SILOS AND ENSILAGE.

THE PRESERVATION

OF

Fodder Corn and Other Green Fodder Crops.

Comprising the Most Recent Information.

NEW AND ENLARGED EDITION.

EDITED BY

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OF THE AMERICAN AGRICULTURIST.

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CONTENTS.

	Page.
INTRODUCTION	7
How is the Fodder Preserved	9
CHAPTER I.	
The Progress of Ensilage	11
CHAPTER II.	
Raising Fodder Corn for Ensilage	13
CHAPTER III.	
Location of and Building the Silo	15
The Size of the Silo	19
CHAPTER IV.	
Cutting and Storing the Fodder	20
The Proper Size to Cut Fodder	20
Filling the Silo	21
Covering the Silo	22
Salt and Straw	22
CHAPTER V.	
Concrete Silos	23
Whitman & Burrell on	26
CHAPTER VI.	
European Experiments in Ensilage	27
CHAPTER VII.	
Messrs. Buckley's Experience in Ensilage	36
CHAPTER VIII.	
Whitman & Burrell's Silos	41

CHAPTER IX.

Ensilage in Hungary 47

CHAPTER X.

The Ensilage of Brewers' Grains 51

CHAPTER XI.

The Ensilage of Other Crops than Corn 54

CHAPTER XII.

The Nutritive Value of Ensilage 60

CHAPTER XIII.

An Above Ground Silo 66

CHAPTER XIV.

"Sour-Fodder"—Primitive Ensilage 69

CHAPTER XV.

Ensilage in Germany 73

CHAPTER XVI.

Sweet Ensilage 77

CHAPTER XVII.

Experience with Ensilage 80

CHAPTER XVIII.

Supplementary Notes on Ensilage 85
- Increasing the Capacity of a Silo 85
- Ensilage for Poultry 86
- The Chemistry of Ensilage 86
- The Character of the Manure 88
- The Ensilage Congress 88
- Crimson or Scarlet Clover 89
- To Build a Cheap Silo 89
- The Temperature in the Silo 90
- Nomenclature 90

PREFACE TO THE NEW AND ENLARGED EDITION.

When this work was first published the preservation of green fodder in the silo was new to the majority of American farmers. Since then this method has passed beyond its doubtful stage, and the question at present is not so much as to whether it is practicable and profitable to preserve fodder as ensilage, as how to build the best and most economical silos, and the proper treatment of their contents. The object of the first edition was to present in a compact form the essential facts concerning silos and ensilage; a new edition being called for, such additions have been made as the progress of the method required, and the work is thus materially enlarged as well as essentially improved.

Though the agricultural world is indebted to M. Goffart, of France, for first demonstrating the practicability of preserving fodder in the silo upon a large scale, others, especially in this country, have done much to simplify and improve the method. Here, where the principal fodder-crop, maize, attains its greatest perfection, this method of preserving it should prove of the greatest value to our agriculture. Already American ingenuity has produced machines and appliances for facilitating the labor incidental to the method, and the construction of the silo has been greatly simplified. American scientists have increased our knowledge of the chemistry of the silo, and investigations still in progress promise to enable us to control the changes which occur within the silo more effectively than heretofore.

New York, June, 1886.

PREFACE TO FIRST EDITION.

The method of preserving green crops, especially those of fodder corn, by means of Ensilage, is one that the wide-awake farmer of the present day can not afford to ignore. The experiments already made in this country show that this method of preserving green crops must, it may be in an Americanized form, be adopted as a part of our system of agriculture. The farmer who looks for information on this subject finds it scattered through the various agricultural journals, or in works which are ostensibly upon Ensilage, but often largely devoted to advertising other matters.

To bring together the facts concerning Ensilage that are really important to the farmer, scattered through the journals and elsewhere, and to present them in a compact form, divested of all irrelevant matter, is the object of the present work, which claims only to be a compilation. In the earlier chapters the leading points are presented, and these are illustrated by such accounts of individual experience as seem most appropriate.

In a compilation like the present, any omission to give credit must be regarded as accidental rather than intentional.

That this little work may be of aid to those seeking information on the subject of Ensilage is the wish of

THE EDITOR.

INTRODUCTION.

Within a very few years the term "Ensilage" has appeared in our agricultural journals, meaning the preserving of green fodder by placing it in Silos. In an introduction to a work on Silos and Ensilage, it is well to define the meaning of these terms. European writers all give the word "Silo" as derived from the Spanish. It means any underground place for preserving grain, roots, or other farm products. In American usage the term "Ensilage" means the preservation of green fodder, especially corn fodder in Silos. The term of M. Goffart, "*Ensilage de Mais,*" has been abbreviated in this country to *Ensilage*, and is supposed to apply solely to fodder corn thus preserved, unless modified, by naming some other crop, as ensilage of rye, etc.

In England the terms "Pitting" and the "Potting" of fodder are sometimes used, to mean the same as ensilage.

Ensilage is used, not only to indicate the process of preserving fodder, but also as a noun, and applied by our writers to the fodder that is thus preserved.

The process of ensilage consists in packing green corn fodder, or any other succulent fodder, in close pits or receptacles, called Silos. It is essential that the silos be perfectly air-tight. They may be built in either of the methods indicated in this work. They may be entirely above the ground, partly below the surface, or altogether underground, in the form of a well or pit; the important point being to have a thoroughly air-tight receptacle.

This method, which has come into prominence through the experiments of M. Goffart, of Burtin, France, has

long been in use in other countries and for other materials. Some twenty years ago the "American Agriculturist" gave an account of a method of preserving clover in Germany. In October, 1873, that journal published an account, by a Hungarian correspondent, of the method of storing fodder corn in pits as practised in Hungary.

In August, 1874, was an account, from the same correspondent, of the method of storing beets, and other roots, cut and mixed with chaff, as followed in Hungary.

In April, 1875, pages 139–40, there was described and illustrated "A Dairy Barn" in Westchester County, N. Y., in which was a pit for the storage of brewers' grains. Several thousand bushels of grains were here kept in good condition for months, simply by excluding the air.

About this time the preservation of green fodder attracted much attention in Belgium and France, and several articles, by farmers and professors in agricultural schools, appeared in the "Journal d'Agriculture Pratique," Paris, the leading agricultural journal of France, giving methods and reporting general success. The important portions of these articles were presented in a condensed form in the "American Agriculturist" for June, 1875, pages 222–223, with six illustrations showing simple pits and extensive receptacles for the fodder, built above ground, with the method of filling, etc.

In September, 1877, pages 335–336, was described "An American Silo." This gave two illustrations of the pit attached to the Westchester County, N. Y., barn, described in April, 1875, with hints as to the utilization of such pits for the storing of corn fodder.

In 1877, M. Auguste Goffart, an eminent French agriculturist, published at Paris a work on "Ensilage." This was translated by J. B. Brown, of New York, and published in 1879. Besides Goffart's original work, this has an appendix giving several other articles and notes

by that author and several of his countrymen, the experience of Francis Morris, of Maryland, extracts from the "American Agriculturist," besides a note giving "Conclusions of the Translator," in which he says: "The first notice of this matter in this country seems to have been made in the 'American Agriculturist' of June, 1875." As shown above, Mr. Brown was not exactly right as to the date, though quite correct as to the fact.

Prof. M. Miles, then of the Illinois Industrial University, in 1875 experimented in the preservation of broom-corn seed. He stored it in pits, just as turnips or other roots are stored, putting on a layer of straw, and covering this with some eight to twelve inches of earth. Pits put up in September were opened the following March, and were found in satisfactory condition; where the covering was only eight inches deep, the outer portion was dry and moulded, forming a compact crust a few inches thick, but the interior was fresh and bright, while a covering of twelve inches of earth preserved it better. A sample of this ensilaged seed, sent to us at the time, was perfectly sweet, and had much the odor of brewers' grains. What may be the feeding value of these immature seeds of Broom Corn is not determined; cattle ate them readily, and there would appear to be no difficulty in keeping them perfectly well, should it be desirable.

HOW IS THE FODDER PRESERVED?

It is well known that a mass of green fodder, if loosely stacked up, will soon ferment, heat, and pass into decay. In the silo, the fodder is closely packed, and in an air-tight receptacle, and these conditions, instead of encouraging decay, prevent it, and favor the preservation of the mass. Several chapters have been written on "The Chemistry of the Silo," but to understand them requires

a familiarity with chemistry not possessed by the average farmer and general reader.

Every farmer knows that manure, another form of vegetable matter, if allowed free access of air, will ferment, heat, and decay. He also knows that manure, if kept under cattle or sheep, and daily trodden down through the winter, will come out in the spring quite unchanged. These are familiar illustrations of the well-known fact that the presence of air is necessary to decay, and that the complete exclusion of air tends to the preservation of perishable substances.

In the fodder corn we have a mass of succulent stems and foliage in which preparation has been made for the production of grain. These are filled with juices holding in solution the material that would soon be deposited in the grain as starch, etc., but now largely in the form of sugar. When the corn plant is cut and packed in the silo, fermentation, the first step in decay, at once begins. By the action of the oxygen of the air on the sugar and other contents of the stalks, etc., various changes take place, one of which is to produce Carbonic Acid. This acid is a gas, in which a candle can not burn or any animal live, and in which no further fermentation can occur. If the silo is air-tight, the very first steps in the fermentation of its contents produce a gas that acts as a preservative and prevents further change. The more compact the fodder corn, the less air will there be among it, and the sooner will the fermentation stop.

The fermentation not only acts upon and changes the composition of the air within the silo, but the fodder itself is acted upon and changed.

Sugar, when present in the juices of the corn, is at first converted into alcohol; and if fermentation continues far enough, acetic acid, or vinegar, will be formed from the alcohol thus produced.

If the silo is properly air-tight, and its contents cut

fine and well packed and carefully covered, there cannot be sufficient air present to allow fermentation to go on to an injurious extent.

The fact that injury may occur to the contents of the silo from undue exposure to the air, should be kept in mind at every step in filling the silo and in feeding its contents.

CHAPTER I.

THE PROGRESS OF ENSILAGE.

Since this work first appeared, ensilage has passed the experimental stage, and has been adopted by so many farmers that it may be considered as an established method among many who devote themselves to dairying. The number of silos in the United States in 1880 is said to have been only six, while it is estimated that there are now about two thousand. In England there were in 1880 only four silos, while now, Mr. M. J. Sutton, in his recent admirable work on "Permanent and Temporary Pastures," estimates that there are between eleven and twelve hundred. In England, the silo will come into competition with ordinary hay-making, allowing the farmer to secure his crops of grass and clover in very wet seasons more promptly and safely than he could as hay. In this country, on the other hand, ensilage will be mainly directed to the preservation of fodder corn, a crop of admitted value, but one which is on all hands regarded as very difficult to cure. In the Southern States, the silo will allow the farmer to preserve one of his most important crops, the Southern Cow-pea. This, which is regarded as most valuable as hay,

is difficult to eure, as the large leaves are shaken off in the process, but packed in the silo, they would yield most valuable cattle food, probably equal in value to ensiloed clover.

An important contribution to the literature of the silo is the report of "Experiments on Ensilage, eonducted at Rothamsted, season 1884–5, by Sir J. B. Lawes, LL. D., F. R. S., and J. H. Gilbert, LL. D., F. R. S." Rothamsted as an experimental station has a world-wide reputation, and the names of Lawes and Gilbert attached to any statement impart perfect confidence in its aceurraey. Possessing ample means, their experiments are eonducted on a scale large enough to be regarded as practical, and having no other object than to arrive at the real facts of the case, their conclusions are accepted as final. It would be well if some of those who in this eountry think they are making "experiments," but are only guessing, eould observe the accuracy and precision with whieh everything is weighed and measured at Rothamsted. This careful summing up of the experiments on ensilage will not be likely to please the enthusiastic advocates of that method. Their conclusions from their experiments are presented in twenty-two numbered paragraphs, the last four of which are as follows :

"19.—There can be no doubt that good food may be preserved in a favorable state for future use by being properly ensilaged. But the results obtained at Rothamsted do not favor the idea that produee whieh is itself not good food, can be made good food by being ensilaged.

"20.—Good ensilage, given in such amount as to supply the same quantity of dry substanees as would be given in chaff or roots, is no doubt a very good food for fattening oxen.

"21.—Good ensilage, given in less proportion and in eonjunction with roots, with the ordinary dry foods in addition, is no doubt a very good food for milking eows.

"22.—In conclusion, it is hoped that the details which have been given of the first year's experiments on ensilage at Rothamsted will afford some useful basis for the consideration of those who may be deliberating whether or not to adopt the system."

CHAPTER II.

RAISING FODDER CORN FOR ENSILAGE.

To one about to undertake the preservation of fodder corn by ensilage, the important points are: growing the crop, building the silo, cutting and storing the fodder, and the methods of feeding. All preparation in the way of raising the crop must have been done some months earlier than the date of the publication of this work; still, for the sake of completeness, we give a brief chapter on raising the crop.

If, as now seems probable, the method of ensilage shall be generally adopted and incorporated in our system of agriculture, we shall soon be supplied with such implements as will facilitate all the work relating to it.

The readiness with which inventors and manufacturers have met the demand for cutting implements, is an indication of what may be expected in other steps of the process, so soon as the needs are made known. Thus far, the experiments in cultivation and harvesting have been made with the implements and machines already in use on the farm. Not only may we look for new facilities in the mechanical appliances, but for improvements in the material, the kinds of corn best suited to the purpose.

One about to experiment with ensilage is met at the outset by the question, "What kind of corn shall I sow?" Here European experience is of no value as a guide, as the varieties recommended there are not known here, and we no doubt already have kinds of corn better suited to the purpose than any known in Europe.

In the majority of the experiments in this country, thus far, the variety sown has been the Southern White, or "Horse-tooth" Corn. A recent variety, "Blunt's Prolific," has been highly commended, and a special kind called "Mammoth Ensilage Corn" is advertised.

The greatest possible weight to the acre of quickly-grown and succulent herbage is required. When the plant has completed its growth, and commences to prepare for a crop of seed, it then becomes woody; the nutritive material in the stalk and leaves is diverted to the grain, and there deposited in a different form.

The production of varieties best suited for ensilage will no doubt soon follow, if we have not already such.

In January, 1881, the "American Agriculturist" figured and described the "Cuzco," or "Peruvian Corn," which, by its rapid and gigantic growth before showing either tassel or ear, suggests that it may be useful in establishing a variety of maize for ensilage, either through acclimation by selection, or by crossing it upon other kinds of corn.

The cultivation of fodder corn for ensilage is not different from that where the crop is to be cured in the usual manner. The land being thoroughly prepared and highly manured, is laid out in rows, twenty to thirty-six inches apart, and the corn dropped four to eight kernels to the running foot, the distances depending upon the size of the variety. The subsequent culture is the same as usual. Several mention the great utility of the Thomas Smoothing Harrow in keeping the crop clean until it is eight to twelve inches high, or too tall for this treatment. Some have raised satisfactory crops without the

use of any other implement or tillage than that given by this harrow, the corn soon smothering the weeds.

The precise condition in which the fodder should be harvested is not generally mentioned by those who have given accounts of their operations, the date being usually stated instead. Some say that they cut up the fodder when "in tassel," and others when the ears were "partly formed." We should naturally expect to find the plant itself the most nutritious just at flowering time, that is, when it has "silked"; how far beyond this it may stand with advantage, experiments are needed to determine.

In cutting up the corn, the sickle or corn knife is generally preferred to a reaper, though we may expect in due time to find these hand implements superseded by more rapid machines, especially devised for the work.

CHAPTER III.

LOCATION OF AND BUILDING THE SILO.

If one were to lay out a plan for buildings with reference to feeding ensilage, he would make the silos the central point around which all the rest would be arranged. But our farms are already planned, the barns already built, hence the silos must come in and form a part of an established order of things. The silo is to preserve fodder which is to be fed at the barn, hence its location must be with reference to the most convenient feeding of its contents. If, as is often the case, the barn has been built near a bank, then this bank may be utilized for the silo, placing this with reference to the feeding floor. The large silos of Whitman & Burrell, at Little Falls, N. Y., were

so built that the roof of the barn could be extended to cover the silos. In some cases it may be most convenient to build the silo within the barn, or, where a basement has been made for the reception of manure, it may be better to convert the basement into silos, and dispose of the manure elsewhere.

So long as our experimenters are not yet agreed as to the best form of the silo, some holding that a deep and narrow one, in the form of a pit or well, is better than a long and shallow one upon the surface, the proper location is difficult to determine. The essential points to be observed in building a silo are given in the following pages, and a consideration of these may help in determining the location.

It must be borne in mind that the silo is to be filled and to be emptied. The filling is accomplished in a few days, while the emptying, by feeding out its contents, may extend through several months. Hence convenience in feeding the contents must, other things being equal, largely determine the location of the silo.

BUILDING A SILO.

It is unfortunate that the first accounts of ensilage were by those who were not obliged to regard expense, but, having abundant means, could construct such silos as seemed to be required. We may add here, that much is yet to be done in "Americanizing" the whole matter, and we have no doubt that the experiments now being made will greatly simplify, not only the building of the silo, but every other step in the method. The wealthy dairy man or other proprietor may make an investment of a few thousands, if he sees that it will give a good return in the feeding of his hundred or more cows, while the farmer with five cows, who all the more needs the benefits that this new method may bring, can not, as

a general thing, afford the outlay of a few hundreds of dollars. Before going into the particulars of building, it may be well to consider what a silo is expected to do, whatever may be the plan. In speaking of ensilage, we now have reference to the preservation of fodder corn by the method though, as will be seen, other farm crops and products may be preserved in a similar manner. The fodder corn, cut small, is packed in a receptacle which is perfectly tight, so that it will not allow water to enter from without, or gases to escape from within. Could a glass jar be made of sufficient size it would be a perfect silo. Large capacity, with perfectly air-tight and water-tight walls, being the objects in view, the structure will vary according to the locality and surroundings. In some places a silo can be most cheaply built of stone; in other places brick will be found the most available material. In other localities still, concrete will be cheaper than either stone or brick, and just as good. These, stone, brick, and concrete, are all well understood building materials, and where one has the means to allow him to avail himself of them, are no doubt the best. But those who can not command either of these should not be deprived of the benefits of ensilage. There are several accounts of successful preservation of fodder corn in silos excavated in a bank of heavy clay soil, in which the fodder corn was packed directly against the earthern walls. We do not recommend this method, as there are many chances of failure. There are many localities where the soil is of such a character that cisterns for rain-water are built by making an excavation of proper size and shape, and covering its interior with one or more coats of cement mortar directly upon its earthern walls. Wherever cisterns of this kind may be built, a silo may be made in a similar manner.

Another modification is possible in wooded countries, where log-barns and even log-houses are still built. A

silo may be laid up of logs as for a log-house, and by taking special pains with the "chinking up," with clay, both inside and out, an air-tight and temporarily useful silo may be constructed.

Silos have been built by partitioning off a space within the barn, using two thicknesses of boards, and placing a layer of tarred sheathing paper between the boards. It is not likely that a silo with wooden walls can last a great while, as a large mass of fermenting material in direct contact with the boards will soon cause them to decay.

Another kind of silo is possible in lumber districts, where slabs are cheap. A frame may be made with slabs set up about a foot apart, to build a hollow wall, which is to be filled in with stiff, clayey soil, to be put in gradually and rammed down hard. By either of these, and other make-shifts, which are, of course, only offered as suggestions, those who can do no better may secure the benefits of ensilage, as well as those who can erect more permanent and more costly silos.

A detached silo must be provided with a roof. In some cases it may be so placed that the roof of the barn can be continued to extend over the silo, and thus materially lessen the cost of building.

In building a silo, whether of brick, stone, concrete, or other material, drainage is not to be forgotten, for to be successful the silo must be not only air-tight but water-tight. In building with brick or stone, the services of a mason will usually be required. If the silo is of concrete, there is nothing in its structure that can not be managed by a person of ordinary tact and ingenuity. Probably the larger number of silos built in this country will be of concrete, and, in view of the importance of the subject, we give a separate chapter on building concrete walls.

