SILOS

FOR

BRITISH FODDER CROPS.

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PRESERVING BRITISH FODDER CROPS

STORED

IN A GREEN STATE.

NOTES ON THE ENSILAGE OF GRASSES, CLOVERS, VETCHES, ETC.

Compiled from Various Sources

BY

THE SUB-EDITOR OF "THE FIELD."

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PREFACE.

THE storage of green fodder in pits is a subject to which the attention of the agricultural world has been directed, from time to time, for many years past. The German practice was described in the "Transactions of the Highland and Agricultural Society" fully forty years ago; but it is not surprising that this fact should be almost unknown to people of the present generation, although the article was copied into Stephens's "Book of the Farm," printed in 1844. It is more remarkable, however, that so little should be known of what has been said and done within the last few years, and that ensilage should now be generally looked upon as a new invention. In the *Farmer*, in 1870, Mr. T. Schwann wrote on the "sour-fodder" process as carried out in Hungary; and he alluded to it again in the *Field* in 1876, when writing about M. Goffart's doings in France. Professor Wrightson, when reporting on the agriculture of the Austro-Hungarian Empire, in the "Journal of the Royal Agricultural Society of England," in 1874, said that this "sour hay" was well worth the attention of our agriculturists; and he returned to the subject in the *Times* in 1875. The *Agricultural Gazette* published an illustrated description of the process about the same period, besides many more recent contributions; and numerous articles have since appeared in the various agricultural journals of the three divisions of the United Kingdom.

A few, but very few, silos have been constructed in this country, as will be seen by the following pages; and these have mostly been built within the last year or two, and are small in dimensions. The experiments of one English gentleman (Mr. A. J. Scott), whose letter is printed on page 179, commenced seven years since—which is as far back as the earliest silos made in the United States. The great impulse given to the ensilage process in this country dates only from the summer of 1882, when the Vicomte Arthur de Chezelles paid a visit to the Royal Agricultural Show at Reading, and gave to Englishmen some account of his doings. The striking woodcut of a silo of more than 1000 tons capacity was calculated to impress itself on the mind; the statement that hundreds of acres of clover, tares, sainfoin, lucerne, and artificial grasses were stored therein showed the application of the system to crops ordinarily grown on British farms; and the subsequent visit of Mr. H. Kains-Jackson to the Château de Boulleaume, and his account of the feeding of 130 milch cows, besides bullocks, sheep, and horses, upon this pitted fodder, proved that the question had at length been brought within the range of the practical politics of the farmyard.

Discussion was no longer limited to the weekly press, but occupied a conspicuous place in the columns of the daily journals, and spread far and wide throughout the kingdom; and on reading about ensilage, people at once began to suggest methods for improving or simplifying a process of which they had had little experience, or none whatever.

It is well for beginners to "hasten slowly;" they should learn to walk before they attempt to run. Many of the suggested improvements are old methods tried years ago, and found wanting; supposed new and simpler processes have long been in use, but have been discarded by the best practitioners as not economical; and plants mentioned as especially suited to the silo have already been pitted, and given unsatisfactory results by reason of the want of chemical constituents requisite to the perfection of the process.

The main object of this book is to give the beginner a good footing, and set him on the right path. With this view, especial reference has been made to M. Goffart's precepts, to which is added such other information as is believed to be reliable; and in the Appendix are collected together many articles and letters illustrative of the subject, particularly as regards experiments at home, and with the ordinary crops of British farms.

Field Office, March, 1883.

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APPENDIX.

BOOKS ON ENSILAGE.

The following is a list of books on ensilage. Those marked † we have not seen, but take the particulars from Dr. Thurber's book:

"Manuel de la Culture et de l'Ensilage des Maïs et autres forrages verts." Par Auguste Goffart. 3rd edition. Paris: G. Masson, 120, Boulevard Saint Germain. 1879.

† M. Goffart's book was translated by Mr. J. B. Brown, and published at New York in 1879.

"Culture et Ensilage du Maïs-fourrage et des autres fourrages verts." Par Ed. Lecouteux. Paris: Librairie Agricole, 26, Rue Jacob. 1875.

"The Book of Ensilage; or, the New Dispensation for Farmers." By John M. Bailey. New York: Orange Judd Company, 751, Broadway. 1881.

† "Ensilage of Green Forage Crops in Silos." By H. R. Stevens, Echo Dale Farm, Dover, Massachusetts. Published by the author.

"Silos and Ensilage: the Preservation of Fodder Corn and other Green Fodder Crops." By Dr. George Thurber. New York: Orange Judd Company, 751, Broadway. 1881.

"Silos and Ensilage. A Record of Practical Tests in several States and Canada." Special Report No. 48; Department of Agriculture. Washington: Government Printing Office. 1882.

"Ensilage: its Origin, History, and Practice; with Experimental Trials and Results, and illustrated by Plans, &c." By Henry Woods. Norwich: Stevenson and Co. London: W. Ridgway, 169, Piccadilly. 1883.

"Ensilage: A System for the Preservation in Pits of Forage Plants and Grasses, independent of Weather. By Thos. Christy, F.L.S. London: Christy and Co., 155, Fenchurch-street. 1883.

"Ensilage in America: its Prospects in English Agriculture. By James E. Thorold Rogers, M.P. London: W. Swan Sonnenschein and Co., Paternoster-row. 1883.

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CHAPTER I.—INTRODUCTORY.

BAD seasons and severe competition have made it imperative on the British farmer to look to something more profitable than corn crops as a means of existence. The most fruitful source of profit seems now to lie in the feeding of live stock of some description or other; for, whereas wheat and other cereals are kept down to exceedingly low prices by the enormous supplies forthcoming from countries where they can be grown at considerably less cost than in these islands, the demand for butcher's meat and for dairy produce increases faster than the supply, and prices are enhanced accordingly, despite the efforts of foreigners to send us dead carcases and live stock, butter, cheese, and other produce.

How long this state of things will last it is difficult to say; but meanwhile it behoves the agriculturist to make the most of his opportunities, and to turn his resources to the best account, so as to be able to hold his own when the pinch comes. If he can, by recourse to new processes, feed his stock more cheaply than heretofore, and store his fodder crops in safety instead of leaving them to rot in the fields under rainy skies, he may be able to withstand competition should it become more sharp than at present. It will be well, therefore, for him to put aside his *amour propre*, forget the fact that British agriculture has been held up as a model for all nations to follow, and ascertain whether there may not be found in foreign books a leaf or two well worth studying and acting upon.

In the year 1876 particulars were given in the *Field* of what was being done, and had long been done, upon the Continent, in the way of storing green fodder in pits as winter food for stock; but nobody then seemed to take heed of the matter in this country. The subject had also been alluded to in the agricultural press of America, and the first silo is said to have been made and filled in 1876 by Mr. Francis Morris, who officiated as president at the recent Ensilage Congress at New York. In the same autumn, Mr. C. W. Mills buried in a trench some maize that had been damaged by frost, and he found its condition so good next spring that he used it for feeding his cattle. After this, others tried experiments; and, M. Goffart's manual having been translated as a text-book, our American cousins set vigorously to work, and proved the process to be both practicable and profitable. Now it has spread far and wide throughout the States, and accounts of the wonderful results have been brought back to the Old World by writers, some of whom appeared to imagine that the process was an American discovery, and quite a new invention.

Seven lean years have made many British farmers more receptive of new ideas than they were formerly. Numbers are now willing to construct silos, and anxious to know how to set about the work; and those who have any knowledge of the subject have freely given information thereon. But practical experience in this country is as yet very limited, and some who have constructed silos have either not had the best advice or have followed notions of their own, and thus have fallen into serious errors through not knowing what to avoid, because they have been unaware of the fact that what they were about to do had been tried long ago, and proved to be bad practice.

The object of these pages is to lay before beginners some information as to what to do and what to avoid. It is undesirable, on every consideration, to start with the notion that all is so easy, success so certain, and cost so trifling, that you cannot do wrong in trying the process. Exaggerated accounts in this respect are sure to produce a counter-current. People who are misled by such statements, and who have not taken the precautions necessary to obtain good results, are sure to cry out that the process is a deception; that they have spent so much in hard cash, have wasted so many tons of fodder, and have obtained in return only a mass of manure.

That the cost may be trifling under certain circumstances, is one advantage of the process, as many persons who cannot afford a large outlay are thus enabled to carry out experiments with their ordinary crops. But they must not run away with the idea that, because the process is easy, success is rendered so certain that they can dispense with precautions necessary to safety. If they are unwilling to take the trouble requisite to ensure success, they had better leave the matter alone, or they may only waste their materials. With due care, good results may be obtained with small means and rough appliances; but such results must not be expected to be as perfect in all respects, nor eventually so economical, as those which can be obtained by the employment of large, well-designed, and permanent structures. It is not by any means essential that people should begin with very costly works: these may, if desired, be afterwards carried out by those who can spare the capital, and who have satisfied themselves by tentative experiments that a judicious outlay on a liberal scale will be a saving of money in the end.

Much of the advice here given is translated or summarised from the writings of M. Auguste Goffart* (of the Château de Burtin, near Nouan-le-Fuselier, department of Loir-et-Cher), who may be said to be the father of the modern process known as *ensilage*, which means storage in a *silo* or pit. The

* Manuel de la Culture et de l'Ensilage des Maïs et autres Fourrages verts. Par Auguste Goffart. Paris: G. Masson, 120, Boulevard St. Germain.

ancient practice of using pits as stores for farm produce (more especially grain) dates back for thousands of years. Old Greek writers mention these pits by the name of *siros;* Latin authors use the word *sirus*—so that storing of corn in a pit would be to put it *in siro.* As in many other words, the letter *r* got changed into *l* in course of time; and old Spanish and French books show that *silo* was the word used for such pits centuries ago.*

* Further information on the storing of corn, &c., in pits by the ancients, as alluded to in the Bible and in many Greek and Roman authors, will be found in the Appendix. Modern French writers have, by the addition of prefixes and suffixes, formed from the word *silo* quite a vocabulary not generally to be found in dictionaries, though some are contained in the latest supplement to Littré, with the authorities and dates of their first-known employment, which only go back for some seven or eight years; but even Littré does not give all that we now meet with. Those which we have seen include *ensiler,* to put in a silo, and *désensiler,* to take out of a silo; and these verbs are used in various tenses, as *j'ensile, j'ensilais, j'ensilerai,* and so on, besides forming participles, *ensilant* and *ensilé.* The noun *ensilage* is used in two senses, meaning the process of storing in a pit, and also the substance stored; *désensilage* is the process of emptying the pit; *ensileur,* the person who stores his farm produce in this way, and so on. *Ensilotage* is another word which has been used; but Littré objects to it as inaccurately formed, there being no *t* in silo. The noun, *ensilage,* is not nearly so recent in its origin as other of the words, for we find it used in French works on agriculture, published twenty years or more ago, which make no mention of the storage of green fodder in silos; it is there used with respect to the pitting of potatoes and other roots, in like manner as potatoes, mangold, turnips, &c., are pitted in this country. In writing in English about this process of storing green crops in pits, some persons turn the word *ensilage* into a verb, and say, "The grass was ensilaged," or, "He was ensilaging clover;" but this mode of expression is both awkward and unnecessary. No doubt we commonly turn a noun into a verb, and say to *pit,* to *pot,* to *pile,* to *stack,* whereas the French, from their noun *pile,* form the verb *empiler,* and from *pot* form *empoter,* with *empotage* as a noun similar to *ensilage* in character. We, however, should never think of saying "I empotaged some plants," instead of "potted;" nor is it desirable to use such words as "ensilaged" and "ensilaging," when we can say "pitted," "siloed," &c. There can be no more objection to the use of *silo* as a verb than there is to our using "stucco" in the same way; and for so employing this and other words ending in o, we have the authority of dictionaries as well as every-day practice.

It is unnecessary, however, to dwell longer on this part of the subject. Suffice it to say that a German named Klappmeyer described, about a hundred years since, a method of keeping green fodder by burying it in a pit, thereby producing a so-called "brown hay;" this process is still practised in some parts of Germany and Hungary, and, with some modification, makes "sour fodder;" and much the same sort of thing has been carried out for years by many persons in France, with certain variations of practice, to suit convenience. More than thirty years ago Klappmeyer's process was tried for two seasons by M. Goffart, but he found the result not nearly so satisfactory as he wished, and then he began experimenting on his own account, and has little by little brought his method of preserving green crops to its present highly improved, if not perfected, state of practice; and, having commenced with four small silos, less than three cubic yards each in capacity, he has gone on building others larger and larger until he has about a dozen silos and his storage of green fodder exceeds 1000 tons a year. He feeds therewith more than a hundred head of horned cattle, besides horses, &c., throughout the winter and far into the summer, until the new crop of forage is ready to be cut. M. Goffart is a practical agriculturist and a man of great energy. He admits that he had but meagre success at the beginning; and for the first twenty years he had to content himself with keeping his green fodder for three weeks or a month longer than he otherwise was able to do; but he persevered nevertheless, changed his mode of practice, and thus eventually extended the time of keeping from a few weeks to double as many months. He says he has found it necessary to alter his opinions in course of time, and to retract advice which he gave years ago; but he only does so when he has proved by experience that he can obtain better and more profitable results by changing his method of procedure, and he may therefore be looked on as a very safe man to follow.

The information here given, however, will not be limited exclusively to what is said by M. Goffart, but will be supplemented by particulars taken from articles and letters in the *Field* and other journals, English and foreign, as well as the official report of the Agricultural Department of the United States—such details, however, being only selected as seem best suited to the circumstances of our own country and its ordinary crops.

In the numerous quotations which we give in the Appendix, there will necessarily be found many conflicting opinions as to cause and effect, even among those who are writing favourably of the system; but it should be remembered that all have not had an equal amount of experience, and it will be seen, from what we have just said of M. Goffart, that even the oldest are compelled by the logic of facts to change their opinions. We have not thought it desirable to expunge these conflicting statements, but would suggest that where anyone is in doubt as to which opinion in the Appendix he should attach most importance to, he will generally find in the earlier part of the book—if the point be one of any particular importance—an opinion from M. Goffart, who may be taken as a fitting person to give the casting vote.

CHAPTER II.—CROPS FOR THE SILO.

Most of the writings on ensilage hitherto published have related to the preservation of maize or Indian corn (commonly spoken of in America as "corn," without any prefix). At present maize is but little grown in this country—so little, indeed, as to be practically non-existent. Accordingly, it is not proposed to say very much here about that plant, although it occupies the greater portion of M. Goffart's book. If in course of time it should be found that maize can be grown with advantage in these islands, so as to be cut green for forage (for it should only be old enough to form the ear, and not be allowed to approach ripeness), it will be very easy to adapt the process to that plant, as the mode of procedure is the same for maize as for grass, clover, green oats, and other English produce, except that with maize it is desirable that it be cut up into quarter-inch lengths, owing to the thickness of the stems, which render it difficult to preserve whole, and more difficult for the cattle to masticate. On economical grounds it is therefore desirable to go to the cost of maize-cutting machinery (worked by steam or horse power, where maize is grown on a large scale), instead of attempting to use the fodder uncut; but with grass, and other of our green crops, there is not the same necessity for cutting into chaff, and such fodder may be preserved in an excellent condition without being chopped up. Some persons, however, prefer to pass it through a chaff-cutter, and there is no objection to this being done; but it is questionable whether there is with these crops, any such advantage as would compensate for the cost of machinery and labour, unless the plants are very hard stemmed; and even these may be preserved whole with a sufficiently liberal allowance of pressure.

Many people seem to be under the impression that silos are of comparatively little use in this country without maize, which they look upon as a more nutritious fodder than our ordinary grass crops. This, however, is a mistaken notion; for, although the ripe Indian corn is a very rich cereal, the entire maize plant, consumed as green fodder, is not nearly so nutritious as is often supposed. It is certainly very highly spoken of by M. Goffart, and he cultivates it largely himself—not, however, because it is more nutritious, but because it suits his soil much better than many other crops, and he says that his land will produce double the weight of maize that it will of mangold. Moreover, he contrives to get two crops a year off the same ground, by cutting green rye in May, and immediately afterwards planting maize, which is sufficiently advanced towards maturity by the autumn to answer his purpose. In America, too, maize thrives so marvellously, and is grown on so extensive a scale, that any mode of preserving it as green fodder, where other winter foods are difficult to obtain, must necessarily cause the system to be widely adopted among the myriads of farmers who dwell on that vast continent. The advantage of maize as a fodder plant is therefore beyond question; though its value lies, not in its inherent richness, but in its abundant growth and consequent cheapness, where soil and climate are suitable. It is not, indeed, so nutritious as fodders ordinarily grown in these islands; and the means adopted for its preservation in pits are not special to itself, but may be equally well applied to the produce of British farms. Thus, M. Goffart says:

> The precepts which I have set forth with respect to the ensilage of maize apply indiscriminately to all other fodders, and ensure the same success. If I have treated more especially of maize, it is because in that marvellous plant I have found the elements of new agricultural wealth from the day when I succeeded in ensuring its indefinite preservation by ensilage, and thus was enabled to feed my beasts thereon throughout the year. Before it was saved by ensilage, maize provided them with food for barely three months, during the season when it could be given to them in a green state.

In other parts of his book, M. Goffart makes the following remarks:

Now, is maize in itself a rich food? Evidently not. Besides the analyses, more or less exact, which have been published, one unanswerable fact proves that it is not rich in nutritive principles, and that is, the large amount which must be eaten to keep beasts in good condition. This fact I have recognised and published a score of times. But, after all, it is merely a question of getting the animals to consume a larger quantity. Nobody would maintain that a given weight of maize would replace the same weight of lucerne, clover, or sainfoin: but that does not prevent anyone from making up by quantity what is wanting in nutritive properties, and thus keeping beasts as well on maize as on the richest of grasses.

My beasts, especially the milch cows, when they live solely on fresh maize during the summer, consume very large quantities, and their bellies are always widely distended, which proves that the food has not all the richness that is desirable, and that they are obliged to make up for defective quality by excessive quantity. When they eat maize that has been in the silo and is fermented, their bellies decrease in size, their ration (which they themselves diminish) is reduced in weight, and their general condition becomes more satisfactory.

I need hardly say that green rye is much richer than maize, and that a smaller quantity of the former feeds as well as a larger quantity of the latter; a mixture of these two fodders constitutes an excellent regimen.

