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OF

PRESERVING GREEN FOOD IN SILOS.

BY

PROFESSOR C. A. GOESSMANN.

[FROM THE TWENTY-EIGHTH ANNUAL REPORT OF THE SECRETARY OF
THE STATE BOARD OF AGRICULTURE.]

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THE SYSTEM OF PRESERVING GREEN FOOD IN SILOS.

BY PROFESSOR CHARLES A. GOESSMANN.

MR. CHAIRMAN, AND MEMBERS OF THE STATE BOARD OF AGRICULTURE, — Complying with an invitation of the Committee for the Arrangements of this country meeting of the Board, I take the liberty of asking your kind attention and indulgence for the presentation of a few remarks on the system of preserving green food in silos for the support of farm live-stock. The uncommon interest so generally manifested, of late, in the discussion concerning the merits of the silo system for storing up green food, is but a deserved appreciation of the important agricultural problem which that mode of keeping fodder, in the opinion of some of its advocates, is destined to solve. As the question how to feed our farm live-stock in a rational and an economical manner can only be considered as second in importance, in a general farm management, to the question how to raise our farm-crops in the most economical way, it seems

but judicious to investigate carefully any system of operation, new to our farm practice, which proposes to improve our present chances of securing economically an increased supply of green food, and thereby enable us to support more live-stock. The reduced area of lands serving as natural pastures, their quite frequently exhausted condition, the large demands for fodder in the dairy business, the increasing prospects of remunerative production of meat for the general market, the gradual change of an extensive system of general farming to an intensive one, — each, in its own way, tends to direct our attention to the consideration of the fodder question. Increased production of the fodder-crops is the most characteristic feature in our modern intensive system of general farm management. In the prevailing intensive system of farming in the most successful districts of Europe, from one-third to one-half of the entire area of cultivated lands is devoted to the raising of fodder-crops. The statement that plenty of fodder produces plenty of manure, and that plenty of home-made manure produces a plenty of remunerative crops, is there quite generally accepted as a safe rule. As the more prominent discussion of the silo system in our agricultural periodicals is, comparatively speaking, of a quite recent date, and the actual tests in our farm practice are still of an exceptional occurrence, it is not strange that quite opposite views regarding its real merits in our situation find their advocates. This stage of opinion is apparently, in a large measure, due to two circumstances: first, to a frequent misapprehension regarding the composition and the feeding value of the silo product — the ensilage — as compared with the original green crop; and, second, to the adoption of a different basis for the estimation of economical points involved. Without intending to detract any thing from the well-deserved recognition of the merits of the valuable experiments of John M. Bailey, Esq., of Billerica, Mass., and others elsewhere within the country, or to anticipate the final results of their practical investigations, I propose to discuss in a few subsequent pages the silo system with reference to its history in Europe, and from the stand-point of a careful scientific inquiry.

The preservation of green food in silos is at present mainly recommended for juicy plants, or parts of plants,

and for certain vegetable-refuse matter from several branches of industry. Prominent among these various substances are the stalks and leaves of the Indian-corn in blossom, the leaves of the sugar-beet roots, and the stems and leaves of potatoes. Grass and clover in wet summer seasons, the refuse pulp of the beet-root from the beet-sugar manufacture, and the potato refuse from the starch manufacture, also diseased and frost-bitten potatoes, and roots of various descriptions, have been kept in silos, and thereby improved for feeding purposes; and, finally, coarse grass-like plants, as rushes (*Juncaceæ*) and carices, or sedges (*Cyperaceæ*), which in their green state are, as a rule, but little eaten by cattle, have been prepared, in some instances, in silos, into a quite palatable and digestible cattle-food. The treatment of these and similar articles for their conversion into ensilage, or sour fodder, is usually carried out in either dry ditches or cemented cisterns especially constructed for that purpose. The green food, or the factory-refuse mass, after being reduced to a proper size for advantageous close packing, is put in layers, in the space prepared for it, and thoroughly trampled down, so as to leave no air-spaces in the mass. Horses are frequently turned to account to secure the desired compactness. In piling the material into the pits prepared for it, pains are taken to raise it, in the centre, to a conical-shaped elevated top somewhat above the level of the surrounding ground, whilst on the sides it is kept somewhat lower. This course is pursued to prevent subsequent depression in the centre of the silo. As soon as the packing-down is accomplished, at least two feet in thickness of earth is filled upon the mass, usually without using any layer of straw or boards to keep the vegetable matter and the soil separated from each other. The success of the entire operation depends on the dryness of the pit, the careful packing-down of the mass in the silo, especially along its sides, and the keeping-out of the air, in particular during the earlier period of fermentation. The contents of a carefully prepared silo soon undergo a peculiar fermentation; in some instances, of an acid character; in some of an indifferent or slightly alkaline character, which continues from one to two weeks, when they are ready for use: they keep in that condition for from six to eight and more months.

The original green food loses, during the period of fermentation, more or less of its weight, amounting, in some instances, to from forty to fifty per cent. This loss consists of more or less organic matter, and largely of water of vegetation. Very juicy articles shrink, for this reason, most: they are also apt to lose soluble constituents by leakage, in case the silos are constructed in a loose sandy or gravelly soil, instead of a compact soil or in cemented masonry. Some of the starchy or saccharine constituents are invariably transformed into lactic acid,—the acid contained in sour milk,—and other products characteristic of a slimy fermentation under the exclusion of air: in some instances considerable quantities of alcoholic products and fatty acids are noticed. The nitrogen percentage of the ensilage is, for obvious reasons, usually higher than that of the green food which served for its production: although a small percentage of the nitrogenous constituents of the green crops is destroyed, and changed into compounds of ammonia or of volatile alkaline compounds of a similar character. The color and the odor of the silo product depends on the success of the treatment, and resembles more or less that of the material used: in case of green food it is usually either dark green or yellowish green. A failure of the silo process is readily noticed by a strong, unpleasant putrid odor, and the dark brown or black color of the vegetable matter, which is also covered by fungi growth.

As agriculturalists differ not only in the details of carrying on the silo system in case of different materials, but also with reference to the same kind, I propose to describe subsequently some of the experiments of competent parties, to give a more comprehensive idea concerning the silo system as carried out abroad. Having on a previous occasion (Report, 1879–80, On the Feeding Value of Corn) described the rules which guide us in our decision regarding the comparative feeding value of our various articles of fodder, I omit further details.

Clover Ensilage.—The ditches were three to four feet wide, and from four to five feet deep, with sides slanting slightly towards the centre. Sixteen cubic feet of space were counted for every ton of green red clover in blossom. The closely packed green clover filled two-thirds of the depth of

the ditch, lined with compact earth; the remaining space was filled with the earth obtained from its construction; subsequently the soil was raised to from six to eight inches above the level of the surrounding ground. The contents of the silo, after ten months' keeping, were found to be of a dark-green color, of a slightly acid re-action, and of an agreeable odor. They were eagerly eaten by cattle.