THE SIZE OF THE SILO

Of course will be determined by the number of animals. The description of Whitman & Burrell's, and other large silos will give some idea of the larger structures. It is estimated that one cow requires for a year five hundred and fifty cubic feet of ensilaged fodder, and if the cows are pastured for half the year, then two hundred and seventy-five cubic feet will be sufficient. Mr. Bailey estimates that to keep two cows for a year, a silo ten feet wide, long and deep will hold sufficient. A silo twelve feet wide, thirty feet long, and twelve feet deep, he estimates will hold about eighty-seven tons, enough to winter twelve to fifteen cows. Where stone is plenty, he thinks that a silo of this size can be built at a cost, besides the labor, of about fifty dollars. Silos have been made by digging a pit, putting in the fodder as in pitting roots, piling it as high as practicable, and then covering with earth. The difficulty in this case is, that in opening, the earth mixes with the fodder; besides there is a trouble in keeping the covering tight as the contents settle; this method might answer where straw is plenty, and a sufficient covering of that can be placed over the fodder before putting on the earth.

CHAPTER IV.

CUTTING AND STORING THE FODDER.

While some have sueeeeded in preserving the fodder corn in pits without first cutting, it is generally eoneeded that it should be eut before storing. Already several maehines, to be driven by horse or steam-power, have been invented and are manufaetured expressly for the purpose of cutting fodder eorn for ensilage.

THE PROPER SIZE TO CUT THE FODDER.

The fodder has been eut by different experimenters in pieces varying from one inch down to one-fourth of an inch, the majority regarding three-eighths of an ineh as the most desirable size. One objeet in eutting fine is to insure the most compaet storage possible and consequent exclusion of air. The paeking away should follow immediately upon the eutting, in order that the juiees of the plant may not evaporate and be replaeed by air. For the same reason, there should be the least possible delay between the field and the maehine that is to eut it for the silo. As Dr. Bailey properly suggests, "tearing or shredding the stalks would be mueh better than eutting," and leads us to hope that a maehine for this purpose may be fortheoming in due time. But at present the eorn must be eut, and for this there is no laek of suitable appliances.

That the size of the pieees is of importanee in other respeets than as regards the preservation of the fodder, is shown by a ease that reeently eame to our knowledge. A friend informed us that one of his neighbors, who had sueceeded admirably in preserving the fodder, found that

after his cows had fed upon it for a while with evident relish, they all at once seemed reluctant to eat it. An examination showed that the gums of the cows were badly cut and inflamed to such a degree that they were unable to chew the fodder. This trouble was found to be due to the fact that in the act of chewing, the short pieces of fodder would generally be bitten endwise, and the outer portions of the corn, which at the base of the stalk might get very hard, being presented endwise to the teeth, were so sharp as to lacerate the gums and the tender parts of the mouth. This gentleman proposed to overcome the difficulty by cutting the fodder longer; if the pieces were longer than broad, the animal would take hold of them in the usual way and bite against the circumference of the stalks rather than against the ends. It is not probable that a difficulty of this kind could occur unless the base of the stalks had become too hard and firm for feeding in any form, and as many have fed the short-cut fodder without any trouble of this kind, it is a warning against letting the fodder get too old, rather than a caution not to cut it too fine.

FILLING THE SILO.

Experimenters generally agree that about two feet in depth daily is better than a more rapid filling of the silo with the cut fodder. The form of the silo will govern the rapidity of filling somewhat: if narrow and deep, it may be necessary to fill in a greater depth daily.

The importance of thoroughly compacting the fodder is strongly enforced by all who have had any experience. The fodder should be spread evenly, mixing leaves and stalks as thoroughly as possible, and as the work proceeds be trodden down very closely and firmly. Where the silo is of a size to allow it, horses or mules have been introduced to do the trampling. The usual custom is to keep

one or two men in the silo to tramp down the fodder as fast as it comes from the cutter. If during the night the surface of the fodder in the silo has dried appreciably, it should, upon resuming the filling the next day, be wetted sufficiently to restore the original moisture; this may be most conveniently done by the use of garden watering pots.

COVERING THE SILO.

When the silo is filled, six or eight inches of straw are laid over the top of the fodder, and upon this a covering of two-inch plank, cut so short that they cannot bind against the walls, as the contents settle. The plank cover is then heavily weighted with whatever material may be most available. Where large stones are at hand, these may be used; logs will answer; boxes filled with gravel or with earth, and even bags of grain have been used. Much of the success of the process depends upon having sufficient pressure. The weighting material must be of a kind that will allow of its removal in part without disturbing the rest.

SALT AND STRAW.

In the early experiments, salt was scattered among the fodder, but this is now abandoned, as it is not necessary to the preservation of the contents of the silo.

In some cases cut straw has been mixed with the fodder in filling the silo, some claiming that it is useful in absorbing superabundant moisture. On grain farms, where straw is abundant, it would be desirable to use a portion of it in this manner, but experiments are needed to show to what extent such a mixture may be made without injury to the corn fodder, by preventing that from being sufficiently compacted. One writer claims that the feeding value of straw thus mixed with fodder corn in the silo is greatly increased. This is one of the

unsettled points in ensilage, and one worthy of careful investigation.

In some instances, where the quantity of fodder corn was not sufficient to fill the silo, hay, especially rowen, has been used to complete the filling. This was put in as soon as cut, and when the silo was opened was found to be in most excellent condition.

CHAPTER V.

CONCRETE SILOS

One of the best methods of laying concrete is by means of planks to form the mold to hold the mortar, the planks being held in place by posts set at the angles of the wall, and at other points if necessary, and by clamps, both the planks and the clamps being held in place by wedges, all of which is shown in the accompanying engravings. Figure 1 represents the planks in position, and the posts set, held together at their tops by strips nailed upon them, while at the ground they should be held in position by stakes and braces. Figure 2 is a diagram showing a section or ground plan of the same things; *a*, *b*, in both figure 1 and figure 2, are iron clamps holding the middle of the planks in position in case they are likely to spread apart. Figure 3 is a representation of the walls while in process of erection.

Planks, planed on the side towards the walls, are provided sufficient for the entire circuit of the building, and when in position the space between them is filled with the mortar. When the mortar sets, which, with a proportion of cement it will do very soon, then the planks

are raised and fixed in position by driving wedges between the posts and the wall, as shown in figures 4 and 5, in which *a*, *a*, are the wedges; *b*, *b*, the planks; *c*, a clamp

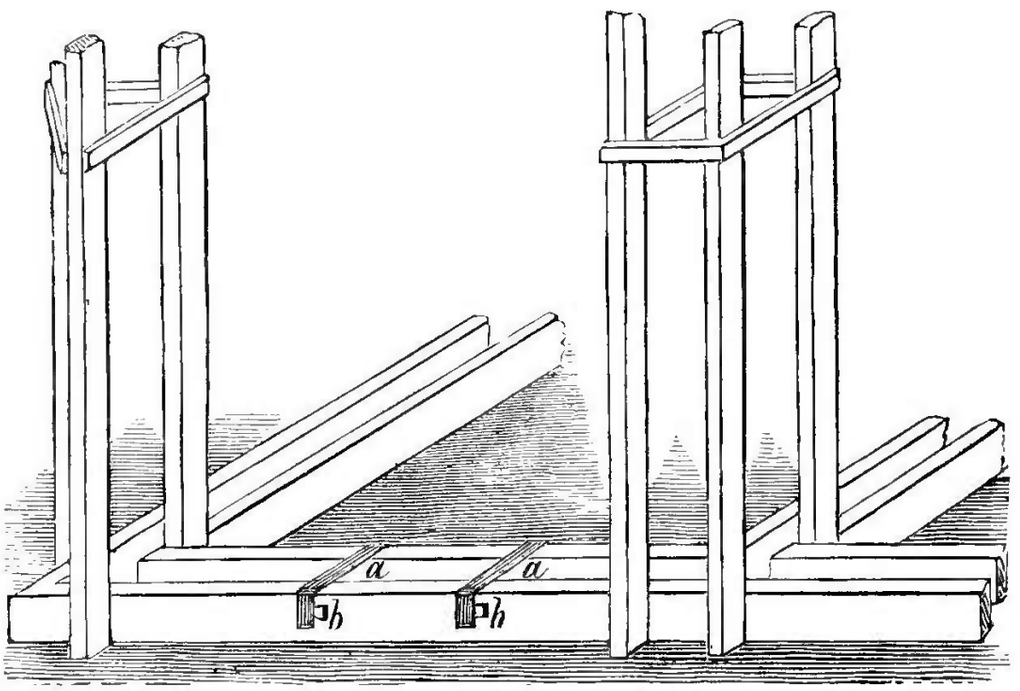


Fig. 1.—THE ARRANGEMENT OF THE POSTS.

holding the planks together, and wedged on one side, and *d*, *d*, the posts. The posts will usually need to be braced well to prevent their springing when the wedges are driven tight enough to support the planks.

Figure 4 shows a section of the wall and one post with

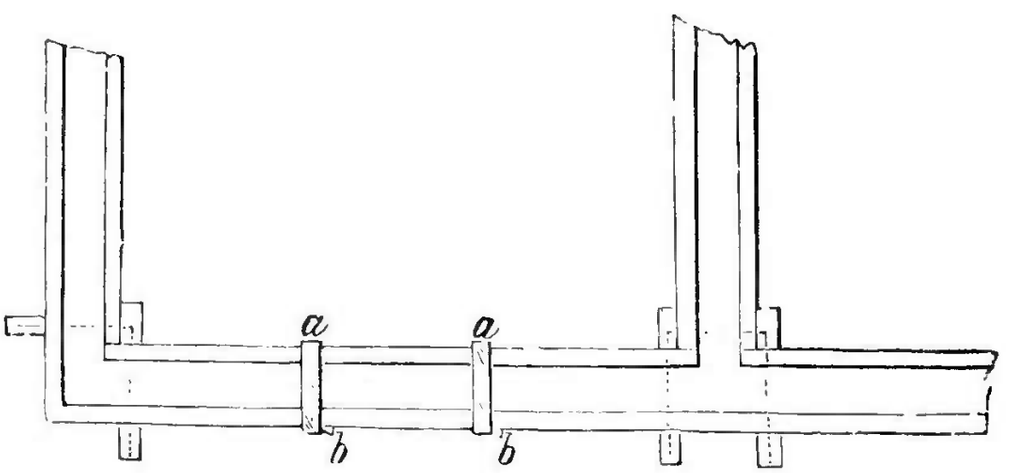


Fig. 2.—ARRANGEMENT OF THE PLANKS.

the wedges, as looked down upon, and figure 5 is a perpendicular cross-section of the same, the letters refer to

the same parts in both engravings. The door frames are introdueed in their plaees and held by braees until the walls rise around them.

Materials Used.—It is best, unless indeed some one in the neighborhood has had experienee, to test beforehand the proportions of sand, gravel, and lime, or

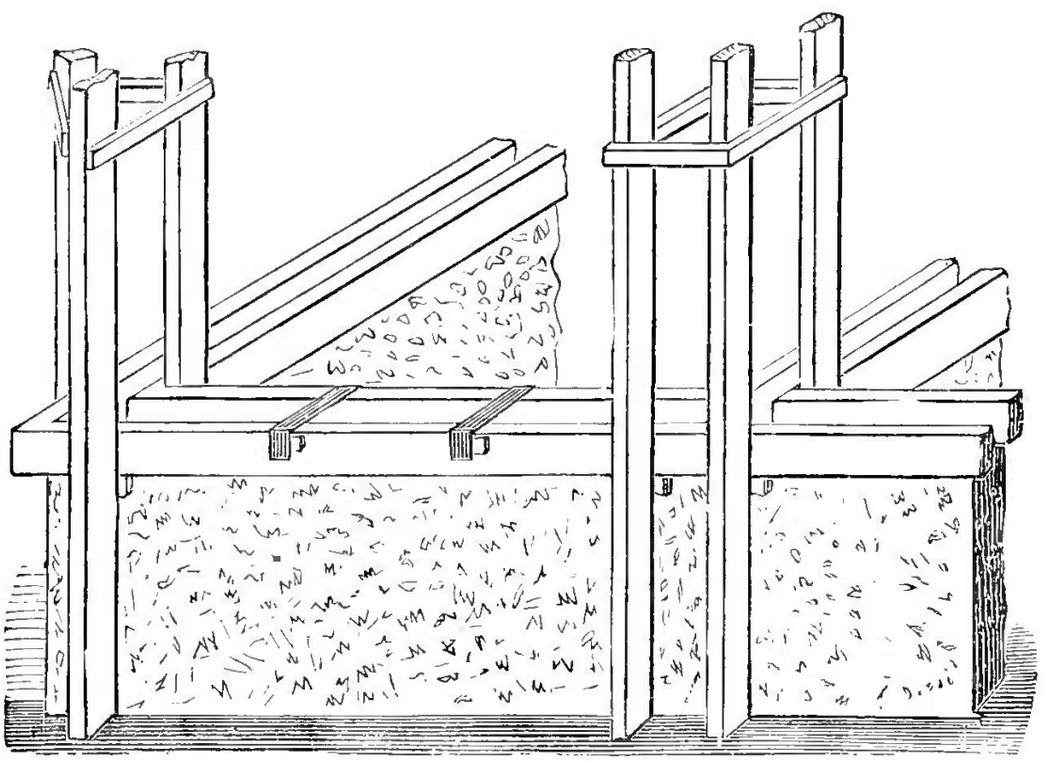


Fig. 3.—METHOD OF LAYING THE CONCRETE.

cement, whieh are best suited to the proposed work. There is so mueh differenee in the various kinds of lime that proportions ean only be given approximately.

Roughly the proportions may be stated as one part lime to seven parts of other materials, half of whieh should be elean washed sand. When sufficient materials are accumulated upon the mixing board, they are first mixed dry by repeated shoveling, then the lime, slaked to a creamy consisteney, is added, and well mixed through the whole, adding more water if necessary. The addition of one-fourth cement, the lime being reduced to three-fourths of one part, and the eement being added after the mortar

is mixed, makes a much quicker setting and harder concrete. When all cement and no lime is used, but a small quantity can be mixed at a time, for it sets so quickly that it could not be placed in position before it became solid. The proportions for a smooth, solid concrete are: one part Portland cement to five parts sharp sand. If

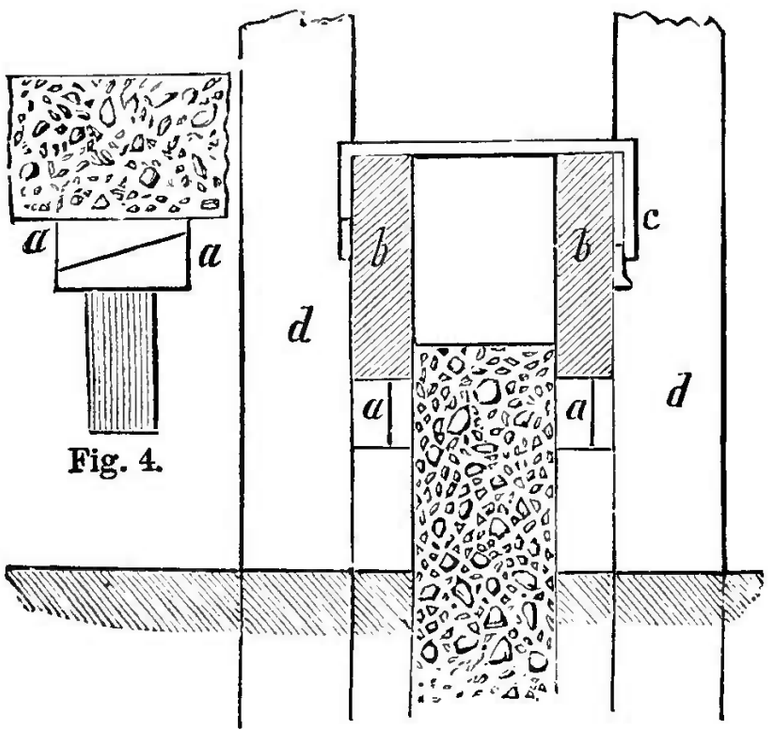


Fig. 4.

Figs. 4 and 5.—RAISING THE PLANKS.

mixed rather liquid, one-third or more, often nearly or quite two-thirds, of the wall as completed, may consist of gravel and coarse broken stones, put in while the cement is being placed in the molds forming the walls.

WHITMAN & BURRELL ON CONCRETE SILOS.

These gentlemen, in their paper on silos, given elsewhere, append the following directions for constructing a silo of concrete: First, having excavated for the silo, dig a trench all around the bottom and fill in with cobble stones, and from one corner lead a drain, if possible, so as to carry off all water. The trench under the proposed walls of the silo being filled with

cobble stones, place standards of scantling long enough to extend twelve inches higher than the top of the wall when it is finished. Place these standards on each side of the proposed wall, and if you desire the wall to be twenty inches thick, then place the standards twenty-three inches apart, and place a pair of standards every five or six feet around the entire foundation. Be particular to have these standards exactly plumb and exactly in line. Fasten the bottoms of the standards firmly in the ground, or by nailing a strip of wood across at the bottom of the standards, and a little below where the floor of the silo will be. Fasten the tops of the standards by a heavy cross-piece, securely nailed, and fasten the pairs of standards in their plumb position by shores reaching the bank outside. Now take plank, one and a half inch thick and fourteen inches wide, and place them edgeways inside the standards, twenty inches apart, thus forming a box fourteen inches deep, and running all along and around the entire foundation of the proposed wall. Fill this box with alternate layers of cobble stone, or any rough stone, etc., and mortar or concrete. First, a layer of concrete mortar, and then a layer of stone, not allowing the stones to come quite out to the boxing plank, but having concrete over the edges, and the concrete must be tamped down solid. Prepare the concrete as follows: Take one part of good cement, Portland is the best probably, and mix with this four parts of sand, and mix the cement thoroughly with the sand while dry, and then mix four parts of clear gravel; make into a thin mortar, and use at once. Put into the box an inch or two of this mortar, and then bed in cobble stones; then fill in with mortar, again covering the stones, and again put in a layer of stone. When the box is filled and the mortar "set," so that the wall is firm, then raise the box one foot, leaving two inches lap of plank on the wall below, and go around again, raising the wall one foot

each day every second day, according to amount of labor at hand. If one-half the bulk of fine-slaked quicklime is added to the water-lime, it will improve it, and costs but little. If Rosendale or Akron cement is used, instead of Portland, then the proportions should be as follows: One barrel of good live cement, three barrels of good sand, three barrels of good clean gravel. If no gravel is obtainable, then use five barrels of sand to one of cement, and bed in all the cobble stones possible. Stone with rough edges are better than smooth, as they bind the wall more thoroughly, but any flat stones found about fields will do as well. A layer of loose cobble stones should be placed against the outside of the wall before the earth is brought against it, so as to have an air space and a free passage for water.

CHAPTER VI.

EUROPEAN EXPERIMENTS IN ENSILAGE.