Without wishing to discourage experiments in the culture of maize in these islands, it is desirable that persons who attempt it should proceed cautiously, and not make large ventures until they have ascertained whether it is likely to succeed on their soils. M. Goffart says: "There are certain indispensable conditions in the physical, hygrometrical, and chemical condition of the soil, the absence of which may render the profitable cultivation of this forage impossible." In his own case, where the soil is favourable, he manures heavily with farmyard and artificial manures, and thus, if the crop does not turn out well, there may be a heavy loss. These matters ought to be taken into consideration, and M. Goffart does not hide them; for, although he is a very warm advocate of maize-culture, where conditions are suitable, he nevertheless says:

Maize is a ruinous crop in bad seasons. Nothing is more advantageous than a successful maize crop; nothing more ruinous than a bad crop of maize. More than 40 tons an acre on the one hand, and less than six tons on the other. Such are the divergencies that I have observed in fifty places in 1878.

GRASSES.

Ordinary meadow grass, rye grass, and clover have been pitted during the last two years by Mr. A. Grant, a gentleman residing in Hants. In the autumn of 1881 he stored in a small experimental silo a scanty crop from 4½ acres of hop clover and rye grass, and found that it made capital fodder. Encouraged by this experiment, he enlarged his scale of operations, and in the summer of 1882 saved in this way about 70 tons of meadow grass, with perfect success. Five acres were cut and carried in heavy rain; and this portion came out of the silo much darker in colour than that which had been carried in fine weather; but it proved to be equally good fodder. Mr. Grant likewise siloed a few loads of Trifolium incarnatum, also cut and carried in rain; but this, having been put into a very small pit, and with insufficient weight on the top, did not turn out so well as other samples; nevertheless it was all eaten up by the cows. The butter-producing quality of the milk was greatly improved. An analysis of a sample of the meadow grass ensilage, which was of a highly nutritious character, will be found in the Appendix, together with a lengthy statement of the results of Mr. Grant's experience.

Rough grass, cut from the roadside, and other coarse, stalky grass and strong aftermath have, when pitted, produced very good results in the North Riding of Yorkshire. Mr. Thos. Easdale, writing from the Estate Office, Pepper Arden Hall, Northallerton, has given full details of the experiment; and from these particulars (reprinted in the Appendix) it will be seen that the quantity of milk and quantity of butter were much improved in cows fed on the ensilage.

On the Earl of Wharncliffe's estate at Hawes, also in North Yorkshire, a heavy crop from five acres of natural meadow grass was put into silo in August, and gave excellent results when opened in January. Particulars of this experiment are also given in the Appendix.

In Wales, too, ensilage has been made from grass. Mr. C. R. Kenyon, of Brynllwydwyn, Machynlleth (whose letter is reprinted in the Appendix), states that yearling calves were particularly fond of the preserved grass, and throve well on it. His milch cows were found to require a little cotton cake or bean meal to keep up the quality of the milk and make rich cream; but the butter had more of the colour, if not the flavour, of that from grass-fed cows, than was the case before using ensilage.

Some rye grass was well preserved in experiments carried out by Professor Carroll, at the model farm of the Albert Institution, Glasnevin, Ireland; and analyses of the grass when cut, as well as of the ensilage, will be found in the Appendix. A mixture of comfrey and lucerne was wholly spoiled, and so was some rye grass that had simply been laid on the ground and covered over by a mound of earth—a process that M. Goffart condemns, as always giving bad results.

Ordinary green grass is made into ensilage by the dairy farmers of Holland; and when, in the spring of 1882, a number of Norfolk tenant farmers accompanied Sir T. Fowell Buxton and Mr. Samuel Hoare in a tour of inspection of Dutch farms, one of the party said in the *Field*: "The greatest novelty we saw in Holland was ensilage made from green grass, which interested us more than anything else; and the experiment will be tried by more than one of us this summer." The ensilage was further spoken of as "capital milk-producing food."

In Norfolk a highly-satisfactory experiment has already been carried out on Lord Walsingham's home-farm, at Merton. Mr. Henry Woods, in a lecture delivered before the Wayland Agricultural Association on Feb. 5, 1883, gave full details of what had been done. It appears that the fodder put into the silo was very coarse common grass, grown in a wood, and of so poor a character that people to whom it had been given, did not care to cut and carry it away; yet after it had been five months in the pit, it proved excellent food for stock, and the cows that were fed partially upon it increased their supply of milk, which improved also in richness, and the quantity and quality were both enhanced from time to time as the rations given to the animals contained increased proportions of ensilage; and when two cows were deprived of the ensilage for a couple of days they each gave three quarts of milk less per day. Analyses of the milk, and of hay and ensilage made from the same grass, are given in the Appendix.

Clovers, Lucerne, and Vetches.

Clovers have been preserved in silos by several English gentlemen with more or less success; but they seem to require a greater amount of pressure than grass, owing, no doubt, to the stems being stronger and more elastic, and requiring more force to expel the air which necessarily is intermingled with the fodder when it is put into the silo. In a previous page it is stated that Mr. Grant's success with Trifolium incarnatum was not so great as with grass; but he attributed this to the fact that the clover was put in a small silo and had also had insufficient pressure.

Mr. A. J. Scott, another Hampshire gentleman (the analyses of whose hay and ensilage are given in the Appendix), was likewise not so successful with some clover as could be wished; for while his clover hay (cut in July) showed 15·87 per cent. of albumenoids, his ensilage (cut from the same field in September) gave but 10·55 per cent. This considerable falling off in nutritious ingredients appeared much larger than would be likely to arise solely from the difference between the quality of the first and the second crop of clover, and the large amount of acid (5·73 per cent.) seemed to indicate that a destructive amount of fermentation had been allowed to go on in the silo. We accordingly made inquiry as to the amount of pressure that had been put upon the fodder; and it will be seen from Mr. Scott's second letter that there was a defect in the arrangements, whereby the ensilage was practically left without any pressure on it after the first settlement, and air would consequently obtain ready admission into the mass—a fact which most probably will account for the unsatisfactory result.

That this loss of nutritive qualities is not necessarily the result of making clover into ensilage, is shown by the analysis of a specimen from the silo of the Vicomte de Chezelles, at Château Boulleaume, near Liancourt St. Pierre, in the department of the Oise, and not very many miles from Paris. Of this immense silo, some particulars, together with an illustration, are given further on; but it may here be stated that the green crops from 170 acres were preserved in this single pit, and that it is constructed to hold about 80 acres more. Samples therefrom were sent to London—one being exhibited for some time at the Corn Exchange, Mark-lane, and afterwards at the Christmas Fat Stock Show at Norwich; and another, that was sent to the *Field* Office, underwent chemical analysis, the result of which is given in the Appendix. Owing to the sample being detained by the Custom House officials (who fancied that the ensilage was some new preparation of tobacco), the analysis was not made till about three weeks after the sample was removed from the silo, and, from being opened and examined, it may meanwhile have undergone some amount of deterioration, as seems probable from the quantity of alcohol and acetic acid; but its nutritive qualities were nevertheless of a very high order; and, as will be observed on comparing the analyses, whereas the albumenoids in the clover hay from Alton, Hants, was 15·87 per cent., and in the ensilage from the same field only 10·55 per cent., the French ensilage contained 18·35 per cent. of albumenoids. Of course these percentages are on the "dry substance," as comparisons cannot otherwise be made of fodders containing different proportions of water. This French ensilage, it may be mentioned, had not been pitted in a whole condition, but had been passed through a chaff-cutting machine before being put in the silo. On a previous occasion, however, M. de Chezelles had stored in the silo about 80 acres of clover, put in unchopped, and much of it dripping wet with rain; yet it cut out in capital condition when the silo was opened, nine months afterwards.

M. Lecouteux, the editor of the *Journal d'Agriculture Pratique,* specially recommends that early crops of Trifolium incarnatum be cut on coming into flower, and while the plant is still tender, when the land can at once be sown with root or other crops. His article (quoted in the Appendix) states that rain is of little importance while the Trifolium is being pitted, and that he has siloed cartloads dripping with water.

M. Darblay (also quoted in the Appendix) likewise shows his success with a similar crop, which he stored in a simple earthen pit.

Some clover ensilage on the farm of Mr. H. Hoare, at Pagehurst, near Staplehurst, Kent, is reported to have been very satisfactory; and this also had been cut into chaff before being pitted. About 50 tons of Trifolium incarnatum were put into two silos, and Mr. Austen, the farm bailiff, was of opinion that there was more food in the ensilage than in the same crop made into hay. Cattle fed upon it exclusively he found to tire of it; so it was mixed with chaffed hay, and thus made very good feed.

Lucerne has been successfully preserved in silos for some years by M. Pornay, of Romorantin (Loir et Cher), and at the district agricultural show at Bourges in 1879 M. Pornay was awarded a silver medal for an excellent sample which he exhibited.

Some half-ripe vetches, corn, and beans were stored in a rough silo by Mr. Imrie, of Whitehill, a member of the Glasgow Agricultural Society; but, as will be seen by the account of the opening of the silo given in the Appendix, the result was not very successful. It would appear, however, that the defect was mainly due to unsatisfactory arrangements.

Green Rye and Green Oats.

Green rye is a favourite crop for ensilage with many French farmers. M. Goffart grows it largely, gets it into the silo in May, and immediately plants maize on the same ground.

Green rye has already been made into ensilage in England; and in the course of a discussion which followed the reading of a paper by Professor Thorold Rogers, M.P., on "Ensilage in the United States" (at the Society of Arts, London, on Jan. 31, 1883), Mr. E. B. Gibson, of Saffron Walden, Essex, said that in the previous May he had put into five small silos the produce of 20 acres of green rye, cut just as it was coming into ear, and passed through a chaff-cutting machine before being siloed. When taken out in September, the ensilage was perfectly good, except a little at the top (which was mouldy, owing, we believe, to the absence of weight on the top of the fodder, and consequently to the air not being excluded). At the time of the meeting Mr. Gibson was feeding forty head of cattle on 1½ bushels of ensilage, 1½ bushels of swede turnips, and 2lb. of cotton cake each per day; and they throve so well that he thought the cotton cake might be dispensed with without any diminution in the milk. So satisfied was he with the results, that he intended to convert a larger quantity of green crop to ensilage; and he felt certain that heavy land farmers would find it highly beneficial to substitute ensilage for roots.

Colonel Tomline has preserved green oats at Orwell Park, Ipswich, where the Prince of Wales went to see the silo opened. The produce of 11 acres was cut into chaff, and pitted during showery weather at the end of July and beginning of August. When opened, in December, the surface was mouldy and rotten, but the mass of ensilage below was in good condition; and the produce of milk and butter from cows fed upon it was vastly improved.

Miscellaneous Crops.

Many other kinds of crops have been put into silos by different persons. Before M. Goffart discovered that, by his improved mode of ensilage, he could keep fodder for much longer periods than he had been accustomed to do, the quantity of maize grown by him was comparatively small. In 1872 the crops of his home farm of 300 acres included

40 acres of wheat, 32 acres of rye, 80 acres of oats, 12 acres of buckwheat, 11 acres of Jerusalem artichokes (producing 2200 bushels), and $3\frac{3}{4}$ acres of maize (producing more than 150 tons), besides which his natural and artificial grasses, vetches included, amounted to 600 tons, and his potatoes to 500 bushels. Six years later his growth of maize had reached 1100 tons. His experiments in pitting crops have been of a widely varied character, for it appears that he has put into his silos not only maize and rye, and various kinds of clover and trefoil, but Jerusalem artichokes, beetroot, sorghum, comfrey, turnips, and potatoes. He says he has been more or less successful with all of them, but makes no special remarks as to his treatment of the majority. With regard, however, to prickly comfrey he gives some particulars, showing that it is very good fodder when freshly cut, but not well adapted for ensilage alone, owing to the paucity of sugary matters rendering it incapable of alcoholic fermentation. He says :

My beasts eat the green comfrey without eagerness, but without repugnance. In autumn, at the time of ensilage, I mix a certain quantity of it with my maize, and obtain very good results. The comfrey appears to be superior to maize in nitrogenous matters, and the maize will come to the aid of the comfrey through its greater richness in certain very useful principles much sought after by the animals.

Maize contains, on the average, only 1·20 to 1·25 per cent. of nitrogenous matters, whilst recent analyses of comfrey credit it with 2·70 per cent, or more than double. These two plants, instead of being opposed, serve to complete one another, to the great advantage of agriculture.

At the beginning of October, 1878, I put in the silo a few tons of comfrey. The fodder was perfectly sound, but it is well known how poor it is in sugary matters, and consequently how little fitted for alcoholic fermentation. The results confirmed our anticipations in all respects. Despite all the care which I gave to this ensilage, I only obtained a "brown hay"—very good food, but quite refractory to alcoholic fermentation. On exposure to the air, the comfrey soon underwent butyric fermentation, and had to be consumed immediately, otherwise it would quickly become unfit for the feeding of cattle.

M. Julien, president of the Romorantin Agricultural Society, in a report to the Central Agricultural Association of Sologne, after speaking of the great advantages arising from the ensilage of maize in that part of the country—where the poorness of the soil, and the irregularity of the climate, varying from excessive wetness to absolute drought, make the cultivation of fodder crops very precarious—says with regard to ensilage:

This process of preservation is also applicable to many other kinds of green fodder, such as rye and rape; buckwheat, before the straw arrives at maturity; the stems of Jerusalem artichokes—an excellent fodder, which is generally wasted; the leaves of beetroot, also clover and lucerne, and especially the aftermaths, which it is impossible at times to make into hay.

As an instance of multifarious contents in one silo, we may quote from the recent report of the United States Department of Agriculture the particulars of what was put into his pit by Mr. C. Cromwell, of Rye, New York:—"(1) 18in. of green oats; (2) 6in. of red clover; (3) 6in. of Canada peas; (4) 2in. of brewers' grains; (5) 2ft. of maize, sowed broadcast, and containing more ragweed than maize in the crop; (6) 5in. of grass; (7) 12in. of sorghum; (8) more maize. Came out excellent, fresh and sweet."

In a report, made in 1875 to the National Agricultural Society of France, by three commissioners (Messrs. Bella, Moll, and Barral) appointed to visit M. Goffart's farm and inquire into the subject of ensilage, the information given has reference chiefly to maize, but the following remarks are also made with respect to the preservation of other materials, many of which are frequently thrown aside as useless:

In the Lyonnais district green leaves of the vine, preserved as food for cattle, and for the goats which have made the reputation of the Mont Dore cheese, have given excellent results from time immemorial. It is the same in cider districts with silos of apple refuse. In various parts of Germany vegetables of all sorts—turnips, cabbages, and divers kinds of leaves, flavoured with a little celery—have been preserved for the feeding of cows for ages as far back in the night of time as cabbages destined for the food of man have been preserved and known under the name of "sour-krout."

In the north of France several eminent agriculturists—M. Georges, of Orgival, near St. Qnentin, among others—have for more than twenty years past successfully preserved their beetroot leaves in silos; others have applied the same process to sliced beetroots, and have found that they kept better than when the roots were placed whole in ordinary pits and silos. The beetroot pulp from sugar distilleries also keeps well when put into silos.

Beetroot, it need hardly be stated, is but another word for mangold, *betterave* being the French name common to all the species of this genus of plants, in like manner as *mangold-wurzel* is the name used by Germans. Accordingly, unless some distinctive expression, such as *betterave globe jaune* is made use of, one cannot say that any particular variety of the plant is indicated; and therefore, where we have used the word "beetroot" in the translation, it does not necessarily mean that sugar-beet is alone referred to—it may also mean the variety that we should designate by the name of "mangold." Of course, with the beetroot pulp just mentioned there can be no doubt; but the sliced beetroots alluded to a few lines before may equally well mean sliced mangold; and the same remark will apply to various other instances where the word "beetroot" occurs.

M. Lecouteux (as will be seen by a quotation in the Appendix) recommends that the roots be cut up, mixed with straw, and put into the silo; and he says that this method is preferable to the common practice of storing them whole. The Commissioners of the National Agricultural Society of France (quoted above) likewise say that sliced roots keep better than those which are left whole. They also discussed the question whether mangold could be profitably grown on M. Goffart's estate, and say:

The question may be asked whether, at Burtin, it would not have been preferable to cultivate mangold (*betterave fourragère*), which also gives considerable returns per acre, and is so easily kept in winter. For anyone who knows the Sologne country, this cannot be a matter of doubt. In other parts there are farms where yellow globe mangold is almost sure to give 40 tons per acre if you give in due season 40 tons of manure. But such results are impossible in Sologne. Mangold is ill adapted to its soil, whereas maize is easily grown there under good conditions, and gives fabulous crops—40, 50, and even 60 tons of excellent forage. Maize is less rich than mangold, no doubt, when both are fresh; but it is better suited to the feeding of milch cows, and is improved by ensilage. We believe we shall not be far from the truth in saying that in Sologne, with equal conditions of culture, the average produce of maize per acre would be at least double that of mangold.

In England the sugar-beet is comparatively little grown; but the remarks made by Mr. Duncan, at the Society of Arts meeting previously alluded to, will show that the refuse pulp from the sugar-beet has been found of value in this country as well as in France. Mr. Duncan said that, some considerable time since, when his manufactory was actively engaged in producing sugar from root pulp, some of the waste of the latter, for which at the time there was no use or sale, was placed in a trench, and remained there uncovered for three years. In a period of great scarcity it was taken out absolutely uninjured, except a very small portion at the top, and the neighbouring farmers were glad to give him 12*s.* per ton for it. When in Canada some time since, he found the Hon. G. Brown was about to convert a large quantity of grass to ensilage. Mr. Duncan has a large sheep farm in Scotland, where the quality of the grass is often so hard and indigestible as to be worthless; and he fully anticipates that he shall derive the utmost benefit in being able to feed his flock on ensilage.

Brewers' grains are often preserved in pits in much the same manner as green fodder. And, long before anything was known about silos in England, filberts, walnuts, &c., were preserved by burying them in the ground. Those who are fond of these fruits, and wish to keep them in good condition, cannot do better than pack them closely in earthen jars, cover the mouth of the jars tightly by some such method as tieing them down with pieces of bladder, and then bury the jars a foot or more underground. They will thus have diminutive silos which will keep the nuts good for many months.