The composition of the clover (*Trifolium pratense*) before entering the silo, and after its removal, was as follows:—

	FRESH GREEN CLOVER. Per cent.	ENSILAGE. Per cent.
Water	77.30	79.14
Nitrogenous matter	4.55	4.62
Ether abstract (fat, etc.) . .	1.19	2.03
Non-nitrogenous extract matter .	9.20	5.98
Crude fibre	5.83	5.80
Ash	1.93	2.43

A sample of both substances, calculated for a perfectly dry material, was found to consist as follows:—

	FRESH GREEN CLOVER. Per cent.	ENSILAGE. Per cent.
Water	—	—
Nitrogenous matter	20.04	22.14
Ether abstract (fat, etc.) . .	5.26	9.76
Non-nitrogenous extract matter .	40.53	28.66
Crude fibre	25.68	27.82
Ash	8.49	11.63

An examination of these analytical results shows that the amount of nitrogenous matter and the fatty acids have increased somewhat in the ensilage, as compared with the green clover; whilst the digestible non-nitrogenous matter of the clover has been reduced to from six to eight per cent in quantity. The total amount of organic matter destroyed has not been stated: it is no doubt larger, and quite worthy of notice, judging from the results obtained in the succeeding experiment, with a plant of similar character.—*esparsette* (*Onobrychis sativa*), cultivated saintfoin, — by H. Weiske.

Esparssette Ensilage.—The material which served in the experiment was cut on the 16th of June. One portion of the green *esparsette* was carefully dried, and saved for an analysis; another portion was packed tightly into a box, and

buried in the contents of a silo of the previously described construction. The silo was opened about two months afterwards for feeding purposes. The box also was opened on that date, and its contents carefully dried and analyzed.

	DRIED ESPARSETTE. Per cent.	DRIED ESPARSETTE ENSILAGE. Per cent.
Water	—	—
Nitrogenous matter	18.56	20.44
Ether abstract (fat, etc.) . .	2.89	6.02
Non-nitrogenous extract matter,	38.60	30.88
Crude fibre	33.93	35.18
Ash	6.02	7.48

A careful weighing of the green food in the box, before and after the treatment in the silo, showed that twenty-four per cent of the organic dry matter of the fresh green plant had been destroyed by fermentation.

Grass, green lucern, and green lupine have been treated in silos with similar results. Quite interesting, in this connection, are the experiments with a mixture of green food and straw, to study the changes of the latter, as far as its subsequent feeding quality is concerned. Green rye and green vetch, with straw of wheat and of oats, were chosen for the investigation. As these two kinds of straw may be cut somewhat before the full ripening of the grains, without any injury to the latter, — a course which cannot be safely followed in the case of barley, etc., — they disintegrate, comparatively speaking, quite readily, and thus become in a higher degree digestible when treated in silos with green food. Rye and vetch were taken just before blooming. One part of either one of the two green plants, and twenty parts of wheat-straw, were cut in a suitable machine into pieces of about one to two inches in length: for every hundred pounds of straw there was added from a pound to a pound and a half of salt. The green food and the straw were placed in alternate layers in the silo, and, after being trampled down, were covered in the usual manner with several feet in thickness of earth. The silos, in this case, were filled in summer, and opened as late as October, and their contents fed during the winter. The somewhat extended period of keeping them fermenting before feeding insured a proper softening and disintegrating of the straw, and therefore a higher

degree of digestibility. The fodder produced in this way had an odor and a taste similar to hay. Professor Voelcker, who speaks favorably of this mode of operation, obtained the following analytical results from the wheat-straw before its treatment, and after its removal from the silo.

	RAW WHEAT-STRAW. Per cent.	FERMENTED WHEAT-STRAW. Per cent.
Water	13.33	7.76
Fat	1.74	1.60
Nitrogenous matter	2.93	4.19
Matter soluble in water	4.26	10.16
Matter soluble in diluted acid and alkalies	19.40	35.74
Raw fibre	54.13	34.54
Insoluble mineral matter	3.08	3.20
Soluble mineral matter	1.13	2.82

These results show a remarkable increase in the soluble and digestible matter of the straw, being raised from twenty-three to twenty-four per cent, to that of from forty-five to forty-six per cent, not speaking of other favorable alterations in the original composition of the straw.

Leaves and Tops of Beet-Roots and Sugar-Beet-Root Pulp Ensilage.—The preservation of these refuse materials becomes a very important question wherever the agricultural advantages arising from the introduction of the beet-sugar industry enter into consideration. They form the basis of an extensive system of stock-feeding for the meat-market and the dairy, which is invariably connected with the beet-sugar industry in Europe. Assuming for the refuse-beet mass—leaves, tops, and pulp—the same amount of moisture which is contained in the fresh beet-root (eighty-two to eighty-three per cent), its quantity amounts in weight to nearly one-third of the entire root-crop, or from five to six tons per acre (leaves, two tons; *pressed* pulp, three tons; and tops, one ton). As an illustration of the changes which the leaves and tops undergo in silos, the following carefully conducted experiments may serve: A ditch from seven to eight feet deep, five feet long, and five feet wide, was filled with alternate layers of leaves and tops from the same lot of roots, until the solid trampled mass reached the level of the surrounding grounds. A layer of leaves, and subsequently a mass of earth several feet in thickness, served as a final

cover. The silo was filled in October, and opened for use in the following March. To ascertain at the same time the exact loss in organic matter which the above-stated beet-root refuse would suffer in consequence of the fermentation in the silo, a definite quantity of the contents of the latter was cut out, and at once carefully packed tightly into a box, and buried in the centre of the silo. The latter was closed in October, and opened for use in March. Leaves and tops had changed but little in color. The ensilage in the silo had lost forty-nine per cent in weight, as compared with that of the fresh green material. The contents of the box had lost by slow fermentation nearly one-fifth (eighteen per cent) of the dry matter contained in the green food. The fresh material contained 10.54 per cent of dry matter, and the ensilage only 8.44 per cent. These results demonstrate that juicy plants in ordinary ditches may lose as high as fifty per cent of their soluble constituents, and that, even in exceptionally careful managed cases, a serious loss of their organic matter is unavoidable. The process, on the other hand, had increased the rate of the digestibility of the cellular matter, and rendered the beet-refuse more palatable to cattle. (O Kellner.)

Analysis of Dry Matter, of Fresh Green Leaves, and of the Ensilage of Beet-Leaves.

	FRESH GREEN LEAVES. Per cent.	ENSILAGE. Per cent.
Nitrogenous matter	26.71	21.23
Fat (ether abstract)	2.75	8.79
Crude fibre	14.99	18.56
Non-nitrogenous extract matter .	37.13	39.42
Ash	18.42	12.00

The pulp of beet-roots, obtained from beet-sugar factories, is treated in silos in a similar way. Frozen roots and potatoes are either crushed or sliced before they enter the silo, and frequently receive previously an addition of one per cent of salt.

A few analytical statements in this connection may not be without interest, as they convey at least some approximate idea concerning the alteration which the sugar-beet root usually suffers before its factory-refuse mass serves as cattle-food. (Ritthausen; Voeleker.)