The "American Agriculturist" for June, 1875, gave, so far as we are aware, the first full account of the European methods of ensilage; the article is here reproduced as a part of the history of the subject, and as giving the methods followed in Europe at that time. The recent experiments in France and Germany in the preservation and feeding of fodder of various kinds are of great value to our farmers. Their object is to economize the use of cattle food. In almost every department of industry it is the savings in labor and material that are cheapening the cost of production, and at the same time increasing the profits of the producers. In every opera-

tion in agriculture there is a vast scope for saving in both labor and materials. Our method of feeding stock is very wasteful; the greater part of the fodder fed every winter is expended in merely keeping the cattle alive. A loss of weight or condition in all kinds of stock equal to from ten to sixty per cent is suffered every winter. There is no necessity for this; stock may be kept increasing in weight during the winter, if the fodder is of the right kind and the stock is properly housed and protected. The feeding of poor, unpalatable fodder is the chief cause of this loss. The appetite needs to be stimulated at the season when the greatest draft is made upon the physical condition of the animal; and to meet this need there must not only be palatable or enticing food, but there must be plenty of it. Corn fodder is largely depended upon as food for stock over a great extent of country, and its use might be well nigh universal, as no forage plant is so easily grown as corn. Could it be preserved fresh and green for six months or more, instead of curing it and using it dry, its value would be greatly increased. That it may be so preserved has been shown by experiment, and the process is claimed to be easy and very profitable. Of late years a great number of French, Belgian, and German farmers have adopted the plan, and some extensive stock-feeders have used it largely, with the most favorable results. Several communications by prominent farmers and professors of agriculture in farm schools have been made to the "Journal of Practical Agriculture," of Paris, from which the following facts have been condensed, and, by the aid of the illustrations, the methods in use may be learned. In figures 6, 7, and

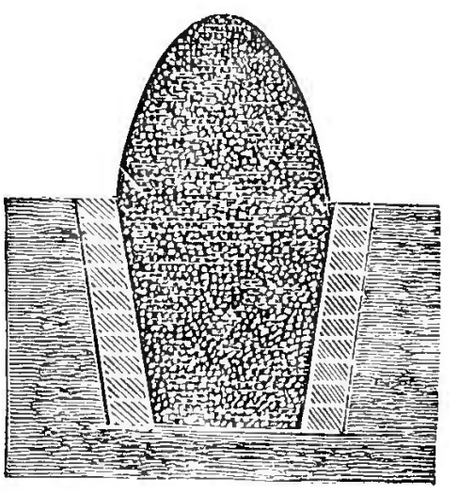


Fig. 6. PIT BEFORE COVERING.

8 are shown the pits, or silos, as they are filled with the cut corn fodder, then covered with earth and pressed down with its weight, and finally as the cut fodder has shrunk through fermentation to less than half its original bulk. These pits are about seventy-five feet long, nine feet wide above, six feet wide at the bottom, and six feet deep. The sides and ends are built up of masonry laid in cement. In these pits the corn-stalks are laid evenly with care in layers of about eight inches thick, after having been cut and exposed to the sun for two or three days. During this time the stalks lose, by expos-

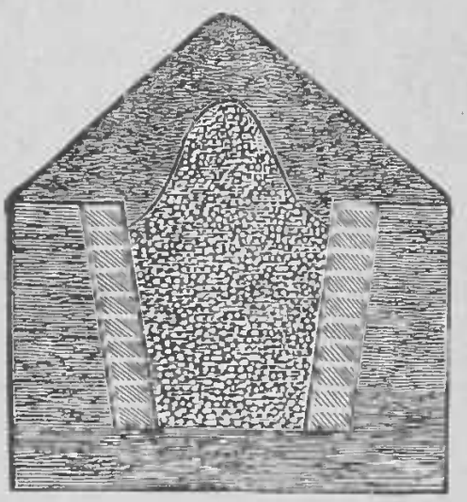


Fig. 7.—PIT AFTER COVERING.

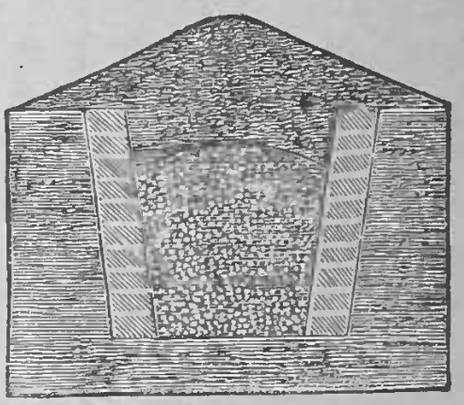


Fig. 8.—PIT AFTER SIX MONTHS.

ure to the sun, two-fifths of their weight when first cut. A quantity of salt is scattered over every layer equal to about sixty-six pounds for each pit. [N. B. It should be borne in mind that this is an account of the early experiments; the previous drying and the use of salt are now abandoned. Late experience has shown that the more succulent the fodder, the better it will keep.—ED.] The three pits hold about eighty tons, or seventy-five thousand kilos, of green fodder. The fodder is heaped up, as shown in figure 6, to a hight of six feet above the surface of the ground, and then covered with earth to a thickness of two or three feet. On the 14th of September, 1872, this work was finished. On the 15th of April

following, one pit was opened, and the fodder was found in perfect condition, except for an inch or two upon the surface and the sides, where it was black and decayed. Its color was yellow, its odor agreeable, but the stalks

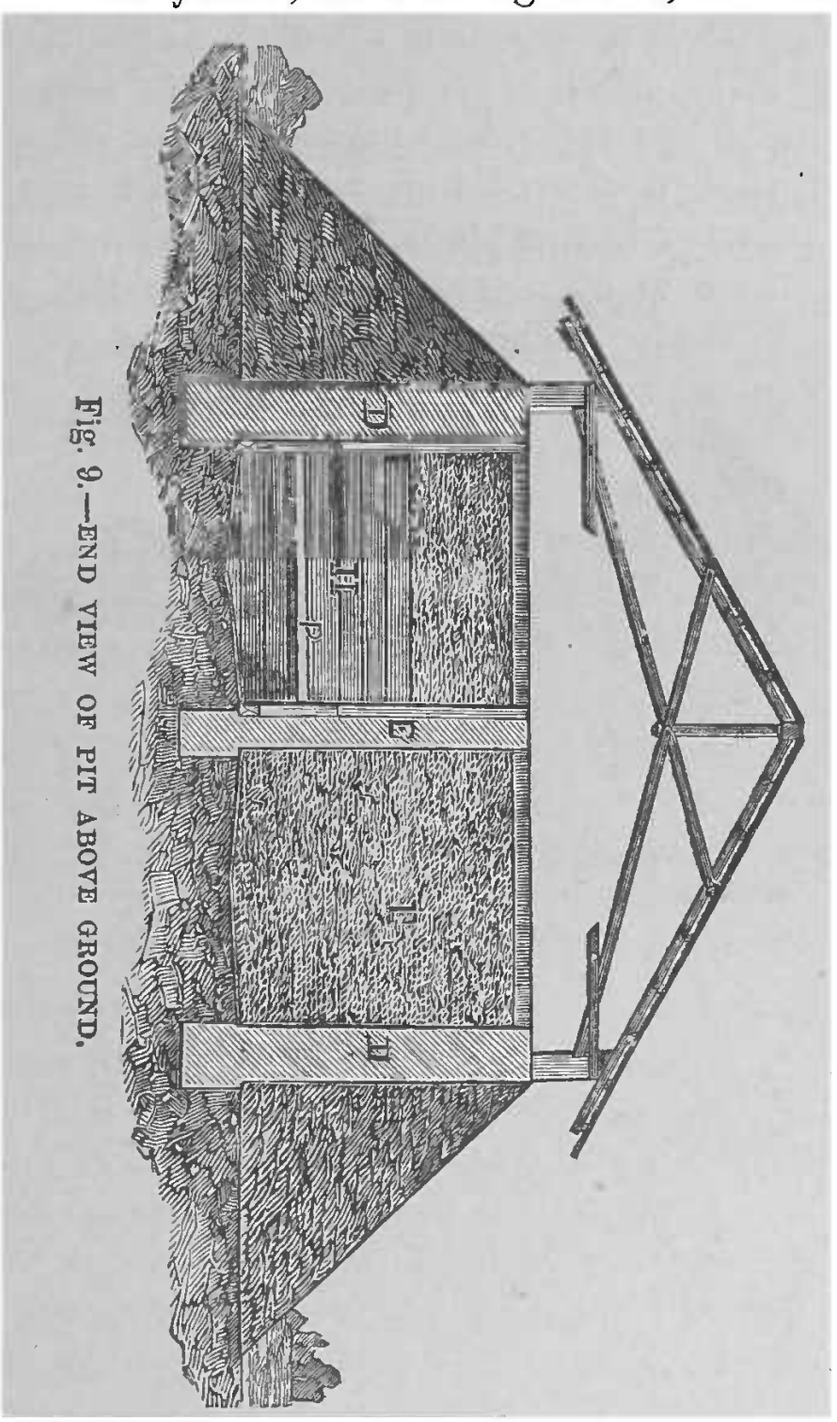


Fig. 9.—END VIEW OF PIT ABOVE GROUND.

had lost all their sweetness, and had acquired some degree of acidity. Twenty-four beeves were then fed about nine hundred pounds daily of the preserved fodder, or nearly forty pounds per head on the average, which was

equal to about sixty pounds of fresh green fodder. The fodder was eaten with great relish, and only some portions of the harder stalks were left. The second pit was consumed July 3d, having been preserved equally well with the first. The third was not opened until the 20th of April, 1874, eighteen months after covering. The fodder was in as good order as that from the other pits, excepting that the discolored and decayed layer was somewhat thicker in this pit than in the others; a result attributed in a great degree to the gravelly and porous character of the covering earth, the preservation being due solely to the exclusion of air. In this instance the fodder was preserved whole, and the cost of cutting avoided. But when the fodder has to be cut for final use, it has been found an economy to cut it before it is stored. This system has been adopted by M. Piret, the manager of a large estate owned by M. A. Houette, at Bleneau, in Belgium. From his statement we find that he made a small experiment in 1868 which was perfectly successful, the cut fodder being withdrawn from the pit in 1869 in excellent condition. In 1870 two pits of masonry were erected above ground, protected at the sides only by banks of earth. They were found equally serviceable with those sunk below the surface, and much more convenient. Following the statement of this gentleman closely, we learn that by the aid of about four hundred and fifty pounds of superphosphate of lime per acre, he has obtained, on fairly good soil, seventy-five tons per acre of green fodder, although the average of his crop was not more than forty-five tons per acre; two hundred and fifty tons of this was cut by a fodder cutter driven by horse-power, cutting two tons per hour, and stored in the pits as follows. The pit was built as shown in figure 9, which represents the section, a dividing wall in the center separating it into two parts. The cut fodder, falling into the pit, was carried in baskets upon

a truck on a portable railway to the end of the pit, where it was packed away in sections formed by a movable partition, and trampled down tightly, salt at the rate of

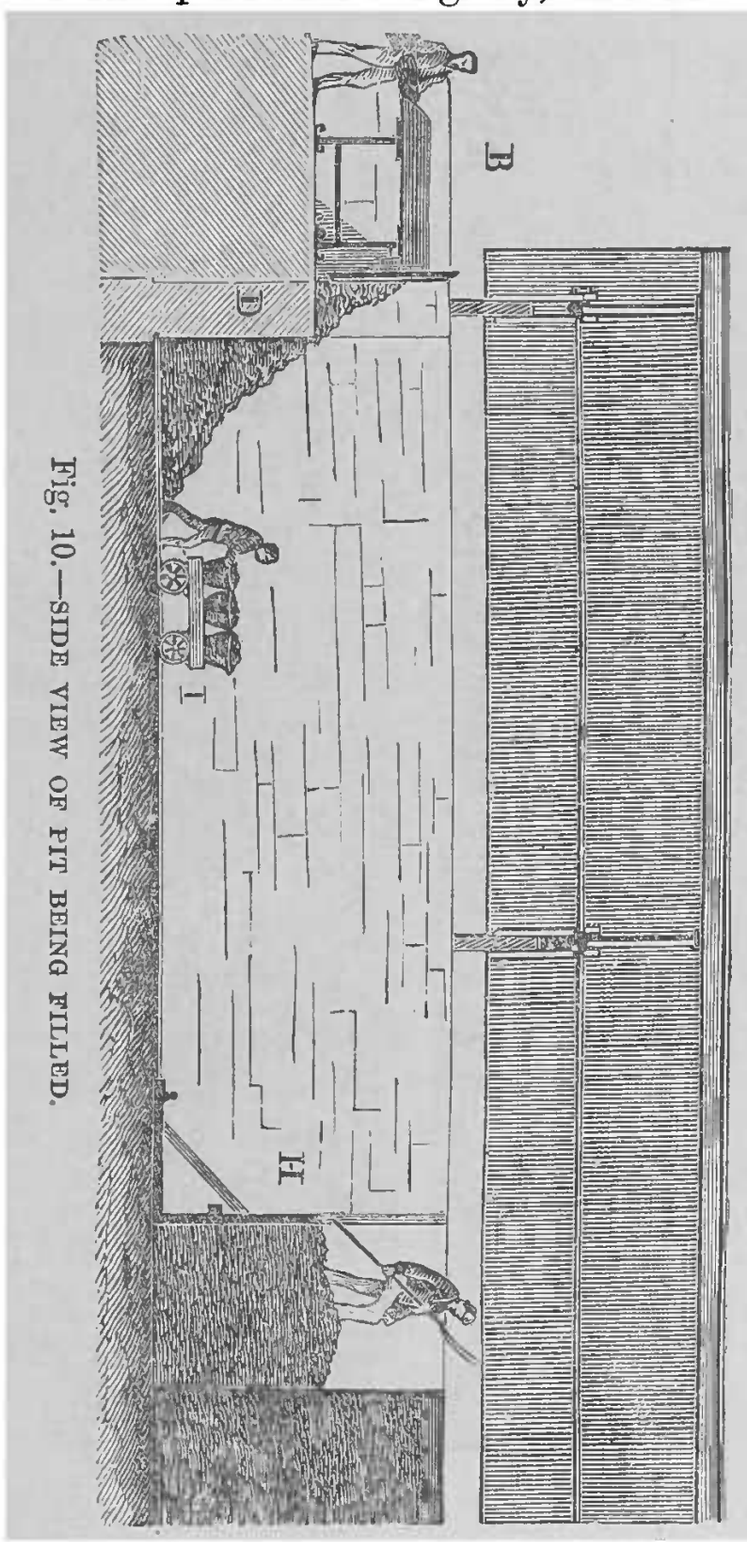


Fig. 10.—SIDE VIEW OF PIT BEING FILLED.

about two pounds to the ton of fodder being added. This pit is seen in figure 10, which represents it in a longitudinal section, and in figure 11, which shows it in plan,

and in which one division is seen filled, and the other in course of filling. When the pits are filled, the fodder is covered with a layer of fine clay, nine inches thick, well

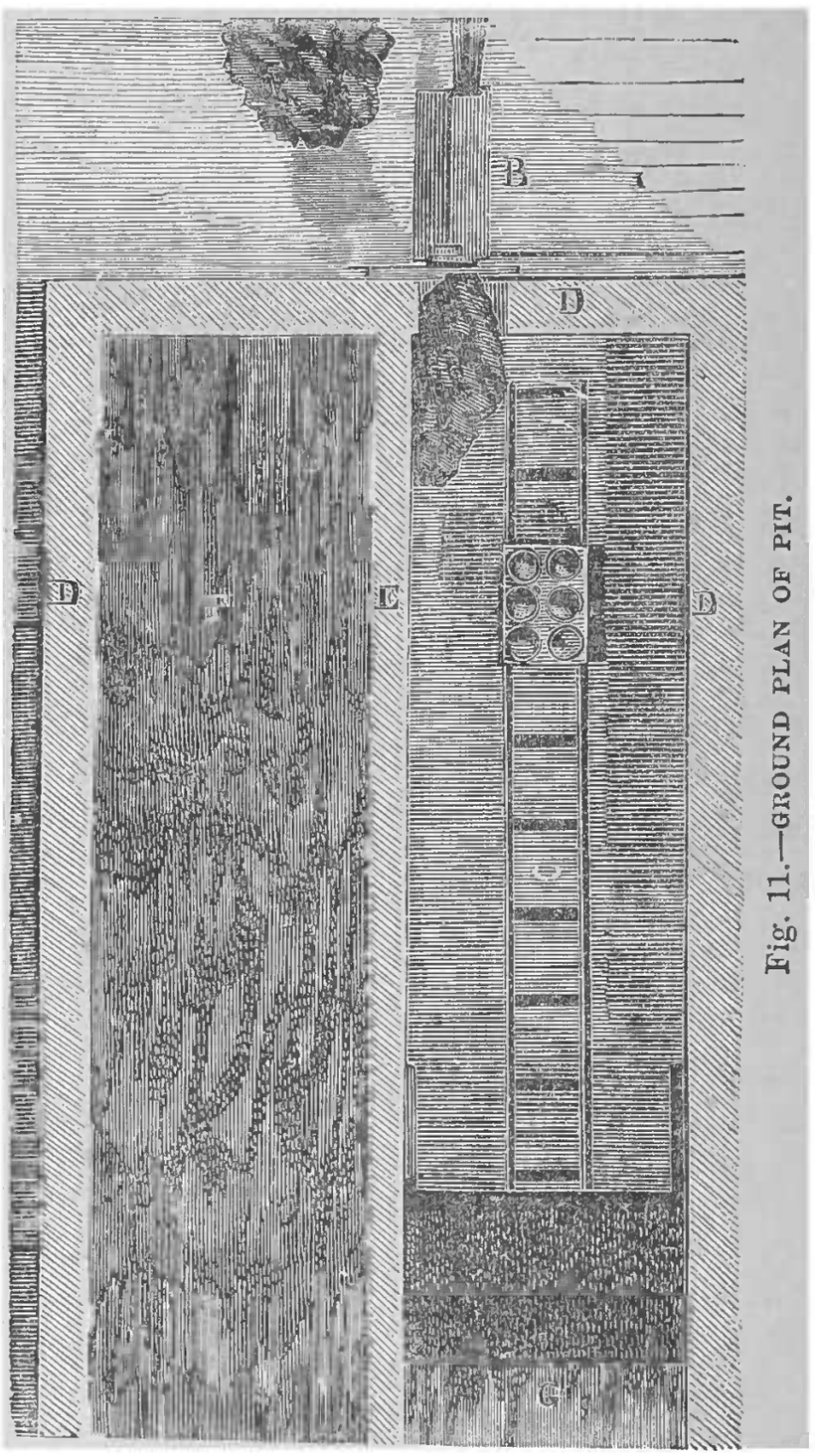


Fig. 11.—GROUND PLAN OF PIT.

beaten down. In these figures the parts are shown by the following letters: *B*, is the fodder cutter; *C*, the rail track; *D*, the exterior walls; *E*, the division wall; *F*, the filled compartment; *G*, that in course of filling;

H, the movable partition with a transverse bar, *P*, which holds it in position; *I*, the truck. The pit is shown in figure 9, as covered with a roof of boards as protection from the weather, a measure of economy strongly recommended by M. Piret. In this figure the covering of clay is shown on the top of the fodder. This is beaten down frequently, as it may become cracked or disturbed by the settlement of the mass beneath.

The cost of the process here described is represented as being about three dollars per ton, including the cutting, carrying, curing, and feeding of a crop equal to nearly fifty tons per acre of green fodder, fifty thousand kilos per hectare. This enormous yield appears almost incredible to us, being a ton to less than four square rods; still we can not doubt but such a yield is not only frequent, but that it is sometimes surpassed. It goes to show that in the cultivation and use of this, our most common crop, we come far short of the possible yield, notwithstanding our favorable climate and the necessity of every available economy to cheapen or increase its production.

CHAPTER VII.

MESSRS. BUCKLEY'S EXPERIENCE IN ENSILAGE.

BY M. C. WELD, IN "AMERICAN AGRICULTURIST."

The good result which many persons obtained last year in pitting corn fodder, leads this year to the making of many pits, or silos, for this purpose, all over the country.