CHAPTER III.—MAKING THE SILO.

It is not desirable to run away with the idea that one pit is just as good as another, and that a rough-and-ready silo will answer exactly the same purpose as one that is carefully made. Cheapness does not necessarily mean economy, and very often it is quite the reverse.

One method which has been recommended, and which is very likely to be attractive to beginners, on account of its simplicity and freedom from outlay, is utterly condemned by M. Goffart. The plan alluded to is that of heaping up fodder on the surface of the ground and then covering it over with earth. M. Goffart says that, except in the case of maize covered up whole, he never knew an instance where the results were not bad. This is borne out by the results of the recent experiments at the Albert Model Farm, Glasnevin, Ireland, where grass covered up in this way became so mouldy as to be perfectly unfit for food.

It is not, however, absolutely requisite to go to a large expenditure before making any attempts at the preservation of green fodder in pits; but it is desirable that the beginner should bear in mind that he cannot obtain from small silos and rough methods of procedure the full amount of success that is obtainable from more perfect appliances. The more carefully all arrangements are carried out, the greater is the amount of success likely to be attained. No doubt very satisfactory results may be obtained with comparatively small expenditure; and where the saving in first outlay is of greater importance to the beginner than a certain amount of waste in the fodder, he can adopt that course which is most convenient to himself. At the recent Ensilage Congress at New York, one of the speakers said: "In the matter of silos, it makes no difference whether they cost 25 dollars or 25,000 dollars; one will preserve your ensilage as well as the other; the only thing required is continuous pressure." But this should be taken *cum grano salis;* for you cannot make the pressure in small silos equally as effective as in large ones, nor can you press the fodder so compactly against rough surfaces as you can where the walls are smooth; and consequently there is more waste of fodder with small silos and rough surfaces than with large silos and smooth walls. Where fodder is so abundant that waste is of no importance, such a statement may pass muster; but it is not in accord with the teachings of the gentleman to whom, at the same Congress, an address was voted to "express their appreciation of the great value of the system of ensilage discovered and introduced by him." M. Goffart has tried cheap methods, and has obtained therefrom results which are not likely to be exceeded by those who are without his experience; yet he has given up rough-and-ready modes of storage, and betaken himself to silos of masonry as being more profitable in the end. Respecting a simple and "cheap" experiment carried out by a neighbour, he says:

> One of them, who had buried more than half his ensilage in his dung-heap, on account of its being putrid, said to me one day: "I cannot boast of having had a thorough success; I have only been half successful."
>
> "What do you mean by half successful?" said I. "Do you mean that you have lost half your ensilage?"
>
> "Well," he replied, "half of it is about what I have lost; but the rest is in very good condition."
>
> "Then," I rejoined, "you ought not to say that you have been half successful; you have not succeeded at all. When a man loses half his investment in any undertaking, he has had no success; it has been for him a most disastrous business."

This was the reply made to a farmer who, nevertheless, by saving half his fodder, had done better than some others who have tried the same method, which was that of heaping earth over a mass of fodder laid upon the surface of the ground.

Earthen Pits, and other Simple Forms of Silo.

M. Goffart does not condemn in equal fashion all simple methods, although he may have ceased to practise them. For example, here are some particulars of the silos which he had in use in 1876, as shown by replies which he gave to a series of questions put by the " Société des Agriculteurs de France :"

I preserve from 300 to 400 tons in eleven silos of various shapes and dimensions. Five are old rectangular rooms, all above ground. Six are oval or rectangular vats of greater or less depth—one being half above ground, and the other five almost wholly underground. The best are the last built, with semicircular ends, and half underground.

I pack the chopped maize in horizontal layers, whether the silos are simple holes dug in firm soils, or whether they are lined with masonry.

Since that time he has built the large silos hereafter alluded to, and increased his ensilage to about 1000 tons per annum.

At a conference held in connexion with the District Agricultural Show, at Blois in May, 1875, he said, with respect to pits simply dug in the ground :

The trial of an underground silo, without walls of masonry, has given favourable results, so far as regards loss, which has scarcely amounted to 1 per cent. of the fodder put into the pit; but the soil crumbles away rapidly when the silo is empty, and in this respect it is inferior to walls of masonry.

And in a communication made to the Farmers' Dinner on Jan. 12, 1876, under the presidency of M. Foucher de Careil, M. Goffart said :

I siloed two tons of chopped green rye before the 8th of May, 1875, in a simple circular hole dug in firm soil without any lining of masonry. I opened it on the 20th September, and except a top layer of an inch in thickness, which was damaged, the rest was in a perfect state of preservation, and was devoured by my beasts, which were then being fed on green maize. Green rye is more easily preserved than maize, and is naturally richer food. All green fodders may be preserved in the same fashion.

In a report to the Central Agricultural Association of Sologne in 1875, particulars of some roughly-constructed silos on M. Goffart's farm are given by M. Julien, president of the Romorantin Agricultural Committee, who says:

We visited the silos, some in buildings, and others in the fields. The first consisted of brickwork compartments in an old cart-shed. They were about 16½ft. long, 6½ft. wide, and 8ft. high, built above ground. They were empty at the time of our visit. A silo in a field was, however, opened in our presence. With the exception of some mouldy patches on the upper layers, the fodder was in a very satisfactory state of preservation, and we can readily believe, with M. Goffart, that it might have been kept much longer. Henceforth, earthen silos will be done away with at Burtin, the owner finding it more advantageous to replace them by silos of masonry, which are more easily managed and give better preservation.

Silos simply dug in the earth should not be of such a depth as to be in danger from infiltration of water. The bottom and walls should be covered with a thin layer of straw, to prevent contact with the earth, and the fodder be then packed in, either cut or uncut. On reaching the surface of the ground, the fodder, having been well trodden down, should receive a thin layer of straw, and then be evenly covered with a good layer of earth, thick enough to prevent the penetration of rain.

The commissioners appointed by the National Agricultural Society of France reported also on M. Goffart's ready adaptation of means to ends, saying:

We have been very favourably impressed by seeing silos placed in an old distillery which, being empty, was now supplying the cows with their daily provender. These silos are simply formed by the side walls of the building, with dividing walls about 8ft. in height. No excavation has been made, and the forage is heaped up on the soil as high as the floor above will permit. Openings have been left in the dividing walls, so as to allow of passage from one compartment to another, in order to fill and empty them in succession.

Some English proprietors have already, in like manner, turned existing buildings to account by running up dividing walls in old barns, as mentioned in the case of the silos on Lord Walsingham's estate in Norfolk, and the Earl of Wharncliffe's in Yorkshire, particulars of which will be found in the Appendix.

In the report, also given there, respecting the experiments on the Albert Model Farm at Glasnevin, Ireland, it will be seen from the analyses that a simple earthen pit gave good ensilage, although the loss of nutritive materials was greater than in the walled silo.

With respect to the use of earthen silos among the small farmers of France, M. Lecouteux, the editor of the *Journal d'Agriculture Pratique,* says :

Silos dug out of sound earth are those generally preferred by small farmers, who do not want buildings of masonry. As I have often said, earthen silos would tend to popularise ensilage on farms where, for some reason or other, they shrink from constructing buildings. At Cerçay [where M. Lecouteux lives] the preference is in favour of buildings ; but under these circumstances—that they are barns which are at liberty in April, May, June, July, and part of August, and which, consequently, may be filled with provender, that disappears in turn, and affords room for the storage of grain crops. Later on, in October, the cereals being thrashed out, the barns become silos for maize. There are thus three successive destinations—silos for maize, silos for trifolium, and barns for cereal crops. It is a suppression of "fallows" in farm buildings; and this kind of fallow is not one of those which cost least.

Mr. Francis Morris, who acted as president at the recent Ensilage Congress of New York, is a strong advocate of earthen silos; and in the Special Report on Silos and Ensilage issued by the U.S. Department of Agriculture in 1882, the following remarks are made with respect to earthen silos and Mr. Morris's operations :

The general use of ensilage must depend largely on its cheapness. Costly silos and expensive machinery must always be insurmountable obstacles to a majority of farmers. For this reason, experience tending to show what is *essential* to the preservation of fodder in silos is of the first importance.

Especial attention is invited to the earth silos mentioned in the statement of Francis Morris, Esq., of Oakland Manor, Maryland. Mr. Morris is a pioneer in ensilage in America, his first silos having been built and filled in 1876. These were in the basement of his barn; walls of masonry. The next year he made a trench in sloping ground, so that a cart could be backed in at the lower end for conveying ensilage to the feeding room. The sides are sloping, and the average depth does not exceed 6ft. The cost is simply the cost of digging a ditch of similar dimensions. This trench was filled in 1877, and regularly since, and has kept its contents perfectly.

Mr. Morris has several silos of the same kind, in different places, for convenience of filling. He uses a large cutter driven by a steam-engine, and packs in the silo by treading with horses. The filling is carried several feet above the surface of the ground, and rounded up at the centre, the excavated earth serving to confine the ensilage. The covering is first roofing felt, then earth for weight.

Mr. Morris has put in whole fodder, and it has kept perfectly. He cuts it fine, mainly for convenience in handling and feeding. Whole fodder (maize) should be laid across rather than lengthwise in the trench, so that it can be taken out easily.

In order that the extent of Mr. Morris's operations may be understood, it is proper to add that his estate at Oakland Manor comprises about 1700 acres. His wheat crop this year (1882) was 5000 bushels, and his maize is expected to reach the same figures. The meadows yield upwards of 200 tons of hay annually. The stock consists of 50 horses and mules, 100 cattle, 500 sheep, and 50 hogs. And as the whole is managed on business principles, Mr. Morris very justly esteems his earth silos of primary importance.

The information given by Mr. Morris himself as to the construction of his silos is very brief. With respect to the locality where it should be placed, he says that the silo should be made in the field where the crop is grown. The feed must be carted, and therefore he considers that time and trouble are saved, at the time of cutting, by putting it into a pit on the spot. He digs a trench "11 feet wide at top, 7 feet at bottom, as deep as convenient, and any length required," and he covers up with 20 inches of earth. The soil is marly clay, and the water never comes in.

The Baron Corvisart is a strong advocate of earthen silos; and in such a silo, on his estate at Châteauneuf-sur-Cher, he stored in 1875 a large quantity of maizé, for a sample of which the Baron was awarded a gold medal at the District Agricultural Show at Bourges in May, 1879. In reporting on this show, M. Franc, professor of agriculture at Cher, said: "Hitherto nobody has produced ensilage kept for so long a time. Four years: it is prodigious. We examined the maize closely, and can affirm that the preservation was perfect." The secret of this fodder keeping so long appears to be simply that it was subjected to exceedingly high pressure, owing to the great thickness of earth piled upon it. In an article on Baron Corvisart's mode of practice in the *Journal* *d'Agriculture Pratique*, the editor, M. Lecouteux, after giving the dimensions of the trench and other particulars, says: "M. Corvisart estimates that his covering of earth exercises upon each square metre a pressure of 4500 kilogrammes. Neither air nor water, says he, with reason, can penetrate and interfere with its good and durable preservation." That such should be the case under so great a mass of earth is not surprising, seeing that 4500 kilogrammes per square metre are equal to about 900lb. per square foot; and as the weight of a cubic foot of earth varies from 80lb. to 100lb., according to its compactness, one can imagine what an immense thickness of soil would be necessary to produce such a pressure. As M. Lecouteux remarks, "It must not be supposed that the digging of these trenches costs nothing;" and he adds that he gives the preference to his own silos, which, as already stated, are simply made by running up dividing walls in already-existing barns; but, of course, people must be chiefly guided by local circumstances.

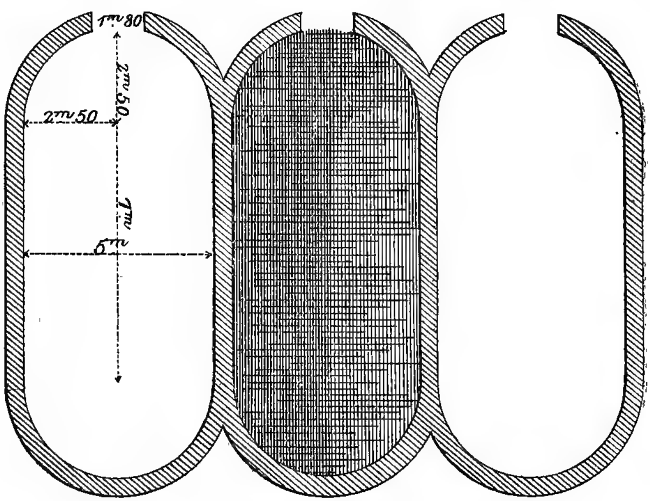
Best Kinds of Silos.

With respect to the question, "What kind of silo is preferable?" M. Goffart said, at the before-mentioned Conference at Blois:

> A silo on the ground level—a kind of room or chamber—is that which gives the best results during cold weather (from December to March exclusively); but as soon as the temperature rises, fermentation sets in with great energy, and in 1874 and 1875, from the month of March, a considerable settlement was seen to go on in such silos, owing to the slow combustion which took place in the mass.
>
> The underground silo, with walls of masonry, does not suffer from this inconvenience. The temperature does not rise in them in March, nor even in April. And at Burtin the ensilage which is being taken from the silo at this time (May 8, 1875) has undergone only a slight fermentation; it is nearly in the same condition as when put into the silo seven months ago.
>
> If I were about to commence the construction of silos, I would choose a rather elevated spot, where the ground could be dug into to the depth of six or seven feet without fear of an influx of water. I would make the silo of masonry, and carry up the walls a similar distance above ground,

and thus I should have a mixed silo twelve or thirteen feet high, and seven to ten feet wide, half under and half above ground. During the winter the part of the ensilage above the ground level would be consumed, and the lower portion be reserved for the hot months, when the part farthest from the entrance would be first attacked, and the cutting carried back towards the door. In this way, I think, excellent conditions would be obtained, suited to the exigencies of the different temperatures.

Since the time of that Congress, M. Goffart has built several new silos, together with extensive cattle-sheds; and he has considerably enlarged his ideas with respect to the dimensions of his silos, in like manner as he has greatly increased the number of cattle which he feeds on ensilage. With regard to shape, also, he has made some modifications, and now prefers the silos to be "elliptical," as he calls them—though they are not strictly elliptical, the sides and walls being straight and



Ground Plan of M. Goffart's Triple Silo.

the ends semicircular. We give a plan of his latest construction, three silos combined together, each being 5 metres (about 16½ feet) in width, the same in height (half being below and half above ground) and 12 metres (about 40 feet) in length; about 24ft. of the walls being straight, with a semicircle at each end. With regard to this modification in form M. Goffart says:

If I have greatly modified my process of ensilage, the modifications have related principally to the form, the dimensions, and above all the covering up of my silos.

The form has particularly occupied my attention; it exercises a very great influence on the results to be obtained. The form ought to be that which avoids every kind of angle and offers the least obstruction to the settlement of the materials in the silo. The elliptical silo represented in the plan fulfils these conditions. All angles are done away with, and the walls being vertical (not sloping as some persons make them) offer the least possible resistance to settlement—but more than is desirable nevertheless. The elliptical form also presents another advantage, which is very valuable as regards the strength of the silos. The underground walls thoroughly withstand the thrust of the earth, which forced in the walls of my first structures, and sometimes rendered them unserviceable.

With respect to the dimensions of my silos (length, width, and height), those who have followed my doings can answer for my constant tendency to increase them in order to obtain the greatest capacity. When you must operate upon considerable quantities of fodder, and have in your cattle-sheds a large number of beasts to feed every day, you must not hesitate to give to your silos the greatest dimensions compatible with the other conditions of an easy and economical service.

Great masses keep much better than those which are small, or in other words, the preservation in small silos is always less perfect than it is in great ones, for these reasons:—However smooth the walls may be made by plastering, the fodder always lodges against them; and whatever precaution may be taken, the settlement close to the walls is sure to be more or less obstructed, and this is detrimental to good preservation. The trampling down alongside the walls may have been very carefully done at the time of filling the silo, you may have heaped on the top of the mass, alongside the walls, a very considerable quantity of heavy weights (which is a practice that I cannot too highly commend), but the best preserved materials will nevertheless be those farthest away from the sides. Near the walls there is commonly some amount of damage, and although it may not be important it is nevertheless desirable to restrain it as much as possible. This particular damage is increased or diminished according as the walls present a greater or less amount of surface in contact with the fodder as compared with the whole mass. Hence there is considerable advantage in giving silos the greatest capacity possible, as those which hold but a small quantity have proportionately a much larger surface of contact.

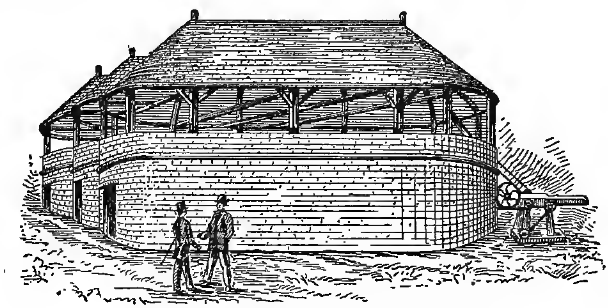
Suppose, for example, a silo one yard square and one yard deep; for a single cubic yard of capacity there would be five square yards of surface. If you multiply these dimensions by ten, and make your silo ten yards every way, you will then have a receptacle of 1000 cubic yards capacity, with a surface of contact of only 500 square yards; that is to say, there would be, for every cubic yard of capacity, only half a square yard of surface, instead of five square yards as in the small silo; and you thus will have diminished by nine-tenths the evil pointed out. I need scarcely say, however, that I do not recommend silos of such dimensions as these. I merely give an extreme illustration in order to render my meaning the more clear.

Fact answers only too well to the theory here set forth. I have continually found the fodder not so well preserved in small silos as in large ones. Whether the silo was great or small, I always used to find that, where the fodder came into contact with the walls, there was a layer from half an inch to an inch in thickness which had not kept well. In large silos this forms but an insignificant part of the mass, and cannot produce any evil effect; but it is otherwise in small silos, where the damage may affect 15 or 18 per cent. of the mass. Nowadays, thanks to the care which I take to put extra heavy weights on the mass close by the walls, the fodder is as well preserved there as elsewhere.