	Water.	Nitrogenous Matter.	Fat (Ether Abstract.)	Non-nitrogenous Matter, includ- ing Sugar.	Raw Fibre.	Ash.
Sugar-beet root (fresh) .	81.77	0.85	15.07	—	1.36	0.944
Diffusion refuse beet-root (fresh)	93.50	0.51	0.035	3.66	1.33	0.962
Diffusion refuse beet-root (pressed)	88.54	0.86	0.11	7.37	1.91	1.23
Diffusion refuse beet-root (pressed, and changed into ensilage)	89.83	1.02	0.08	5.94	2.53	0.60

Corn Ensilage.—The treatment of corn-fodder in silos has of late acquired considerable prominence in Austria and France. Both countries contain quite large areas of land, well fitted by climatic conditions for an advantageous cultivation of corn. The successful and extensive application of the silo system in the sugar-beet industry of those countries has apparently greatly stimulated inquiries into its usefulness for general farm practice. In many instances in France, where the sugar-beet root is sold from a small farm to distant sugar-factories, and high freight rates prevent the return of the refuse beet-root pulp to the root-grower, corn ensilage is used to make up the deficiency in fodder, caused by the sale of the root-crop. Our late home experiments are apparently largely inspired by the teachings of distinguished French agriculturalists. As I have reason to suppose that interesting descriptions of our home experiments will be presented here to-day by gentlemen intimately acquainted with that subject, I shall confine myself to the description of an investigation carried on at the agricultural experiment station at Vienna, for the purpose of ascertaining the precise effect of the silo fermentation upon the composition of green-corn fodder, and the degree of loss which the organic dry matter suffers under that treatment.

The green-corn fodder was cut at an early stage of blooming, and, without any other preparation, carefully packed into silos of the usual size and form. Several feet in thickness of earth served as a cover. An analysis of the green corn before filling the silo, and after its opening from two experiments, gave the following results:—

	Water.	Nitrogenous Matter.	Fat (Ether Abstract).	Non-nitrogenous Matter.	Crude Fibre.	Ash.	Sand.	Dry Matter.
A.								
Fresh green-corn fodder,	79.35	0.90	0.76	10.82	6.67	0.63	0.87	19.72
Ensilage from 15 inches depth in the silo . . .	57.69	1.86	1.88	7.48	18.32	1.90	1.80	33.24
Ensilage from 30 inches depth in the silo . . .	77.84	1.06	1.08	7.48	10.38	1.01	1.21	22.22
B.								
Fresh green-corn fodder,	76.72	0.98	0.92	12.24	7.70	0.64	0.80	23.28
Ensilage from a depth of 37 inches	80.63	0.80	1.11	6.78	8.40	0.82	1.46	19.37

The following calculation of these results, calculated for the dry matter, gives a better chance to notice the changes of the latter in the green crop, as compared with the silo product:—

The Loss of the Dry Matter of the Green Crop in the Silos, stated in Percentages.

	Nitrogenous Matter.	Fat (Ether Abstract.)	Crude Fibre.	Non-nitrogenous Extract Matter.	Ash.	Sand.
A.						
Ensilage from 15 inches depth in the silo	27.8	13.0	3.40	44.5	5.9	—
Ensilage from 30 inches depth in the silo	32.4	14.5	5.3	57.9	2.10	—
B.						
Ensilage from 37 inches depth in the silo	34.4	3.1	12.4	55.5	2.30	—

Both nitrogenous and non-nitrogenous extract substances suffered the largest loss. The slight alteration in ash constituents proves that but little, if any, organic matter was lost in any other way than by fermentation. The corn ensilage contained in both cases various alcoholic products, and considerable quantities of fatty volatile acids. A careful comparative examination (A) showed, that, at about

fifteen inches depth in the silo, 27.9 per cent of the organic matter of the green-corn fodder had been lost, and, at a depth of thirty inches, 34.70 per cent; whilst in a second trial (B), at from thirty-seven to thirty-eight inches in depth, 34.8 per cent were lost. These results, in connection with those noticed in the previously described experiments with beet-root refuse and esparsette, demonstrate plainly that the preservation of green fodder in silos causes a considerable loss of valuable organic constituents, even when managed in an exceptionally careful manner. Those who are somewhat familiar with the transformation of starchy and saccharine substances into alcoholic products, and subsequently into acids, know that in either case nearly one-half their weight passes off in a gaseous state, and are therefore expecting in the silo treatment the largest losses in those articles of green fodder which contain in considerable proportion one or the other, or both, of these widely diffused proximate organic constituents of plants.

The composition of ensilage varies in a not less degree, taking the entire contents of a silo into consideration, than that of the green crop which serves for its production. The same is true as far as the ensilage in different parts of the silo is concerned, as has been shown in the preceding pages.

Composition of Corn Ensilage from Different Silos.

	Moser.		v. Jöhren.	Goessmann.*
Water	80.63	77.84	83.827	80.70
Nitrogenous matter	0.80	1.06	0.706	1.56
Fat (ether abstract)	1.11	1.08	0.769	0.62
Non-nitrogenous extract matter	6.78	7.48	9.176	8.92
Crude fibre	8.40	10.38	4.263	6.43
Ash	0.82	1.01	1.261	1.77 (crude)

Some Extremes of Variations in the Composition of Green-Corn Fodder.

	Per cent.	Per cent.
Water	76.8	85.7
Nitrogenous matter	0.9	2.0
Fat (ether abstract)	0.4	0.7
Non-nitrogenous extract matter	6.4	15.3
Crude fibre	3.0	5.9
Ash	1.0	1.2

* From the silo of John M. Bailey, Esq., of Billerica, Mass., December, 1879.

From the previous analytical demonstrations it will be quite obvious that the recommendation of the corn ensilage cannot well be based on its higher feeding value, pound for pound, as compared with green-corn fodder. The increased digestibility of the cellular matter in the corn ensilage, and the small, if any, increase of nitrogenous matter, is from a physiological as well as a commercial stand-point, to say the least, a doubtful compensation for the sugar and starch destroyed by the fermentation of the corn-fodder in the silo. An economical and rational feeding of the corn ensilage, as well as the green-corn fodder, requires as a rule, except when fed for a mere sustenance, an addition of a stronger article of food to meet the requirements of either growth, or work, or the production of milk and flesh. The silo system furnishes no exception to the rule that our practical modes of preserving fodder are accompanied with a loss in quantity and quality of valuable plant constituents, and that any attainable higher feeding value of our fodder-crops is almost invariably secured at the sacrifice of quantity. The question of waste is simply a matter of *degree*, when comparing existing modes of keeping fodder with that of the silo system. The correctness of the previous exposition once conceded, it remains for me to discuss briefly some of the circumstances which tend to make the introduction of the silo system a valuable addition to our modes of keeping fodder, and thus of increasing our resources for farm improvement.

The management of the silo system for preserving fodder is independent of the weather, — an advantage of particular importance in the case of juicy plants, so largely represented among our fodder-plants. The long period required for their change into dry fodder, or hay, endangers in a higher degree quantity, and in particular quality, than in the case of common grass. Exposure of green crops to rain, even for a short period, during the hay-making, alters the quality of the hay far more than usually suspected. A few analytical results may convey some more definite idea about the extent of the change.

