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Ensilage

William Carter Stubbs

ENSILAGE.

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BATON ROUGE, LA.

WM. C. STUBBS, A. M. PH. D.,

DIRECTOR.

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LOUISIANA STATE UNIVERSITY AND
AGRICULTURAL AND MECHANICAL COLLEGE,
Baton Rouge, La., October .., 1888.

MAJOR T. J. BIRD, Commissioner of Agriculture, Baton Rouge, La.:

DEAR SIR—I hand you herewith Bulletin No. 17, containing experiments in Ensilage, with results of chemical investigation by Professor B. B. Ross.

Respectfully submitted,

WM. C. STUBBS,
Director.

ENSILAGE,

Or, the preserving of green substances in pits, or *silos*, has become of such frequent occurrence in parts of this country that no well regulated stock farm is without its silos. In the South, where our winters are of such short duration, the necessity for green food is not so imperative as further North. "Will it not, however, pay every owner of stock, even as far South as Louisiana, to build silos and have ensilage, as a part of his stock rations, even during our short winters?" is a question often asked by our most enquiring farmers. To solve this question, this Station undertook the following experiments.

It must be understood, however, that while any green crop, such as grass, clover, pea-vines, sorghum and corn, can be preserved in pits, the latter crop is the one universally used for ensilage. It possesses many superior qualities. It can easily be grown. It produces large tonnage. It is relished by all kinds of stock, and is easily and cheaply handled.

In the Spring of 1887, two acres of land were taken, thrown up into rows five feet apart, furrows opened, corn drilled and covered with a harrow. After it was well up, it was thinned to a stand of one stalk to three or four inches. After that the cultivation was the same as with field corn. One acre of this was ensilaged, and the other cured into fodder.

While the corn was growing, a cheap and useful silo was constructed on the bank of the bayou, in the following manner: A pit 8x10x12 was dug, with perpendicular sides. From the bottom of this pit a ditch was dug to the bayou, to let the water off. A permanent drain was made by nailing two six-inch boards together and inverting them in the ditch and filling with soil. Into the walls of this pit—at the bottom, middle and top—were sunk scantlings 2x3, parallel with bottom of pit and with each

other. Upon these were placed common ceiling, projecting above the pit about one foot. The pit was now ready for ensilage.

On the 5th of July, after the corn had reached its roasting-ear stage, and the grains began to glaze, it was cut down and hauled by wagons to the pit. Here a Ross ensilage cutter received the corn, and after cutting it in desired lengths, (one-half to three-fourths inches), emptied it directly in the pit. An occasional tamping and leveling of the chips was necessary. After the pit was filled, a little dry oat straw was placed over it, and then covered with twelve-inch boards sawn so as to fit, lapping the planks so as to break the joints. When thus covered, it was weighted with barrels filled with sand. A cheap cover over the pit completed our work.

On the 7th of December, during the session of the Louisiana Central Fair Association, it was opened, and save a thin layer on the top and sides of the pit the fodder was well preserved. It was tested by both cows and horses, and from the readiness with which they devoured it, the unanimous verdict of many visitors was that it was good. The pit was then closed and not opened again until February, when its contents were distributed to the farmers, for use, the Station having no cattle of its own.

That ensilage is a valuable forage for a dairy, has been abundantly proven; and though few cows take readily to it at first, all will eat it and and after a while become fond of it.

In filling a silo, it is no longer deemed necessary to rush the green fodder directly to the pit, fill the latter as fast as possible and cover with dispatch. On the contrary, the corn cut in the morning is permitted to lie in the sun all day, and then ensilaged. Even rapid filling of the pit is objectionable, and two or three days' respite while filling is now deemed advisable. In fact, those who practice ensilage on a large scale, now usually have several pits. They partially fill and go on to the next, leaving several days' interval between their work at each pit. In this way, the first stage of fermentation, together with the heat produced, is over before the pit is closed. So, too, after the pit is filled it is left for several days before it is covered.