Formerly I recommended silos of small dimensions; but that was because I had not then discovered the marvellous results which may be obtained by the employment of heavy weights in establishing and maintaining density in the silos. When ensilage was taken out, the air quickly penetrated into the mass in the silo (where a want of sufficient density gave it free passage), and rapid deterioration was the result. It was natural, therefore, to endeavour to check this as much as possible; for the first effect of the penetration of air was to raise the temperature of the mass to a very high degree by continuous fermentations (first alcoholic, then acetic, then putrid) which rapidly succeeded one another; and the mass being thus a prey to a kind of slow combustion, went on continually deteriorating as long as the ensilage remained in the silo. Under such circumstances it was necessary to make the silos small, and to get the contents eaten as quickly as possible. But when at last I discovered that, by maintaining a constant density in the mass, the penetration of air was rendered impossible, I then could abandon the small silos for others on a more important scale.

Two years' experience have proved to me that my elliptical silos are superior in form to all others. If I modify them in the future, it will be solely with respect to their height, which it will be advantageous to increase still further. This will be an easy operation, as it will necessitate no alteration in that part which is already in existence.

Since writing the above, however, M. Goffart has said that, in consequence of the greater difficulty and cost of roofing satisfactorily the triple silo, he should be inclined, in any future structure, to make it with two instead of three divisions, and obtain the same capacity by an increase of length. He had previously made both double and single silos with the rounded ends, so had had practical experience of their respective advantages. It may be added that the triple silo just described is only separated by a 10ft. road from a feeding shed for nearly eighty beasts, the doors of the silos facing those of the cattle shed. The accompanying illustration gives a view of M. Goffart's triple silo.



ELEVATION OF M. GOFFART'S TRIPLE SILO.

In America, some of the writers on this subject recommend that the silos be made rectangular, and that the corners be cut off. This is but a reversion to a former practice of M. Goffart, who said in his communication to the Farmers' Dinner of January, 1876:

I have siloed in 1875 as I did in 1874, except a few improvements which have given better results. Having observed that the angles of my old silos constituted weak points, where the fodder did not settle evenly, and where its preservation was not so good, I replaced the right angles by obtuse angles. The inconvenience disappeared; thanks to this simple modification the angles no longer present the exceptional damage, which goes on increasing with time.

But, although he found an improvement from the corners being cut off, he found still further improvement from the ends being rounded, and hence his subsequent recommendation of "elliptical" silos.

As to precautions to be taken in the construction of silos, M. Goffart says:

Too much care cannot be taken in the construction of silos. The underground part especially ought to be the object of particular precautions. The fact should never be lost sight of that the walls have constantly to resist two kinds of thrust, in opposite directions. When the silo is empty the masonry has to undergo pressure from the ground without; and this is especially dangerous to new walls. When the silo is full, the masonry, more particularly that which is above ground, has to withstand the pressure exercised by the ensilage, increased as it is by the weights requisite to put thereon in order to secure preservation.

Any undue economy in these constructions may have to be paid for very dearly. Nevertheless it is not necessary to slavishly follow the method which I have adopted. Instead of making all my walls of brickwork, I might, so far as regards the underground portion, have made use of hydraulic concrete, which costs one half less than the former, but in such case you should be very sure of your materials and workmen, which can seldom be relied on in country places.

It would be advantage for those who have a hill at hand to utilise it, so that one side of the silo should be entirely underground and the upper part of the wall be on a level with the ground by which the waggons containing the fodder could be brought up, and upon which the chaff-cutting machine could be placed, if used, so that the chopped fodder would fall from the machine into the silo. It is impossible, however, to lay down a general plan suited to all situations; the arrangements will depend upon the surface of the ground, the existing buildings which are to be utilised, the nature of the soil, and so forth.

In choosing a site for the construction of silos, it is desirable not to lose sight of the fact that their distance from the feeding sheds may have a considerable influence on the economy of labour. They should be as close at hand as possible, in order to diminish carriage; but sometimes there is an advantage in placing silos farther away, in order to avail oneself of more suitable ground.

The door of the silo ought to be at the end; because, if opened in the middle of the long wall, two surfaces would be exposed to the action of the atmosphere. The door should be closed before putting in the fodder, and this may be done by means of planks fitting into grooves in the walls. Such was the method that I first adopted; but now I close the entrance of my silos by means of temporary brickwork plastered inside with hydraulic mortar, and this wall is pulled down again at the time of opening the silo. This brickwork closes the opening much more effectually than the boards, whatever care may be taken to adjust them one upon another. Each of these openings may be closed up by a bricklayer in the course of an hour or two.

Having given the plan of silo recommended by M. Goffart as best for the storage of green fodder, we now add some particulars from other sources, seeing that what may suit one person's means and requirements may not be equally convenient to another.

The Vicomte de Chezelles' Silo.

There is, we believe, no single silo in the world that approaches the dimensions of that built by the Vicomte de Chezelles, at Liancourt St. Pierre, in the department of the Oise. From a letter written by the Vicomte (printed in the Appendix) it appears that the silo is 216ft. long, by nearly 20ft. in width, and has a depth of 13½ft. The produce of 170 acres of clover and other green crops were put into this pit last summer, and there was still space for more. The capacity is given in the estimate appended to Mr. Kains-Jackson's article as 1475 tons; but making the same allowance for unoccupied space as we have done in other cases, we estimate its capacity as 1200 tons. The particulars included in the Appendix, and the illustrations also given there, render it unnecessary to enter into more detail at present. Few persons would be likely to build so huge a silo, but it might be made of any length required.

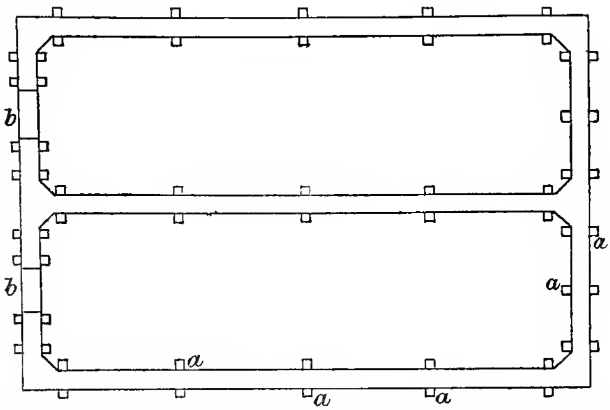
American Silos of Concrete, Wood, &c.

In his American "Book of Ensilage," Mr. John M. Bailey gives a plan which has some degree of resemblance to a double silo of M. Goffart's, except that the ends are not rounded off, as he now builds them, but have the inner angles removed as previously alluded to. Mr. Bailey says:

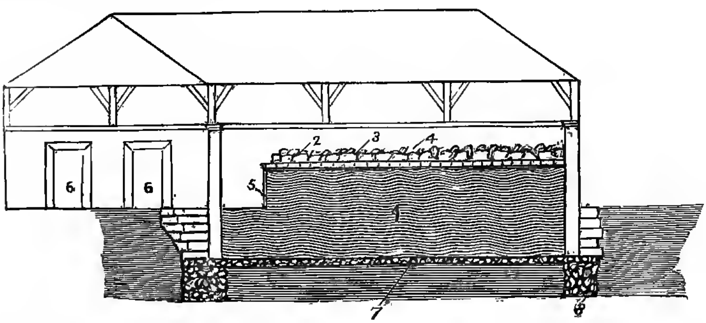
> Having resolved to try the experiment thoroughly, I selected a side hill, excavated on the west side and south end 7ft. deep, and put in on the west side a solid stone wall 44ft. long and 12ft. high, built of very heavy stone and in a most substantial manner. I afterwards banked up on this side to the top of the wall, making a level spot upon which to set an engine and ensilage cutter; also to drive carts upon, to deposit the fodder as it came from the fields.
>
> I then commenced building the silo walls. These are 15in. thick, built in the following manner: First, 3in. × 4in. scantling are set up at each of the angles, and also at intervals of about 8ft. on each side of the

walls. These scantlings being placed 18in. apart, planks 12in. wide and $1\frac{1}{2}$in. thick are set up inside the scantling, leaving 15in. between the planks as the thickness of the walls.

M. Goffart recommends that the corners be rounded. I thought that cutting them off, as shown in the diagram, would answer as well and be much less expensive.



The concrete is made by mixing one bushel of cement with three of plastering sand and four of clean gravel. This is thoroughly mixed together when dry; it is then wetted and thoroughly mixed again, making a very thin mortar.



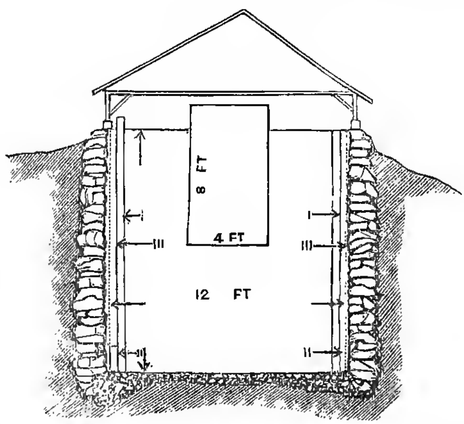
1. Ensilage.
2. Straw uncut.
3. Plank covering.
4. Stone weights.
5. Vertical slice to be taken out daily.
6. Doors.
7. Cement floor.
8. Drainage.

About 3in. in depth of this mixture is put in between the planks; then stones of all sizes and shapes are packed and bedded in this layer of concrete, after which another layer of concrete is poured in on top of this layer of stones, and the operation is repeated until the space between the planks all round each silo is filled; then the planks are raised about 10in., and the space filled with concrete and stones as before, until the walls are at the desired height. The best way is to have a sufficient number of hands to just raise the wall the width of the plank each day.

A 4in. × 12in. sill was bedded on the wall in the last layer of concrete. Upon the sill a wooden building was placed, with posts 5ft. high, the beams on the top of these posts being thoroughly braced to the posts, thus firmly tying the whole structure together.

The cost of the structure will, of course, vary in different localities, as the cost of labour and materials varies. My silos (capacity about 400 tons) cost me about $500 (100*l.*), or about 5*s.* for each ton's capacity. Large ones will cost less, small ones more.

Silos may be built of stone, pointed with cement mortar, and plastered on the inside; or of brick, or of concrete, as mine are. Whichever



material is the cheapest and most convenient in any locality is the best to use. Brick will cost more than the concrete. Concrete wall costs here about 10 cents (5*d.*) per cubic foot.

Large silos 40ft. to 50ft. long, 15ft. to 18ft. wide, and 16ft. to 24ft. deep are the cheapest: they will not cost more than 4*s.* or 5*s.* for each ton's capacity. They require no repairs, and, if properly built, will last for ages. The cost, therefore, of storage-room for ensilage is about 3*d.* per ton yearly. My plans of building silos are cheaper than to dig pits in the ground.

Small silos, capable of holding enough ensilage for ten to twenty cows, can be constructed by digging and walling up, as for a cellar, when stone is plentiful. Mix one part cement with two parts sand, and make a concrete floor about 1in. thick. Put a cheap battened roof over it to keep the rain and snow out, and you have just as good a silo as any. One

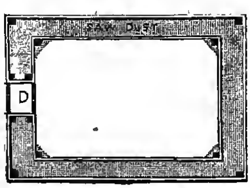
12ft. wide, 30ft. long, and 12ft. deep would not cost, besides the labour, over 10*l.* where stone is plentiful, and it would hold enough ensilage to winter twelve to fifteen cows.

The figure opposite gives a sectional view of the silo, letter I showing 3 × 4in. scantling; II, $1\frac{1}{2}$ × 12in. plank, between which and the rough wall a concrete or grout is poured; and III, a dotted line showing the face of the concrete pointing and plastering. A door 4ft. × 8ft. is in the centre.

Anyone who intends to do his own concrete work would do well to obtain fuller information respecting the proportions and proper mixing of the cements of our own country; and they will find detailed particulars in various works, such as "A Practical Treatise on Concrete," by Henry Reid, C.E., or "Concrete, its Use in Building, and the Construction of Walls, Floors, &c." by Thomas Potter, both books published by Messrs. Spon of Charing Cross, London.

In some of the American statements of cost there are very wide differences; but, with regard to figures that are very low, it must be borne in mind that vast numbers of farmers in the States are their own carpenters, bricklayers, and labourers; and, in stating what their silos have cost them, some of them allude only to money paid out of pocket, taking no note of the work they have done themselves in their spare time, or of the use they have made of any lumber or rough materials found on their own farms. At the recent congress at New York some ensilage was shown from a silo said to have cost only $10 (about 2*l.*), and to hold ten tons. This would be nearly as large as the Durham silo, of which particulars are given in the Appendix, and for which the mere excavation of soil costs one-third more than the entire outlay on the American silo. As to the construction of the latter, no particulars are given, so we cannot say how it was done. Possibly, however, it was a wooden silo, built entirely above ground, or the end of a barn partitioned off.

In some of the accounts of ensilage in America it has been stated that ice-houses have been turned into silos. It must not be supposed, however, that these are necessarily pits dug in the ground, lined with masonry, and closely shut in above, as is the case with most of the ice-houses in this country. In the States ice-houses are commonly built of wood, above ground, and are left open to the air between the roof and the top of the walls, so that there would be little difference in their method of storing ice and storing fodder. In these ice-houses the walls are built of double planking, much after the fashion shown in the ground-plan for building the concrete walls of Mr. Bailey's silo on page 33. But, of course, the joists that are there represented outside the planks should be between the boards in the wooden silo, as the inside walls of the silo should be as smooth as possible; and planed boards, placed upright, would be better than rough ones, because they would allow the fodder to slide down more evenly and pack better—which is a very great advantage. We have not seen a representation of a wooden silo, but the following small figures of an American ice-house will doubtless afford a tolerable idea of some among those which are said to have been applied to



the storage of green crops instead of the storage of ice. The window shown in the building is intended for the purpose of ventilation, already alluded to as common in American ice-houses; but in a building specially erected for a silo it would be advantageous, for convenience of filling, to have the roof raised, as shown in the side view of Mr. Bailey's silo. The following description of the mode of making the walls of a similar structure may be interesting as showing how American farmers set to work in such matters:

Mark out your ground the size you require for the house; then, commencing at one corner, dig a double set of holes opposite each other, 1 foot deep and 2½ft. apart, on each side of the intended building, say

3ft. equidistant, so that when the posts stand up they will present a double row, 1½ft. apart. Then set in your posts, which should be of oak, chesnut, or some lasting wood, and pack the earth firmly around them. The posts should be full 8ft. high above the ground to where the plate of the roof is attached. If the posts are sawed, they may be 4in. × 6in. in size, set edgeways towards each other. If not sawed, they may be round sticks cut from the woods, or split from the body of a tree, quartered, and lined to a surface to receive the planking. Of course, when the posts are set in the ground, they are to show a skeleton of what the building is to be when completed. When this is done, square off the top of each post to a level all round; then frame or spike on to each line of posts a plate, say 6in. wide and 4in. to 6in. deep, and stay the two plates together strongly, so as to form a double frame. Now plank or board up closely the inside of each line of posts, that the space between them shall be a fair surface. Cut out, or leave out, a space for a door in the centre of the side where you want it, and board up the inner partition sides of this opening, so as to form a door-casing on each side, that the space between the two lines of posts may be a continuous box all around. Then fill up this space between the posts with sawdust, well packed from the ground up to the plates. For the roof, take common 3in. × 4in. joists for rafters; or, in place of them, poles from the woods, long enough, in a pitch of full 35° from a horizontal line, to carry the roof over the outside of the plates. Secure the rafters well to the plates by pins or spikes, and then board over.

English Silos.

The silos as yet built in England are generally small, and of an experimental character. Particulars of several are given in the Appendix, which we may summarize here as follows:

The Hampshire silo of Mr. A. Grant is 30ft. by 11ft., and 10ft. deep, divided in the middle; besides this he has a small experimental pit, 6ft. × 6½ft. × 6½ft. The capacity of the former would be 66 tons, and of the latter little more than 5 tons, according to the rule stated on page 45.

The Yorkshire silo, a plan of which is given by Mr. Easdale, is 12ft. long, 7ft. wide, and 8ft. deep, giving a capacity of about 13½ tons.

Mr. Hoare's silos, at Pagehurst, Kent, are described as two 10ft. cubes separated by a wall. Their capacity would thus be 40 tons.

Colonel Tomline's silo, at Orwell Park, Suffolk, is 26ft. by 12ft. and 12ft. deep, or 75 tons capacity.

Lord Walsingham's first experimental silo (described in Mr. Woods' lecture) was a very small one, only 4ft. broad, 4ft. 4in. deep, and 8ft. 4in. long, or barely 3 tons capacity. In his second season he had a barn divided into compartments, so as to make three silos, each 14ft. 4in. by 6ft. 3in., and 9ft. 3in. deep, the total capacity of the three being about 50 tons.

The silo on the Earl of Wharncliffe's estate, described by Mr. Broderick, is also made in a barn, and consists of two compartments, each 14ft. square by 15ft. deep, the capacity of the pair being not quite 60 tons.

Mr. Kenyon's silo, in Wales, is 11¾ft. by 10ft., and 11ft. deep, having a capacity of 26 tons.

Mr. Gibson, of Saffron Walden, has five silos, 14ft. by 12ft., and 12ft. deep. If the ensilage in these pits could be compressed in the ordinary way, their total capacity would be rather over 200 tons; but, as they are covered over with a concrete top, with manholes for filling, and no weights are put on the fodder, they must hold much less than the above weight. The quantity of rye put in last June was estimated at 80 tons. We shall be glad to hear that an alteration has been made in this arrangement, as we consider the process a bad one, tending to direct waste of material from mouldiness, and indirect waste from unchecked fermentation in the pit.

The Rev. C. H. Ford has a silo constructing at Bishopston, co. Durham, the dimensions being 15ft. by 7ft., and 8ft. deep, or about 18 tons capacity. Details are given in Mr. Ford's letter in the Appendix.

Mr. Kains-Jackson, being a Kentish man, has given the name of the "Kentish silo" to the design which appears on page 40. It will be seen that it is about three-fourths underground, and that it is covered by a movable roof, which can be taken off in sections, or run to and fro, as required during the process of filling or emptying the pit. Further details will be found in the following particulars and specification:

This silo—which I call a "Kentish silo"—could be conveniently placed alongside any farm roadway for ease of access, or adjacent to the homestead. Its movable roof renders it a receptacle that would serve many purposes of storage. In the specification, cost has not been spared so far as the employment of best materials, but such structures should last many generations; in fact, the "Kentish silo" would be well nigh an indestructible "farm improvement." The illustrations may be left to speak for themselves.