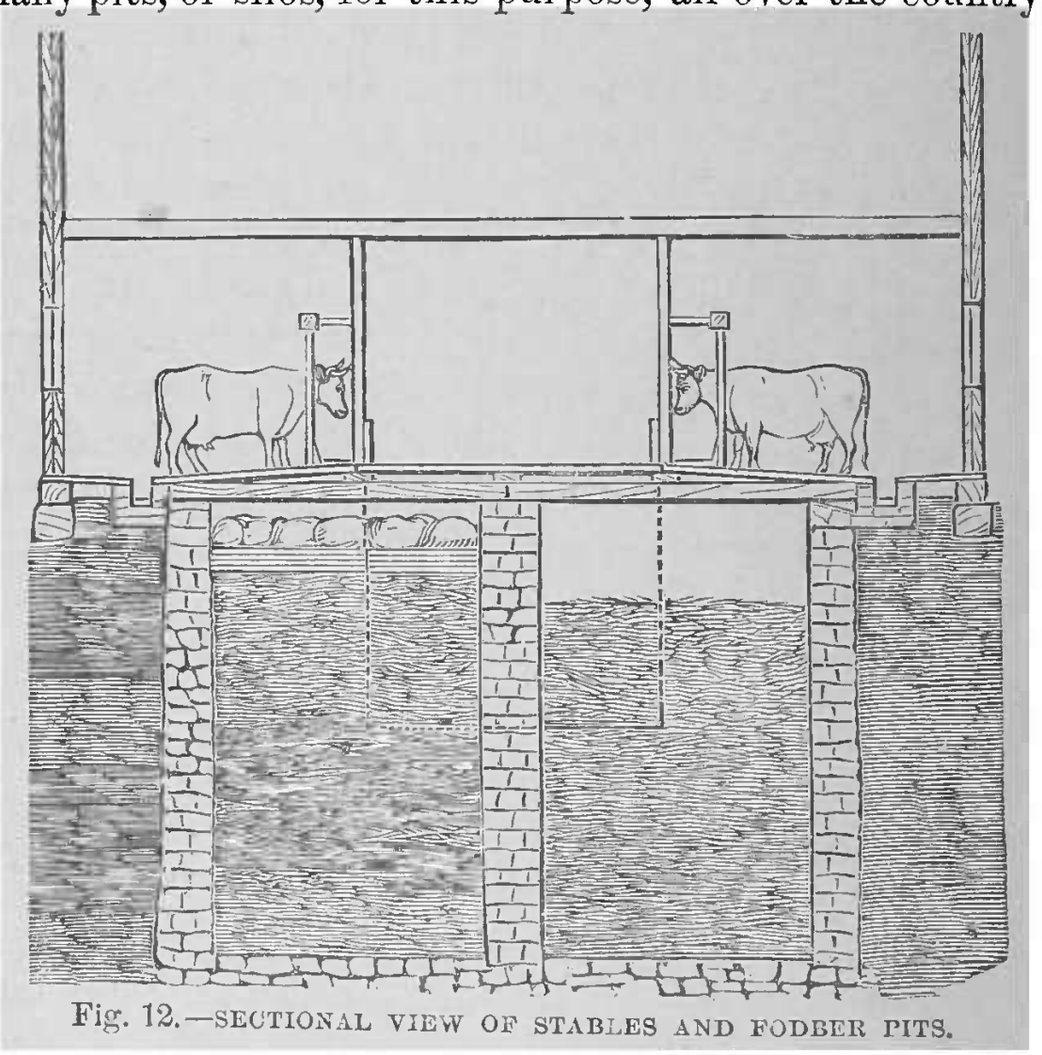


Fig. 12.—SECTIONAL VIEW OF STABLES AND FODBER PITS.

So that if there is the least question as to the utility of this process for the preservation of corn fodder, it will be soon set at rest by a thousand experimenters.

I was much interested in witnessing the filling of the pits built by the Messrs. Buckley Brothers, of Port Jervis, N. Y., whom I visited about the middle of September.

It has been their habit for many years to put in a large area of sowed corn, which was cut and put up for curing in stooks, and afterwards housed or stacked near the barns. This year they have a larger area than usual, a large part of which they put down in pits for winter feeding. This matter of pitting or ensilaging corn fodder has been carefully investigated by them, and they have made, this year, two pits under the cow-barn floor. These pits, figure 12, are twenty-two feet long, nine feet wide, and fifteen and a half feet deep, side by side, with a two-foot wall between them. They are walled all

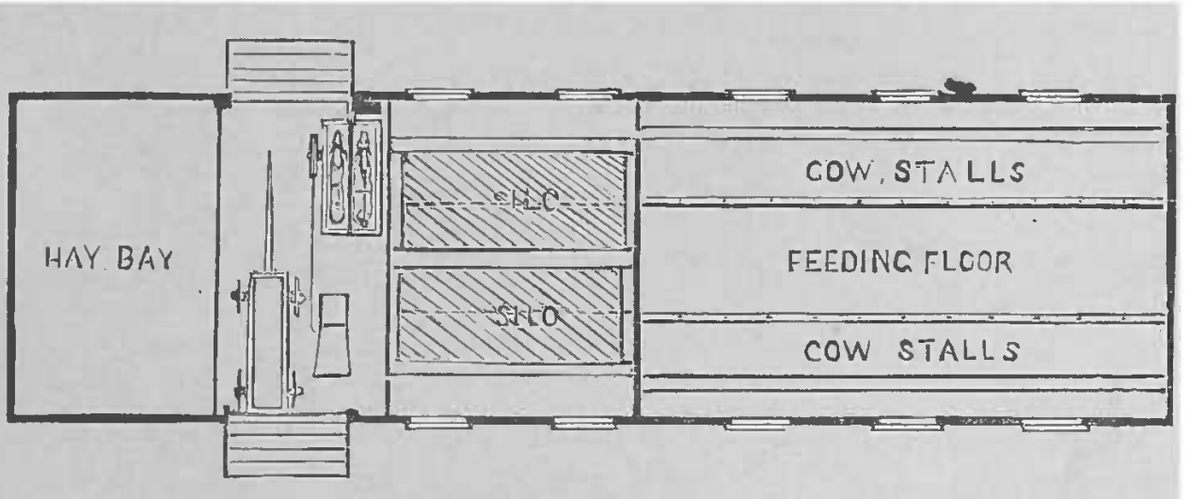


Fig. 13.—FLOOR PLAN OF BARN, CATTLE STABLES, ETC.

around, and cemented water-tight. They would answer well as cisterns. These two are just built, but there is an old one, ten feet wide, fifty feet long, and seven feet deep, which is under the feeding floor. The location of these pits is shown in the accompanying plan, figure 13. The cow-barn is one hundred and twenty feet long, by thirty feet wide. The feeding floor is ten feet wide, and the standing space for the cows is the same width on each side. There is room for thirty-six cows in this stable, up to the barn floor. The floor, the stalls, and all, from side to side, was taken up for the filling of the pits, but was relaid.

At the time I was there the work of filling was going

on in full blast. A pair of powerful mules were at work in the horse-power. The feed-cutter stood directly behind them, and cut the stalks in half-inch pieces, at the rate of two tons an hour. It required three men to tend the cutter, taking the corn from the wagon, feeding it to the cutter, and seeing that it was properly shunted off into the pits, where one man spread it as evenly as possible and trampled it down. At noon and evening half-a-dozen men got into the tanks, and trampled the fodder down as firmly as they could. One man and one team were required to haul the fodder from the field. As soon as a wagon load was brought into the barn, the team was ungeared and hitched to the empty wagon. In the field, the teamster assisted in the loading. There were three men in the field cutting up the corn and loading the wagon. Thus the labor required was as follows: Two teams and one driver, four men in the barn, and three in the field; eight men in all. With this force they were putting in about twenty tons a day.

The stalks were rather dry; the juice did not squirt out of them when they went through the cutter, and the chaffings were not even moist to the touch. When packed in the pits, a strong fermentation sets in very soon. The corn that had been packed the day before was steaming hot, no doubt having a temperature of one hundred and ten to one hundred and twenty degrees Fahrenheit. It had a vinous odor, which was very sweet and pleasant. Mr. Charles Buckley gave us the figures of the cost of these two pits, which is as follows:

Digging, 112 days work at $1	$112.00
Masons' bill	94.44
Men to assist the masons, twelve days work	12.00
Bill for lime and cement	78.10
Total outlay	$296.54

This does not include anything for stone, for the stones

taken out of the pit were sufficient for the walls, and more too. Neither is any charge made for superintendence, and no doubt it would be fair to add fully ten per cent for the supervision and actual labor, which at one time or another the farmer himself gave, or say three hundred and twenty-five dollars in all. There were fifty barrels of cement used, and about half as much lime, part of which, eight barrels, was very good, and the rest, fifty bushels, cheap and of a low grade. The proportion of sand to cement and lime in the mortar with which the walls were laid up, was about two-thirds, but in coating over the surface, to make the whole water-tight, nearly pure cement was used. Thus the pits were filled, each one receiving its quota of ten tons, more or less, being well trodden down, allowed to settle over night, and again trodden down in the morning before work, all hands being engaged in the trampling. When full as possible, settled and trampled, and beginning to heat in the top layers, it is covered with six inches of long rye straw, any other straw will answer, and this, with a layer of planks, cut to fit crossways, but not so long as to bind. Stones are piled, or rather laid, upon the planks, so that fully one hundred pounds to the square foot rests upon the fodder. Thus it is left for winter use. Filled full, one of these pits will hold sixty tons. That is, containing as they do over three thousand cubic feet, or two thousand four hundred bushels, at fifty pounds to the bushel, which the compressed, moist, and almost solid fodder will weigh; this is equal to one hundred and twenty thousand pounds, or sixty tons.

As to the keeping, there can be no question, if the work is properly done. A brisk fermentation comes on, as we have seen, as it does in a tub of apple pulp for making cider. If the air has very slight access it will go on to ultimate decay; but if it is kept out, the little air

at first present is driven off by the earbonic aeid gas which is formed, and the mass eeases to ferment, and remains as if it were in an air-tight case. There is, however, a slight access of air upon the surfaee, and its action upon the juices in the straw and upper layer of fodder is just enough to maintain an atmosphere of earbonie gas over the mass, and in the straw, which is like a rubber blanket, confined as it is beneath the planks. The stable will be replaced over the pits, and when the time comes for feeding there will be no going out in storms and "slush" and ice to haul in the fodder from out-of-door pits, but the floor will be taken up over a sufficient spaee, and enough feed removed from one end for two days, when it will be packed down again and covered closely. I think rubber blankets, tarpaulins, canvas, or any eoarse cloth painted with boiled oil, would be exeellent to pack elose down upon the fodder to exclude the air. One thing strikes me as very important, and that is, to know for a certainty that there is no settling of earbonie acid gas in the pit, after a considerable opening is made. A man going into a place filled with this gas, as often oceurs in deep wells, is overpowered before he knows it, falls, and drowns as surely as if he were under water, and is even less likely to be resuscitated. The way to know whether a man can enter with safety, is to lower a lantern, whieh, if it burns freely, shows that there is not a dangerous proportion of gas in the air of the pit.

CHAPTER VIII.

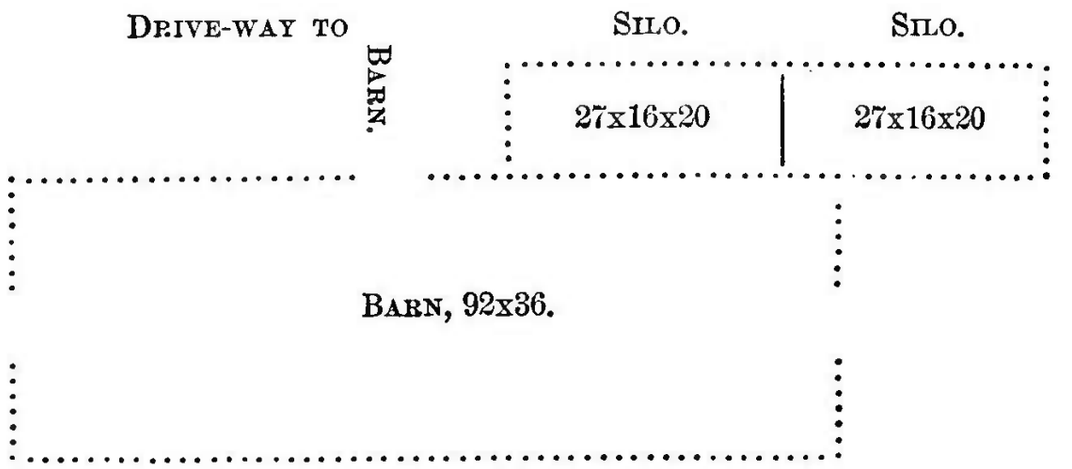
WHITMAN & BURRELL'S SILOS.

Among the most enterprising experimenters with ensilage are Messrs. Whitman & Burrell, dairymen at Little Falls, N. Y. They have given very full accounts in their local paper, the "Little Falls Journal and Courier," from which we quote the essential portions of their article describing their silos :

Our new barn and silo are located on a side-hill. The barn is ninety-two feet long, thirty-six feet wide, and has three floors : First, the cow stable in the basement, nine feet high, two rows of stanchions, twenty feet space between the rows. About three feet four inches back from the stanchions is a wrought-iron grating, three feet three inches wide, after the plan of Prof. E. W. Stewart, upon which the hind feet of the cows stand. Under the grating is a trench, three feet two inches wide, and twenty-eight inches deep ; this is laid in cement, and is water-tight. All droppings from the cows pass through the grating, and the urine is all saved, as well as the solid excrement. There is a drive-way, eight feet wide, between these gratings. Sections of the gratings are on hinges, and can be turned up, and the manure from the pit loaded on to the sleigh or wagon. The vault has to be cleaned out once in three or four weeks. Cows are kept perfectly clean and dry, and we think the arrangement is a good thing.

On the floor above the cows, also nine feet high, and the same size as the cow stable, is the granary and room for storage of all agricultural tools, implements, and machinery. This floor also has entrances so that a team can be driven in at one end and out at the other. The

floor above is the main barn floor, and entrance is from the side-hill right into the center of the barn. The silo is on the hill-side next to the barn, thus:



The bottom of the silo is on a level with the cow-stable floor, and there are entrances into the silo from both the cow-stable and the floor above. The top of the silo is on a level with the upper or main floor of the barn, so that the fodder can be taken out on either of the three floors of the barn. You will appreciate the convenience of this arrangement. The silo is built of stone; the walls are three feet thick next to the bank, and two feet thick next to the barn; the roof of the barn extends over the silo. All around the walls twelve inches of cobble stone are filled in from top to bottom, so as to prevent any water lodging against the walls. Capacity of entire silo about four hundred tons, or two hundred tons for each compartment.

On June 1st we put in about seven acres of corn, with a drill, rows twenty-one inches apart, and dropping six or eight kernels to a foot. In September we cut the same, hauled to the silo as fast as we cut in the field, and with a feed cutter of the largest size, or next to largest size, we cut, at the rate of over one hundred loads per day, into pieces three-sixteenths to one-quarter of an inch in length, which was evenly distributed in the silos and

trodden down. The corn was large, stalks twelve to fourteen feet high, single ones weighing five to five and a half pounds, with ears on full of milk. Into one silo we put sixteen feet, and into the other eleven feet. As soon as filled, one taking three days and the other four, we put on the covers. These are of plank, three feet wide, sixteen feet long, and two inches thick, fitting together closely; and upon these covers we put fifty tons of stone to each silo, the stone having been picked up on the farm. Within a week one had settled to twelve and a half feet and the other to eight and a half feet.

On the 26th of October we opened the silo having eight and a half feet of ensilage, and found the fodder as green and sweet as when first put in. We used no straw under the covers, and yet right next to the boards the corn was all right. We have fed the stock since October 26th, and they are all right, looking and feeding well. One cubic foot of ensilage weighs forty-seven pounds. We are feeding sixty-five pounds to each cow per day, with four pounds of middlings and half a pound of oil-meal, or cotton-seed meal. We had, before we began feeding the ensilage out to the stock, two hundred and twelve tons, and the exact cost of harvesting it, filling the silos, putting on stone, etc., was two hundred and seventeen dollars, allowing full wages for our own time, etc. We are now going to feed fifty to fifty-five pounds to each cow per day, and increase the grain to about six or seven pounds for the cows still giving milk, and half as much to the dry ones.

This two hundred and twelve tons from seven acres, or a little over, is a large result, and is equal to seventy odd tons of hay, costing but three dollars per ton, or ten tons to the acre. We believe that by putting all the manure back on the seven acres of land that we can get up to forty and possibly fifty tons to the acre. We see no reason now why the cows that are being fed on en-

silage will not continue to do well in condition and product, and our plan now is to raise about fifteen acres of corn next season, 1881, and this will be sufficient to fill the silos full, giving us four hundred tons, and this will keep forty cows three hundred and sixty-five days; but as we shall pasture all of the side-hill during the summer season, about twenty acres, the pasture will also grow better, because the cows will drop more upon it than they take from it. We think we can give the cows all they will eat, morning and evening, of the ensilage, and keep in this way fifty head the year round on fifteen acres of corn and twenty acres of hill-side pasturage. We, however, immediately after taking off the corn early in September, plowed up the stubble and put in winter rye. This came up finely, and we will top-dress it this winter, and early in the spring give it a good bushing in. We expect to cut the rye by June 1st or 5th, and cut that up the same as we do the corn and store it in one of the silos, then immediately plow the same seven acres and put in corn; whether this will work remains to be seen. But we have full confidence in the perpetual fertility of this corn land, because it is to be replenished, not only with what grew upon it, but from the grain fed with the ensilage: for, by the plan we have adopted, the liquid manure is as perfectly saved as the solid, and the most accurate experiments show that the fertilizing matter of the liquid is greater than in the solid manure. Prof. Stewart reports that he has found the manure from one cow, standing upon the self-cleaning platform, carried fresh to the field, the liquid all absorbed by the soil, equal to the manure from three cows saved in the old way, by throwing into a pile and carrying it to the field months afterward. In fact, there is no fertilizing matter wasted or lost, except that carried off in the milk.

The beauty of the system is, that, instead of spreading the manure from forty or fifty cows over two hundred

acres, we use it all on the fifteen aeres that furnish the fodder, and shortly the land must become very rich, and then we can use the manure on other land. If we were to build a silo on level land, we would excavate ten or twelve feet below the surfaee, and then let the walls of the silo run up ten feet, using the earth that was excavated to make a bank about the walls above ground. We would locate the silo close to the barn, making the top of the silo on a level with the barn floor over the cows; then, in feeding out the silo, the fodder could be easily raised with any of the same appliances used for raising and earrying hay, and with a track running to the shutes, the car could be dumped so that the fodder would be deposited in front of the stock. The walls of the silo should be perfectly plumb and parallel, so that the followers, although fitting closely, can settle without binding when loaded with stone. As you build the silo walls, point up as you proeeed, both inside and outside, and then plaster the entire inside, bottom as well as sides, with Portland cement, as it is necessary that the silo should be water-tight, like a cistern.

A cheaper way to build a silo, and one which Prof. E. W. Stewart, of the "Live Stock Journal," advocates, is to build it of water-lime eoncrete.

We think that stone walls two feet thick, plastered with Portland cement, are better than concrete, and where people can afford to build of stone they had better do so. In regard to the size of silos, we would make them twenty feet deep, and put them as much below ground as possible, if good drainage can be had, banking up around the outside with the earth that is excavated, as before stated. A silo thirty feet by sixteen feet, and twenty feet deep, will be large enough to contain two hundred tons of pressed ensilage, and this would keep thirty-five cows six months, feeding about sixty pounds per day. For one hundred eows, we would advise building a silo

one hundred feet long, dividing it into three compartments by means of two cross walls, and then feed out one at a time. This would provide an empty silo in the spring, which would be ready for the winter rye, clover, June grass, etc., Hungarian can't be grown early, which could be harvested early in June, cut up same as the corn fodder, and stored in the silos for summer feeding. Our ideas are, that it is best to give the stock a good feed from the silos every morning and night during the summer in addition to pasturage. Now, as to whether people can afford to put in silos, etc., we can only say that on our upland farm we had, at the beginning of winter, two hundred tons of hay. If we had put in fifteen or twenty acres of corn, and cut and stored it in the silos, we would now have been able to have spared all of the two hundred tons of hay, and, as the price is now extreme, twenty dollars per ton, we would have received for it enough to have paid all expenses of building both barn and silo, besides raising and harvesting the corn fodder, and we should have had fully as much manure to put back on the farm as we will have now in feeding the hay. But even if hay was but eight dollars to ten dollars per ton, it would pay to put in the corn crop for ensilage, and build the silo to contain it. The stock would be kept as well upon the ensilage as upon hay, and give as much manure, and the hay, if it were sold at eight dollars to ten dollars per ton, would pay all expenses the first year. The right kind of corn for seed costs eighty-five cents to one dollar per bushel, and we hope to get a feed-cutter capable of cutting ten to twelve tons per hour, or one hundred tons per day, for about one hundred and fifty dollars, and not require over a two-horse tread power to run it. Corn ensilage is probably not a perfect food for cows in milk. Linseed meal, or cotton seed meal, with bran or oat meal, will produce a good flow of milk. Fifty-five or sixty pounds of ensilage food, with

three pounds of linseed meal, and four pounds of bran, will answer satisfactorily.