It is not necessary for its preservation to cut the corn, but it is far more economical. Ensilage cutters are cheap, and the power required to cut the corn is not great.

The most valuable variety of corn for ensilage is yet a mooted question. In the North and West, our Southern field corn is largely sold for ensilage purposes; and it has, doubtless, on account of size of stalk, superiority over Northern corn. But have we not a variety, or varieties, which have, in themselves, a superiority over our common corn, for ensilage?

This year there were grown upon the Station many varieties of corn—among others, two of Mexican corn. The latter were very conspicuous on account of large stalk and immense height. Several stalks were over thirteen feet high and measured one and one-half ($1\frac{1}{2}$) inches in diameter. A trial will be given these varieties next year.

That corn can be kept in pits in a good condition, in Louisiana, is now abundantly demonstrated. Whether it will be economy to establish silos, is a question which the farmers must decide.

Pits can be built in barns, above ground as well as below the ground. The former has the preference always, with those who have had experience with silos, since they are much easier fed from.

The fact that ensilage can be successfully practiced in Louisiana, coupled with the further fact that corn here grows enormously large and tall, makes the potentialities, large as they were before, even now greater of raising all kinds of stock profitably in this State.

Samples of the ensilage and of the cured fodder were given Professor B. B. Ross, who kindly investigated their chemical properties and digestibility. I herewith insert his able report:

LOUISIANA STATE UNIVERSITY AND
AGRICULTURAL AND MECHANICAL COLLEGE,
Baton Rouge, La., October —, 1888.

PROF. W. C. STUBBS, Director Experiment Station, Baton Rouge, La.

DEAR SIR—I herewith hand you report of examination of the samples of corn fodder and ensilage submitted to me for analysis.

Very respectfully,

B. B. ROSS,
Professor of Chemistry.

ANALYSES OF SAMPLES.

The sample of ensilage was carefully drawn from the silo, and weighed immediately in order that the amount of water present could be accurately determined. After being well air-dried, the sample was cut up very finely and the size of the particles further reduced by thorough grinding and pulverizing. At the same time a sample of fodder was obtained, cut at the same stage of growth as the ensilage sample, which was likewise prepared for analysis by a process of thorough pulverization. The ensilage, when first taken from the pit possessed the characteristic odor of acetic acid (vinegar), showing that acetous fermentation had set in, although it doubtless had made comparatively little progress, as in closed silos the gases produced in incipient fermentation check any further tendency to decomposition. After being completely air-dried, however, all traces of this odor disappeared, the dry sample having the very agreeable smell possessed by fresh clover, and quite in contrast to the musty odor of the corn fodder, itself.

The methods followed in the determination of the proximate constituents of the feeding stuffs, were essentially those adopted by the official Association of Agricultural Chemists, at their last annual meeting. Below is given the percentage composition of the ensilage and dry fodder, not only for the air-dried and completely dried substances, but in the case of the former the analysis of the fresh substance is also given:

ANALYSIS OF FRESH ENSILAGE.

	Per cent.
Water	74.94
Ash	2.61
Crude Protein	2.04
Fats	0.64
Carbohydrates	12.26
Crude Fibre	7.51
Total	100.00
Digestible Protein	1.48

ANALYSIS OF THE AIR-DRIED SUBSTANCE.

	Ensilage. Per cent.	Fodder. Per cent.
Water	11.72	10.50
Ash	9.20	5.87
Crude Protein	7.19	8.59
Fats	2.24	1.52
Carbohydrates	43.20	48.77
Crude Fibre	26.45	24.75
Total	100.00	100.00
Digestible Protein	5.22	5.61

ANALYSIS OF THE COMPLETELY DRIED SUBSTANCE.