As to the cost, any country builder could give an estimate from the specification given below. The amount, as given to me by a "quantity surveyor," is not a very important one; but each district having drawbacks or facilities, tenders should be obtained in the localities where the silos have to be built. Doubtless the walls might be made of concrete; indeed, good concrete has many recommendations, but bricks or stones always form valuable materials in themselves, and are permanent representatives of the outlay, whereas "concrete" scarcely represents money, and is a substance that somehow seems to invite fraud in the making. Where the proprietor or tenant supplies the right materials and sees them properly mixed, concrete silos may be recommended.

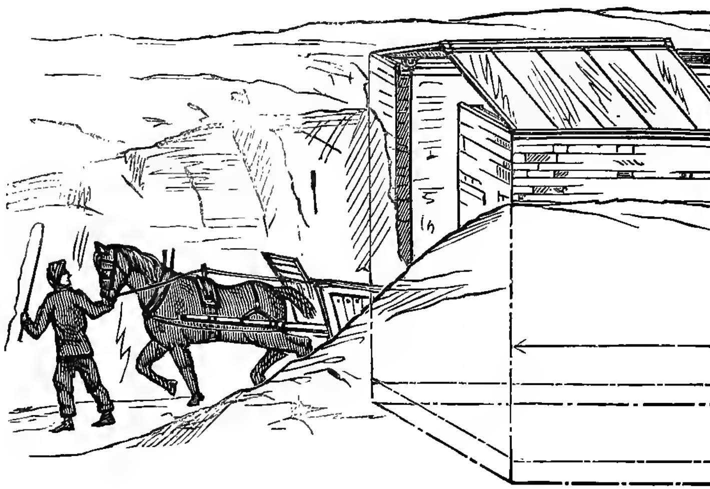
SPECIFICATION OF WORKS required to be done in building a silo for the storage of grass, clover, and other green forage.

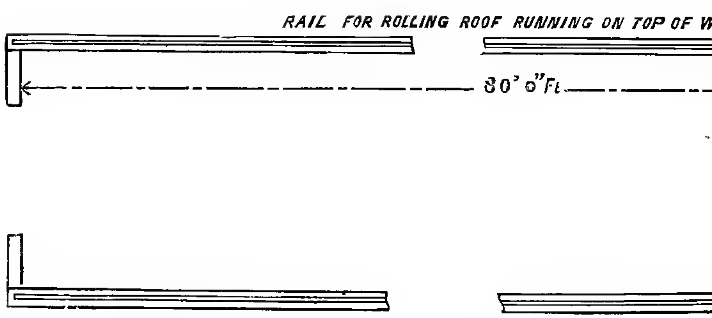
Excavator.—Excavate to a depth of 12ft. from the surface of the ground, to a length of 80ft. and breadth of 10ft., and cart away the soil to where directed. The earth in the foundations is to be well rammed down, so as to form a natural bed, and not made up of loose earth; sand, if found, is to be allowed for by the contractor. Excavate the earth at one end in front of silo, 30ft. long, gradually sloping to bottom of pit, as shown, if required.

Bricklayer.—Build in Flemish bond the walls and piers of best hard well-burnt grey stocks, laid in cement composed of one part of approved cement and three of clean sharp sand, with footing of four courses of brickwork. Build in the one end of wall 15ft. × 10ft., and build a brick pier 15ft. × 1ft. 2in. on each side at other end, as shown. Lay the bottom of the pit with concrete 1ft. in depth, with a layer of asphalte 2in. in thickness on top. Form a drain in the asphalte and concrete through the centre the entire length, with a fall of 6in. from the centre towards each end, and also with a slight fall from either side of walls. Provide and lay a damp course of unbroken slates, laid, breaking joint in cement above projection of footing course. Leave a rebate at top of walls the entire length to receive the wall plate; size, 9in. by 6in.

Carpenter.—Provide and fix a wall plate to run the entire length of pit (80ft.) on each side, size, 6in. by 6in., to receive the rails, and secure same firmly to walls with nails or screws; provide wood blocks for same, to be inserted in the wall.

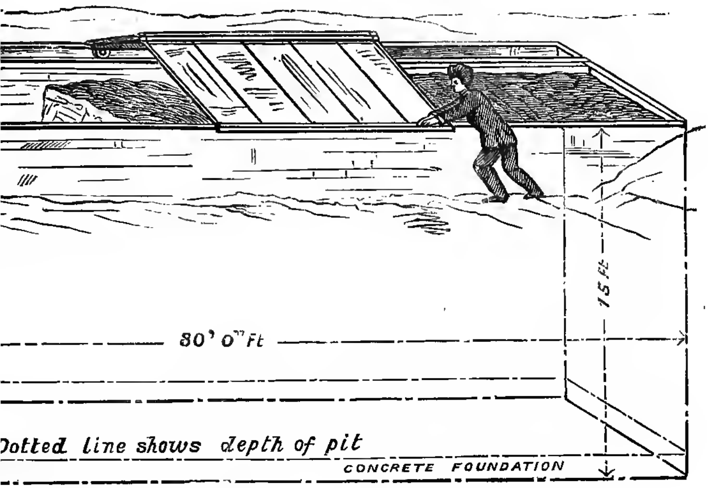
Founder and Smith.—Provide and fix iron rails, 4in. by 2in., to run the entire length of walls on each side (viz., 80ft.). Provide eight covers, as shown, with galvanised iron roofs, 1-16th of an inch in thickness,



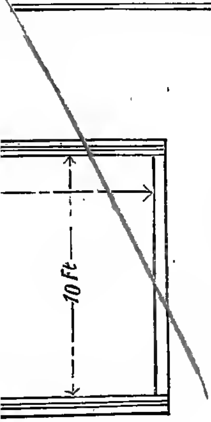


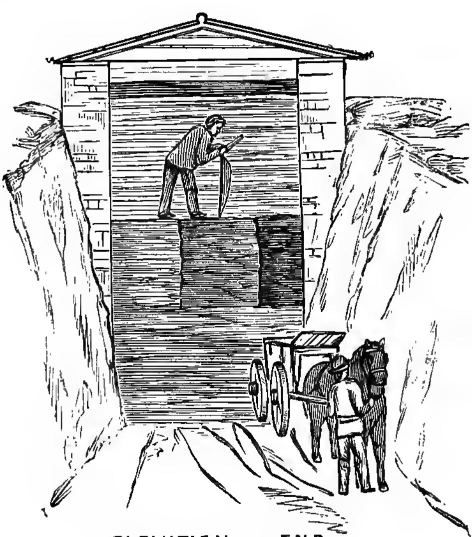
PLAN

THE KENTISH SILO.



PERSPECTIVE ELEVATION





ELEVATION OF END

each 10ft. by 10ft., with bearers and six rollers, three on each side, to fit rails; make same to run easily, the roofs to have a pitch of 1ft. 6in. from centre; the galvanised iron cover to be firmly joined together at ridge, and to project over the bearers and rollers, as also over the walls a distance of 2in., with a small eaves gutter on either side of the cover; each end of the cover (roof) is to be made so that, when the covers are close together, they will overlap each other slightly, as shown in the drawing, to prevent rain from drifting in.

General Remarks.—The whole of the work is to be carried out without stoppage, and to the satisfaction of the owner for whom the works are done; the materials are to be sound and good in their respective trades, and everything left complete and in good working order at finish. The contractor failing to complete any of the works commenced by him, shall be liable for the cost incurred in obtaining another contractor to finish the work, and the amount so forfeited shall be deducted from the original contract.

According to the rule given in the next chapter for estimating the capacity of silos, the structure here described would hold 240 tons of ensilage; but, of course, the length could be reduced as thought desirable, and the capacity diminished in proportion.

CHAPTER IV.—COST OF SILOS.

The cost of silos must necessarily be influenced by various circumstances, as the materials of which they are made, the dimensions that are chosen, the nature of the soil on which they are built, and the power of adapting existing buildings to new purposes. It is impossible to lay down a general rule as to what any particular structure should cost, even when you have chosen the size and materials, because local circumstances will make a considerable difference in the outlay, and what may be a cheap mode of building in some districts will be very expensive in others.

In certain localities, abounding in gravel and sand, concrete may be very cheaply made; in other places it may be advisable to have recourse to quarried stone; elsewhere brickwork may be more economical; while some estates may have an abundance of timber that can be profitably turned to account. Even those who would adopt the simplest form of silo, by merely digging a pit in the ground, will find that they cannot advantageously do in loose, porous soils, liable to incursions of water, what others can accomplish in firm, sound earth, out of the reach of floods.

The mere cost of excavation becomes a considerable item where pits are dug in the ground, whether these are or are not lined with masonry, concrete, or planking. Work of this kind may be said to have a fixed rate of cost, because, if you wish to have a pit of 10 cubic yards capacity, you must dig out 10 cubic yards of soil, and if you wish to make it two, three, or twenty times larger, you have two, three, or twenty times as much work to do, and the cost is proportionately increased.

It is otherwise with structures built above ground. There, if you double the length of each of your walls, you double the cost of building them; but the space they inclose is increased fourfold, and consequently the relative cost of that space is only one-half that of the smaller enclosure. And if you make all the walls ten times as long, the space is increased 100 times, and the relative cost is only one-tenth. Obviously, therefore, large silos must be relatively much cheaper than small ones, except so far as regards the cost of excavation; and even where excavations form part of the scheme, if they are lined with masonry or concrete, &c., the cost of building walls in these structures will follow the same law as when the walls are wholly above ground.

Where there are unused barns, outhouses, &c., they may often be rendered serviceable as silos at a very moderate outlay. M. Goffart, M. Lecouteux, and other French farmers have thus freely availed themselves of the means at their disposal, as will be seen from quotations given further on; many American farmers have done the same; and a similar course has been followed in England, on the estates of Lord Walsingham in Norfolk, and the Earl of Wharncliffe in Yorkshire.

Estimations of Capacity and Cost.

What is here proposed to be done is, not to say that silos of such and such dimensions can be built in any way for a given sum; for, although some readers might find it true, others would find it false. Even where a manufacturer in London or any other large town may undertake to supply materials at a certain rate, the expense of conveyance by rail and road may add considerably to the first cost, especially if workmen are sent likewise. Widely divergent statements have, however, been made public as to what silos have cost, or must cost, but so little has been said to explain the circumstances affecting the respective buildings, differences in size, and variations in estimates of capacity, that the conflict of assertion has been very bewildering. It is thought, therefore, that a collection of facts from various sources—principally foreign, because so little has yet been done in our country—may not be without utility to those who would form some notion of the expenditure incurred under circumstances having more or less resemblance to their own.

In giving these statements of cost, an endeavour has been made to reduce them to a common standard. One man may say that his silo has entailed an outlay of a certain number of dollars, and that it will contain so many tons of fodder; and another may have a larger silo but be content with a much more moderate estimate of its capacity. Obviously no fair comparison can be made under such circumstances; and therefore, in all the records here given, the capacity of the silos in tons is calculated at the rate of 50 cubic feet to the English ton—we say English ton, because the American ton is only 2000lb., and therefore is about one-tenth less than ours, being, in fact, a little under 18cwt.

The reasons for taking 50 cubic feet of capacity as representing a ton of ensilage are these:—M. Goffart has shown that ensilage, well compacted under heavy pressure, has a weight averaging about 812 kilogrammes the cubic metre, which is equivalent to almost exactly 50lb. per cubic foot. He also shows that, if proper care is taken in filling, there need not be more than about one-tenth of the depth of the silo unoccupied when the fodder has settled down. If, then, we take 50 cubic feet at 50lb. each, we get 2500lb.; but, deducting one-tenth of this for unoccupied space, we get 2500 – 250, or 2250lb., and therefore we have a very close approximation to the English ton, which is 2240lb.

It may be considered that silos in general are seldom or never likely to contain more than a ton weight of ensilage in 50 cubic feet of space, whereas many that are unskilfully filled and insufficiently weighted will hold a very great deal less. How greatly persons may be out in their estimates will therefore be seen by the following statement made by an owner of silos in reply to questions issued by the U.S. Department of Agriculture :

Last season my silo was 32ft. by 14ft., and 12ft. high; I have added 10ft. to the height, and built another the same size. The whole capacity is now 1000 tons.

This is a remarkable example of exaggerated estimate. The cubic contents of these two silos is under 10,000ft. each, and 1000 American tons are equal to 2,000,000lb., so that, if not an inch of space were left unoccupied in these two silos, the ensilage would have to weigh more than 100lb. per cubic foot to make up that weight. Our estimate of the capacity of these two silos is barely 200 tons each, or a total of 400 tons.

Wooden Silos.

In America wooden silos on a large scale have been built, as well as small and make-shift contrivances. The largest we have heard of are those of the West Point Butter and Cheese Association, Nebraska. This association owns a herd of more than 300 milch cows, which were fed on ensilage as far as the supply permitted. The following particulars were given by Mr. William B. Eager, vice-president and manager of the association. In this, as in the subsequent instances, the particulars of the silos, and the cost in dollars, are extracted from the report of the U.S. Department of Agriculture; but the capacity and cost per ton, placed between brackets, are the results of calculations we have made on the standard already explained.

Four silos, joined together, requiring five side walls. Dimensions of each silo, 40ft. by 12ft., and 19ft. deep, inside measurement. Made of upright pine timbers 12in. wide, lined inside with 2-in. plank, outside with inch boards; space between filled with dry clay tamped solid. Floor, 2-in. plank, over four inches of broken brick. The four silos cost $2400, complete, and all above ground painted. [Capacity, 730 tons; cost, 13*s.* 6*d.* per ton.]

The following additional particulars respecting these wooden silos are quoted from the American *Cultivator and Country*

Gentleman. It will be observed that the apparent difference of dimensions arises from the thickness of the walls, those just stated being internal measurements; the 54ft. mentioned below is made up of four silos 12ft. in width, with the intervening and external walls:

The West Point building is 54ft. by 43ft., and substantially built, the posts and plates being of pine timbers 12in. square. It is set in an excavation on a side hill, so that the north side is against a bank 20ft. deep, while the south foundation is level with the roadway. The studding of the walls and the partitions between the four silos into which the building is divided is 2in. by 12in., planked on each side with 2in. pine, and the 12in. space between is packed with clay. This renders the sides perfectly air-tight. Mr. King, the superintendent, says if they were building again they would use bricks, and cement the walls, which would save the inconvenience of cross-beams in each silo.

Here are details of some other large wooden silos. The first was built by contract for $500, its owner having previously built a concrete silo, partially underground, which cost (including drainage) more than $1300, although its capacity was less.

Wooden silo, all above ground. Dimensions, 40ft. by 20ft., and 18ft. deep. Built of chestnut posts, set in the ground 3ft. apart, with double lining of hemlock boards, and tarred paper between. Cost, $500. [Capacity, 290 tons; cost per ton, 7*s*. 3*d*.]

Wooden silo, 20ft. by 30ft., and 12ft. deep, 5ft. above ground and 7ft. below. Sides of 2-in. pine boards, tongued and grooved; bottom of concrete. Total cost of silo, roof, and drainage, about $500. [Capacity, 144 tons; cost per ton, 14*s*. 6*d*.]

The following particulars, it will be seen, relate chiefly to silos made in buildings already existing. The use of wood under such circumstances seems to be commonly adopted; and in many cases the partitions in silos of concrete or masonry are made of double walls of wood, lined with tarred sheathing paper, or filled with sawdust, ashes, or earth tightly rammed. It will be observed that "hemlock" is the wood frequently used: this is a very common species of spruce fir grown in American forests. In various instances, with wooden and other silos, we give particulars of how they are built, thinking that these may be of interest to many readers, although the owners have not furnished any details of cost.

Silo all above ground, and was one end of a hay barn, new timbers being thrown across barn to constitute one side of silo, the other three sides being sides and end of barn. Upright 2-in. plank nailed to girths of barn, the plank coal-tarred, building paper put on, and 1-in. boards nailed on to break joints with plank, and the boards coal-tarred. No bad taste imparted to ensilage by the tar. Had to plant heavy timbers at two sides of silo, and tie them together to keep silo from bulging. Dimensions, 10ft. by 18ft. and 16ft. deep. Cost, including four extra iron rods and extra timbers, $114. [Capacity, 58 tons; cost per ton, 8*s*.]

Silo built in a barn, and made of double walls of hemlock boards, the space between being filled with sawdust. Dimensions, 13ft. by 12ft., and 8ft. high. Cost, $30. [Capacity, 25 tons; cost per ton, 5*s*.]

Silo built on basement floor of cattle-feeding shed, but not underground. Dimensions, 18ft. by 22ft., and 20ft. deep. Walls of matched hemlock boards, with 3-ply roofing-felt between; timbers 3in. by 10in. running horizontally, the lower six being 12in. from centre to centre, then increasing in space one inch until the top is reached. There is a row of doors, one for each division, between the timbers. [Capacity, 160 tons; cost not stated.]

Dimensions, 24ft. by 12ft., and 12ft. deep. Built of wood, as wood affords less moisture than stone or brick (this is for silos underground). The cost all depends on the cost of labour and lumber. I build them for 100 tons at a cost of $50. [A silo of the dimensions here given would, however, only hold about 70 tons.]

Concrete Silos.

Concrete is a favourite material for silos in the United States, and the following are particulars of some of those reported to the Department of Agriculture. It will be seen that there are very wide variations in statements of cost, owing to nothing having been charged in some cases for labour or for materials found on the farm, whereas in others everything has had to be paid for. In many cases the information is undesirably vague as regards roofing. Where the silo is made in a barn, there is, of course, no outlay in this respect; and where built outside an existing cattle-shed, the cost of lengthening a sloping roof, so as to extend it over the silo, would be less than roofing-in a separate building. We cannot, however, supply details that are wanting in the Report.

Silo, 40ft. by 14ft., and 19ft. deep, half underground. Concrete walls, 1ft. thick. Cost 1320 dollars, including a deep under-drain, which cost perhaps 150 dollars. [Capacity, 212 tons; cost per ton, 26*s*. The owner of this silo afterwards contracted for the erection of wooden silos, particulars of which have already been given, and the cost per ton was only 7*s*. 3*d*.]