(E. SCHULZE.)	Good Clover-Hay. (No rain.)	Clover-Hay exposed for two weeks to rains.
Water	14.11	14.76
Nitrogenous matter	11.22	8.15
Fat (ether abstract)	2.40	1.61
Non-nitrogenous extract matter	35.33	29.61
Crude fibre	33.68	43.02
Ash	4.26	2.86
Sum of nutritive matter	48.95	39.36 (— 20)
Matter soluble in water	27.77	15.34 (— 45)

(E. HEIDEN.)	Good Clover-Hay.	Clover-Hay exposed for two weeks of rainy days.
Water	14.51	14.51
Nitrogenous matter	17.05	14.02
Fat (ether abstract)	5.06	3.29
Non-nitrogenous extract matter	31.04	9.77
Crude fibre	25.72	52.69
Ash	6.62	5.72

Good lucern-hay lost, in consequence of an exposure to some rain-showers, within two days, 7.13 per cent of its dry matter (O. Kellner); in another case, where the lucern-hay had within six days repeatedly suffered from rains, a loss of 16.7 per cent of dry matter was noticed. The nitrogenous and non-nitrogenous soluble constituents of the plants are mainly affected by rain. The stage of growth, the more or less advanced state of dryness of hay, and the surrounding temperature, control here, to a large degree, the extent of the loss in soluble organic matter.

Fodder-plants like clover, with coarse juicy stems and tender leaves, usually suffer seriously in their feeding value, by frequent handling, from loss of leaves, which are the most nutritive parts of the plant. The loss due to this source shows itself everywhere in the inferior digestibility of a common clover-hay, used in actual trials, as compared with carefully prepared clover-hay, where a large proportion of its leaves had been saved. The differences in the rate of digestibility of the various constituents of green clover and clover-hay, obtained from the same crop, arising from the

loss of leaves in the case of the clover-hay, has been noticed to amount, even in a careful farm management of hay-making in fair weather, to from two to six per cent less of the several proximate constituents of the dry matter in the clover-hay. Observations on lucern confirm the previous statement. The following analytical results give some more definite idea regarding the amount less digested of each constituent in the case of clover-hay as compared with the green clover. Cattle served for the experiment. (Kühn.)

	EXTREMES.		AVERAGE.
	Per cent.		Per cent.
Total dry matter of fodder	1.3	to 5.6	3.7
Organic matter	3.7	" 6.0	5.1
Nitrogenous matter	1.4	" 4.1	3.0
Non-nitrogenous extract matter	3.9	" 6.1	4.9
Crude fibre	2.3	" 6.8	4.4

Careful investigation of a quite recent date (Kühn, Wolff, etc.) has proved that a mere drying of our common fodder-crops, as grass, clover, and other leguminous plants, does not affect their rate of digestibility. The green fodder, and the dry fodder or hay (entire plant) from the same plant, in the same stage of growth, have shown a corresponding rate of assimilation of their dry substance. Whenever, therefore, the production of dry fodder can be carried on in a short period of time and in a satisfactory manner, the largest amount of dry matter of the highest attainable feeding value may be secured from the plant in that way: no other current mode of preserving its feeding value can equal it in regard to the quantity of the result. As, however, the quality of a dry fodder, as hay, clover, stover, etc., depends on the influence of the weather, and the mode of handling and of keeping, — circumstances which are to a large extent, in ordinary farm practice, beyond personal control, — our various articles of dry fodder are frequently far from what they might be, or ought to be. The above few analytical statements regarding the loss, in case of the dry fodder, by waste, of the tender parts of the plant, as well as regarding the influence of rain on half-dried fodder, give us at least a chance to *approximate* the loss, in nutritive constituents, from these two sources, which are liable to acquire unusual importance in case of those plants for which the silo system

has been judiciously recommended. The ensilage contains, without any particular exertion, the entire fodder-crop, leaves and stems unimpaired. The quality and quantity of the ensilage, in case of a carefully constructed cistern and ordinary care in management, suffers mainly from but one source, — fermentation. The waste of nutritious plant constituents in the silo appears, probably, to most of us large, even ruinous, because we have taken but little pains to find numerical values for the depreciation in the feeding value of our fodder-crops, which our current modes of preserving fodder are liable to permit or to favor.

Preferring actual results to mere approximations, and ascribing, therefore, to the silo system a higher rate of unavoidable waste of feeding value than to any other current mode of preserving fodder, it ought to be remembered that there are some redeeming features connected with the product of the silo, — the ensilage, — for which it will be difficult to find one definite numerical value when comparing it with the dry fodder of the same plant; namely, the silo fermentation increases the rate of digestibility of otherwise indigestible constituents (cellular matter) of the green fodder, and thereby compensates somewhat for the waste of valuable soluble organic matter; and the ensilage of those crops for which the silo system is judiciously recommended is almost invariably more acceptable to all kinds of farm live-stock than the dry fodder.

When we add to the previous enumeration of exceptional advantages arising from the introduction of the silo system the one that it will tend to increase the production of one of our most important fodder-plants, the corn, and that it will enable us eventually to take care of important refuse materials from various branches of agricultural chemical industry, as sugar or starch manufacture, we can but desire that its financial relation to our farm economy should receive the most careful practical investigation. The silo system is not a substitute for existing modes of preserving fodder, but will prove a most valuable assistance to increase our chances of securing larger quantities of good fodder.

do is to reduce it to a certain lower proportion; and that is all that Mr. Goffart would claim. Probably his translators have not given us his full views. The process of fermentation is so well understood, that it is no longer a matter of controversy. Scientists agree on that entirely. The practical results, at least, are fully agreed upon. We know what becomes of sugar in the presence of nitrogenous matter. We know, that, whenever the cellular structure of a plant is injured (as is the case with the contents of silos in the majority of instances), transformation begins. The soluble nitrogenous matter comes in contact with the saccharine and starchy substances; and what is the effect? The sugar is changed, according to circumstances, either into lactic acid, or into alcohol and carbonic acid, and subsequently into acetic acid; and we find, therefore, in our best-constructed silos, with corn-fodder, acid to a large extent; namely, acetic acid and lactic acid. The former is the result of the oxidation of the alcohol. That is the natural consequence. Fermentation and oxidation are two distinct processes. The one causes the breaking-up of certain substances into compounds of a simpler constitution; as, for instance, sugar breaks up into alcohol and carbonic acid. Nothing is lost from the make-up of the sugar. Acetic acid means the access of oxygen to the alcohol, and the formation of water. Alcohol and carbonic acid are only intermediate processes. Therefore, if we are not careful, we may destroy the contents of the cells as starch and sugar to a ruinous extent. In other words, a silo treatment may destroy fifty per cent of the feeding value of your food. The above-described experiments tend to prove that we cannot prevent the destruction of from twenty to twenty-five per cent at least. Scientists do not agree as to the physiological value of the various compounds produced. In regard to starch and sugar, we know by experience what they are worth in the animal economy: what lactic acid is worth, we are yet in doubt, and what alcohol is worth is still a matter of dispute to-day. We have thus, in one case, compounds of recognized physiological value, whilst on the other side we have a series of products of decomposition without any proof of what they are relatively worth in the animal economy as compared with the substances from which they originated.