CHAPTER IX.

ENSILAGE IN HUNGARY.

The preservation of green fodder crops has long been practised in several countries of the Continent of Europe, by essentially the same process as that now termed ensilage, but under the names of "Sour Hay," and "Sour Keep." In Germany, clover has long been preserved in this manner, and especially have the leaves of the Sugar Beet been kept in pits for winter feeding.

In October, 1873, the "American Agriculturist" published an article from its correspondent G. C., a farmer in Hungary, entitled

"SOUR-FODDER MAKING,"

the essential portions of which, with the engraving are here given: "Although the writer is not acquainted with American farming except by reading of the 'American Agriculturist,' nevertheless I communicate a method of preservation of juicy fodder peculiarly important for corn-producing America.

"The corn is sown broadcast, or drilled in rows nine to eighteen inches apart, two metzens to one Austrian joch, or about 3.3 hectolitre to one hectare. [This is nearly three and a half bushels to the acre.—Ed.] The cultivation remains the same; the field must be kept free from weeds. At blossom time the corn is mown, loaded into wagons, and hauled in. The home-brought

corn is put in large ditches, German Grube, Miethe, ten or twenty rods long, and is here pressed in by a few men walking on the green corn. The engraving, figure 14, will explain the whole. The ditch is twelve feet deep, twelve feet wide at the top, and six feet at the bottom. The length will need to be sufficient to contain the fodder to be preserved. The ditch must be dug in dry ground. When the ditch is filled, the green corn is built like a stack upwards about ten feet over the level of the

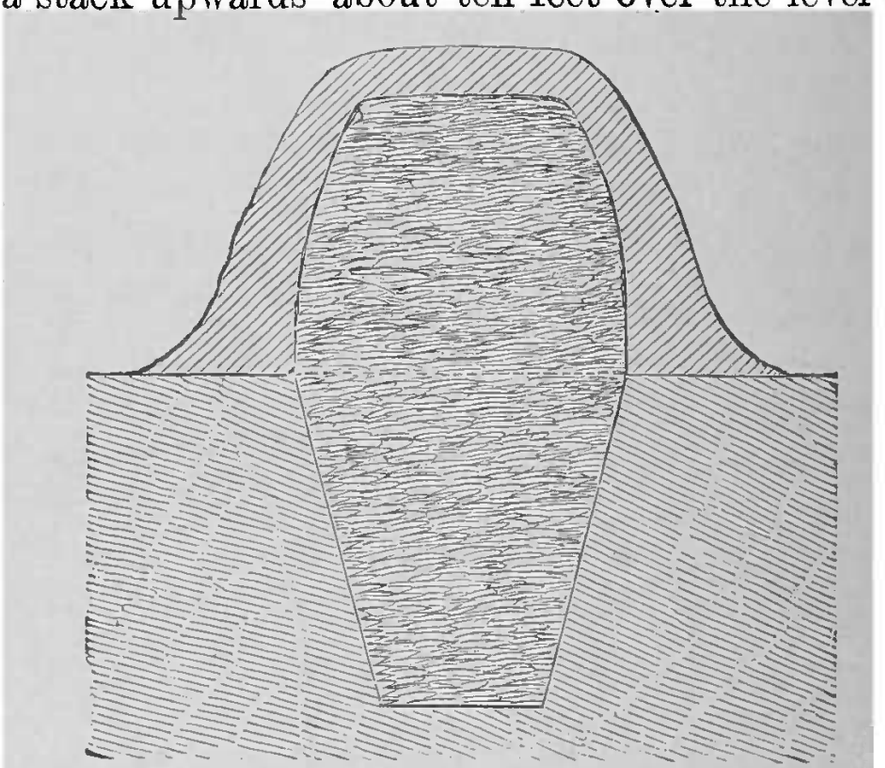


Fig. 14.—SECTION OF HUNGARIAN DITCH.

ground, as shown in the engraving. The finished stack is then covered with earth about two feet thick on every side. It is best to cover the top of the stack at first, because the weight of the earth pressing down the green corn, so much earth is not needed for covering as is the case when the sides are covered at first.

"This sour-hay making enables us to store a large quantity of juicy fodder for the winter, and if well covered with earth it may be stored for a few years without any injury. The most important of all is, the beasts being once acquainted with this sour-hay, like it very

much. With us, in Hungary, the sour-hay is cut and mixed with corn meal, or some other ground grain, and given to the cattle; but the sour-hay may be fed uncut also.

"In sections where stones and bricks are to be obtained cheaply, the sides of the ditch may be walled, but it is not necessary.

"I should be very glad if these lines would serve to encourage the sour-hay making of corn by the American farmers."

ENSILAGE OF ROOTS.

The following year the "American Agriculturist," published, in August, 1874, another article from the same Hungarian correspondent, in which he describes the preservation of beets with chaff, giving this also the name of "sour-fodder." "The chief necessity of every dairy farm, or cheese and butter factory, is to feed a juicy food to the cows at every season of the year; this is easily provided for in the spring, summer, and autumn, by feeding green rye, wheat, clover, a mixture of oats and peas, corn, etc., but in the winter we have no other milk-producing fodder than beets and corn sour-hay. It is known to every farmer, how difficult is the preserving of roots in the winter, and that large quantities of them are injured and therefore spoil. To avoid this, we cure the beets and other roots with chaff into sour-fodder. This method of using root-fodder has been in use on large farms in Hungary for some years, and has always been successful. The method of making this so-called sour-fodder is as follows: at first we have a ditch made in a dry place [the ditch may be of the dimensions already given for corn fodder.—Ed.] When the beets are taken up in the usual manner they are hauled in, washed, and cut with a machine. Then the pit may be divided into

sections, for instance, for a length of ten rods into five sections, and by this division the labor is very much facilitated, because the first section can be covered with earth, while the second section is being filled. When a certain quantity of beets are cut, we place at first a layer of chaff upon the ground of the first section, upon this chaff is placed a layer of cut beets, in the proportion of one pound of chaff to ten pounds of cut beets; these two layers are then solidly mixed with a fork; after having done so, a layer of chaff and beets is again laid down, and again well mixed. This is repeated until the mixture reaches the top of the ditch; then it must be built up-

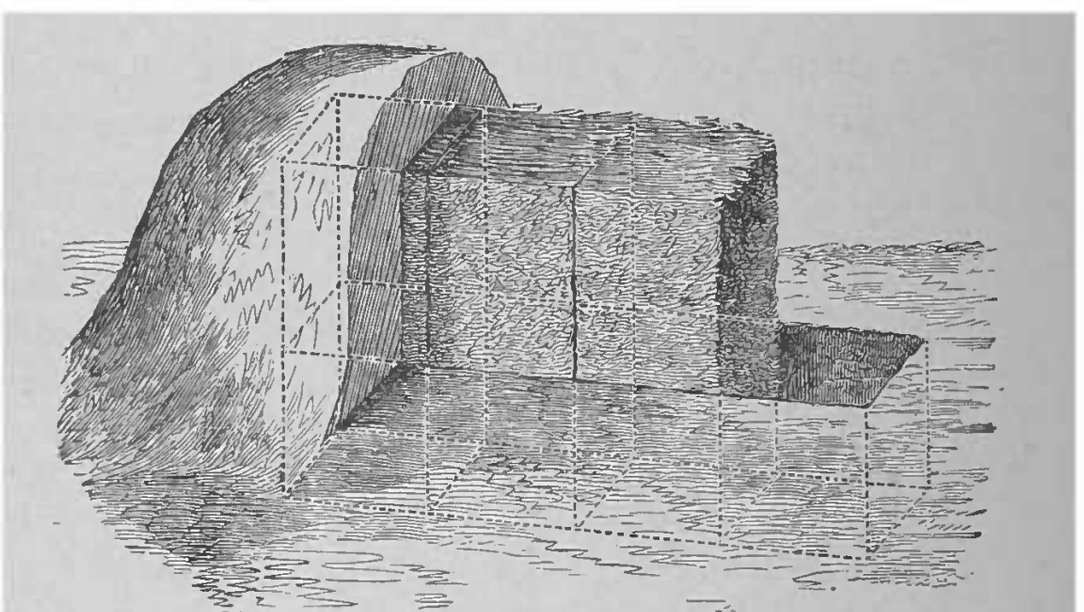


Fig. 15.—PIT OF BEETS AND CHAFF.

ward from six to nine feet above the level of the ground. On the top of the stack are laid a few sheaves of rye-straw, to prevent the fodder being mixed with earth; then the first section is covered with earth, commencing the covering at first on the top of the stack. When the first section is finished, the second and all following sections are managed in the same manner, as above described; when the whole ditch is filled, we take care that the stack is covered on every side with one and a half to two feet of earth. This sour-fodder, mixed with corn meal or

other feed, will be relished by the daintiest beast. The engraving, figure 15, shows the whole arrangement. The first and second section of the ditch is filled, the first one is also covered with earth."

CHAPTER X.

THE ENSILAGE OF BREWERS' GRAINS.

In an article published in the "American Agriculturist," there was given a description of a silo for the preservation of Brewers' Grains. This was attached to a dairy barn at Katonah, Westchester Co., N. Y., and had at that time been in successful use for many years. The silo in this case is square and deep, and attached to the barn. The engraving, figure 16, shows the shape and method of construction of the silo, and at figure 17, the manner in which it is used. It will be seen that the only difference between the operation of this and the French silo, is, that the former has not so dense and compact a covering as the latter. A very close covering is not so essential with brewers' grains, as with corn fodder, because they pack much closer and exclude the air better than the looser corn stalks; but when the latter are cut up into chaff, and thoroughly well pressed down, a mere covering of planks, nicely jointed upon the edges, would be sufficient for the exclusion of the air from the mass below. It is always preferable to cut the fodder into pieces, not longer than one inch, for the reason that it then packs more closely and the preservation is more complete. The silo, shown in figure 16, consists of a sort of basement cellar, with the door opening into the cow-

stable, and the rear sunk for the most part beneath the ground; a road passes to the end of it, where there is a door, shown by dotted lines, for the purpose of receiving the grains. The walls are of stone, and the floor is of cement. The silo is covered with an ordinary shingle roof. The grains are packed in solidly, until they reach the level of the door at the top, when they are covered with boards, and some straw is thrown over the boards.

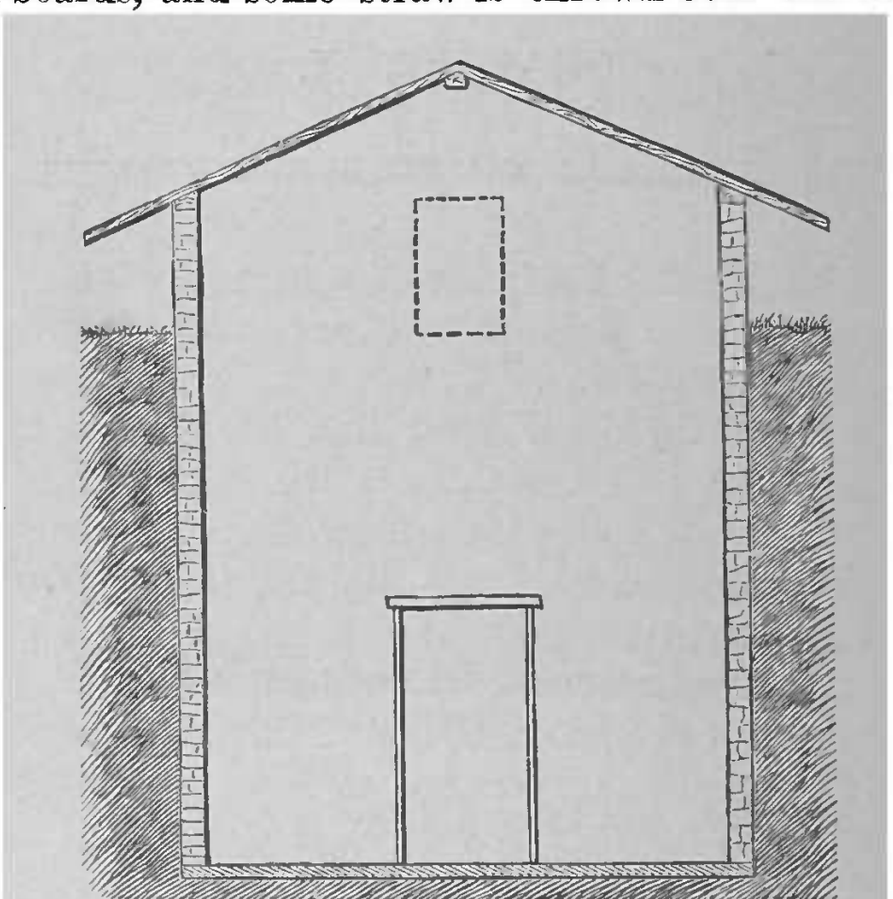


Fig. 16.—METHOD OF CONSTRUCTION OF THE SILO.

When the grains are required, the lower door is opened, and the grains, as fresh as when put in, but somewhat sour, are dug out for use. As the mass is cut away, nothing is done to the surface which is left exposed to the air; but as the grains are very quickly used in this large dairy, there is not time for them to be injured, and the surface is made fresh every day by the removal of what was left exposed the day before. The same method may be applied to the preservation of corn fodder. As cut

green fodder lies in a looser and more open mass than grains, it would be necessary to have a cover as nearly impervious to air as possible, for use when the silo is opened and the preserved fodder is in course of consumption. This may be easily done by means of wide planks, jointed smoothly at the edges, which should be laid upon the face of the mass of fodder as it is cut away. Pins may be inserted in a few of these planks, upon which another

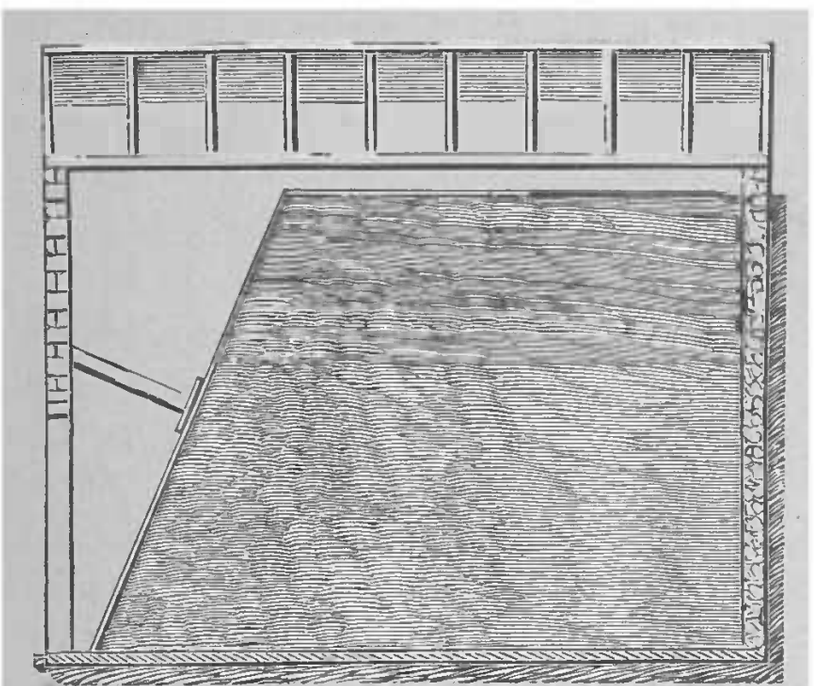


Fig. 17.—MANNER OF COVERING.

plank may rest, and the whole cover may then be pressed tightly against the fodder by means of a piece of timber placed with one end against the wall, and the other end resting upon the cross-plank, and thus made to act as a wedge. This is shown in figure 17; It will be necessary to cut away the mass of fodder smoothly and regularly, leaving an even surface for the planks to rest against.

CHAPTER XI.

THE ENSILAGE OF OTHER CROPS THAN CORN.

The experiments with ensilage have been, in this country, at least, so generally made with Indian corn, that, in the popular mind, the term is understood to refer to the preservation of that crop. Reference has already been made to the preservation of other crops, and some examples have been given, including one of the successful preservation of Brewers' grains for a series of years in a receptacle that is essentially a silo.

In Germany and France, where large areas are devoted to the cultivation of the Beet as a source of sugar, the closest economy is observed in every step. Indeed, the success of this culture depends largely upon the proper expenditure of the beet-root pulp after the factory has extracted the sugar, or all that it can profitably remove.

Frost greatly diminishes the yield of sugar; hence the beets are topped and harvested before there is any danger from this source. As a consequence, the leaves are in excellent condition, being in nearly full growth. While beet-leaves, and especially beet-pulp, contain a large amount of earthy matter, salts of various kinds, that unfit them as an exclusive food for animals, they are of great value when properly mixed with feed of other kinds, and their preservation is an important matter to the farmer who cultivates the sugar-beet. The great mass of beet-tops can not be fed out before it would spoil, and ensilage comes in as an important aid in its preservation. From the accounts given in European works it appears that the beet leaves are merely packed away in pits, and directly in contact with the earth.

The farmer who delivers his beets at the sugar factory

bargains for the return of the pulp, and this valuable cattle food has also been preserved with success by burying it in a similar manner.

The Beet-sugar industry is making a slow, but healthy growth in this country, and the time is not far distant when the preservation of the leaves and pulp by ensilage will be of great importance.

Hungarian grass usually comes in to supplement a short hay crop, and being sown late, it is cut late, and is often in danger of being caught by frost before it can be cut and cured. The few experiments that have been made show that this grass may be preserved in silos, and thus treated makes excellent fodder.

Mr. W. C. Strong, the well-known horticulturist of Brighton, Mass., tried packing Hungarian grass in the silo, just as it came from the field, without cutting. The attempt resulted in failure, there being so much air included in the mass that decay took place. In other instances, where the grass was cut before storing, it kept in a satisfactory manner, and made excellent ensilage.

Millet.—Under this name a variety of plants are cultivated in this country, and there is much confusion in the application of the term. The true Millet of Europe, *Panicum Miliæcum*, is rarely cultivated with us. It is to this plant that the name, Millet, should be restricted, and with all other grasses it should be used with a prefix. The plant most generally cultivated in this country as "Millet" is one of the forms of *Setaria Italica*, (also *S. Germanica*, which is but another name for the same,) and is a variety of the "Hungarian grass." The form known as "Hungarian grass" runs more to foliage, while those varieties known as "Giant," "Hungarian," "Bengal," "Golden," and other kinds of Millet, have larger panicles, and produce more largely of seed or grain than the others.

For the purposes of ensilage, the variety known as

Hungarian grass would be better than any of the forms called Millet, as they are likely to give a large supply of herbage.

The name of Millet, with the prefix "Pearl," that is, "Pearl Millet," has, within a few years, been given to a plant well known in Southern localities as "Cat-tail Millet," from a resemblance of its dense heads to those of the real "Cat-tail," *Typha latifolia.*

"Pearl Millet" is properly *Penicillaria spicata*, and belongs to a different genus from any other grass known as Millet. The trials that have been made with it show it to have value as a fodder plant. Like several other grasses, which are large enough when well established, this is very small at the start. When a stand is fairly made, it grows on with great vigor, and allows several cuttings to be made during the season, the number depending upon the latitude. As a plant for ensilage it is worthy of the attention of southern farmers.

