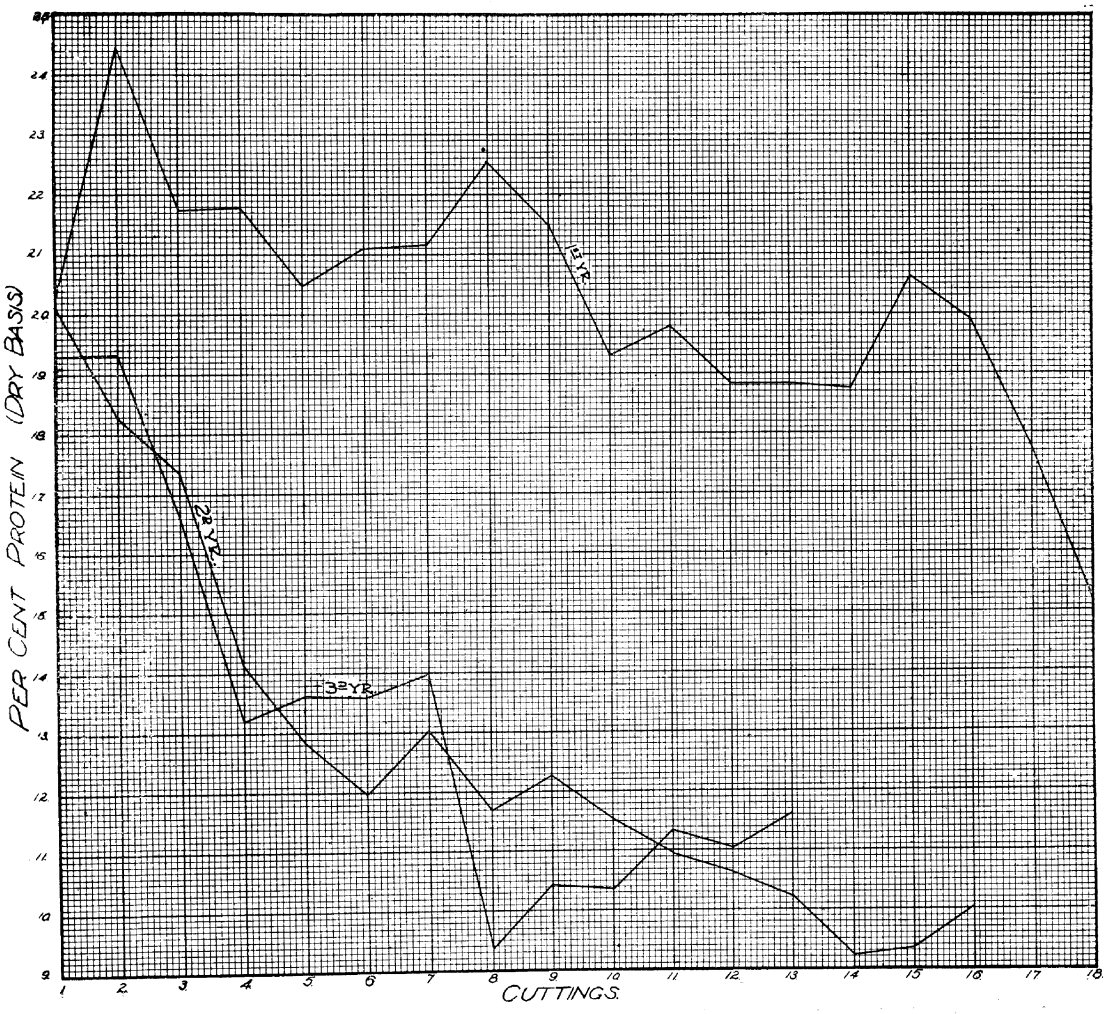


Fig. 4.

protein than the more mature, because the roots have been holding all winter a supply of food material for the use of the young plant when the time to grow came around.

Without doubt our grass would be very much improved by the addition of fertilizer such as mentioned in Part I. The grass is very thick now and some cultivation is desirable.