There is, therefore, what I call unavoidable destruction in the operation of the silo system, as a partial fermentation is, in practice, still unavoidable.

Mr. WARE. I am very glad of the explanation; but I am sorry to have some of the starch taken out of the ensilage system. It strikes me that the box that has been spoken of, placed in the bottom of a silo, would not be compressed so solidly as a silo well loaded would be. If that is the case, I think it would account for a large portion of the destruction that took place in that box.

Now, in illustration, I would like to state one fact that has come under my own observation, that it seems to me is exactly in the line of this silo preservation. I live on the seashore, and we on the seashore depend very largely upon the ocean for material for fertilizing purposes in the form of kelp. Kelp taken from the seashore, and exposed to the air, will, within thirty-six or forty-eight hours, even in winter, reach a state of high fermentation, and become so warm, that maggots will be produced even in the middle of winter. Now, when we have a large amount of kelp come up on the shore, we go to work and team it up, load after load, treading it down continually, until we have a pile perhaps eight or ten feet high, which becomes very solid; and two or three months after (although it is a substance that will ferment very rapidly,—as quickly as green corn fodder), while the surface of that pile for the depth, perhaps, of ten inches, where it has not been trodden quite solid, will be badly decayed, the remainder of the kelp-leaves are perfect, the color is retained, and it seems to retain all the characteristics of the fresh plant.

Now it seems to me that here is an illustration of the operation of a silo. This kelp has been preserved, if you please, by this system of ensilage, in a perfect condition, with no appearance of fermentation having taken place. It seems to me that the great object in our silos is to follow out this simple illustration; that is, we must fill the silo so rapidly, and tread the green fodder so solidly, and load it finally so heavily,—as I understand, not less than twelve hundred-weight to the square yard,—that the air will be expelled; and it will be kept hermetically sealed from the air, so that fermentation cannot take place.

Now I may be mistaken. I have not gone into it, although I have studied the matter carefully; but, if fermentation cannot be prevented in that way, I fear that our system of ensilage is not going to meet the expectations that I, at least, had conceived of it.

Professor GOESSMANN. We apply the name "fermentation" to several changes which are taking place in vegetable matter. We have the vinous fermentation; and alcohol and carbonic acid are its products. We have the slimy fermentation; and lactic acid, a non-volatile acid, is mainly produced. These latter changes are everywhere taking place where nitrogenous matter is mixed with non-nitrogenous matter under limited access of air. They are very serious, and cannot easily be prevented. It is a mere matter of degree. Take, for instance, a simple grape-berry. You can keep that berry by drying it carefully, as is done on a large scale. But take that berry, and give it the slightest laceration with the finest needle you can conceive of, and that berry is gone. From that spot disintegration will take place, and it is only a question of time what shall become of it. It is an illustration of the process of destruction that is continually going on in the world. After life comes death. The moment that cellular system is broken, there is a retrograde movement, and the grape-berry goes back to its elements. So it is simply a matter of degree. I might say, of course, that the changes take place in different directions. In one case, it is lactic acid; in the other case, it is acetic acid. But what does it matter? A change from a valuable constituent of fodder into a constituent of very doubtful value is the result. We shall always find the largest losses in the ensilage in the corn; and, if we should take sugar-corn, it would be still more ruinous, as sugar is a most essential constituent of that kind of corn; and for this reason, ordinarily, the decomposition of the sugar-corn would be far greater than of the common corn.

Mr. CHEEVER. Before the professor leaves the platform, I would like to ask him if our canned fruits do really keep perfectly in glass jars, sealed tight, put up boiling hot, or whether there is fermentation going on in those bottles.

Professor GOESSMANN. When you can your fruit, it being heated up to a certain high temperature, you bring

it up to the point of the destruction of life. Fermentation is due to living organism floating in the air. These living germs, coming in contact with vegetable matter, begin to develop, and will continue to develop just as long as their life lasts. If you heat up any article to be preserved to a point where you destroy the living organisms, and seal it up air-tight while hot, you will fail to find any alcoholic products in that can.

Mr. CHEEVER. Then the two cases of putting ensilage into an air-tight box and canned fruit into bottles are not parallel?

Professor GOESSMANN. No.

Mr. CHEEVER. I suspect that box was filled as tightly as possible. If we know what influences the result, we shall be very careful to exclude that influence; and I suppose the parties considered that very carefully. They knew air was a destructive element, and, if they wanted to obtain a result worth any thing, they adopted a system which they thought would best bring about the result, and excluded air as much as possible. Taking that for granted, is not a tight box in the middle of a silo far better protected than any part of the silo?

Professor GOESSMANN. The only practical way to do it better is to turn in water at a certain stage, and let the water exclude the air. These experiments have, however, not been sufficiently tried to determine what the exact result would be. The water would probably dilute the material so much as to make it worthless.

Mr. WHITTAKER. I should like to ask the professor, in connection with this matter of the exclusion of atmospheric air, a question which I think bears very seriously upon the point. In order to preserve any thing practically, as I understand it, we have either to get rid of the water, or get rid of the atmospheric air. If we retain the water, we must expel the atmospheric air: if we retain the atmospheric air, we must get rid of the water. Now, here is the point with regard to this ensilage business. We fill the silo, and, in filling it, we put in a certain quantity of decayed matter. Can that be avoided? I have always been taught that matter in a state of decay, however small it may be, will carry decay through the mass. It would not make any dif-

ference if the silo was as big as this building, and filled full, if there was a piece of decaying matter as large as my fist in it, it would produce decay in the whole mass eventually. The entire exclusion of atmospheric air will prevent that. But do we exclude atmospheric air from our silos? I do not believe it has ever been done. We fill the silo, and the matter we put in is loaded with atmospheric air. As it goes in, atmospheric air goes in with it. We put our plank on top of it, we weight it down, and we put earth on top in order to exclude the atmospheric air. But we have all the atmospheric air in the silo that was in the material we put in, and, when we compress that, we simply condense the atmospheric air that is in there, and, by condensing it, we render it more efficient to prevent fermentation. Is not that so?

Professor GOESSMANN. Oh, yes, sir! It is only a matter of degree. It is practically impossible to exclude air absolutely. The simple question is, practically, Can we, with a moderate expenditure of time and labor, preserve our fodder in that exceptional way? If a simple mode of operation will not do it, the whole thing is not worth having; but, if a simple mode will accomplish it, it is. There is a partial loss which is inevitable.

Dr. STURTEVANT. In the changes which are taking place, there is a production of carbonic acid gas, which excludes the air to a certain degree. In some cases, certainly, where an opening is cut down into the silo, and a lighted candle dropped in, the candle will be extinguished. This carbonic acid gas in some silos certainly expels the atmospheric air to a certain extent, occupies its place, and stops putrefactive change.