Sorghum, in its different kinds, is worthy of consideration as a plant for ensilage. *Sorghum vulgare* has developed into several distinct races. Those forms which are grown for an unusual development of the seed panicle are known as Broom Corn. Other varieties have been produced in which the saccharine matter of the stalks is developed to its highest point, and are cultivated for syrup and sugar. Other varieties still are cultivated for their grain, which, under the name of Durra, etc., are the principal bread food of some oriental peoples. Of late, some of these grain-producing forms have been offered as forage plants, and it is likely that some of these may be found of value for ensilage. Indeed, all of these kinds of Sorghum, with the exception of Broom Corn, are likely to give ensilage of great value, and should receive attention in those localities where their culture is found profitable for feeding green or curing dry.

Rye sown for a forage crop is of great value, especially

on a dairy farm. It has the disadvantage of maturing rapidly, and all at once; so soon as the heads begin to form, the stalk becomes hard and woody, especially at the lower part, and loses its nutritious qualities.

Where ensilage is practised to a large extent, it is well, as Messrs. Whitman & Burrell propose, to have a silo empty by the time the rye is in its best condition for fodder, at which time it may be cut and stored, thus preserving this valuable crop in its greatest perfection.

Both Oats and Wheat, cultivated for fodder crops, have been successfully converted into ensilage. We have not heard of the use of Oats and Peas as an ensilage crop. This mixture is a favorite fodder crop with many farmers, and converting it into ensilage would allow it to be secured for future feeding at just the time of its greatest perfection, which is before the formation of the grain and seeds has materially diminished the nutritious value of the herbage in either.

Among the kinds of forage that have been preserved in silos in Europe is the foliage of the Jerusalem Artichoke, *Helianthus tuberosus*. A variety of this, called the "Brazilian Artichoke," is most generally cultivated, though it is "Brazilian" only in name. It differs from the old and well-known form in having shorter and rounded tubers, which grow close around the base of the plant, and these usually have a red skin. The variety known as "Brazilian" is regarded as vastly preferable to the old form with long and scattered tubers.

This crop is coming into use in some parts of the country, as affording a valuable food for swine. The yield of tubers is often enormous, and as the harvesting is done by the animals themselves it is cheaply raised. The crop is, however, a very exhausting one, there being few plants that take from the soil and deposit in their herbage such a large amount of potash as does this. Wherever the Artichoke is grown, the stalks and foliage

should be returned to the soil in some form. The French convert them into ensilage. Cattle and other animals are remarkably fond of the recent foliage, and it will be worth while for those who cultivate the crop for the tubers to experiment in the saving of the herbage in silos, either by itself, or mixed with corn or some other plant, that its valuable constituents may be returned to the land in the manure.

In the agriculture of the Southern States the Cow Pea largely takes the place occupied by clover on northern farms, both as a crop to be plowed under for green manuring, and as food for domestic animals.

The crop is not one that is cured into hay without difficulty, as the large stems and foliage are very succulent and heavy, and lie so compactly that there is danger of moulding and decay. When made, the cow-pea hay needs to be handled with care, as the leaves readily break away, and every time it is moved the finer portions of the hay become scattered; consequently caution is required in feeding it, or the rations will be very unequal. The portions from the upper part of the mow will be little besides bare stems, while that lower down will have more than its proper share of the foliage. By preserving the cow-pea in silos these difficulties would be avoided, and the southern farmer will be thus enabled to provide his animals with this rich fodder in a vastly better condition than is otherwise possible.

It is not necessary that the value of the cow pea, as an ensilage crop, should be confined exclusively to the Southern States. Though it cannot be depended upon to ripen its seeds in northern localities, it will, in the climate of southern New York, yield an abundant crop of most nutritious herbage. This plant is one which should receive the attention of those interested in ensilage. There are some twenty or more named varieties of the cow pea in cultivation in the Southern States, varying almost

as greatly in the size and color of the seeds as do the garden beans. The plants differ much in size and vigor, as well as in their disposition to run, and seek some support upon which to climb. Some, if provided with poles, would climb to the hight of several feet, and these, in field culture, twine about one another and form a dense matted mass that prevents harvesting by the mowing machine. Some varieties are preferred by southern farmers for plowing under, others are considered best for hay, and still other kinds for the production of ripened peas.

The "Johnson Grass," also in some localities called "Guinea Grass," and "Means Grass," is a tall perennial species, *Sorghum Halepense*, with thick tuberous roots, that is of late being planted extensively in the Southern and some of the Middle States. It allows of several cuttings during the season, and is highly esteemed by those who cultivate it, both for feeding green and for hay. This is another plant that promises to have its value greatly increased by being preserved in silos.

Buckwheat is one of the crops that has been suggested as proper for ensilage, though we have no definite accounts of its employment in this manner. It has the merit of giving a fair crop upon poor land. The straw, after the grain has been removed, is not regarded as especially valuable, and indeed, when fed to swine or used as bedding for them, is apt to cause an eruption upon or irritation of the skin. If stored in the silo, this should be done before the grain has formed, just at flowering time, in order that the herbage may be in the most nutritious condition.

Prickly Comfrey, *Symphytum asperrimum*, a plant that has been rather slow in finding a place in our agriculture, is in Europe commended as one useful for ensilage, especially to mix with fodder corn in the silo. We have seen no definite accounts of experiments with this plant in the form of ensilage. In some localities in Virginia, and

on some dairy farms in New England, it has been cultivated to some extent. The chief merit claimed for it is its abilty to furnish green fodder very early in spring and late in the fall, and we enumerate it as one of those plants that may possibly be of valuc in the silo.

CHAPTER XII.

THE NUTRITIVE VALUE OF ENSILAGE.

BY J. M. MCBRYDE, PROFESSOR OF AGRICULTURE, ETC., UNIVERSITY OF TENNESSEE.

The sueeess of Ensilage appears to be fairly established by experiments in many different localities, and is therefore no longer an open question. Concerning the nutritive value of the new food, however, the views are many and conflicting. We have enthusiastic farmers, on the one hand, declaring that ensilage is almost equal, pound for pound, to hay, that it is suffieient by, and of, itself not only to sustain life, but to fatten, that it ean hardly be improved upon; and, on the other hand, scientists assert that its value is to be estimated by its percentage of dry matter alone. The first refer you to the results of experiments where estimated amounts of this and other stuffs were roughly fed to different farm animals of various weights and ages; the seeond to the results of reeent analyses, showing that it eontains eighty per eent and upwards of water. The last affirm: "Average ensilage eontains eighty-two and a half pounds of water and seventeen and a half pounds of dry substance in one hundred, and a ton of it, skillfully fed, will make twenty pounds live weight of beef, whieh, at five and a half

cents, would be one dollar and ten cents. The manure might bring it up to one dollar and fifty cents per ton, feeding value. In view of the above showing, the claim that ensilage is a nutritious feeding stuff is simply preposterous." Now any one who will take the trouble to make the necessary calculations from the data furnished by No. 14, in Series 2d of the subjoined experiments, will find that one thousand two hundred and twenty-three pounds of ensilage made twenty-seven pounds of beef, live weight, or about forty-three and three-quarter pounds to the ton. In other words, the estimated amount is wide of the mark by upwards of one hundred per cent. Again, the results of all the following experiments go to show that ensilage is not of itself a perfect food, and that its nutritive value is greatly increased by the addition of other matters.

I do not propose, however, to discuss in detail the experiments of the several Series, my space is too limited for this, but simply to ask that all those interested in the subject will examine them, candidly and fairly, for themselves. I have said enough, I hope, to show the importance of experiments carefully and accurately made, without previous bias or prejudice. As such these are offered, for no expense or labor was spared to make them thorough and reliable. They are herewith submitted in full and without reserve, along with the fewest possible words explanatory of their history and bearing. It must be premised that every pound of food was carefully weighed, the animals were confined in separate stalls, and were as nearly as possible alike in age, blood, and general condition, except in Section II of Series 1st, designed simply to test the life-sustaining power of ensilage, and in Series 3d, establishing its forcing qualities when properly combined with other foods.

In Sections II and III, Series 1st, the results of the experiments are not as unfavorable to ensilage as they at

SERIES 1st.—Experiments testing nutritive and milk-producing value of Ensilage, *Jan. 2 to Feb. 1.*

No. of An'al.	*Daily Rations Per 1,000 pounds Live Weight.*	*Weight Jan. 2d.*	*Weight Feb. 1st.*	*Gain per month.*	*Gain per day.*	*Gain per cent.*
	I. *Hay for Standard of Comparison.*	lbs.	lbs.	lbs.	lbs.	lbs.
15	20 pounds of Hay	687	700	13	0.43	1.8
	II. *Ensilage alone.*					
14	40 pounds Ensilage	825	805	—20	—0.66	—2.4
9	50 " "	965	957	— 8	—0.26	—0.8
16	60	900	875	—25	—0.83	—2.7
	III. *Ensilage with Dry Forage.*					
6	10 pounds Hay, 20 pounds Oat-straw	700	720	20	0.66	2.8
1	10 " " 20 pounds Ensilage	580	540	—40	—1.33	—6.8
4	20 " Oat-straw, 20 pounds Ensilage	535	537	2	0.06	0.3
	IV. *Ensilage with Dry Forage, and Foods rich in Albuminoids.*					
7	10 pounds Hay, 20 pounds Oat-straw, 6¼ pounds Corn meal	505	525	20	0.66	3.9
12	10 " " 20 " Ensilage, 6¼ " " "	555	595	40	1.33	7.2
13	20 " Oat-st. 20 " " 6¼ " " "	450	480	30	1.00	6.6
	V. *Hay and different Meals.*					
2	20 pounds Hay, 6¼ pounds Rice-corn Meal	800	860	60	2.00	7.5
3	20 " " 6¼ " Corn meal	865	915	50	1.66	5.7
5	20 " " 6¼ " Cotton-seed meal	705	745	40	1.33	5.6
	VI. *Ensilage and different Meals.*					
8	40 pounds Ensilage, 6¼ pounds Corn meal	680	750	70	2.33	10.2
11	40 " " 6¼ " Cotton-seed meal	640	705	65	2.16	10.1
10	40 " 6¼ " Rice-corn meal	590	607	17	0.56	2.8
	VII. *Ensilage and Bran,* Milch Cows.					
17	24 pounds Hay, 1 peck Wheat-bran	850	840	—10	—0.33	—1 1
18	12 " " 24 pounds Ensilage, 1 peck Wheat-bran	820	805	—15	—0.50	—1.8
19	48 " Ensilage, 1 peck Wheat-bran	700	690	—10	—0.33	—1.4
	VIII. *Milk Production,* same cows and rations as VII.					
	Cows from five to seven months with calf.	*1st Period—Average No. of lbs of milk per day from Jan. 10 to Jan. 19, inclusive.*	*2nd Period—Average No. of lbs of milk p'r day from Jan'y 20 to Jan'y 29, inclusive.*	*3rd Period—Average No. of lbs of milk per day f'm Jan'y 30 to Feb'y 8, inclusive.*	*Loss or gain in 3rd Period as compared with 1st in lbs.*	*Loss or gain in 3rd Period as compared with 1st, per cent.*
17	¾ Jersey, ¼ Scrub	12.8	12.7	12.3	—0.5	—3.9
18	¾ Shorthorn, ¼ Scrub	8.0	9 2	9.6	1.6	20.0
19	¾ Jersey, ¼ Scrub	9.6	9 3	8.6	—1.0	—10.4

SERIES 2d.—Testing nutritive value of different kinds of Ensilage.—*March 15th to April 9th.*

No. of Animal.	*Daily Rations For every 1000 pounds of live weight.*	*Weight, lbs.*					*Gain in 25 days.*	*Gain per day.*	*Gain per cent.*
		Ma'ch 8th.	*Ma'ch 15th.*	*Ma'ch 23d.*	*April 1st.*	*April 9th.*			
							lbs.	lbs.	%
15	26 pounds Hay	737	740	750	765	782	42	1.68	5.67
9	50 pounds Clover Ensilage	990	995	970	976	985	—10	—0.40	—1.00
14	58 pounds Corn Ensilage	850	858	860	869	885	27	1.08	3.14
8	5 pounds Hay, 6¼ pounds Corn meal, 40 pounds Corn Ensilage	757	767	782	802	815	48	1.92	6.25
10	5 pounds Hay, 6¼ pounds Corn meal, 40 pounds Clover Ensilage	636	642	655	680	700	58	2.32	9.03

SERIES 3d.—Testing forcing value of Ensilage.—*May 2d to June 3d.*

No. of Animal.	*Daily Rations Per 1000 pounds live weight.*	*Weight, lbs.*				*Gain in the several Periods.*	*Gain per day.*	*Gain per cent.*
		May 2.	*May 19.*	*May 27.*	*June 3.*			
						lbs.	lbs.	%
15	26 pounds Hay, 8 quarts Corn meal, first 10 days, 10 quarts second 10 days, 12 quarts third 10 days	750			830	80	2.58	10.6
9	10 pounds Hay, 20 pounds Ensilage, 8 quarts Meal first 10 days; 10 quarts Meal second 10 days; 12 quarts Meal third 10 days.	1075		1150		75	3.00	6.9
14		9 0			1025	105	3.38	11.4
8		830	867			37	2.17	4.4
6		842		895		53	2.12	6 2
20	Hay and Meal in this and two preceding series of the best quality.	1085			1150	65	2.09	5 9
21		1040		1135		95	3.80	9.1

first sight appear; for it must be explained, first, that the month of January, during which this Series was continued, was the coldest and most inclement experieneed in this section for years; second, that No. 14 was a eow, dry upwards of a month prior to the commencement of the tests, but which, about one week thereafter, eame back to her milk, she was finally dried off about the middle of February; and, third, that No. 16 was a singularly savage and unthrifty two-year-old Shorthorn bull, that ill-brooked the close confinement incident to the experiment. Again, Nos. 1 and 4 of Section III were yearlings, weaned only a week or so prior to January 2d. They had received, up to within a few days of that time, hay, meal, and slops. No. 1 refused its rations at first, and never ate more than half of the amount allowed. No. 3, after the first week, ate nearly all. The close eorrespondence of the results of Nos. 3 and 5 in Section V, and Nos. 8 and 11 in Section VI, is especially worthy of notice, and makes these four experiments particularly valuable. In No. 18 of Section VII the heavier loss is perhaps explained by the greater flow of milk, as shown by the same number in Section VIII. It was remarked by several in attendance on the animals that those fed on ensilage alone appeared to suffer much more from the cold than the others. Here we have practice confirming theory, for the conversion o' a portion of the carbohydrates into acid and other principles, by the fermentation incident to the process, and the consequent loss, comparative, of the fat-formers, the fuel of the animal body, would lead us to expect just such results.

In Series 2d the animals were the same as those designated by similar numbers in Series 1st. Each, No. 15 excepted, received during thc interval between the two Series a daily ration, per one thousand pounds of live weight, of fifty pounds of ensilage, corn; six pounds of the best hay, and three pints of corn meal, and in this

time, about six weeks, No. 15 gained forty pounds; No. 9, thirty-eight pounds; No. 14, fifty-three pounds; No. 8, seventeen pounds; and No. 10, thirty-seven pounds. The weather during the continuance of this Series was damp and unfavorable, but by no means as cold as in the January preceding, hence the better results in case of No. 14, fed on ensilage alone. No. 9 demands a word or so of explanation. Our farm animals relished the corn ensilage from the start, but rejected the clover ensilage at first, and it was several days before they became accustomed to its use. This animal, No. 9, refused its rations for a week, and in that time lost twenty-five pounds. All the loss occurred in the first week. After that time, becoming reconciled to the new food, it made steady and continuous gains. This experiment enforces the necessity of frequent weighings. It is evident that the highest percentage of gain in both Series were made by animals fed on mixed rations of ensilage and matters richer in albuminoids.

In Series 3d, the animals were forced for the June market, and all the dates save the first show the day when each was sold to the butcher. In the interval between this Series and the preceding, all the animals except No. 15 received the same rations as in the first interval. No. 15 alone of all our farm animals, upward of forty head, persistently refused the ensilage from the first. It was therefore allotted the ration of hay in Series 1st and 2d, and, in the first interval, three pints of meal in addition. After the close of Series 2d, we endeavored to force it to eat the ensilage, but without success. Hence its loss of thirty pounds between the last two Series. The rapid gain of No. 21, a thoroughbred Shorthorn, three and four-fifth pounds per day, is especially noteworthy. No. 14 was quite heavy with calf. One striking fact greatly in favor of ensilage was noticed during this Series. The animals, although receiving

heavy and constantly increasing amounts of meal, never became gorged. From the beginning to the end of the Series their appetites were hearty and vigorous, their bowels open but not too loose, their digestion good. One word as to the cost of the rations. The price of meal and hay, of course, varies in different localities. The corn ensilage, from the planting to the final weighing down in silos, cost us one dollar and fifty cents per ton, or seven and a half cents per hundred-weight. This estimate includes the price paid for fertilizers, interest on land, etc.

[The experiments given above are worthy of the careful consideration of all who are interested in the subject of ensilage, and, with the explanations given of them, these tables convey the story in a most compact form. Tables with figures repel many persons, but there is no other method by which facts like these can be presented so compactly. The foregoing article, with the tables, is from the "American Agriculturist."—ED.]

CHAPTER XIII.

AN ABOVE GROUND SILO.

The owner of a silo made of wood and entirely above ground, describes in the French "Journal d'Agriculture Pratique" the method of its construction: A certain number of beams, *A*, figure 18 (which are described hereafter), are laid upon the soil at a distance apart of about two feet. Each one of these beams has a mortice at each end. The corn-stalks are discharged upon these beams and laid crosswise of them, building up the pile very regularly. When this is done, some boards are laid upon

the pile, and other beams, *C*, placed directly over the lower ones. The uprights, *B*, *B*, pierced with holes, are set in place; these pass through the mortices of the beams, and the ends which pass through the lower beam, *A*, are secured below by strong iron bolts, through the holes in

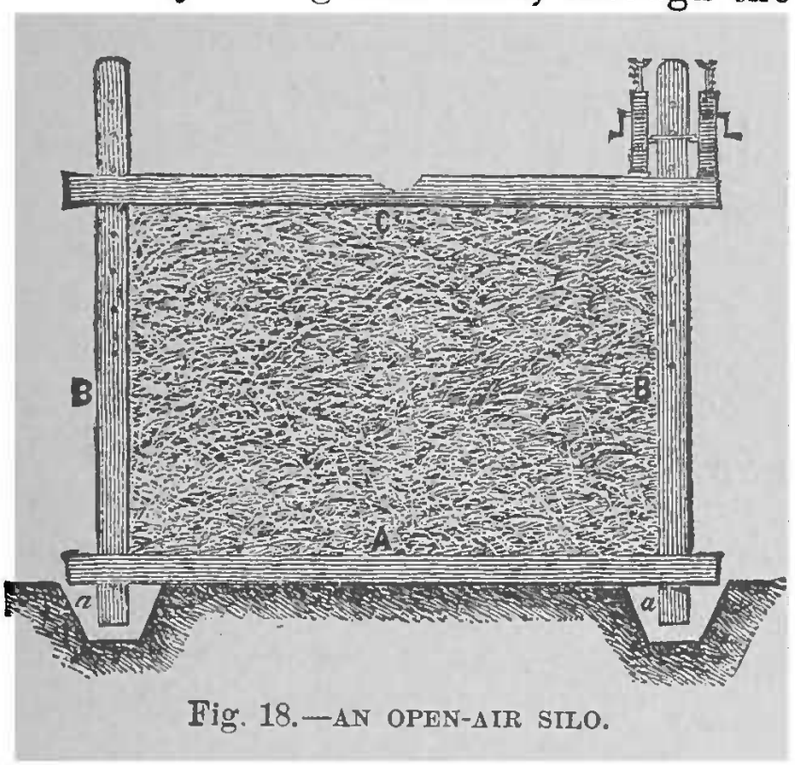


Fig. 18.—AN OPEN-AIR SILO.