TABLE IV

Composition of Various Hays*

	Water	Ash	Protein	Fiber	Nitrogen-free Extract	Fat	Number of Analyses
Bermuda, first year average	7.38	9.13	18.72	21.57	40.71	2.49	18
Bermuda, second year average	6.52	8.03	11.91	24.85	46.60	2.09	16
Bermuda, third year average	10.74	6.43	11.95	24.15	44.84	1.89	13
Barley, average	10.60	5.30	9.30	23.60	48.70	2.50	4
Oats, average	16.00	6.10	7.40	27.20	40.60	2.70	12
Red Top cut at dif. stages	8.90	5.20	7.90	28.60	47.50	1.90	9
Red Top cut in bloom, average	8.70	4.90	8.00	29.90	46.40	2.10	3
Orchard grass average	9.90	6.00	8.10	32.40	41.00	2.60	10
Timothy, all analyses, average	13.20	4.40	5.90	29.00	45.00	2.50	68
Timothy, cut in bloom, average	15.00	4.50	6.00	29.60	41.90	3.00	12
Timothy, soon after bloom, avg	14.20	4.40	5.70	28.10	44.60	8.00	11
Timothy, when nearly ripe, avg	14.10	3.90	5.00	31.10	43.70	2.20	12
Kentucky blue grass	21.20	6.30	7.80	23.00	37.80	3.90	10
Cut when seed in milk	24.40	7.00	6.30	24.50	34.20	3.60	4
Cut when seed ripe	27.80	6.40	5.80	23.80	33.20	3.00	4
Hungarian grass average	7.70	6.00	7.50	27.70	49.00	2.10	13
Meadow fescue average	20.00	6.80	7.00	25.90	38.40	2.70	9
Italian rye grass average	8.50	6.90	7.50	30.50	45.00	1.70	4
Mixed grasses average	15.30	5.50	7.40	27.20	42.10	2.50	126
Raven (mixed) aervage	16.60	6.80	11.60	22.50	39.40	3.10	23
Mixed grasses & clovers, avg	12.90	5.50	10.10	27.60	41.30	2.60	17
Swamp hay average	11.60	6.70	7.20	26.60	45.90	2.00	8
Salt marsh hay average	10.40	7.70	5.50	30.00	44.10	2.40	10
Red clover average	15.30	6.20	12.30	24.80	38.10	3.30	38
Red clover in bloom average	20.80	6.60	12.40	21.90	33.80	4.50	6
Alsike clover average	9.70	8.30	12.80	25.60	40.70	2.90	9
White clover average	9.70	8.30	15.70	24.10	39.30	2.90	7
Crimson clover average	9.60	8.60	15.20	27.20	36.60	2.80	7
Japan clover vaerage	11.00	8.50	13.80	24.00	39.00	3.70	2
Vetch average	11.30	7.90	17.00	25.40	36.10	2.30	5
Serradella average	9.20	7.20	15.20	21.60	44.20	2.60	3
Alfalfa average	8.40	7.40	14.30	25.00	42.70	2.20	21
Cowpea average	10.70	7.50	16.60	20.10	42.20	2.90	8
Soy bean average	11.30	7.20	15.40	22.30	38.60	5.20	6
Flat pea average	8.40	7.90	22.90	26.20	31.40	3.20	5
Peanut vines without nuts	7.60	10.80	10.70	23.60	42.70	4.60	6
Soy bean straw average	10.10	5.80	4.60	40.40	37.40	1.70	4
Horse bean straw average	9.20	8.70	8.80	37.60	34.30	1.40	1
Wheat straw average	9.60	4.20	3.40	38.10	43.40	1.30	7
Rye straw average	7.10	3.20	3.00	38.90	46.60	1.20	7
Oat straw average	9.20	5.10	4.00	37.00	42.40	2.30	12
Buckwheat straw average	9.90	5.50	5.20	43.00	35.10	1.30	3

*The analyses reported are, with the exception of Bermuda hay, taken from U. S. Dept. Agr. Farmers' Bull. 22, 1910.