Professor GOESSMANN. There are two processes in operation in fermentation which we have to keep in mind: one is the action of air, and the other is the action of living germs. The exhaustion of the air amounts to very little, as you will understand when you know that one pound of sugar will dispose of all the oxygen in that silo, and leave nitrogen behind. Nitrogen takes its place. The presence of nitrogen excludes air. As Dr. Sturtevant mentioned, if you put a light into the silo, it will go out as quickly as in carbonic acid. Therefore there are two causes which will

dispose of the air. The destruction of the germ-life is a far more important question. That is disintegrating without air: that transforms all the constituents, it changes the sugar, etc., into lactic acid without the aid of air. In our canning system we get the germs out of the air: the heat destroys them. A little air we do not care about. A few grains of sugar will dispose of the oxygen of the air very effectually; but it cannot dispose of the germs that are there. They are living beings, multiplying by millions, and we know that those forces are most powerful. It is that continued multiplication which destroys the plant.

Mr. WHITTAKER. As I understand Dr. Sturtevant's point, it is, that, as the carbonic gas increased, the oxygen would be expelled; but, if the oxygen cannot get out, I do not know where it is to go. As I understand that the carbonic acid, when formed, is no greater in bulk than the oxygen that is contained in it was before it was converted into carbonic acid, this carbonic acid formed from oxygen will occupy just the same space, and no more, as the oxygen before it combined with the carbon to make carbonic acid. Consequently the atmospheric air would be just as prevalent, notwithstanding it was mixed pretty well up with the carbonic acid. It would not be displaced, but would occupy just the same space that it occupied before it was combined.

Dr. FAXON (of Quincy). Among my labors at the National Sailors' Home, of which I am superintendent, has been the reclaiming a large quantity of salt meadow, part of it covered with black grass, which I cut yearly, and used for bedding altogether. Last May I went to Billerica, and saw the silo of Dr. Bailey, and I concluded that all there was to a silo was the exclusion of air: so I thought I would try the experiment with some of my black grass. I took a lot of old boards, and enclosed one of the end bays in the barn, ten feet by twelve, in the loosest manner, and I put into that all the black grass I cut on two acres and a half of the marsh, and trod it down very thoroughly. I think I commenced on the fifteenth day of June, which was Tuesday, and I finished on Saturday. The grass was cut every day after the dew was off, and put into the bay. On the barn-floor side I put up simply one upright three by three post, and put in the boards. The heat was sufficient to be disagreeable to the

hand, and people said the barn would burn up. When all was in, I put boards on crosswise, and loaded that grass, which was then about eleven feet high, with stones, at the rate of at least a hundred pounds to the square foot, and reduced the pile as much as I could. It sunk at least a third in bulk. Some four or five weeks afterwards — possibly it was not more than three weeks — I commenced on the front side, and took down the boards, and cut off a strip about two feet wide, which had moulded for about three inches in. That fodder was a rich tobacco-color, and, instead of being acid to the taste or smell, it was positively sweet. It had a taste like honey. The flies came to it in swarms. I fed it to my cattle, and, although there was not a creature that would eat this black grass in its original state, they all ate it readily. My cows did not decrease in milk: they kept in just as good condition all through. I fed them almost exclusively on this fodder. I don't believe I gave two pounds of hay a day to the cows. Of course, there was some transformation in the product which rendered that fodder, which before was of little value, of considerable value. I am not going to discuss the question as to whether silo product is worth more than the same product would be if fairly saved in a dried condition. I simply state the results of my experience, that any other man, if he chooses, may try the operation.

QUESTION. How long did the grass remain in the field after it was cut?

Dr. FAXON. It was carried directly to the barn. Probably there was none of it remained an hour on the ground after it was cut. I fed it until midsummer.

I tried another experiment about the same time. I had a box that I had used to steam food in. I begin to cut my grass as soon as it is high enough, and feed it to my cows. I took that box, and put in probably a ton of grass, and weighted it the same way; and at the end of three weeks it had developed quite an acid smell and taste. You could not get any such sweet taste out of it as out of the black grass.

I will mention an experiment with corn-fodder. I had a lot of fodder that I cut in October. It was sowed the last week in July between my potatoes. I marketed the potatoes; and when the frost came, to save that fodder, I made a pit eighty-four feet long, ten feet wide, and fifteen inches

deep, and put the corn in this pit. On the edge of the pit, so as to make them flush with the inside edge, I put up a lot of old posts six feet apart; and I boarded up the sides five feet high, loosely, with hemlock boards. It took nearly a thousand feet. As the fodder was cut when the dew was off, I brought it to the pit and laid it in, butts all one way, lapping the butts as one laps shingles, so as to make the small tops lie with the butts; and I carried that process out the whole eighty-four feet. Not having quite as much as I wanted, I carried down there five large tip-cart loads of fodder that was cut when the corn was, and from which the corn had been husked, and put that on top of the green fodder, which raised it above the boarding: I put on top a little thatch of eel-grass, and threw on fifteen or eighteen inches of dirt. When the mass settled, the acid smell was scarcely perceptible. You could put your hand in five days after the first lot was put in, and the heat was not at all uncomfortable. You could feel it was warm.

Professor GOESSMANN. I can but confirm your observation. The result depends entirely upon the composition of the plant. Grass and clover will produce an ensilage quite different from corn. A plant which has little sugar will act quite differently from a plant that has a great deal of sugar. There is no need of having an acid: it may be even alkaline. The main question is to prevent the change from going beyond a certain point, and injuring the feeding value of the material. Those plants which contain the largest amount of sugar will produce the largest amount of acid: therefore corn ensilage is usually sourer than that from clover or any other plant.

Dr. FAXON. The mass settled down so that it would weigh fifty pounds to the cubic foot. It was a little mouldy at one end for two or three inches; and I shovelled off the dirt, and cut that part out, and I found there was a great deal more acid than there was in the bay of black grass. But the cattle ate that fodder just as well as they did the other, and the increase in milk was quite remarkable. I had been feeding shorts, four quarts, cotton-seed meal and Indian-meal a quart each, daily. I diminished the grain within two days just one-half, and the milk increased one-eighth; and I fed with that about five pounds of hay to each cow per day.

The silo product is not mouldy anywhere. The fodder that was perfectly dry and put on top is eaten up just as clean as can be. By this simple method farmers can preserve their fodder in a moist condition, so that the cattle will eat it all; and they can save labor, because it is much easier to put it in a silo in the field than to cut it up. If you cut it up, it will heat tremendously in twenty-four hours.

I have no doubt but that I shall raise a great deal of corn-fodder, and put it up in that way, simply because it is handy; and we can get more of it in that way than in any other.

I don't know but I should hesitate in regard to putting sugar-corn down in this way, after what has been said about it.

Professor GOESSMANN. It would depend upon at what time it was put in.

Dr. FAXON. I planted some green corn for market, and it gave me a little over twelve pounds of fodder to each kernel. That was the Burr corn. There were eleven thousand kernels to the acre, and that is nearly sixty tons of green fodder. The land had been in grass seven years. I ploughed it up last year to kill the witch-grass out of it. It had been top-dressed nearly every year, and this last year it was manured simply with a very little compost of hen-manure. I planted my corn the first day of May (rows four feet apart, one grain in a place a foot apart); and along in July I cut some of it up for fodder, and got at the rate of sixty tons to the acre. I feed about sixty pounds a day of the corn-fodder. Dr. Bailey says that is sufficient to feed a cow, without any hay: I do not think it is. I feed a little hay, and I think I get a better result.