A. The pressure is produced by two powerful jacks, placed opposite each other at the upright *B*, and resting upon the beam *C*. The power of the jacks is exercised against a stout iron bolt placed in a hole in *B*. As the handles of the jacks are turned, the beam *C* is pressed down, and when a new hole in the upright *B* is exposed, an iron bolt is passed through it to retain the pressure,

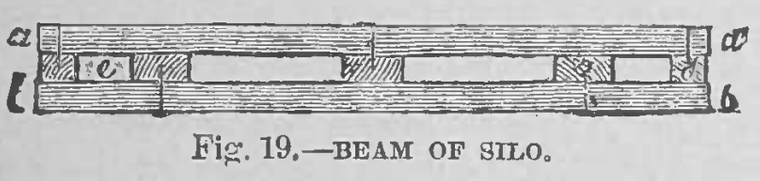


Fig. 19.—BEAM OF SILO.

and the jacks are taken to the next upright on the same side of the silo. After all upon one side have been treated, the jacks are taken to the uprights of the opposite side, and the pressure applied. This is continued until the last beam has been pressed at both ends. Pressure is

applied in this manner daily for eighteen days; after this it suffices to press every eight or ten days. The ensilage is removed by taking off one frame, consisting of two beams and two uprights, and cutting off the corresponding slice of fodder. The corn-fodder preserved in this manner was the Caragua corn, slightly whitened by frosts. It was in a perfect state of preservation. Only a thickness of between three and four inches all around the pile was black and moldy. One of the advantages of this method is the ability to regulate the pressure at will. A beam (*A*, *C*, figure 18) is shown in figure 19; this is formed of two pieces of timber, *a*, *a*, *b*, *b*, separated by the blocks, *c*, *d*. The spaces between the end blocks, and those next to them, form the mortices *e*, through which the uprights, (*B*, figure 18) slide. The owner concludes the description as follows: "The silo I have made, holds about two and a half tons of corn-fodder. The frames are about two feet apart, and the length of the mass is about ten feet. The two jacks exercise a pressure of over twenty thousand pounds at each end of the beams, amounting in round numbers to about sixteen thousands upon each square yard. It is to this powerful pressure that I attribute the perfect preservation of the ensilage in the open air, without the aid of a fodder cutter, and without any masonry or earth-work."—*American Agriculturist.*

CHAPTER XIV

"SOUR-FODDER"—PRIMITIVE ENSILAGE.

[It has been evident to those who have watched the progress of ensilage in this country that this method of preserving fodder presented great advantages to those with sufficient capital to construct silos and carry out the method on a large scale. On the other hand, it offered little to the farmer with but a few cows, as he could not afford the outlay required for building silos and providing the appliances necessary in preparing and storing the fodder. On page 47 is given an account of the methods of preserving fodder, in Hungary, without the use of a silo, but by merely pitting it in the earth, and we now give a description, by Mr. H. Nicholas Jarchow, of the German method of preparing "sour fodder," which was apparently the first attempt at preserving fodder by means of ensilage. This chapter will afford useful suggestions to those who would preserve their fodder on a small scale, and experiments judiciously made will, no doubt, greatly extend the benefits of this method of preserving green fodder of all kinds.—ED.]

Mr. Jarchow says:—In Northern Europe there occurred, about half a century ago, several successive years which were so unusually cold and wet at harvest time that farmers, being unable to harvest their forage crops, left them to rot on the field. The second cut of clover and the aftermath were generally lost. A German farmer, whose name is now forgotten, conceived the idea of throwing his entire forage crop, cut late in the fall, into a deep pit dug in the field, and to cover it with earth to protect it from frost. The forage when thrown into the pit was very wet, was hard on account of the growth of woody fibre, and the most hoped for it was that it would make

a useful addition to the compost or manure heap. Upon opening the pit the following spring the farmer, to his great astonishment, found, instead of a mass of manure, a solid body of vegetable matter, giving off an agreeable odor, the individual parts of which were thoroughly fermented and softened. Upon trial, he found that the farm animals ate the contents of the pit with avidity, improved on it and soon preferred it to their usual feed.

The results of this farmer's experiment soon became widely known, and agriculturists, especially dairymen, imitated this method of curing forage. The agricultural journals took up the subject, and these and scientific investigators concluded that there was here discovered a new and cheap method of preserving fodder plants, and one especially adapted to small farms. A method, which, by fermenting them, would render the plants more digestible and nutritious and at the same time more palatable.

This method received the name of "Preparation of Sour-Fodder." It is true that there appeared opponents to this method who declared that animals did not like forage thus prepared, and when forced to eat it were subjected to maladies and even died. When these cases were investigated, the untoward results were found to be due to improper preparation, allowing the forage to mold, to salting the fodder or to exclusive feeding on fodder thus prepared. As early as forty years ago it was, in Germany, an established fact that well prepared sour fodder, when properly fed, would not only be eagerly eaten by the farm animals, but would agree with and improve them.

I well recollect that in that year of general dearth, 1847, the agricultural journals advised farmers to preserve their fodder plants in this manner in order to keep them longer, to improve them and to increase the quantity of forage. It was remarked that every plant, if it

were not poisonous and had not become too dry, could be made useful for feeding purposes. The farmers accordingly gathered not only the proper forage plants, but potato vines, turnip leaves, the leaves of trees and grape-vines, the last cut from meadows and clover-fields; nay, they even gathered plants which are usually refused by animals, such as horsetails (*Equisetum*), swamp grasses, sedges, etc. It was demonstrated that these plants, under this treatment, became not only harmless but palatable.

TO PREPARE SOUR-FODDER.

The method followed in Germany is to excavate oblong pits, having a surface of 200 to 300 square feet, and eight to ten feet deep. These are made on a part of the farm where there is a heavy clay soil, and where there is a perfect drainage, so that no water can settle in the pit. The sides of the pit must be perpendicular. The forage, after it is stowed in the pit, begins to shrink, and unless the sides are perpendicular the mass cannot settle equally. Some farmers line the bottom and sides of the pit with brick. These afford excellent storage places for sour-fodder, but the mason work is not necessary.

THE FILLING OF THE PITS.

As soon as the fodder plants are cut, and before they can dry, a layer two or three feet thick is uniformly spread over the bottom of the pit and tramped down by the workmen. It is not advisable to use wooden rammers as the layers are apt to be, in parts, too closely compacted. Layer after layer of fodder is added, and tramped down, until the mass of fodder reaches three or four feet above the surface of the soil. Earth is then to be thrown around this portion which projects above the top of the pit to form a sort of curb around it about four feet thick, which is to be firmly pressed down. By

spreading the forage evenly as it is added, and tramping it down uniformly, the air is expelled from the mass. To expel the air more certainly, and to avoid air spaces in the fodder, water is often poured into the pit shortly before closing it. In case the fodder is cut during a dry time, water will be required to generate fermentation. Salt, the addition of which has been recommended by some, has not been found to be advantageous, as it delays fermentation. After the pit has been filled in the manner described, a layer of clayey soil, three or four feet in thickness, is thrown upon the fodder. This covering should be somewhat the highest in the centre, and pressed down all around so that it may shed water. A few days after the pit is made the top will begin to settle and cracks will appear in the covering of earth. More earth must be added and firmly pressed down in order to exclude the air.

In about six or eight weeks fodder thus pitted will be cured and ready for use, and will be preserved, unimpaired as food, for several years, if it has been judiciously treated.

The method here given is the usual way in which German farmers prepare "sour-fodder," though there may be differences on account of local or climatic reasons.

OPENING THE PITS.

In opening the pits, care must be taken to prevent the access of air and water to the forage. It is best to make a small opening at one end of the pit, and having taken out the needed quantity of the forage, to close the opening with straw, or boards, and earth. The fodder within the pit will be found in a compact mass, which must be cut with a suitable knife, and must be fed before it dries and becomes worthless.

CHAPTER XV

ENSILAGE IN GERMANY.

[Those who, by travel or by reading, are at all familiar with German agrieulture, have known of the methods of preserving fodder crops followed in that eountry. They know that even the smallest farmers, as a matter of strictest eeonomy, often preserved their elover and other fodder erops as "sour-fodder," "sour keep," and "brown hay"—and these terms, and the artieles they represent, were familiar to them long before "silo" and "ensilage" had a plaee in the literature of agrieulture. The origin of this German method is given in the preeeding ehapter by Mr. Jarehow, and it will be seen that ensilage was suceessfully praetised by German farmers long before the silos of M. Goffart presented the subjeet of ensilage upon a sufficiently grand seale to attraet the attention of the agrieultural world. We would not detraet from the eredit due M. Goffart for his labors, but we would not have the humble farmers of Germany deprived of their share of praise for establishing silos on a small and praetieable seale. Mr. Jarehow has prepared, at our request, the following ehapter upon the general praetiee of ensilage in Germany.—Ed.]

In German husbandry, beet raising is of the greatest importanee, not only for sugar making but also on aeeount of the great nutritive value of both the beet and its leaves. Though the leaves are oeeasionally thinned during the time of the growth of the plants, at harvest, in the fall, there is a great mass of green leaves on hand, averaging 4,000 pounds to the aere. These leaves represent to the German farmer a money value of from six to seven dollars. When dried, the leaves lose their nutritive properties, while when pitted green they are not only

fully preserved but undergo chemical changes which adapt them for feeding purposes.

Sour-fodder, made from beet leaves, is cured as follows: The leaves, together with the upper, green, woody part or "neck" of the root, are cut and left a day or so on the field to dry off a little, so that the adhering soil may be easily removed. Wooden forks are used and a sieve five feet long; this is made of laths which are separated three-quarters of an inch in order to allow the adhering earth, which is loosened by shaking the sieve, to pass through readily. The leaves, after having been thoroughly shaken in the sieve and freed from the soil, are packed in pits six to eight feet deep, which are at the bottom six feet and at the top ten feet wide. The leaves are then closely tramped down. The forage is accumulated in the pit in this wise to a height of three feet above the surface of the soil, and is then surrounded with a wall of closely pressed earth three feet thick. The whole pit is then covered with three feet of earth. Some farmers, fearing that the fodder may be spoiled in the pit, add salt to it, but the opinion at present universally accepted in regard to the use of salt is that it is injurious. The principal object of pitting the forage is to cause fermentation and the formation of lactic acid, and both of these are hindered by the use of salt. Lactic acid is formed when lime enters into organic compounds, some of which contain—and others do not contain—nitrogen. These conditions are present in the beet leaves. From experiments it appears that an addition of grain chaff to beet leaves has proved to be very advantageous, because this dry, and by itself nutritious substance, absorbs the liquid constituents of the beet leaves when packed with them in the pits. Besides, an addition of chaff, not exceeding five per cent of the weight of leaves and beet heads, regulates the fermentation of the green mass, renders it drier and more acceptable to the farm animals, while at the same time the woody

fiber in the chaff becomes softened. The sugar in the beet leaves and heads is entirely decomposed, and those parts of the plants which contain nitrogen are also subjected to decomposition, while the fatty substances increase by thirty-three per cent. In fresh beet leaves the proportion of the nitrogenous nutritive properties, to those which do not contain nitrogen is 1 : 2.5 (just as in clover hay). After the beet leaves have undergone the full process in the souring pit, this proportion is changed to 1 : 5, a proportion which is found in good meadow hay. Owing to the fermentation in the souring pit, beet leaves therefore lose the uncommonly rich proportion of their nutritive properties, and enter into a good medium proportion, such as is found in the standard fodder, meadow hay.

After from five to six months the pit may be opened, and there will be found a well preserved nourishing fodder which every farm animal will eat with avidity.

Maize or Indian corn, in North German husbandry, does not play so important a part as in South Germany, because the summers in the northern portion are seldom sufficiently hot to allow of its ripening. Maize, therefore, in North Germany, is only cultivated for soiling. But if cut green, maize cannot be used exclusively in feeding their cattle when farmers wish to fully utilize it, because maize does not contain a sufficient amount of nitrogenous substances. This proportion must be at least 1 (containing nitrogen) : 7 (not containing nitrogen), but is in green maize mostly 1 : 10. seldom 1 : 9.5. Farmers, therefore, mix green maize with other fodder materials in order to make up for the deficiency of nitrogen in green maize. Usually they resort to clover in blossom, young grass, oil-cake, etc. If, at the approach of September, a farmer has a good stock of green maize on hand, it is mixed with clover hay or good meadow hay and pitted in the same way as other fodder plants are

treated in the souring pit. The forage is ready for use at the end of eight or ten weeks; it has a dark green hue and emits an agreeably sour odor.

In South Germany and Austria the summers are warmer and of longer duration than at the north. There the maize ripens in time and can be utilized in the same manner as in America. Maize is, in these parts of Europe, used for the preparation of sour forage, but only after it is fully ripe and the ears are gathered. Freshly cut maize stalks are laid lengthwise in pits ten feet wide and the laborers closely tramp them down. When the pit is filled, heavily loaded wagons or heavy rollers are drawn over the pit, and thus its contents are pressed together as much as possible in order to avoid cavities in the mass, and the consequent accumulation of air. The space gained by this pressing is at once filled with fresh stalks and stamped down again, and the filling and refilling are continued until the mass of fodder is three feet above the surface of the soil. The top of the fodder heap is made one foot narrower than at the surface of the soil in order that in sinking, the mass may not catch on the wall and cause cavities. The projecting part of the souring pit is surrounded with a heavily pressed earth-wall, three feet thick, and then covered with a layer of earth of the same thickness, to which a conical shape is given. In from three to four months the fodder is ready for use and can be preserved by proper treatment, especially by protection against air and water, for several years in a good, sound condition.

In conclusion, I may remark that in Germany, in feeding green maize in soiling, the earlier ripening kinds have proved much more valuable than the late ripening. The reports of several of the principal experiment stations concur in stating that the early ripening sorts of maize, grown upon equally large areas of the same soil, contain, when cut at the same time (September 1st) from one-

sixth to one-fifth part more of dry substance than the later ripening. Besides, the dry substance of the early ripening varieties contain much more nutritive constituents than the later ripening, and that, in regard to the nutrition of animals, three pounds of forage of the former are estimated to be equal to four pounds of the late ripening kinds.

CHAPTER XVI.

SWEET ENSILAGE.

In the early days of ensilage the writer received a fruit jar, the cover of which closed it air-tight, containing finely cut corn stalks. No letter of explanation accompanied the jar, and after waiting several days for one, the contents of the jar were examined. Upon removing the air-tight cover, the odor of acetic acid was so positive and pervading as to suggest the thought that some one had discovered a method of producing vinegar from corn stalks and had sent this specimen to illustrate his method. We afterwards learned that it was sent as a sample of ensilage which was so sour that the owner feared to feed it to his cows. It has been the experience of those who have preserved fodder in silos that, when opened, the ensilage was often intensely sour, and upon exposure to the air, often grew still more sour. On the other hand, the contents of other silos, when opened, were quite without acidity, and even had a rich odor like that of dried fruit, as described by some, while others compared the odor to molasses. While the animals ate the sour ensilage with avidity, there was a feeling of apprehension that long continued feeding upon such intensely acid food might result unfavorably, and one of

the first questions presented to those interested in the science of ensilage was: "How can we secure sweet ensilage?" This subject early engaged the attention of Manly Miles, M. D., now Professor of Agriculture at the Massachusetts Agricultural College at Amherst. Doctor Miles presented the results of his experiments, and the views derived from them, at the Ensilage Congress of 1884.

Doctor Miles' conclusions are here given in our own language: The various kinds of fermentation that take place in vegetable substances are due to minute plants (*Fungi*) which by their growth set up changes in vegetable compounds. Thus, the yeast plant ferments the bread, beer, etc.; and similar minute plants, which occur in fruit juices, produce wine, cider, etc. The minute plants which produce these forms of fermentation require the access of air that they may perform their functions. There is another group of these minute organisms which multiply in a different manner from those just noted, and which cause the formation of lactic and other acids, which are known as *bacteria*. These occur in myriads in fresh ensilage, and live, multiply and carry on their fermentation when the air is completely excluded from the silo. Doctor Miles' experiments were directed to ascertaining the conditions under which these bacteria live, and how they could be destroyed. He found that the bacteria of lactic fermentation, and of kindred ferments, are killed by a temperature of 116°, if this be long continued for some time; but they are destroyed much more promptly if exposed to a higher temperature of 120° to 125°

When freshly cut corn ensilage is exposed to free access of air in the silo the mass heats. It undergoes a process of gentle burning (*Eremacausis*), with a rise of temperature which may readily reach to 150° Hence, if the cut fodder lies up loosely in the silo, and that is

slowly filled, the filling being continued through several days, a high temperature, from 125° to 140° or more, may be easily obtained with an impereeptible loss of fodder

Doctor Miles ascertained that the exclusion of air from fresh ensilage, whether packed or not, does not only not destroy the growth of the bacteria of fermentation, but promotes it. The result of this continued growth of bacteria is the conversion of the entire contents of the silo into what is known as "sour ensilage." This is sourer the older it is. There are a great variety of products from this repressed fermentation, and on exposure to the air the ensilage becomes, in some cases, still sourer from the formation of acetic acid, or vinegar.

It has been ascertained that the exclusion of air from ensilage that has been heated to 120° or 125°, stops all action, and the mass gradually cools down. The bacteria of fermentation are, at this temperature, completely destroyed—root, branch and germ—and the mass remains as if it were in a completely sealed preserve jar. Indeed, the process of ensilage is much the same as that of preserving fruits. By the exclusion of air while the substance is hot, fermentation cannot take place.

The above is essentially the theory as announced by Doctor Miles. After its announcement, cases in which the filling of silos had been, by accident, very slow, in which great heat had taken place, and on this account were supposed to be ruined, were reported ; but, contrary to expectation, they yielded sweet ensilage, the best the farmers reporting the cases had ever seen. The odor of the ensilage was positively sweet—like that of molasses, and it was greatly relished by the cows and proved to be superior as a milk-producing feed.

After the theory and practice of Doctor Miles were announced, we heard of those of Mr. Geo. Fry, in England, who had been working in the same direction, and had ar-

rived at the same conclusions. Since then Doctor Miles' views have been confirmed over and over again.

In a pamphlet, entitled "The Theory and Practice of Sweet Ensilage," George Fry, F.L.S., gives the results of his experiments upon sweet ensilage. The reader of Mr. Fry's work must bear in mind that his ensilage is very different from our own, where Indian corn (maize) is almost the sole crop ensiloed. Mr. Fry's experience was with "green rye, crimson clover, with and without oats; tares or vetches, with oats; *Trifolium pratense* (red clover), with rye grass; and meadow grass." The whole teaching of Fry's book may be summed up in this, from page 42:

"One condition, I believe, to be absolutely essential for the production of sweet ensilage, viz.: The temperature of the ensilage must exceed 122° Fahr.; if that temperature is not reached, the ensilage will be sour."—How far this axiom will apply to ensilage of Indian corn, experiments must verify.

CHAPTER XVII.

EXPERIENCE WITH ENSILAGE.

J. P. ROBERTS, PROFESSOR OF AGRICULTURE, CORNELL UNIVERSITY.

I have had some experience in building silos, and in cutting and feeding ensilage, and perhaps it may be of some value to those who intend to adopt this new method of preserving fodder. As I have formerly stated, the silo should be long and narrow, with the long side next to the barn. If the extreme inside length were thirty-two feet and the width sixteen feet, there should be three cross divisions in it; this gives four compartments, eight by sixteen feet each. If the extreme depth of the silo is twenty feet, it can be filled up fifteen feet and will settle

to about eleven, nearly all the settling occurring within forty-eight hours. Nearly all the upper half of the silo is for temporary use, and, therefore, may be constructed of rough unmatched boards. There will be wanted, at most, only twelve feet of air-tight, stone, or wooden wall.