TABLE V

Feeding Value of Bermuda and Other Hays

	Total Dry Matter	Protein	Carbo-hydrates	Fat	Nutritive Ratio
Bermuda — first year	92.62	20.21	67.24	2.69	1:3.06
Bermuda — second year	93.48	12.74	76.43	2.23	1:6.4
Bermuda — third year	89.26	13.39	77.29	2.12	1:6.1
Barley*	89.40	5.11	35.94	1.55	1:7.7
Oats	84.00	4.07	33.35	1.67	1:9.1
Orchard grass	90.10	4.78	41.99	1.40	1:9.4
Red top	91.10	4.82	46.83	0.95	1:10.2
Timothy (all analyses)	86.80	2.89	43.72	1.43	1:16.2
Kentucky blue-grass	78.80	4.76	37.46	1.99	1:8.8
Hungarian grass	92.30	4.50	51.67	1.34	1:12.2
Meadow fescue	80.00	4.20	43.34	1.73	1:11.3
Mixed grasses	87.10	4.22	43.26	1.33	1:11.0
Rowen (mixed)	83.40	7.19	41.20	1.43	1:6.2
Buffalo-grass	50.10	6.20	42.01	1.28	1:7.2
Prairie-grass	51.50	0.61	46.90	1.97	1:84.2
Mixed grasses and clovers	87.10	6.16	42.71	1.46	1:7.5
Red clover	84.70	7.38	38.15	1.81	1:5.7
Alsike clover	90.30	8.15	41.70	1.36	1:5.5
White clover	90.30	11.46	41.82	1.48	1:3.9
Crimson clover	91.40	10.49	38.13	1.29	1:3.9
Alfalfa	91.60	10.58	37.33	1.38	1:3.8
Alfalfa, first stage	59.50	13.24	39.26	0.89	1:3.1
Alfalfa, second stage	58.30	11.90	40.67	0.39	1:3.5
Alfalfa, third stage	60.00	10.43	43.17	0.69	1:4.3
Cowpea	89.30	10.79	38.40	1.51	1:3.9
Soy bean	88.70	10.78	38.72	1.54	1:3.9
Wheat straw	90.40	0.37	36.30	0.40	1:100.5
Rye straw	92.90	0.63	40.58	0.38	1:65.8
Oat straw	90.80	1.20	38.64	0.76	1:33.6
Soy bean straw	89.90	2.30	39.98	1.03	1:18.4

The nutritive value of Bermuda hay is clearly demonstrated in Tables IV and V, where it is compared with other hays. The term nutritive ratio, Table V, may need some explanation. It is calculated from carbohydrates, (crude fiber plus nitrogen-free extract; table IV), fat and protein. The fats produce 2.25 times as much energy as carbohydrates, due to the fact that they require about that much more oxygen to be completely consumed when burning. Fats and carbohydrates when used up in the body act in a similar way for the development of animal heat and muscular force. Protein can serve the same purpose as fats and carbohydrates, but it is useful in other ways in addition; for example, it is necessary for the formation of lean flesh, blood, nerves, horns, hair and wool, the albumen and casein of milk, etc. It is apparent that protein is absolutely indispensable to the growing animal, and for that reason one of the most valuable constituents of foods. With these facts in mind the steps necessary to calculate the nutritive ratio may be followed.

Protein, on account of its importance and value in a food has been selected as a basis for comparison or unity in arriving at a nutritive

*This and the following calculated from Table IV. See Kans. Exp. Sta. Bull. 115.

ratio. For example, the nutritive ratio of the first year's cutting of Bermuda hay may be obtained from the data presented in Table V, as follows:

Fat 2.69 per cent., multiplied by 2.25, equals 6.05, which added to 67.24, the per cent. of carbohydrates, gives 73.29. Now dividing 73.29 by the protein content, 20.21 per cent., the nutritive ratio of 1:3.6 is obtained.

So then, the nutritive ratio is simply another way of stating the above. One pound of protein is equivalent to 2.25 times the fat added to the carbohydrates.

A study of Table IV reveals the fact that Bermuda hay is superior to nearly every hay mentioned. It is excelled in protein content by but clover, vetch, serradella, alfalfa, cowpea, flat pea and soy bean. But it must be pointed out that in this table the water varies in the different hays, so a truer value would ignore the water. In Table V the protein is expressed on the dry basis. Here one may notice that Bermuda hay excels them all with the exception of one sample of alfalfa.