Professor GOESSMANN. There is a point which needs explanation. Feeding corn-fodder, which differs in its composition from the requirements of the animal to support its life, can only be accomplished by the waste of one or the other constituents of the material. If we feed an article of fodder in which the nitrogenous matter stands to the non-nitrogenous as one to nine, we give, in many cases, more non-nitrogenous matter than the animal requires. For instance, a milch cow requires, according to long-continued experiments, the proportion of one to five and a half,—almost one-half nitrogenous matter more to give you the benefit of the other

half of non-nitrogenous matter: in other words, you waste half. The same is true if you feed green grass alone, or hay alone, or clover-hay alone. The proportion of nitrogenous to non-nitrogenous matter in good clover-hay is about one to three, or one to three and seven-tenths. Now, if a cow needs only the proportion of one to five, you waste a fair proportion of good fodder in that clover-hay. The experiment has been successfully tried to see if we can supplement our hay and clover by straw, or by materials that contain one to nine, or one to ten. Here comes in the question of cheapness of feeding, which the farmer has to study. There is an actual waste of feeding value in feeding the best hay without any addition, under almost any conditions. That fact has been established by practice. The same is true with regard to clover-hay and other leguminous plants. We are just beginning to discuss this important question of rational feeding; and we can never come to a decision, unless we take into consideration, besides the character of the fodder, the particular requirements of the animal. If we feed for sustenance merely and for the production of milk on the same scale, we waste, in one way or the other, our food; and it is necessary for us to learn in what proportion we can economically supplement by lighter and inferior articles of fodder our strong articles of fodder, as, for instance, good clover or meadow hay. It is important to consider the requirements of the animal with reference to what it is to do. A horse to do good work requires a larger relative amount of nitrogenous matter than a horse that stands idle. An ox which is kept through the winter simply for work in the spring can be kept at a far cheaper rate than an ox that is put to daily labor. With us the question remains, how to make a practical application of this fact.

I listened with a good deal of interest to the discussion on feeding yesterday; but, for one, I must say that there is no basis for comparison. Without having any information regarding the quality of the fodder which has been fed, how can we draw any reasonable deduction as to its feeding value? The question of quality is of the first importance. The discussion of ensilage, I think, has come up at the proper time. It may serve as the means of stirring up the fodder question, which needs further ventilation (there can be no doubt about it) as much as the fertilizer question.

Mr. BOWDITCH. I would like to ask what the effect would be upon the fodder if a rain should come up, and it should be wet as it was being put into the silo.

Professor GOESSMANN. It would have no effect whatever. That is one of the great advantages. It renders us independent of the season in regard to those crops which suffer most from exposure.

Dr. WAKEFIELD. We have listened to a very able address from Professor Goessmann on the ensilage system. He has given us the facts in regard to the preservation of fodder in silos which cost considerable money. We have had an experiment given by another doctor, which any of us can try. It is within the means of anybody here who raises corn to try the experiment, because all he has to do is to plough up his land, and make his silo in the field. I am very much interested in this last process, because it comes down to my means, and, I think, to the means of all of us. I do not see why, from his description, the fodder is not preserved substantially as well as in the expensive silos. He says his cattle eat it readily, and he says his milk keeps up. Those are the two things that we want. The professor has stated here what is lost and what is gained by the silo, and he says that it is necessary to exclude the air; and the question is, how much shall be excluded? We cannot go into the process of extracting the air by an air-pump; but, if we can exclude it sufficiently by piling up some rough hemlock-boards at an expense of something like fifteen or twenty dollars, we can afford to do it if we can obtain a feed, which, in the main, answers the purpose just the same as if we had an air-pump in operation, and pumped all the air out, which would be too expensive a business for us to engage in.

It seems to me that this experiment is of vast importance to us. We have heard what the professor said here about experiments in Germany and France, and the experiments which are made in silos which cost a great deal of money. If we can have the same advantages, in the main, without so much expense, then there is a great amount gained. Now, this ensilage that Dr. Faxon has brought here looks like tobacco; but if his cows don't call it tobacco, and will eat it, and give milk in proportion, it does not make any difference

whether it has turned green, or gray, or dark-colored. We want the facts in the matter, so that we may know whether we can get the benefits of this system without too much expense. Here is a chance, I conceive, to try the experiment. He has tried it on a cheap scale, and we can all try it in a similar manner.

Dr. FAXON. I wish to say that there is one thing which might make this cheap process of preserving fodder of value. It is very easy for us to buy oil-cake, or any nitrogenous commercial article; but if we can raise forty, fifty, or sixty tons of corn-fodder on an acre, and by that means keep four or five cows in the barn, and put the manure on the ground, it will enable us to use a good many acres that are of no value now. That is the point we are after. I will not take issue with the professor on the loss; but the question is, How much shall we gain? If we have land that does not bring in net five dollars an acre, if we can make it yield fifty dollars an acre, there is so much gained. That is the only practical point there is about it. It enables us to save fodder that we could not save in any other way.

Mr. JOHNSON (of Framingham). I suppose the matter of dollars and cents is to come into this silo question, and therefore I venture to speak of the cost of preserving field-corn. To take sixty tons of green corn and cut it up into pieces an inch long, and put it into silos, is very expensive. I think Dr. Faxon has demonstrated thoroughly that corn can be kept in the inexpensive way he has described. Now I wish to state, that in 1866 or 1867 I packed a bay of hay that was not in the field over an hour from the time the scythe dropped it. The timothy was not in full blossom when it was cut. I packed it so that it was all laid even and straight through the mow, and kept it as nearly air-tight as possible. The barn had no cellar. The hay was packed close to the ground, with plank underneath. That hay was thoroughly preserved. It had a fine brown shade, and was the sweetest and best hay for milch cows that I ever fed. I could not put in my hay where there is a cellar underneath in that way. That hay was, as I have said, thoroughly preserved, except about a foot in depth, which could not be kept as tight as the rest of the hay in the mow. I am confident that the gentleman's theory is correct, and his experi-

ment is correct every way; and hay may just as well be kept dried in that form, as dried three or four days, and lose half of its value.

The CHAIRMAN. Why didn't you go on getting your hay in that way?

Mr. JOHNSON. I did, until I got a cellar under my barn.

Mr. SIMONS. The last gentleman who spoke left the inference on my mind that he thought the drying of hay was injurious. I understood the professor that drying did not injure it.

Professor GOESSMANN. No crop loses in its feeding value by careful drying. It is the only process by which the ordinary feeding value of grass may be preserved entirely. The making of brown hay, as Mr. Johnson has described, is a practice which is carried on, to some extent, here and there, and when we cannot dry our grass it comes in as a great help; that is, the loss is not as great as in a silo. But it is more difficult, and I suppose will be found more difficult to manage successfully than the management of a simple silo.

Mr. WILLIAMS. What effect does falling dew have?

Professor GOESSMANN. The falling of dew is not of any particular consequence.

Mr. WILLIAMS. Then there is no disadvantage if we do not cock our hay up at night?

Professor GOESSMANN. I have never seen any evidence of it.

QUESTION. Is there not always a loss when hay is stored damp enough, so that sufficient heat is generated to change its color?