Silo sunk in gravel bed in back part of barn cellar; the top of silo being on a level with feeding room in front part. Dimensions, 12ft. by 8ft., and 8ft. deep. Cost between 50 and 60 dollars, "less value of gravel." [Capacity, 15 tons; cost per ton, about 15*s*. or 16*s*., but the farmer looks upon the gravel dug out as having a value, which may be set off against part of the outlay.]

Three silos, adjoining feeding sheds, with top on same level as floor. Two silos 22ft. by 11ft., and one 22ft. by 15ft., and all 12ft. deep. Built of concrete, four parts sand, one part cement; walls 18in. thick, with corners rounded. The three silos cost $600. [Capacity of the three silos, 195 tons; cost per ton, 13*s*.]

Six silos, side by side, 25ft. by 16ft., and 14ft. deep. Concrete, one part cement, five parts coarse sand, five parts small stones; built between planks supported by studding in such manner that the planks can be raised after being filled with concrete. A wedge driven lightly between studs to spring them apart, say half an inch, allows the planks to slip upward easily and without cracking walls which are still soft. Cost, about six cents (3*d*.) per cubic foot of contents, having to haul sand, cement, and lumber three miles. [Capacity of the six silos, 670 tons; cost per ton, 12*s*. 6*d*.]

Separate silo, 12ft. by 20ft., and 12ft. deep, 6ft. being below and 6ft. above ground. Built of concrete, 12in. thick. Cost, $160. [Capacity, 58 tons; cost per ton, 11*s*. 6*d*.]

Silo 32ft. by 12ft., and 10ft. deep, built on a bank adjoining a cow-shed, with door opening from bank side into the silo—the floor of silo being about 3ft. lower than floor of cow-shed. Built of concrete 14in. to 16in. thick; one part cement to five parts sand, mixed while dry, then wetted so that it will pour from the pails in which it is carried; any kind of stone being used. Posts set in the ground, and lined with 2-in. plank, were used as framework; and when this was taken down the walls were plastered with cement made with less sand. The bottom was covered with gravel about 2in. thick. Cost, $200, including light frame building over it. [Capacity, 77 tons; cost per ton, 11*s*.]

Two compartments (adjoining and opening into cattle shed), each 13ft. by 19ft., and 19ft. deep, with 6in. of the corners cut off from top to bottom. Built of concrete, one part cement to four and a half of sharp gravelly sand, wetted with whitewash made by slacking quicklime under water two days previous to using. All the field stones that can be put in are embedded in the cement. Cost, about $250, exclusive of roof. [Capacity, 92 tons; cost per ton, without roof, 11*s*.]

Silo connected with barn, opposite cattle. Dimensions, 30ft. by 12ft., and 14ft. deep. Wall, 18in. thick, one-third cement, two-thirds sand. Cost, $225. [Capacity, 100 tons; cost per ton, 9*s*. 6*d*.]

Three silos adjoining end of barn and opening on a level with stables; each 15ft. by 10ft., and 16ft. deep. Concrete walls, 20in. thick, made of cement, gravel, and small stones. Cost of the three silos, $100 each. [Capacity, 46 tons each; cost per ton, 9*s*.]

Silos, 40ft. by 12ft. and 15ft. deep, 10ft. being below the surface of the ground. Concrete 17in. thick below the surface, and 12in. thick above ground, cemented so that the inside was perfectly smooth. Cost, sixty-five barrels cement, $100; excavating, $25; hauling stone, $75; labour, $110; whole cost, $310. [Capacity, 144 tons; cost per ton, 9*s*. Excavating is here set at a very low figure, the cost not amounting to 6*d*. per cubic yard. A marked difference is shown in the first brick silo opposite.]

Silo 40ft. by 13ft., and 13ft. high to the sills of the superstructure. Walls, 16in. thick, made of concrete; a gable roofed building, with sills bedded in top of cement walls, increases depth of silo 5ft. Cost $400. [Capacity, including the superstructure, 187 tons; cost per ton, 9*s*.]

Silo by the side of and parallel with barn, and so arranged that the ensilage comes from the silo to the floor directly over the animals to be fed—the barn being built against a side hill, with the silo on the upper side. Dimensions 50½ft. by 12½ft., and 16ft. deep. Built of concrete made of hydraulic cement, gravel, and cobblestone. Cost, 350 dollars, including roof. [Capacity, 200 tons; cost per ton, 7*s*. 3*d*.]

Three silos, 20ft. by 12ft. each, with 10ft., 18ft., and 22ft. respective depth. "As I have sand, gravel, and stone near, it enables me to build cheaply. My three silos, with capacity of 250 tons, cost 300 dollars." [The American ton being about one-tenth less than the English, this agrees very closely with our estimate of their capacity, which is 240 tons; cost per ton, 5*s*. 3*d*.]

Silo under barn, extending up and opening into driveway in front of cattle. Dimensions 21ft. by 11ft., and 18ft. deep. Concrete 15in. thick up to floor of driveway (9ft.) and matched boards above (9ft.) Cost, $75 or $80. "I used a part of my barn cellar, therefore had no excavating." [Capacity, 83 tons, cost per ton, 3*s*. 9*d*. to 4*s*.]

Two silos, 30ft. by 15ft., and 22ft. deep, 18ft. being of concrete, and 4ft. of framework. Cost 300 dollars for materials, superstructure included; "did the work ourselves." [Capacity, 200 tons each; cost per ton, 3*s*., without labour.]

Silo, 60ft. by 11ft. and 12ft. deep, with doors opening into cattle-feeding shed. Made of rough stone, lined with concrete. Cost 75 dollars for cement. "I did the work with my men in spare hours, during stormy weather." [Capacity, 160 tons; cost per ton, barely 2*s*.—the only direct outlay being in the purchase of cement, the other materials and labour being found on the farm.]

Brick Silos.

Bricks appear to be but seldom used in America for this purpose, the only records we find being the following, except in instances where they are used in making additions or alterations:

Silo 23ft. by 12ft., and 12ft. deep, 10ft. being below and 2ft. above ground. Walls of brick, 12in. thick, laid in cement; bottom, one layer of brick with 2in. cement over. Cost of brick, cement, lime, and labour, $275. About $75 of this amount was for labour in excavating and removing dirt. [Capacity, 66 tons; cost per ton, 17*s*. 6*d*. The amount paid for excavating and removing earth seems very heavy, as there would only be about 140 cubic yards dug out, and the cost would thus be about 2*s*. 3*d*. per cubic yard.]

Two silos adjoining, on upper side of hillside barn, each being 21ft. 3in. by 10ft. 6in., and 11ft. deep. Brick walls, 12in. thick, each long side strengthened at the middle by buttress 16in. thick; sides and bottom lined with cement. The two silos, and extension roof of barn over them, cost $350. [Capacity of the pair, 96 tons; cost per ton, 15*s*.]

Silo 30ft. by 14ft., and 12ft. deep, built of two courses of hard-burnt brick laid in cement; bottom cemented. Cost, $250; but I had everything to buy or hire; under favourable circumstances, as good a silo could be built for $125. [Capacity, 100 tons; cost per ton, 10*s*. 6*d*.]

Silo in corner of barn, with door opening into feeding alley. Dimensions, 14ft. by 17ft., and 23ft. deep; built of bricks and cement. Cost, about $175. [Capacity, 110 tons; cost per ton, 6*s*. 6*d*.]

Stone-built Silos.

The silos built of stone include those which have cost a higher sum (as compared with their capacity) than any others included in the returns made to the U.S. Department of Agriculture; but they appear to be built regardless of expense, and, as the owner says, they are not a fair criterion of what silos should cost. They stand first on the following list, which is arranged in order of cost per ton:

Two silos, built underground, with stone walls 18in. thick, laid up and faced with cement; bottom concrete; a blind drain extends around the sides. "The cost of my silos is not a fair criterion for others who seek utility only. The silo I have just finished is built in the field where my cows pasture, for the purpose of supplying them with green fodder in the months of July, August, and part of September, when the grass is dried up. This silo is 6ft. by 8ft., and 9ft. deep. This silo will cost me about $150. The one constructed last year cost almost $350. It is 9ft. by 15ft., and 15ft. deep. Both are covered by ornamental buildings, which add about half of the cost." [Capacity of small silo, about 8½ tons; of larger building, about 20 tons; and the cost per ton in each case about 3*l.* 13*s.*]

Two granite silos, one 24ft. by 12ft., and the other 24ft. by 7½ft., both 13ft. deep. The granite laid in cement and grouted inside; thickness of walls not stated. Cost of both silos, $500. [Capacity of the two, 120 tons; cost per ton, 17*s.* 6*d.*]

Silo 64ft. by 20ft., and 26ft. deep. Walls of stone and cement; the floor of stones, 4ft. by 6ft. each, laid in cement. Cost, about $2000. [Capacity, 675 tons; cost per ton, 12*s.* 6*d.*]

Silo connected with cattle shed. Dimensions, 25ft. by 18ft., and 15ft. deep. Stone wall, laid up dry; 4ft. thick at bottom; 3ft. thick and 12ft. high; the last 3ft. rubble and cement 18in. thick; lined from 2in. to 4in. thick with cement on the bottom and sides. Cost, $350. [Capacity, 135 tons; cost per ton, 11*s.*]

Silo on a side-hill, the top level with roadway. Dimensions, 30ft. by 20ft., and 20ft. deep, divided by a partition. The walls are of limestone, 3ft. thick and 13ft. high, laid dry and faced with cement; above this height there is 7ft. of matched boards; the partition is also of matched boards, double, and filled with earth. Cost, $600, exclusive of farm labour. [Capacity, 240 tons; cost per ton, 10*s.* 6*d.*, besides farm labour.]

Silo built in a steep bank at end of barn. Dimensions, 35ft. by 16ft. and 22ft. deep. Built of field stone, pointed with cement, and plastered. The soil being blue gravel, the digging was expensive, making the whole cost about $550. [Capacity, 246 tons; cost per ton, 10*s.* 6*d.*]

Two silos under one roof, each 36ft. by 12ft., and 12ft. deep. Built of stone laid in mortar and cement. Cost, $500. [Capacity of the pair, 207 tons; cost per ton, 10*s.*]

Silo, 45ft. by 15ft., and 14ft, deep, divided by a wooden partition. Stone walls, 10ft.; wood, 4ft. Cost, about $450. [Capacity, 190 tons; cost per ton, 10*s.*]

Two silos, each 33ft. by 14ft., and 16ft. deep; 18in. walls of stone and mortar, lined with cement. Cost, $500. [Capacity of the two silos, 315 tons; cost per ton, 6*s.* 8*d.*]

Silos of Mixed Materials.

The Americans seem very fond of using several kinds of materials in their silos, and in many cases the stonework or concrete is only carried up to the ground level, and the remainder is built of wood. The first example in the following list goes much more fully into details of cost than any we have met with. In many other cases the particulars are altogether wanting:

Two silos, 20ft. by 12ft., and 12ft. deep—5ft. being above ground and 7ft. below. One silo was built of stone, laid dry, 18in. thick, faced with 6in. of grout cement and small stones, and one thin coat of cement to make a smooth surface. Bottom grouted and smoothed; superstructure of wood to shed water. The second silo was constructed of small stones, and cement made thin and poured between the stones. In constructing this wall, 2in. by 4in. studding was placed plumb 2ft. 1in. from face of excavation and 3ft. apart. Inch boards were placed horizontally on inner side of studding, between which and face of excavation the stones were laid. When completed, the boards and studding were removed, and the face of the wall pointed with cement to make a smooth surface. The cement mortar used was in proportion of one of cement to two of sharp sand. One silo was weighted with stones packed in barrels; in the other, four cast-iron screws were attached to beams overhead. Cost of Silo No. 1:—Excavation, $112·63; laying walls and cementing, $143·31; wood and labour, $87·55; 40 barrels cement, $47·20; total, 390·69. Cost of Silo No. 2:—Excavation, $42·90; laying walls, $87·77; cementing, $20·50; cement and freight, $159·95: ironwork for press, $37·96; wood and labour, $132·09; screws and freight, $50·24; total, $531·41. [Capacity 58 tons each; cost of No. 1 silo per ton, 28*s.*; cost of No. 2 per ton, 38*s.*]

Double silo, exterior wall, 2ft. thick and 16ft. high; partition wall, 1½ft. thick, of stone and cement, forming two pits, each 14ft. by 15ft., and 16ft. deep. On the wall I built a frame, 9ft. posts, sided up with grooved and tongued boards, covered with building paper, then clapboarded. Inside of studding, lined up with 1¼in. grooved and tongued spruce, well painted, and flush with inside of silo wall, so that the covers may run down without any impediment, making a total height of 20ft. The floor is grouted with gravel and cement 8in. thick, and inside of walls plastered with cement. Cost, $1000. [Capacity of the pair, 178 tons; cost per ton, 23*s*. 6*d*.]

Double silo, 24ft. long, 7ft. and 8ft. wide respectively, and 15ft. deep. Built of stone; outside walls dry, 30in. thick at bottom and 20in. at top; division wall 20in. thick, laid in cement, and all walls plastered with cement. The walls were built by masons, in accordance with their notions of fitness, with the result of an extravagant cost. Above the silo walls is a kerb of matched boards, 6ft. high, for settling room. Of course a roof covers the whole. Cost between $700 and $800. [Capacity, 150 tons; cost per ton, 20*s*. to 22*s*.]

Silo, near cattle shed, the ensilage being raised in a box by means of a hay-carrier arrangement to a car, which carries it to the cattle shed. Dimensions, 27ft. by 12ft. and 15ft. deep, with 3ft. kerbing around the top. Walls of rubble sandstone 18in. thick, made smooth inside with cement. Cost, $413·42, including superstructure, which cost $119·40. [Capacity, 97 tons; cost per ton, 18*s*., including superstructure.]

Silo, 40ft. by 13ft., and 13ft. high to the sills of the building covering it; the walls being of 16in. concrete, on which are bedded the sills of a gable-roofed building, which increases the depth of the silo 5ft. Cost, $400. [Capacity, 187 tons; cost per ton, 9*s*.]

Silo, 16ft. by 9½ft., and 9ft. deep, in barn cellar, near to cattle stalls. Walls of stone and concrete for 6ft., and the rest of wood. Adding value of stone and sand on hand, the total expense was about $100. I used 16 barrels of cement. [Capacity, 47 tons; cost per ton, 9*s*.]

Silo on one side of barn floor, 50ft. by 15ft., and 18ft. deep. Walls stone and cement, 4ft. to basement floor, brick and cement 10ft. to feeding floor, and double matched boards 4ft. above floor; bottom and walls below floor cemented. Cost, $521, which is much more than necessary. Mine was the first one built in this vicinity, and I wished to avoid a failure. [Capacity, 270 tons; cost per ton, 8*s*.]

Silo, 18ft. by 12ft., and 15ft. deep, 10ft. being stone wall, then a sill and studs 5ft. to plate, sheathed flush with the wall. Cost, $100. [Capacity, 65 tons; cost per ton, 6*s*. 6*d*.]

Silo in corner of a barn, which has a cellar 9ft. deep. Dimensions 14ft. by 11ft., and 18ft. deep, 9ft. being below and 9ft. above floor of barn. The walls below, on two sides, are the cellar-walls cemented; on the other two sides they are made of brick and cement: and above the barn-floor there are two thicknesses of boards with tarred sheathing paper between them. Cost $84. [Capacity, 55 tons; cost per ton, 6*s*. 6*d*.]

Silo, 20ft. by 15ft., and $17\frac{1}{2}$ft. high. The wall at the bottom is 3ft. high and 1ft. thick, of brick laid in cement; on this wall is a plank laid in cement for a sill; the remainder of the wall is of studding and 2in. plank, with two thicknesses of tarred paper, and over the paper are boards. The floor is of brick, laid in and covered by cement. Cost, about $150. [Capacity, 105 tons; cost per ton, 6*s*.]

The wide divergencies in these statements of cost are very striking, but the difference as regards the substantial nature of some structures as compared with others, and the extent to which existing buildings have been turned to account in some cases, will go far to explain much of the difference, especially if we bear in mind the fact that American farmers are very handy men, and do much of their own building work. When everything has to be paid for, there seems no reason for supposing that silos would cost less in America than similar structures in England; indeed, the reverse might be expected to be the case, seeing that the cost of labour is much higher there than here, and the price of purchased materials is not often likely to be less.

French Silos.

In France, on the other hand, it may be expected that silos would cost less than in England, because labour is cheaper; and the statements made by M. Goffart and the Vicomte de Chezelles both bear out this impression. In excavation alone a large saving would be effected. The statement of cost of M. de Chezelles' silo, given in the Appendix, puts down 65 centimes per cubic metre (equal to 5*d.* per cubic yard) for excavating and carting earth; whereas, in Mr. Hale's estimate of his Durham silo, the cost of excavating alone is stated as 1*s.* per cubic yard; and in one of the American reports recently given (page 51) the sum stated for excavating and carting is equivalent to about 2*s.* 3*d.* per cubic yard; verily a most remarkable difference. In concrete work there is not such a wide divergence—Mr. Bailey stating it as 10 cents per cubic foot (or about 11*s.* per cubic yard) in America, while M. Goffart gives it at 12 francs the metre (or 7*s.* 6*d.*

per yard) in the account below. The brickwork, at 20f. per cubic metre, is equal to about 12*s.* 6*d.* per cubic yard. In England, in favourable localities, concrete may cost 7*s.* or 8*s.* per cubic yard, and in others it will cost double, if not more.

M. Goffart gives the following particulars respecting the construction of his last silos, which, he says, were much more costly than they would be in many places, owing to the nature of the soil:

My farm at Burtin presents exceptional difficulties to the formation of silos. It is traversed by a little river, the Néant, which has a weir across it for the service of my water-wheel, and thus a very high head of water is kept throughout the neighbourhood. Everywhere on the farm, water is found at the depth of about 3ft.; and, as I always make my silos at least 6ft. deep (because the underground part keeps much cooler in summer than that which is above the soil), I am obliged to make this lower portion water-tight, in order to avoid flooding; and this entails a pretty heavy outlay. The works are as follows:

The excavation made for the foundation of my silos is carried down about 7ft. below the ground level. In order to dig so far down without being stopped by water, it is necessary, in the first place, to cut a drain to carry off the waters to the depth of 7ft., and conduct them into the mill stream about 80 yards below the turbine.