PART III.

DIGESTION EXPERIMENTS WITH BERMUDA HAY

A series of feeding tests, lasting seven days, was made on three sheep to determine the digestibility of Bermuda hay. The animals were fed nothing but the hay with the exception of a small amount of salt, and they were allowed to drink all the water they wanted at feeding time. They were fed twice a day, 7:30 a. m. and 5:00 p. m.

Each sheep was kept in a separate stall during the experiment and a bag was fitted on the animal to collect the feces. All were put on Bermuda hay seven days before the exact determinations were started, so as to be certain that individual traits would not effect the results to any extent; also, to arrive at the proper amount of hay to be fed each day.

TABLE VI

Daily Consumption of Bermuda Hay

The weights are in grams*

Day	SHEEP NO. 1			SHEEP NO. 2			SHEEP NO. 3		
	Hay offered	Hay refused	Hay eaten	Hay offered	Hay refused	Hay eaten	Hay offered	Hay refused	Hay eaten
1st.....	550	140	410	550	21	529	550	17.5	532.5
2nd.....	550	60	490	550	59	491	550	36	514
3rd.....	550	127	423	550	273	277	550	40	510
4th.....	550	37	513	550	149	401	550	27	523
5th.....	550	64	486	550	183	367	550	40	510
6th.....	550	76	474	550	53	497	550	24	526
7th.....	550	102	448	550	47	503	550	16	534
Total....	3850	606	3244	3850	785	3065	3850	200.5	3469.5

In Table VI the feeding weights are given, showing the amount of Bermuda hay eaten by each sheep daily. In the tables of analytical

*One ounce (Avoir.) equals 28.3495 grams.