Professor GOESSMANN. Yes, sir: there is no doubt about that. Heat indicates a chemical transformation, a change of valuable material, no doubt. The difference between brown hay and ensilage is a mere matter of degree, nothing else. If brown hay is well managed, the production of it undoubtedly saves more than the production of ensilage will. But as I understand, and general observation tells me, it is more difficult to prepare brown hay of good feeding qualities than to prepare good ensilage.

QUESTION. Is it possible, in getting in hay that is not thoroughly cured, to tread it solid enough in the mow to preserve it any better than if it is not trodden down? Can you exclude the air by that operation?

Professor GOESSMANN. Yes, sir: quite sufficient to reduce it to the smallest quantity. You will find the outside portion of the hay injured rather more than the interior part, because that affords a freer passage for the air.

Dr. FAXON. A gentleman just asked about putting in hay green to make brown hay. It should be known that it is not necessary to dry hay a great deal. I will relate an operation of mine, simply to show you how a large mass of partially dried green fodder can be put in. Some seven year ago I mowed about ten acres of Hungarian grass, mixed with wormwood: it was almost as thick as it could stand. I finished cutting it at night, and left it until the next morning. The next day that stuff was as green as it could be. There was certainly as much as twenty tons of it, two-thirds or more wormwood. I made a stack of it, thatched the top, and it steamed there until February. I did not cut that down until August, the second year after; and there was not a brown straw in it: it was just as dry and fresh as it could be, showing that there was not enough water left in the stack to produce any organic change, or else that it all worked off in steam. That was the best lot of hay I ever saw of that kind. There was not a foot of it at the top damaged.

Major EMERY (of Lowell). I certainly, for one, have felt more pleasure, and been more benefited, by this lecture, than by any paper or any lecture I have ever heard or read since I have been in the farming business. It seems to me that either chemistry must go under, or this silo business. I think chemistry has done more for farming than any thing else of late years. I think it has taught us more in the right direction, and in the end will produce more. It will revolutionize most of our modes of farming.

I have discussed this same subject with Dr. Bailey at Billerica; and, to show you how people look over the surface, I will name one thing that came up. He took the ground that fermentation created and brought out the sugar, which is entirely different from the fact. I took the ground that fermentation brought out the alcohol. Now, we have had the yellow-fever in the West, and we have had a commission of the Board of Health to look after it, and see if there cannot be a stop put to it. We have had the small-pox in many

places, and we have had the Board of Health after that. Now the American people have the disease of silo on the brain; and we have a man here who has, I think, shown you the merits of it. I hope that the State Board of Agriculture will print this address in some form, so that every man who has silo on the brain can read for himself, and make up his mind whether he will have a silo or not; whether he will go according to the facts as given us by chemistry, or whether he will take the thing that first strikes his mind, because his cows appear to do a little better, and perhaps, the first week, will yield a little more milk. I think the lecture to which we have listened is worth more than any paper that was ever put out by any agricultural society; and I hope that it will be published in such shape, that every farmer who can read and understand will know the exact benefits or disadvantages from excluding the air from this green food. I am not a chemist, and I do not know whether the ground taken by Mr. Bailey is right or not; but, when I have a piece of timber that I want to use, I turn it over to see if there is not a knot on the under side. I hope the people will look this matter over very carefully before they spend any money.

Capt. MOORE. I would like to ask Professor Goessmann whether, in his judgment, there has been any improvement over the old plan of "making hay when the sun shines."

Professor GOESSMANN. No: I stated that most distinctly. There is no improvement over that method if the weather is favorable; but, as I said, the system of ensilage will be an assistance in saving, in many instances, a large quantity of valuable food. In unfavorable seasons it will undoubtedly prove very valuable to the farming community, under proper management. I think simple ditches will do. It is not necessary to have expensive masonry in a silo. A pit, if lined with boards to prevent leakage, will do as well on a moderate scale. The only difficulty about a silo made in the ground, and unlined, is, that a large amount of the soluble portion of the material will be apt to leak into the loose soil. I stated that in one case fifty per cent of the value had been lost by simple leakage in the ground. What we want to preserve is the nutritive portion of the fodder: and, if any part of it passes into the ground in form of a solution, much is lost; for the solution contains the most valuable portion of

the fodder. It is for this reason not the proper thing to construct a silo in loose soil. It would be far better to line it with some suitable material, and use it year after year for the same purpose.

Mr. WHITTAKER. I want, before this meeting dissolves, to submit a resolution; and I would like to state the reason why I submit it. When it was first announced that the Board of Agriculture was to hold its annual session in Southborough, there was a good deal of criticism elicited in connection with it. It was thought highly preposterous to make the attempt to hold this meeting of the Board in a small place like Southborough, where there was not a hotel, within four or five miles of the town; and how we were going to manage it, and how we were going to get an audience to listen to the addresses that might be delivered, was a question that nobody could solve. When I came here the other morning, I supposed the meeting commenced at the usual time, ten o'clock; and I got here about eight, in order to be present at the opening of the meeting. It seemed to me a remarkably quiet place. It was so quiet, I could not get away from the idea that I had made a mistake, and come up on Sunday. But that is not the point. At a great many meetings of the State Board previously, it has been supposed that it was necessary to go to some populous centre in order to get an audience. This delusion has been dispelled in Southborough. As I understand, the population of this town is not much over twenty-five hundred. We have had very stormy weather. Yesterday was an exceedingly stormy day, and yet this hall was full. I do not know what we should have done, if it had been a pleasant day, so that people could get here. This hall certainly would not have been large enough to hold the audience. There are ladies enough in Southborough interested in this matter to fill this hall if it had been a pleasant day. They have been interested enough, small as the place is, to feed us, and feed us well. I do not know that we were ever better fed, better entertained, or better cared for in every respect at any place, however large.

Now, Mr. President, I submit this resolution:—

Resolved, That the guests of the State Board of Agriculture desire to express their thanks to the board for holding this meeting in a strictly agricultural district.

The resolution was adopted.

QUESTION. I would like to ask the professor one question: What, in his judgment, would be the effect upon domestic animals of eating the product of a silo day after day, and week after week, through the winter? Whether it would induce any disease in the stock? That is a serious question to my mind.

Professor GOESSMANN. Feeding exclusively ensilage in large quantities is not to be recommended. It ought to be supplemented, without doubt, in many instances, with some other stronger article of food. Ensilage contains frequently a large quantity of acid, and I should recommend that it be supplemented by something else to counteract the effect of the acid. For instance, give forty pounds of ensilage, and supplement with some hay, and similar, even stronger articles of fodder from time to time. No one article of fodder can be used economically for all kinds of animals in different conditions, with equal advantages.

The CHAIRMAN. Before dissolving this meeting, in behalf of the Board of Agriculture I desire to express again our great gratification at this large and most intelligent audience. The meetings have been larger and better and more successful, I think, than any of the country meetings I have ever attended; and, while we feel thankful for our kind reception here, we certainly ought to thank you, in behalf of ourselves and our speakers, for the close attention which you have paid to the papers; and I believe you will be rewarded for this in the present, and still more when you receive the Secretary's Report.

And now, in behalf of the Board, I bid you farewell, and hope for a happy return to your homes.

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