One year I raised and ensilaged about three acres of Southern white corn. The drouth cut it short, and there proved to be scarcely fifty tons of it. It was fed to fattening steers, milch cows, and three-fourths blood Holstein heifers, coming two years old in June and July. The three heifers selected were an average of six that had been running in an open basement, and had been fed on hay alone. They were put into stanchions on a plank floor (for the first time) and about two weeks afterwards the experiment began. Each was daily fed fifty pounds of ensilage and one-half pound of malt sprouts. The weights at various times were as follows:

	No. 1.	*No.* 2.	*No.* 3.
Feb. 24.....	770 pounds	650 pounds	780 pounds
March 3.....	832 "	850 "	834 "
" 10.....	850 "	890 "	850 "
" 17.....	840 "	900 "	820 "
" 24.....	824 "	882 "	824 "

March 31st two pounds of cotton-seed meal were added to each ration:

April 7.....	890 pounds	850 pounds	840 pounds
" 14.....	872 "	938 "	862 "
" 22.....	870 "	925 "	902 "
May 1.....	916 "	960 "	926 "

If the weight of March 3d be taken as the most correct, it is evident that there was no such true gain as the figures between February 24th and that date indicate, but rather an increase of the contents of the stomach, due to more palatable food—then, the increase shown is but fourteen pounds for the three animals in twenty-one days. It is evident that this ration was very close to a maintenance one, as it was meant to be. The analysis of the ensilage, as well as all the other foods experimented with, has been made. The gain in the last twenty-three

days, when the two pounds of cotton-seed meal were added, was two hundred and twenty-two pounds, while in the interim of fourteen days, from March 24th to April 7th, the gain was fifty pounds. Without doubt, this last gain was largely made during the first seven days of April, when the meal was fed. From the above, may not the following conclusions be drawn? That Southern corn ensilaged will maintain young animals, but that it is better economy to add to it some food rich in albuminoids. The heifers, fed as above, came through the winter looking far better than the three of the same age fed on hay, and done much better in the spring after they went to pasture.

In February we had two aged cows go dry, and one heifer; they were then low in flesh, having been milked over a year. With feeding stuffs ranging from thirty-five to forty dollars per ton, they could not be sold at an average of more than twenty-five dollars. I determined to feed them. They weighed as follows:

	Heifer.	*No.* 1.	*No.* 2.
Feb. 21.....	1,150 pounds	1,000 pounds	980 pounds
April 20.	1,320 "	1,150 "	1,070 "
Selling price....	$65 74	$50 00	$49 97

They were fed fifty-two pounds of ensilage and eight quarts of corn-meal each, per day, until April 5th, when two quarts of cotton-seed meal were substituted for two quarts of corn-meal. The best results in feeding for milk was when ensilage was fed in connection with about two pounds of corn-meal, two pounds of bran and three pounds of cotton-seed meal.

On the 16th and 17th of June following I put into one of our silos (eleven by sixteen, and twenty-eight feet deep) three acres of rye and one and a half acres of clover; one load of clover was sandwiched between two loads of rye. The fuel was one and a half cords of two-foot wood; the engineer a sixteen-year old student; one man in the silo the first day, two the second; seven men and two teams

to cut, haul, and feed the material. The rye averaged fully six and a half feet in height, and grew on the ground where the ensilage corn grew last year, which was again planted to ensilage corn. The clover was heavy, and together they filled twenty-two feet of the silo. It settled six feet in forty-eight hours, and appeared to be about done. This, at forty-five pounds to the cubic foot, gave sixty-three tons. The pressure is secured by about three tons of stone piled at the corners, and a screw anchored in the bottom of the silo, made of two sections of one and a quarter inch square iron; the third section round, four feet of it having threads cut, five to the inch. Two eight-inch timbers are laid lengthwise about four feet apart; short blocks upon these form a sure foundation for the circular, cast-iron cap, upon which the nut turns. Notwithstanding all that has been said against the rod pressure, I like it. The silo was covered, weighted, and screwed down within half an hour from the time the cutter stopped, and less than two hours labor of one man had been spent in turning down the screw; ten minutes will unseal it.

The reader who is balancing the pros and cons of ensilage in his mind, is without doubt still undecided, but I think I have given data from which a better understanding may be reached. It is utterly impossible for anyone to make others' circumstances similar to his own, but it may not be unprofitable to enumerate the various items of cost, etc. First, we have a stationary engine for threshing—a horse power may be used. The silos of one hundred and fifty tons capacity together cost about three hundred dollars. The cutter cost one hundred dollars, but we need one for other use. Two of the men employed cost one dollar per day; seven men, one dollar and twenty-five cents per day; and one man, one dollar and seventy-five cents per day. The teams are worth very little to us about that time of the year and their

labor is light. There is a little charge to be made for the use of tools and implements. The three acres of rye had a dressing of fifteen loads of farm manure, worth to us fifteen dollars. Perhaps half of this should be charged to the succeeding corn crop.

What it will cost A or B to raise three acres of rye, I cannot say, nor what one and a half acre of clover is worth; the second growth will probably be heavier than the first. From September until June I had ready sale for about 5,000 quarts of milk per month, at five cents per quart. If drouth comes, it is difficult to produce it, for the more cows one purchases the more the evil is aggravated; but with ensilage, cows can be kept from flies, out of the sun, fed in the stables, and turned out at night.

I believe the greatest utility of silos will be found to consist in the means they furnish of preserving forage plants in a green and palatable state, which may be easily grown in abundance in May and June, but if not then secured they would become dried up and nearly worthless; or, if dried and housed, the animals appear to have but little relish for them in the hot dry days of August. The reasons for building silos with small compartments are manifold; a small compartment may be filled and sealed up in a single day, thereby not seriously interfering with the regular work. Each forage plant may be taken when in its best condition. One compartment may be filled early with rye and clover, which is showing a tendency to spoil by lodging, or is full of weeds that it is desirable to eradicate; a second, with oats and a second cutting of the former clover field, or a weedy, belated piece of timothy. A piece of fodder corn and aftermath would fill a third compartment later in the season.

If the compartments are small, they may be uncovered entirely and fed from the top, and if not all consumed, they can be filled up with new material; or, if one or

more compartments are entirely emptied, they may be refilled in September, thus securing a two-fold benefit from them. From my experience, I judge that a compartment not entirely emptied in the spring, if disturbed only on the top, would sustain little loss until June if resealed, or it might be left open, and a little of that exposed to the air daily, fed to the horses as cut feed. Our horses, thus fed last winter, relished it very much.

There are many problems in regard to ensilage that are still unsolved; but should everything be found favorable to the new method, still there are men who would have no more use for a silo, than for a trotting-horse. There are men having so little energy and skill, that should you give them the best herd of Shorthorns, they would become little better than scrubs in ten years. Under certain conditions the method can be adopted with profitable results; but he who rushes thoughtlessly into it will find that ensilage is too "Frenchy," unless mixed with a liberal allowance of brains.

CHAPTER XVIII.

SUPPLEMENTARY NOTES ON ENSILAGE.

The following items, of interest to those who are investigating the subject of ensilage, not properly belonging to either of the preceding chapters, are here brought together in a supplement.

INCREASING THE CAPACITY OF A SILO.

Cut fodder corn finally settles in the silo to two-thirds or one-half its original bulk. If a silo be filled and

weights put on, the mass settles, and there is a great waste of space. To obviate this, and to utilize the full capacity of the silo, Mr. Mills proposes to erect a frame of plank to extend above the upper edge of the masonry of the silo to a hight corresponding to about half its depth. After the silo proper, the enclosure of masonry, concrete, or of whatever the structure may be built, is filled with the material, this frame is to be put on, and the filling continued into that. The covers and weights are to be placed upon the contents, and after these have settled down to the silo proper, the frame is to be removed and the covering put on permanently.

ENSILAGE FOR POULTRY.

All who have had any experience with poultry are aware of the great benefit that comes from a proper supply of green vegetable food during the winter. This is ordinarily supplied by feeding cabbages, stored in the usual manner, or roots. Those who have tried it, assert that ensilage of Indian corn may be fed to fowls as an equivalent for other green food at a much less expense than such food can be supplied in any other form.

THE CHEMISTRY OF ENSILAGE.

Like other new methods in agriculture, ensilage has its enthusiastic advocates, and its opponents, or, at least, those who are indifferent to it.

Much that has been written upon the subject is in a style that may be considered as sensational, and calculated to repel the earnest seeker after facts, and convey the impression that a method advocated in so extravagant a manner may not be of real value.

It is claimed by those who are opposed to the method, that chemical analysis shows that corn fodder is injured by ensilage, and its feeding value lessened by the loss of

important constituents. This statement rests mainly upon the results obtained by Moser at the Vienna Experiment Station, an abstract of whose article was presented by Prof. H. P. Armsby, of the Sheffield Scientific School, New Haven, Conn.

The summing up of the analyses of Moser shows that the corn fodder, as treated by him, lost in the silo from eight to thirty-eight per cent of albuminoids, and a loss of thirteen to fifty-eight per cent of nitrogen-free extract, such as starch, sugar, etc.

It should be stated that these analyses are not strictly those of ensilage, but of corn fodder made into bundles, placed in the silo at different depths, and surrounded by the cut fodder. A portion of the bundles of fodder were allowed to wilt for a few days before they were buried in the cut fodder, a condition to which ensilage, in this country at least, is not subjected. It is a well-known fact that fermentation can not take place without a loss in the material fermented. The object in ensilage is not to encourage fermentation, but to check it. If the silo is perfectly tight, fermentation will cease as soon as the oxygen in the air that is inclosed in the cut fodder is used up. The more perfect the process, the less will be the fermentation, and, of course, the smaller the loss in the constituents of the fodder. That there will be some loss is inevitable, but it will not be claimed that Moser's analyses show what that loss is, in the best constructed and best managed silos. When that loss of feeding constituents is accurately ascertained, we shall then be able to judge whether or not it is counterbalanced by the advantages of ensilage.

The author of the article referred to, Prof. Armsby, in his admirable "Manual of Cattle Feeding," remarks: "Corn being a comparatively cheap crop, the losses of material during the fermentation might be compensated by the improved quality of the residue."

"It does not appear from Grandeau's analyses, however, that there is any marked difference in this respect between fresh maize and ensilage. If this is generally the case, then fermented corn fodder has all the advantages of the fresh fodder, and no others, except perhaps as regards palatability, and ensilage is to be looked upon simply as a method of preserving corn fodder; and the question of its adoption is a purely economical one."

THE CHARACTER OF THE MANURE.

In considering the advantages of ensilage, the superior mechanical condition of the manure from animals fed upon it, should not be overlooked. When ordinary corn fodder is fed without cutting, the animals reject the hard lower portions, and these go to the manure pile, adding to its bulk rather than to its value, and making the manure very difficult to handle or to manage. The fodder being cut fine for ensilage is all eaten. Should any be rejected, and find its way into the manure, the small size of the pieces make them unobjectionable.

THE ENSILAGE CONGRESS.

In the year 1882 some gentlemen interested in the preservation of fodder by ensilage, and in the machinery used in the process, issued a call for a meeting of those who practised this method. It was held in New York City and was attended by an unexpectedly large number, showing that the method of preserving fodder by ensilage was already receiving the attention of many farmers and dairymen. The results of the first gathering were so satisfactory that it was followed each year by others, and at the meeting in 1886 a permanent organization, The Ensilage Congress, was formed. The Congress has the usual officers, and is to meet yearly in New York City at the call of the President. The officers chosen for 1886

were: President, Edward Gridley; Secretary, J. B. Brown; Treasurer, W. W Merriam; Vice-Presidents, O. B. Potter and nineteen others. The annual dues are two dollars. A Report of the transactions of the Congress is published yearly.

CRIMSON OR SCARLET CLOVER.

Those who read recent English works on ensilage will find frequent mention of the Crimson or Scarlet Clover (*Trifolium incarnatum*), frequently called in England red-top clover. This is an annual species, growing about two feet high, and bearing an oblong head of very brilliant flowers—so showy, indeed, that the plant is often cultivated as an ornamental annual. As an agricultural plant it is of some importance in Europe, being sown in autumn and perfecting in early spring. In his work on "Sweet Ensilage," Mr. George Fry makes frequent reference to this clover. On page 57 he says: "Then, again, there are many excellent fodder crops, such as *Trifolium incarnatum* (in my opinion the finest of all British fodder crops)," etc.

This clover was introduced into this country as early as 1818, but has never made a place for itself in our agriculture. It may be now, in view of its value as an ensilage crop, and the fact that being an annual, it may be of use as a cleansing crop, that some of our farmers may be induced to make a trial of it. Its feeding value, while not equal to that of the perennial clovers, stands high.

TO BUILD A CHEAP SILO.

Whatever cheapens the cost of the silo, or lessens the expense of filling it, will hasten the introduction of the method, especially upon the farms of those of moderate means. Professor Manly Miles, of the Massachusetts Agricultural College, in describing the silos used by him

in his important experiments on ensilage, says: "A balloon frame of scantling, of suitable size, covered on the outside with matched boards, and lined on the inside with two thicknesses of one-inch matched boards, with a layer of tarred paper between them, thus securing a practically air-tight inclosure, surrounded by a dead-air space as a protection against frost, is, in the opinion of the writer, the best and cheapest form of construction. If the boards and timbers are saturated with hot coal-tar, which can readily be done with trifling expense, the duration of the silo will be very much increased."

THE TEMPERATURE IN THE SILO.

To ascertain the temperature of the ensilage at any given depth in the silo, provide a piece of gas-pipe an inch in diameter. At the lower end of this pipe, weld, or attach by a screw thread, a short, steel point. Just above this point bore several holes about one-eighth of an inch in diameter. At the upper end of the pipe, attach a ferrule to which are welded two arms, six to nine inches long. Thrust a lock of wool down to the bottom of the tube, to serve as a cushion upon which the thermometer may rest. To ascertain the temperature of the ensilage at any required depth, thrust the gas-tube down to this distance, allowing it to remain for about ten minutes. Then lower down to the bottom of the tube a thermometer (which has its degrees marked on its stem) by means of a string until it rests upon the wool below. In the course of an hour withdraw the thermometer quickly and read the temperature.

NOMENCLATURE.

New methods and new processes introduce new names, and ensilage has proved no exception to this. It may be

convenient to give here such names as have been adopted, as well as some that have been proposed.

SILO—A pit, and, as now used, the receptacle for fodder preserved by this process, whether above or below ground.

ENSILAGE—The method of saving fodder in silos; also the contents of a silo, or pitted fodder. In England this is abbreviated to SILAGE, which is sometimes used in this country, but it failed of adoption by the last Ensilage Congress.

TO ENSILO—To place in a silo.

ENSILOER—One who ensiloes.

ENSILOED—Perfect participle of to ensilo.

ENSILOING—Present participle of to ensilo.

The substitution of silage for ensilage would be convenient, leaving ensilage to indicate the system of preserving fodder. The matter was discussed at the last Ensilage Congress, the chief objection to silage being that it was English. The Congress voted to retain ensilage to denote both the system and the contents of the silo. Still, if it is found more convenient, silage will come into general use.

THE CHAMPION SILO OF ENGLAND.

The Royal Agricultural Society of England was last year commissioned by its President, Sir Massey Lopes, to offer a prize of $500 for "the best silo in England and Wales in actual work during the winter of 1885–86." In the competition for this prize there were no less than thirty-seven silos, the result being that the prize was awarded to Mr. John Morris, of Tutham Court, Madley, Herefordshire, for the silo of which we give an illustration (fig. 20). In their report to the Royal Agricultural Society, the judges give a capital description of this silo. It is an entirely new structure, thirty-six feet in length, fifteen feet in width, and thirteen feet in height, with a

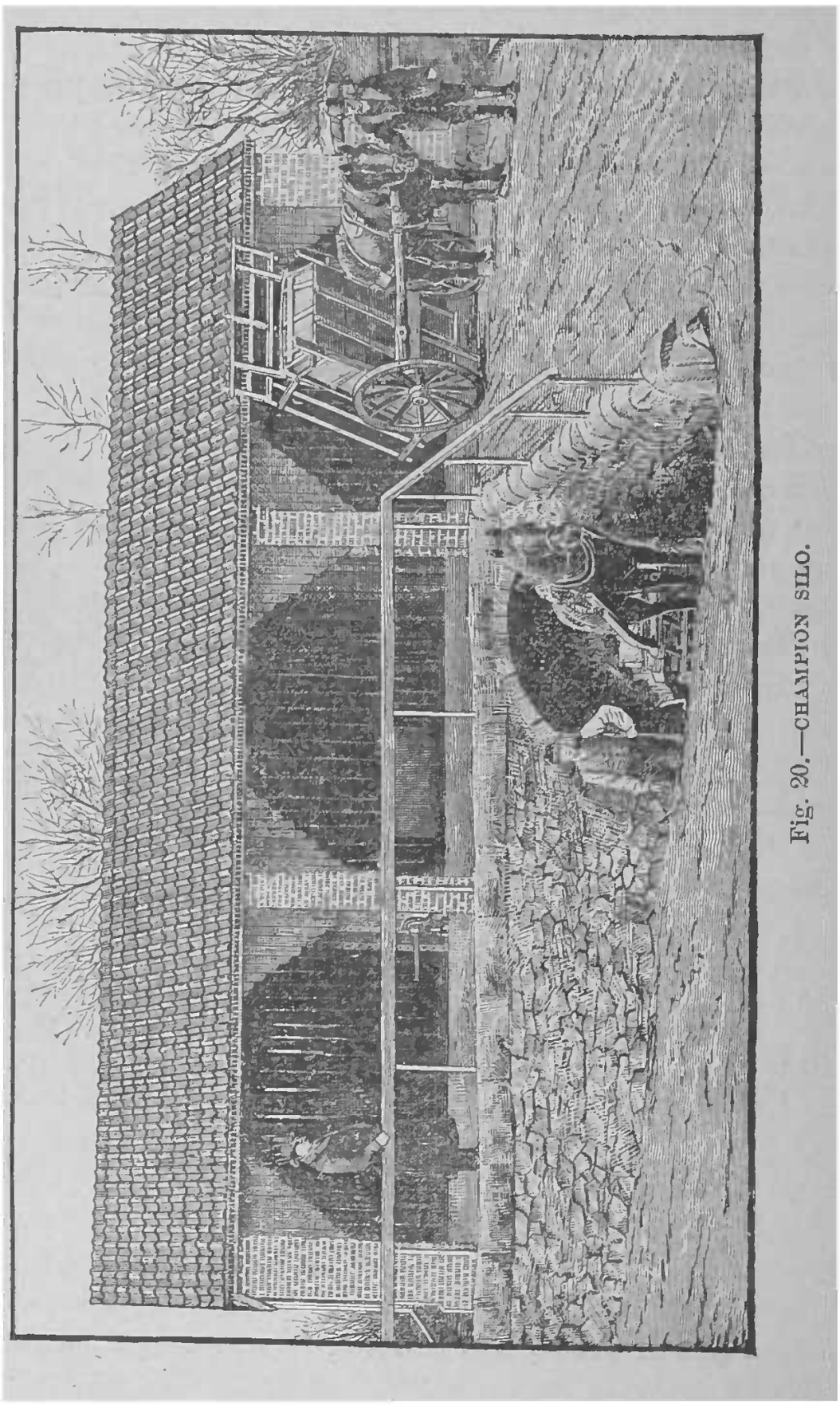


Fig. 20.—CHAMPION SILO.

super silo or shed above, seven feet in height to the eaves of the roof. The silo may be described as an underground silo, walled in with stone, and excavated ten feet deep, the surrounding ground being banked up three feet to the top. On the coping are built ten brick piers, seven feet in height, and upon these the roof is supported. The silo is divided by two cross walls into three compartments. In these walls are planked openings, affording ready communication from one compartment to the other. There is a third opening in the front wall. The middle compartment, which is approached from the farm-yard by a walled, sloping road, wide enough for a cart to pass along. The cost of building this silo amounted to one hundred and two pounds, eighteen shillings and eightpence, (five hundred and fourteen dollars and fifty-six cents), the cost being moderate, and amounting to only fourteen shillings (three dollars and fifty cents) per fifty cubic feet of capacity. The silo was filled in fourteen days, during which time the weather was superb. The crop consisted of oats and grass, cut in full bloom, and unchaffed. The pressure adopted was that of men and horses first treading down the contents, and then continued pressure by leverage. The ensilage was found good and sweet, and was well utilized. The silo is in close proximity to the cattle folds, where some hundred head of pure bred Herefords are kept. There were about one hundred and fifty tons of ensilage made in this silo, and the whole has been eaten by the Herefords without the slightest waste. The silo has thus proved a success in every way.

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