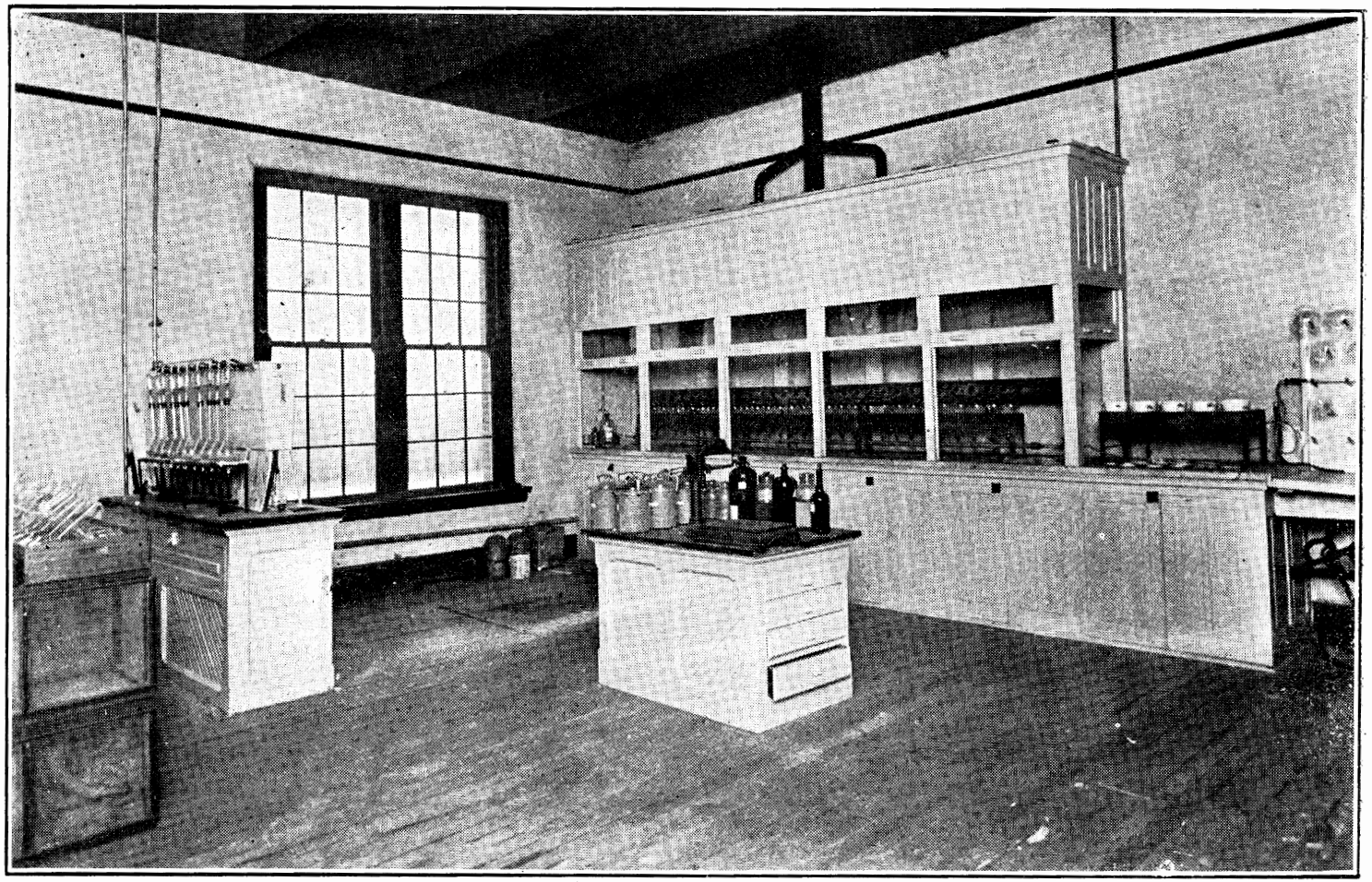


Fig. 5.—Nitrogen Laboratory, Oklahoma Agricultural Experiment Station.

results below will be found the analyses of the hay as fed, and also the portion not eaten. From the analyses of the hay and the feces the feeding value may be calculated.

TABLE VII

Analyses of Combined Samples

Sample	Loss on air drying	Water	Ash	Protein	Fiber	N.-free Extract	Fat	Nitrogen
Bermuda hay as fed	.....	7.87	7.44	10.81	28.87	43.58	1.42	1.73
Not eaten by sheep No. 1	.....	7.98	8.34	10.81	28.70	42.54	1.63	1.73
Not eaten by sheep No. 2	.....	7.96	7.87	11.20	29.08	42.05	1.83	1.79
Not eaten by sheep No. 3	.....	10.92	10.60	9.97	28.42	38.50	1.58	1.60
Feces sheep No. 1	74.73	7.44	10.09	8.84	25.48	46.21	1.93	1.41
Feces sheep No. 2	67.38	7.22	9.32	9.01	24.91	47.73	1.81	1.44
Feces sheep No. 3	49.86	5.07	9.32	8.31	28.24	46.19	1.86	1.33

TABLE VIII

The Digestibility of Bermuda Hay*

SHEEP NO. 1

	Food Offered	Food Rejected	Food Eaten	Weight of Feces	Food Digested	Per Cent. Digested
Fresh material	3850.0	606.0	3244.0	5801.0	.....	.....
Total water	303.0	48.4	255.4	4491.8	.....	.....
Air-dry substances	3850.0	606.0	3244.0	1414.5	1829.5	56.39
Dry matter	3547.0	557.6	2988.6	1309.2	1679.4	56.02
Ash	286.6	50.5	236.1	142.8	98.7	41.80
Protein	416.0	65.5	350.5	125.0	225.5	62.91
Fiber	1111.4	173.9	937.5	360.5	577.0	61.59
N.-free extract	1678.0	257.8	1421.2	653.6	767.6	54.01
Fat	54.8	9.9	44.9	27.3	17.6	39.20

*All weights are in grams.