	Ensilage. Per cent.	Fodder. Per cent.
Ash	10.42	6.56
Crude Protein	8.14	9.60
Fats	2.54	1.69
Carbohydrates	48.94	54.50
Crude Fibre	29.96	27.65
Total	100.00	100.00
Digestible Protein	5.91	6.33
Per cent. of total Protein digestible	72.60	65.94
True Protein	6.19	7.82
Per cent. of True Protein to Crude Protein	76.04	81.46

EXPLANATION OF ANALYSES.

In the analysis of feed stuffs the proximate and not the ultimate (or elementary) constituents are generally determined. It has been found that in order to arrive at the relative merits of fodders, etc., for feeding purposes, it is only necessary in most cases to ascertain the percentages of ash, albuminoids (or protein), fats, carbohydrates, and woody fibre, or cellulose. It is also of the utmost importance that the proportion of water present in the sample be correctly determined, as the percentage of this substance in feed stuffs is so variable that no proper comparison of their relative nutritive values can be instituted until the pro-

portion of the constituents present in the dry substance can be ascertained.

The amount of dry matter can be determined by heating the substance at a temperature of 212 degrees, Fahrenheit, until the sample shows no further loss of weight; the difference in weight representing the amount of water present. Upon exposure to the atmosphere the dry sample will re-absorb a considerable proportion of moisture, usually regaining the amount previously contained in the air dried feed stuff.

The ash contains the mineral constituents of the feeding stuffs, and its proportion is ascertained by burning out the combustible portions, with free access of air. These mineral substances consist chiefly of potash, soda, lime and magnesia in combination with hydrochloric, carbonic, phosphoric and sulphuric acids, and also silica, together with a little unconsumed charcoal.

As these mineral substances generally occur in sufficiently abundant quantities in most forage plants, the amount of ash is considered of little importance in estimating the feeding value of fodder. Crude protein (or albuminoids) constitutes the chief bulk of the nitrogenous substances present in feeding stuffs. The term is quite comprehensive in its scope, and includes such substances as the casein of milk, fibrin of flesh, and albumen of blood and the egg, which are considered as modifications of a primary substance (protein), these different forms bearing a general resemblance to each other in composition and properties, and convertible into each other by processes carried on in the animal body. These albuminoids substances contain carbon, hydrogen, nitrogen, and oxygen, and frequently a small proportion of sulphur. Indeed, the exact chemical composition of the different modifications of albuminoids has not yet been definitely determined, but it is known that nitrogen is one of the least variable (in quantity) of their constituents, and that the average proportion of that valuable element is about sixteen per cent. So that, in the analysis of feed stuffs, the rule generally adopted in ascertaining the percentage of albuminoids is to first determine the percentage of nitrogen present and then multiply this per-

centage by 6.25 (16x6.25–100). This does not give us the exact but only the approximate amount of albuminoids present, as all albuminoids do not contain sixteen per cent., nor is all the nitrogen in the feed stuffs combined in the form of albuminoids. However, in the statement of the percentages of the proximate constituents determined, the proportion of crude albuminoids given is in each obtained by multiplying the nitrogen present by 6.25. This has been done because it approximates very closely the true percentage, and because all of the standards of comparison to which we can refer in determining the relative nutritive values of fodders, give albuminoids as determined in the same manner. The true albuminoids in both the ensilage and the fodder have been determined, however, and in the statement of analysis the percentage is given together with the proportion of true albuminoids to crude albuminoids.

The albuminoids are regarded as the chief constituent of value, as, without undergoing any very considerable alteration, they are utilized in the animal body, in the formation of animal albuminoids, such as the fibrin of muscles and tendons, and the albumen and casein of blood and milk; and not only contribute to the growth of the animal, but tend to repair and replace the worn out muscles, membranes, tissues, etc.

The term fats includes all matters extracted from the dry fodder by ether, and the proportion of fats is generally less than that of any other proximate constituent. Vegetable fats are utilized in the animal economy, either in making fat or in furnishing heat to the body by the oxidation of their carbon and hydrogen; this process of oxidation being perfectly analagous to the ordinary processes of combustion.