The excavation being finished without obstruction, owing to this preliminary drainage, I lay down, over its whole extent, a bed of concrete, 6in. thick, composed of broken bricks and hydraulic cement. Upon this bed of concrete I build, up to the ground level, vertical walls, which form the boundaries of my silos, making them two bricks (or 18in.) thick. Arrived at this ground, I reduce the thickness of the walls to a brick and a half (about 14in.), and then carry them up to their full height of about 17ft. The walls finished, I give the inside and the bottom a coating of Portland cement, so as to make the whole perfectly water-tight. These works cost:

155·562 cubic metres of ordinary brickwork, at the rate of 20 francs the cubic metre	3111f.	24c.
30·47 cubic metres of concrete, at 12 francs the metre	365	64
Cost of excavation, coating with cement, and other expenses, about	700	0
Total	4176f.	88c.

My three connected silos thus will have cost me as nearly as may be 4176f. 88c. (about 167*l.*); and as their total capacity is 812·45 cubic metres, each cubic metre of capacity will have cost me 5f. 14c.

These explanations suffice to show that silos at Burtin cost more than in most cases. I had to build on perfectly flat ground, often full of water, the intrusion of which into the silo must be prevented at any cost. I had sad experience of this not long ago. The water found its way through a crevice into one of my silos filled with green rye; and all that part which the water reached, to the depth of about a foot, was spoilt. I have therefore spared no expense to attain the desired end, and I am certain of having attained it, by drainage especially.

A cubic metre being equal to about 35⅓ cubic feet, the total capacity of these silos will be about 28,690 cubic feet, and the cost barely 1½d. per cubic foot of capacity. It is stated by M. Goffart that his ensilage averages 812 kilogrammes (or about 16cwt.) per cubic metre, which would be about 50lb. per cubic foot, and consequently the silos above mentioned would contain about 650 tons of ensilage if they were full. Taking these silos, however, as already explained, at nine-tenths of their full capacity, their contents would weigh rather more than 570 tons, and the cost per ton would be about 6*s.*; but to this would have to be added the roofing, of which no mention is made, and the addition of which would seem to have been an after-thought, as M. Goffart says:

I have of late come to the conclusion that large silos should not be without a permanent roof. The absence of covering was not inconvenient for my small silos, which could be quickly covered up by means of a few hundred faggots, but it was no longer the same when my silos had each of them more than 500ft. of surface. I have therefore decided to cover each of my new silos by a slate roof, although it is somewhat costly. The most economical roof would doubtless be obtained by the use of bituminous paper, for which a light framework would suffice. Unfortunately it only answers when it is of excellent quality and put up by able workmen.

The cost of the Vicomte de Chezelles' large silo is proportionately much less without its covering—which, however, is not merely a roof, but is a kind of Dutch barn, in which are stored the grain crops of the farm. From the particulars given in the Appendix, it will be seen that the cost of the silo alone was about 160*l.*, and that of the barn superstructure 250*l.*, or 410*l.* in all. The capacity, estimated as before stated, would be about 1200 tons, or about 2*s.* 6*d.* per ton for silo alone, and nearly 7*s*. a ton if the Dutch barn be considered merely as the roof of the silo—which, however, would not be a fair representation of the facts, seeing that the barn is applied to other purposes.

English Silos.

Very little is known as yet as to the cost of silos in England, because so few have been built, and the expenditure on these has, in most cases, not been stated.

Mr. Hoare's double silo, with a capacity of 40 tons, and without any roof, is reported to have cost 50*l*., or 25*s*. per ton.

Mr. E. Gibson's five pits cost 150*l*.; and from their dimensions they should, if properly filled and weighted, contain about 200 tons; but the quantity of green rye put in them is said to have been 80 tons. Taking their full capacity, the cost per ton would be 15*s*.

Lord Walsingham's three silos, made in a clay-built barn, and having about 50 tons capacity, cost 30*l*., or 12*s*. per ton.

Mr. Ford's silo, of which estimates are given in the Appendix, has 17 tons capacity, and the cost varies from about 40*l*. to 44*l*., according as it is built of rubble slag, concrete, or brickwork. If the excavating and carting be done by the owner, the cost would be reduced to the extent of 6*l*. or 8*l*., as shown in Mr. Ford's letter: the estimates also include 16*l*. for concrete blocks, for weights, and the pulley for lifting them. Altogether the total cost per ton, without any of the reductions alluded to, is a shilling or two over or under 2*l*. 10*s*., according to the materials used.

Mr. W. A. Gibbs, the well-known inventor of the hot-air apparatus for drying wet hay and corn crops, has widely circulated in the agricultural and daily press a letter on estimates for silos, in which he says:—

From America it is reported that Mr. Mills has had two silos constructed of 40ft. long, 13ft. wide, and 20ft. deep. The walls are 2ft. in thickness, and made of concrete and stone, faced with cement. The cost of these is said to have been about $700 (140*l*.). These two pits held the produce of thirteen acres, which is stated as 600 tons.

In order to ascertain what silos of these dimensions would cost us in England, I obtained an estimate for two exactly similar in size and mode of construction, and found they would cost me 780*l.*; but the contractor explained that, if I had had gravel on my estate for the making of concrete, they could probably be made for 400*l.* On the other hand, he pointed out that, if in sinking 20ft. or any less depth it caused an influx of water, this would largely increase the cost, and he declined to be bound by any definite estimate of cost that would cover that contingency.

Mr. Gibbs appears, however, to be under a wrong impression as to the work done in America for 170*l.* being similar to that for which the English contractor asked more than five times as large an amount of money. He says: "The discrepancy between the American estimate and the one furnished by my contractor is too great to be reconciled, unless by a clerical error;" but he has overlooked the fact that Mr. Mills's two silos are not new buildings, made with walls of concrete and stone 2ft. thick, but are silos constructed inside a large barn, the concrete walls of which are utilized, and surmounted by a wooden structure. The particulars of these silos given in the "Journal of the American Agricultural Association" are as follows:—

He (Mr. Mills) has two silos or pits, each 40ft. long, 13ft. wide, and 20ft. deep, located in the centre of his barn, the walls of which are constructed of a concrete of stone and cement 2ft. thick, the sides and ends parallel, and the bottom well cemented. Upon the walls, flush with the inside of them, a structure of ordinary boards is built, 15ft. high, which serves as a feeder to the pit, and which, when both are filled, will compensate for the shrinkage of the mass by compression.

It does not appear that there was an excavation in the barn; but in the estimate furnished by Mr. Gibbs's contractor there would be excavation to the depth of 20ft., which, in the two silos, would require the removal of more than 20,000 cubic feet of soil. The capacity of the two silos, on the same basis as previously stated, would be about 260 tons each, and the cost of the alterations and additions equal to 7*s.* per ton. The 780*l.* estimate of Mr. Gibbs's contractor, for digging 20ft. into the ground (which is not to be recommended) and building the silos of stone and concrete, would amount to about 33*s*. per ton; and the 400*l*. estimate, in case of there being gravel for concrete, would be about 18*s*. per ton.

At a meeting of the Croydon Farmers' Club on the 1st of March Mr. Lascelles exhibited some portable concrete blocks, easily screwed to wooden framework, and thus formed into buildings, which may be put up very quickly and taken down again at will. The system promises to be well suited to the formation of silos under some circumstances; and if we should receive plans and estimates of cost in sufficient time, they will be inserted in our Appendix. We also give there some estimates by Mr. T. Potter of the cost of making silos in chalk soils.

Relative Capacity of Silos and Hay-Barns.

Many landowners build on their estates permanent hay-barns for the use of their tenants; and as, by the pitting of green crops instead of drying them, it may become desirable to construct one kind of permanent building instead of another, it may be as well, while considering the capacity and cost of silos, to take into consideration also the cost and capacity of hay-barns. No doubt it may be said that hay-barns can be dispensed with, as, indeed, is already done on many farms, where the hay is stacked and thatched, instead of being put under roofs; but, although this is so commonly done, it does not follow that it is the best course of procedure; and, unless hay-barns were believed to be economical in the end, it is hardly to be supposed that the owners would go to the expense of building them at all.

With the keeping of hay, as with the preservation of ensilage, there are two modes of proceeding. You may have sound permanent buildings that will last for generations, or you may have makeshift contrivances which avoid any large outlay at first, but entail a continued repetition of indirect expenditure afterwards. Silos of masonry, &c., may be dispensed with in like manner as it is possible to dispense with hay-barns; the fodder may simply be buried in the earth, as already shown, instead of being put in permanent buildings;

but persons who have had long experience with the rough methods have nevertheless found it worth their while to go to the expense of replacing them by masonry and concrete, as being, on the whole, more economical. Beginners can choose for themselves which course they prefer.

As ensilage is so much heavier than hay, owing to its being preserved with all its moisture, and thus being about three-fourths water, some persons seem to imagine that it must occupy a large amount of space as compared with hay. But the reverse of this is the case; for if a barn were turned into a silo, it would contain about double as many acres of grass as it would hold if the grass were made into hay.

Dry hay, as it is commonly called, contains, on the average, about 15 per cent. of moisture, so that in a ton of hay there would be about 17cwt. of really dry substance. The ensilage made from grass contains about 70 per cent. of moisture. In Mr. Grant's excellent sample of grass ensilage from Hampshire there was just that proportion; in some others there was more, and in some less. In a ton of such ensilage there would consequently be 6cwt. of dry substance, as against 17cwt. in hay; *i. e.*, the weight of feeding-matter in a ton of hay would be not quite three times as great as that in a ton of ensilage.

Hay would require, however, about six times as much barn-room as ensilage. We have already stated that one ton of ensilage would occupy 50 cubic feet, making allowance for space unoccupied by settlement. Hay, when first packed in barn, could hardly exceed 7lb. or 8lb. per cubic foot on the average, and therefore nearly about 300 cubic feet of space would be required for a ton. Hence, weight for weight, hay requires, as above stated, about six times as much space as ensilage; but ensilage has only about one-third as much dry substance as hay; consequently, in a silo of a given size double as much feeding-matter may be contained as could be put in a hay-barn of equal dimensions.

As to the cost of permanent hay-barns, there will be found in *The Field* of March 3, 1883, a plan and statement of cost of some hay-barns built upon the Earl of Shrewsbury's estates in Shropshire, Staffordshire, &c. Although sound and well-built, they are not extravagant structures, but are recommended on account of their economy. The cost is from 12*l.* to 14*l.* per bay, according as a large or a small number is built, and the capacity of the bay is about 14 or 15 tons, so that the cost would be about 18*s.* per ton; and, as a ton of hay contains about three times as much dry feeding-matter as a ton of ensilage, 18*s.* per ton for the hay-barn would be about equivalent to 6*s.* per ton for the silo.

Roofs over Silos.

A considerable difference in the outlay will be necessary if roofs are dispensed with. Such is not unfrequently done in France, where the silos are covered by means of faggots, trusses of straw, or any other convenient matters, being stacked over the pit, thus affording shelter as well as weight. In other cases a thicker layer of soil is made to answer the same purpose—a tarpaulin being first placed over the fodder, in some instances, if the earth is porous. Both these methods have been adopted by M. Goffart, and the latter is used by some American farmers. Still, there is no doubt that roofs are advantageous; and M. Goffart said on this point, when replying to a series of questions in the *Journal de l'Agriculture*:

Is there any advantage in putting a roof over open-air silos?

It is an expense which I have hitherto dispensed with, because, having filled my silos, I stacked over them a quantity of faggots intended for consumption on the farm. I thus obtained increased pressure (always very useful) as well as a temporary covering. Nevertheless, there are certain local conditions under which, in the absence of faggots or straw, it would be advantageous to establish a permanent roof, which would also shelter the men when filling and emptying the pit.

In another passage (quoted on p. 57) he refers to the use of waterproof paper on light framework as a cheap form of roof. For such a purpose the "Willesden Paper," made by the Waterproof Paper Company, Canal Works, Willesden Junction, seems well adapted. It is 4½ft. wide, made in long lengths, and varies in price according to thickness; the 4-ply or roofing paper costing about 2*d.* per square foot. A thinner paper would probably suit as a waterproof lining between boards, if silos are made of wood.

Weights and Planks.

Another considerable item of cost will be weights if they are purchased. In the estimate of Mr. Ford's Durham silo it will be seen that concrete blocks for weighting form about one-fourth of the whole outlay, and the tackle to facilitate the moving of them costs nearly half as much as the blocks; whereas the planks are a comparatively moderate item. In none of the American estimates do we find any mention of expenditure on this respect. Anything available is turned to account—blocks of stone, boulders, barrels of earth, sacks of grain, casks of cider, blocks of firewood—in short, anything of weight that may be on the farm. Barrels form a very favourite vehicle for the weight, all sorts of substances being packed therein and headed up. As they can be readily rolled along, and whipped up by means of slings or falls, with a horse to pull the rope that runs over the block, the process of loading the cover is quickly accomplished, and a large amount of weight can be put on by standing the barrels up on end and close together. On this subject of covering and weighting M. Goffart says:

When the ensilage is of great thickness, the cost of planks is not very important; but when the silos are shallow, the cost per square foot should not be lost sight of, for it may become a rather heavy item. In any case it would be a matter of importance to get rid of it, and I am going to try some experiments for this purpose. I shall dispense with planks upon one of my silos, and shall merely place upon the bed of straw some well-burnt bricks, so as to form a compact layer of sufficient height to give the weight of about one hundredweight per square foot. My silos have a surface of 500 square feet, and my bricks weigh about 5lb. each, therefore 10,000 bricks will be required for each of my silos. These bricks would cost some 8*l.* or more, but they would have the same value after as before the temporary use to which they are put. Bricks in any case will be better to handle than blocks of stone, the irregularities of which make the work painful and slow. Of course for such a purpose it will be requisite to have well-burnt bricks, so that there should be no fear of breaking.

If I had silos in England or Belgium, where cast-iron is cheap, I would not hesitate to get blocks cast of pig-iron, of such shape that they would lie sufficiently close together. To be of a convenient weight, they might be about 3in. thick, and for facility of handling should be cast with a handle, as is done in the large weights used with scales. In this way a very useful method of rapid shifting might be obtained.

I need not say that weights once raised up to the top of the silo ought not to be taken down outside: they should be placed on the surrounding walls; and this is what I intend to do with the bricks.

Those who have near them quarries of cut stone would probably have the advantage of buying rough-hewn stones, having an even surface, and a thickness of 10in. or 12in. I will suppose a mean density of 100lb. to 120lb. per square foot. In this case a single layer would suffice to produce sufficient pressure. Old paving stones might, in certain cases, be used advantageously, especially when they are nearly cubical in shape.

I intend to employ three different modes of covering my silos—(1). Broken stones with old sackcloth put between so as not to let the stone get mixed up with the fodder. (2). Bricks without boards. (3). Placing upon boards the sacks of phosphate intended for my manure heaps. But here, as in everything else, advantage should be taken of local resources whatever may be most economical, but without losing sight of the other conditions of good service, for nothing would be more dangerous than a mistaken economy with regard to the means of compression.

Many persons are naturally anxious to avoid the trouble and labour consequent on the use of heavy weights; but the difficulty is to find anything that will answer as well. Commissioner Loring's American report says, pithily: "Screws are used by some instead of weights. The objection to them is that they are not self-acting, like gravity." Consequently, if they are not continually watched, and screwed down from time to time, the pressure may be lost as the fodder settles down, and the air will get in and produce mischief. Various methods have been suggested, and we reprint in the Appendix some that have appeared in *The Field*—not because we have faith in them, but because readers may have an opportunity of seeing what has been done, or proposed to be done, in this way, and may know that nothing has yet been proved to be really a practical substitute for weights, while some experiments have shown that damage to the ensilage may easily result from using mechanical appliances, and not making sure that they continue to act.

CHAPTER V.—FILLING AND EMPTYING THE SILO.

As soon as the crop is cut, it should be put into the pit, and not be allowed to lie and wither in the sun. When the water evaporates from the plant, air enters and occupies the vacant cells; and air in the silo is much more to be feared than damp. Indeed, with the ordinary green crops grown in this country, there seems to be little fear of their containing too much moisture for ensilage. Even maize, which contains a larger proportion of water than our grasses and clovers, is not found too moist when pitted alone; and, in his earlier experiments, M. Goffart spoilt some of his ensilage by partially drying his maize.

Mixture of Dry Material with Green Fodder.

It has been said that, in order to absorb the moisture in the green fodder, it is necessary to mix with it some amount of dry chaff. This, however, is a mistake, and is contradicted by the experience of years in France and America, as well as by results obtained last season in England. The addition of dry chaff may even do more harm than good, especially if added in large proportions, as a very undesirable amount of fermentation may be produced. The effects of mixing dry chaff with green fodder are thus stated by M. Goffart:

When I first began with ensilage, I had, as the chief means of feeding my beasts, a very large quantity of straw chaff, and whole straw of wheat, rye, oats, &c. To induce the beasts to eat it, I mixed it as much as possible with maize and rye chopped up green; but I was not long in finding out that the greater the proportion of straw the less the time the mixture would keep. One fifth in volume, or one tenth part by weight, was the utmost that the maize could take without being quickly impaired. When I exceeded these limits, the time it would keep diminished continually, and ended by not lasting longer than forty-eight hours. I attribute this to the fact that the straw, which is very dry by itself, takes from the maize too large a proportion of its moisture.

A moist condition in ensilage, instead of being a cause of deterioration, is, on the contrary, in some measure indispensable to the good preservation of the materials put into the silo.

In its normal condition, maize contains 85 per cent. of water. When, by the addition of dry straw, the average amount of water in the mixture is reduced below 75 per cent., its good preservation is greatly compromised, and will very quickly become impossible if an attempt is made to go beyond that.

Besides the too great dryness which may result from the presence of the straw, another serious inconvenience is offered by this material—particularly rye straw. This straw, when chopped up, consists of a large number of small tubes with a hard envelope that long resists decomposition; these tubes contain a considerable quantity of air—the worst enemy of ensilage. Oat straw and others of soft texture are, from the latter point of view, much less dangerous than rye straw.

When I have, at the commencement of my autumn ensilages, used up the straw chaff from the threshed corn (which always are in the way owing to the great amount of space which they occupy), I afterwards put my fodders into the silo without any mixture whatever, and I find they turn out well. There are, however, some cases in which it is desirable to add straw chaff, particularly with maize—but without exceeding suitable limits.