TABLE IX

The Digestibility of Bermuda Hay

SHEEP NO. 2

	Food Offered	Food Rejected	Food Eaten	Weight of Feces	Food Digested	Per Cent. Digested
Fresh material	3850.0	785.0	3065.0	4289.0	.....	.....
Total water	303.0	62.5	241.3	2991.0	.....	.....
Air-dry substances	3850.0	785.0	3065.0	1399.0	1666.0	54.35
Dry matter	3547.0	722.5	2824.5	1298.0	1526.5	54.05
Ash	286.6	61.8	224.8	130.4	94.4	41.99
Protein	416.0	89.9	328.1	126.0	202.1	61.60
Fiber	1111.4	228.3	883.1	348.5	534.6	60.53
N.-free extract	1678.0	330.1	1347.9	667.7	680.2	50.46
Fat	54.8	14.4	40.4	25.3	15.1	37.37

TABLE X

The Digestibility of Bermuda Hay

SHEEP NO. 3

	Food Offered	Food Rejected	Food Eaten	Weight of Feces	Food Digested	Per Cent. Digested
Fresh material	3850.0	200.5	3649.5	3217.0	.....	.....
Total water	303.0	21.9	281.1	1685.7	.....	.....
Air-dry substances	3850.0	200.5	3649.5	1613.0	2036.5	55.8
Dry matter	3547.0	178.6	3368.4	1531.3	1837.1	51.57
Ash	286.6	21.3	265.3	150.3	115.0	43.35
Protein	416.0	20.0	396.0	134.0	262.0	66.16
Fiber	1111.4	75.0	1054.4	571.9	582.7	44.73
N.-free extract	1678.0	77.2	1600.8	745.0	855.8	53.46
Fat	54.8	3.2	51.6	30.0	21.6	41.83

TABLE XI

Average of Three Sheep—Digested Material

	Air-dry Substances	Dry Matter	Ash	Protein	Fiber	N.-free Extract	Fat
Food eaten	3319.5	3060.5	242.1	358.2	958.3	1456.6	45.6
Dung excreted	1442.2	1379.5	141.2	128.3	393.6	688.8	27.5
Digested	1877.3	1681.0	100.9	229.9	5647.0	7678.0	18.1
Per cent. digested	5652.0	54.92	41.68	64.19	58.93	52.71	39.69

Tables VIII to X, inclusive, give the results for each sheep and show a very good agreement, demonstrating that the animals were in practically the same condition. Sheep No. 2 did not digest the Bermuda hay quite as well as the others, but the difference is hardly worth considering.

In Table XI the results obtained from the three animals have been averaged. The value of the figures may be clearer after a study of Table XII where the digestibility of Bermuda hay is compared with other feeds that were tested with sheep. In this table the composition of the feed is not given as it is the object of the table to show only to what extent each feed mentioned is digested. The results are expressed in percents.

TABLE XII

The Digestibility of Various Feeds Compared With Bermuda Hay

	Digestibility of the			
	Fat	Fiber	Protein	N.-free Extract
Dakota prairie hay*	39.9	60.1	42.5	56.5
Corn stover	36.3	72.1	52.5	63.7
Corn ensilage	66.4	68.3	56.7	78.4
Alfalfa	37.4	43.8	77.8	71.7
BERMUDA HAY	39.7	58.9	64.2	52.7
Oklahoma prairie hay	36.0	54.9	9.7	43.9
Alfalfa	44.0	53.3	75.2	72.1

*The results for the first four samples are from S. Dak. Bull. 114, 1909.

The data in the above table shows that Bermuda hay is easily and well digested.

The fat and protein content, the most important constituents, should be noted; in this respect Bermuda hay is excelled by but ensilage and one sample of alfalfa. When the expense of these foods is considered it will be apparent that Bermuda hay has no equal.

SUMMARY AND CONCLUSIONS

1. Bermuda grass grows rapidly, is the best pasture grass grown in the Southern States, and is particularly suited to the climatic conditions of Oklahoma.

2. It makes a good lawn, prevents land from washing, and grows on almost any soil.

3. The most practical method of planting Bermuda grass is to set out small pieces of the sod.

4. This grass makes a hay which is remarkably high in protein, being excelled by but few hays.

5. The nutritive ratio of Bermuda hay varies from 1 :3.06 to 1 :6.4.

6. Bermuda hay is easily digested and has no equal as a cheap food for cattle.