The class of substances called carbohydrates are, in conjunction with the fats, also of great utility in producing and maintaining animal heat, but practical experiments, within recent years, have led scientists to believe that fats have two and one-half ($2\frac{1}{2}$) times the value of carbohydrates in the production of heat by their oxidation. Carbohydrates, as the name implies, consist of carbon together with hydrogen and oxgen, in the relative proportions in which they exist in water. Under

this term are included starch, sugar, gums and other bodies closely allied in chemical composition and properties.

The cellulose, or fibre, constitutes the most insoluble and, generally, the most indigestible portion of feeding stuffs. Although pure cellulose (as lint cotton) is identical in composition with starch, in its physical properties and chemical deportment there is the widest difference. It was formerly considered almost, if not wholly, indigestible; but experiments have shown that quite a large percentage is digested by animals, and may be turned to account either as an auxiliary or as a substitute for fats or carbohydrates, in furnishing oxidizable and heat-producing constituents to the blood.

In order that each of the principal constituents of feeding stuffs may be utilized to the greatest possible advantage, in the performance of their several functions in the animal economy, it has been found essential that they exist in certain relative proportions, just as in the application of commercial fertilizers to soils the relative percentages of their three essential constituents must be taken into consideration.

It has been ascertained by carefully conducted experiments in cattle feeding that in estimating the comparative feeding values of fodders, there should be determined what is known as the nutritive ratio—or, the ratio of digestible carbohydrates to digestible albuminoids—just as in the operation of a steam engine there is a ratio between the cost of fuel and the cost of the materials of repair. In determining this nutritive ratio, fats must also be taken into consideration, and as they are assumed to have a value of two and one-half ($2\frac{1}{2}$) times their weight of carbohydrates, the amount of digestible fat, after being multiplied by two and one-half ($2\frac{1}{2}$), is added to the digestible carbohydrates.

In calculating the nutritive ratios of the fodder and ensilage analyzed, the percentages of digestibility of the carbohydrates and fats were taken from the results of practical digestion experiments on corn fodder in Europe, while the percentage digestibility of albuminoids was determined by means of artificial digestion with pepsin solution. It was found that there was

almost a perfect coincidence in the nutritive ratios of the two feeding stuffs: the ratio for ensilage being 1:6.26, while that for the fodder was 1:6.43.

DIGESTION EXPERIMENTS.

The digestibility of the albuminoids in the feeding stuffs was determined by treatment with pepsin solution corresponding closely in composition and solvent or digestive power to the gastric juice, the most important of all the animal digestive fluids. The principal constituents of this juice are lactic and hydrochloric acids, and a substance called pepsin secreted in the lining of the stomach and possessed of wonderful digestive or peptonizing properties, especially as regards albuminoids.

Pepsin is at present largely prepared from the stomach of the pig (*pepsina porci*), and is frequently administered medicinally to aid or promote digestion.

The pepsin solution used contained ten (10) grams of pepsin in two (2) litres of water, acidulated with ten (10) grams of hydrochloric acid—(Sp. gr. 1.1975)—and the finely ground material was kept at a constant temperature of 104 degrees, Fahrenheit, for two periods of twelve hours each, one-tenth (0.1) per cent. of hydrochloric acid being added at intervals of three hours, so that at the end of the twenty-four hours (24) one (1) per cent. of the acid would be present.

As the principal function of the gastric juice is to digest albuminoids, only the result of the digestion of albuminoids is given in the statement of analysis. It was found, however, by analysis that the cellulose was completely indigestible in the pepsin solution, and only a comparatively small proportion of the fats and carbohydrates were digested. It will be seen on reference to the table of analyses that 65.94 per cent. of the albuminoids in the fodder were digestible, and 72.6 per cent. of albuminoids in the ensilage, while the results of a large number of practical trials in feeding animals show that an average of 73 per cent. of albuminoids in corn fodder is digestible.