As a case in point, where it would have been desirable to mix some straw chaff with the chopped maize, before putting it in the silo, M. Goffart mentions an instance where some maize had been allowed to stand until it had become too ripe and had got frost-bitten. Consequently, it parted with its moisture much more readily than usual, and when the silo was being filled, and before any weights were put on, the juice of the maize ran out in a way that had never happened before with him; for ordinarily there is no liquid whatever in his pits. In such a case as this it would certainly have been advantageous had a sufficient amount of dry chaff been mixed with the chopped maize to absorb the moisture; but it was quite an exceptional circumstance as regards maize, and can have little application to our ordinary British fodder crops.

Straw chaff very often is mixed by M. Goffart with his green fodder, before putting it in the pit; not, however, for the purpose of preserving that which is moist, but to render digestible that which is dry. With oat-straw, and other soft material, it suffices to mix the chaff with the ensilage after the latter is taken out of the pit, but it is otherwise with such harsh straws as wheat and rye, the latter especially. Both these he uses for feeding purposes; but he found them practically valueless if only mixed with the ensilage a few hours before being eaten, as they are so tough as to pass through the animal almost unaltered; whereas a few months in the silo, mingled with the green fodder, renders them digestible. Accordingly, this course is adopted by M. Goffart as a matter of economy, and with due care not to use too large a proportion of straw, for he is fully alive to the danger, as is evident from the following observations which he made in the *Journal de l'Agriculture*: "Last winter I tried four experiments in four different silos. One contained pure maize, and in the other three straw was added in different proportions; and the greater the proportion of straw mixed with the maize the worse was the preservation." He thereupon resolved not to mix the straw before pitting; but after a time he returned to his former practice, not because he approved of the mixing, but because he could not otherwise render the harsh straws digestible.

M. Lecouteux, editor of the *Journal d'Agriculture Pratique*, was formerly in favour of mixing chopped straw with his maize before putting it in the silo, but he afterwards changed his opinions, and in 1879, in reply to the question whether such a course is necessary, he said:

> It is certain that some persons have congratulated themselves on making such an addition. If I have removed it from my present course of practice, it is because, contrary to my former ideas, I find that maize needs no straw to absorb its excess of juice. It attains in the silo, when unmixed, all the qualities that are desirable for good provender. But I fear I shall not have enough maize for my ensilage of 1879, and therefore I shall mix together the maize and the late second crops (clover, lucerne, and rye grass, the leguminous plants predominating), which are almost always very difficult and very expensive to make into dry fodder. In this way I shall fill my silos and free myself from the never-ceasing rains of the present year.

INFLUENCE OF WET WEATHER.

From many quarters at home and abroad, there is evidence that fodder can be pitted in wet weather, and yet make excellent ensilage. Mr. A. Grant (whose experiments in Hampshire are detailed at length in the Appendix) said in letters to the *Field :*

I filled up the pit during continual heavy showers, carrying the grass as quickly as it was cut. The cost of cutting, carrying, and burying the grass was 7*s.* 1*d.* per acre. It would have cost me perhaps 1*l.* or more per acre to make the same grass into hay. . . . . I am now feeding my cattle upon it. If there is any difference between it and some which was cut and carried in fine weather, it is in favour of that carried during rain. It was purposely carried in wet weather, for the sake of the experiment. This is my second year's experience of ensilage, and I consider it a most valuable plan of preserving cattle food; but, like everything else, it demands care and thought. It involves a considerable outlay, but it ensures a great saving of money and time and anxiety in the hay season. It also gives an easy means of preserving late crops of artificial grasses, such as second-cut sainfoin, late lucerne, &c., at a time of the year when it is almost impossible to make hay.

Mr. Thos. Easdale, in the Yorkshire experiment which he details, says that some of the grass was wet with dew and other portions partially wet with rain.

M. Goffart thus answers a question on this subject:

Is there any inconvenience in putting maize into the silo when wet with rain?

None at all. Last October I filled my silo in the open air in frightful weather. On several occasions the rain fell in torrents; but the success of that ensilage was none the less complete.

M. Lecouteux (in an article given in the Appendix), in describing the ensilage of Trifolium incarnatum, mentions that he had put cartloads into the silo when dripping wet; and the Vicomte de Chezelles did the same with his mixed clovers, and in both cases the ensilage was excellent. American writers, also, have given information to much the same effect.

Chopping up Fodder.

Our ordinary British fodder crops do not, as a rule, require to be chopped up in the same way as maize. An exception may be made with respect to rye, which is so hard in the straw; but with our grasses and clovers the operation may be dispensed with; and, indeed, it will be difficult to improve upon the sample of Hampshire ensilage made from unchopped grass by Mr. A. Grant, who has given details of his operations (with an analysis of the ensilage) in an article which appears in the Appendix. Clovers will doubtless require greater pressure than meadow grass, especially if left till the stems have become hard; but this should not be done, it being best, as a rule, to cut fodder for ensilage while it is young and full of sap. Of course, if anyone has convenience for cutting up the fodder into chaff, this may be carried out, as in the case of the Vicomte de Chezelles, who last year passed through a powerful chaff-cutter the produce of 170 acres of clover, sainfoin, lucerne, tares, and artificial grasses, before putting the fodder in his silo. Two years previously (as shown by a letter in the Appendix) he siloed about 80 acres of mixed clovers, put into the pit in a whole condition, and much of it dripping with rain. Some of this was chopped before being given to the cows, fatting beasts, &c.; but the store stock had it given them unchopped.

When the food has to be cut up before being eaten, it is well to consider whether it may not be more profitable to do this at once, on a large scale, instead of doing it by driblets from day to day, when actually required. There are some kinds of food, such as roots, which it is unprofitable to give to animals in a whole condition. Some French authorities already quoted (page 18) say that roots keep better when sliced and siloed than when pitted whole. May it not be more profitable, then, to cut up a lot at once and put them in the silo instead of cutting up enough for the day's rations? This is a matter that may perhaps be worth experimenting on.

Maize, like mangold, is a fodder which is more profitably consumed when chopped up than when given whole; and this is what M. Goffart says on the economical side of the question as regards the effect on the animals:

The advantage of chopping up the maize is not only as regards the process of ensilage, but it can be done more economically by steam power than by leaving the beasts to masticate it; for this is not done free of cost, seeing that the labour of grinding up the food is done at the expense of a certain portion of what is eaten.

Formerly, when I gave the unchopped maize to my beasts, I have seen them occupied in incessant efforts to break up the great stems, and this labour so exhausted them that they did not improve, as they since have done, on this excellent food, now that it is given to them in a form more favourable to consumption.

People do not sufficiently take into consideration the influence which the physical condition of the food, when consumed, has upon the effects produced. Imagine two men, one obliged to feed upon unground wheat, and the other with the same quantity of wheat turned into flour; you may be sure that the two men will not derive the same amount of benefit from their food, although chemically they may be the same.

And this is what he says on the economical side of the question as regards direct expenditure:—

The cost of chopping up and pitting 1000 tons of maize costs, at the outside 1000f. (40*l.*) It is work done on a large scale, with the rapidity due to the employment of powerful machines—that is to say, with all the economy which belongs to the most advanced industrial processes. Instead of proceeding day by day to chop up maize for the daily food of your cattle, you prepare in one fortnight the food for 200 days; you have put your maize into such a condition that the man who looks after the cattle has nothing to do but to go to the silo, a few yards from the feeding sheds, and fill the baskets which have to be emptied into the manger.

Here are some figures which will more clearly show the economy of employing chopped and siloed maize as compared with other modes of feeding, so far as relates to the expense of labour. In a farm in the valley of the Loire, which is carried on under the ordinary conditions of that district, a number of beasts are fatted every winter on mangold, hay, and oilcake; a dozen beasts fed in this way give constant employment to one strong man, who every day washes and cuts up the roots, and chops up the hay or straw necessary for feeding the twelve animals. This man is paid at the rate of 2¼f. (1*s.* 10*d.*) per day, and he therefore receives for every animal under his care nearly 2*d.* a day.

At my farm at Burtin, with the maize prepared in advance and put into the silos, a few yards from the cattle-sheds, two men, who are also paid 2¼f. per day, look after eighty beasts at a daily expense of little more than a halfpenny a head. The difference in favour of Burtin is therefore for each beast a daily saving of about five farthings, and on my eighty beasts there is a daily saving of 10f. 68c. (about 8*s.* 6*d.*)

Take at this rate 200 days (and 1000 tons of maize will give at least the quantity necessary for that) and the total economy in labour in favour of the ensilage represents at Burtin for the last season more than 2000f. (80*l.*)—*i. e.*, more than double the sum expended in chopping up the maize and making it into ensilage.

Slow *v.* Quick Filling.

Various persons have recently advised, with respect to the filling of silos, that the process should be carried on as rapidly as possible, and that, if it cannot be completed in one day, the boards and weights should be put on at once and not taken off again till the filling is resumed. Such, indeed, was the advice formerly given by M. Goffart; but he has found cause for altering his course of procedure as appears by the following remarks:

Some years ago I advised the filling of silos as rapidly as possible. This mode of proceeding sometimes leads to inconveniences which have been pointed out by farmers in such terms as these: "When we have, in accordance with your directions, filled *as quickly as possible* a silo with chopped maize, and covered it with planks and heavy weights, the settlement produced during the first few days is so considerable, that the upper half of the silo soon becomes empty, and consequently useless. We therefore require two silos of 100 cubic yards capacity in order to obtain 100 cubic yards of ensilage; and the cost of making silos is thus doubled."

The undoubted inconvenience thus pointed out disappears almost entirely when one has several silos of some capacity, so as to extend the period of ensilage over a week or ten days.

I was wrong when I formerly said: "Fill your silos as quickly as possible." Now that more effective means can be made use of, and that some agriculturists put into the silo 100 or 120 tons a day, I say on the contrary, "Don't fill the same silo too rapidly; but so arrange as to fill several at a time in order to allow a settlement to take place."

In filling a silo by putting in every day a fresh layer of maize about half a yard in thickness, you will check fermentation sufficiently meanwhile, and at the end of a week or ten days of filling in this way the spontaneous settlement will be so great that the settlement afterwards will not exceed one-tenth of the total height.

Such was the result which I obtained at Burtin last autumn. My silos, which are about 16½ft. in height, had an empty space at top of about 20in., or only one tenth of their capacity.

This advice is supported by experiences from America, various instances being recorded of an extension of the filling process over longer periods than mentioned above. One of the most noticeable of these is given in the American *Cultivator*, by Mr. Gilbert Morton, who says that he took twenty-one days in filling his silo, containing 70 tons, and he adds that "This shows that if we can take care to keep the corners and sides well trodden, we can take our own time in filling." When, through delay in the filling, the surface of the fodder in the pit shows symptoms of dryness, some American writers advise that it be sprinkled with water by means of a garden watering-pot. It is not advisable, however, that this be done too copiously, as the water would run through to the bottom instead of remaining where it is wanted. A slight sprinkling, repeated several times at short intervals, would be much better than putting on the same quantity of water all at once.

Another thing should not be lost sight of in regard to slow filling, and that is the greater opportunity it affords for the escape of air from the pitted fodder. When the plant is cut and put into the silo it retains for a time its natural elasticity, and no reasonable amount of weight that can be put upon it will so compress the mass as to drive out the air. If boards and weights are put on at once, much air will be shut in that ought to be driven out, and until the oxygen in the air is all burnt up, fermentation will continue to go on, and great heating and consequent waste may be the result. If, however, small layers of fodder are put in day after day, the undermost portion becomes readily compressible before the process of filling is completed; and, under the weight of each newly-added batch of fodder, the air is forced up through the mass, which being still open and porous, offers little obstruction to its escape. Thus, not only is the silo better filled, but there is less heating, and M. Goffart never obtained ensilage with so little signs of fermentation as he has done since he adopted this gradual method of filling his pits.

There is one inconvenience, however, with regard to slow filling, and that is, that it would be very troublesome for the owner of a single silo to put in only a small quantity day by day, and thus tediously spin out the process. When there are several silos available (and M. Goffart has a dozen or more), the men can be shifted from one to another at will, and the work still go on vigorously; but it is different with operations on a small scale, and under such circumstances one can scarcely do better than follow the method adopted with Mr. Grant's and Lord Walsingham's silos, viz., filling and weighting the pit without delay, and at some convenient time afterwards, when the mass has well settled down, lift off the weights and boards, and fill up again to the brim.

With respect to his mode of filling his silos during his early experiments M. Goffart says:

> In 1852 I had four underground silos made with masonry, and cemented, each having a capacity of about three cubic yards; these silos I have filled again and again continually. Until 1872 my ensilage (which, moreover, was carried on upon a very limited scale) was regarded by me only as a means of prolonging for three weeks or a month the advantageous use of maize as food for my stock. With that view I have made hundreds of experiments. I have mixed chopped maize and straw in various proportions, to ascertain which would give the best results. I have made silos in the open air, covering the fodder sometimes with trusses of straw, sometimes with firm soil (never with sand, be it understood). I have filled my four cemented silos with all sorts of mixtures which would have put me on the road to definitive success if I had not been always frightened too soon by slight indications of damage which I fancied I observed on the surface, and which I unintentionally brought about by my too-frequent examinations.
>
> 1873 arrived, and this time I had a genuine success, due in some measure to chance; for it must be admitted that chance nearly always plays an important part in the most fortunate discoveries.

What the chance was which led M. Goffart to his present practice is thus told in another part of his book:

My first real success in ensilage was obtained in this way. I had filled a kind of room with chopped maize, to nearly its full height, leaving an empty space of only half a yard between the maize and the ceiling; then I spread a layer of straw over the maize. Failure would have been inevitable if I had folded my arms after these insufficient arrangements. But I did not abandon the work which I had thus roughly begun, and for several weeks I sent every morning a labourer (to whom I had given some old clothes) to trample down the mass for a couple of hours, going over it on all fours. The space between the maize and the ceiling was soon doubled and trebled; and when I cut the ensilage I had the satisfaction of finding a better preserved material than any I had obtained up to that time.

What have I done since then? I have simply replaced the man on all fours, trampling down the mass at daily intervals, by a continuous pressure effected by means of heavy weights. From the time that was done success has been complete; and yet I do not profess to believe that the last word has been said by myself, or that others may not seek for, and perhaps find, other improvements, and especially simplifications of the process.

The Use of Salt.

Salt has often been recommended as a preservative of ensilage, and some persons have used it in inordinate quantities. But if the process is properly carried out, and the fodder in a sound condition, salt is needless for preservation; and if these conditions are not complied with, the salt will not suffice to remedy the defect. M. Goffart's opinion is as follows:

Is it necessary to make use of salt in a silo? You can do without it. I often dispense with it myself, without the good keeping being interfered with; but I think the moderate use of salt is favourable to the health of the animals, and I sometimes mix some with my ensilage at the rate of 2½lb. to 3lb. to a ton, so that the animals may get 1oz. to 1¼oz. in their daily ration of food.

M. Lecouteux, writing in the *Journal d'Agriculture Pratique*, says: "I no longer employ salt, experience having demonstrated that it is not required in order to obtain good fermentation." And Dr. Thurber says that in America the use of salt is generally abandoned.

In Lord Walsingham's first experiment with ensilage, not only was salt mixed with the fodder at the rate of 20lb. to the ton, but a layer of salt one inch in thickness was spread over the surface before covering up the mass. When the silo was opened, instead of the ensilage being well preserved, it was rotten for a depth of four or five inches. This unsatisfactory result was thought to be due to the grass and clover having been pitted when wet with rain. But grass and clover have been put into the silo elsewhere when saturated with rain, and yet have been well preserved; and in this case the probability is that the result was due to the layer of salt. This would at once destroy all vitality in the herbage, and make it an impenetrable mass, through which the air within could find no exit, and it would thus be shut inside and produce decay. In the second experiment the quantity of salt mingled with the fodder was raised to 40lb. a ton. The ensilage was good, not because of the large quantity of salt—for quite as good preservation has been obtained without any salt whatever—but probably because a large admixture of salt, evenly scattered throughout the mass, is far less detrimental to success than a similar quantity placed in one layer upon the surface. It will be seen above that M. Goffart considers from 1oz. to 1¼oz. a sufficient amount of salt in a day's ration of ensilage, which varies from about 60lb. to 70lb. In similar quantities of Lord Walsingham's ensilage the cows would receive from 17oz. to 20oz. of salt.

The Covering Boards.

These are ordinarily boards of 1½in. or 2in. in thickness; if thicker they do not adapt themselves so well to any inequality in the packing. They should cross the narrow way of the silo, and be half an inch or an inch short, so as to sink freely down without any obstruction; the small amount of vacant space, with heavy weights, is not objectionable—indeed, it is an advantage rather than otherwise, as it permits the air to escape as the fodder settles down. For the same reason, it is not requisite that the boards should fit very closely together on the top. Some persons have had their boards tongued and accurately matched together, so as to form large sections; but this is objectionable for several reasons. They are not so readily handled; a larger portion of the surface has to be exposed in cutting out than is either necessary or desirable, so that there is greater risk of damage; whereas, if the boards are put in singly, you can take out one or more, according to your requirements; and, finally, although they may serve better to exclude air, they also are more effectual in keeping air in—a proceeding which is most strongly to be deprecated.

Closing the Doorway.

In silos that are wholly or partially above ground, there is usually a doorway; the closing of this is a matter that requires some degree of attention; and the nearer the door is to the bottom of the silo the more carefully should it be attended to. M. Goffart experienced some trouble in this way, and made various changes with a view to get over the difficulty. He found that thin wood warped under the action of the damp, and let the air penetrate. He replaced it by small beams or bars of wood about 4in. square, made to fit closely, and to slide down upright grooves placed one on each side of the doorway. These did not open and overhang one another like ordinary boards, but kept out the air much better, and the damage decreased accordingly. With his last silos, however, he adopted a still more certain method of excluding the air, viz., temporarily bricking up the doorway. He says:—

> I now close the entrance of my silos by means of temporary brickwork plastered inside with hydraulic mortar; and this wall is pulled down again at the time of opening the silo. This brickwork closes the opening much more effectually than the boards, whatever care may be taken to adjust them one upon another. Each of these openings may be closed up by a bricklayer in the course of an hour or two.

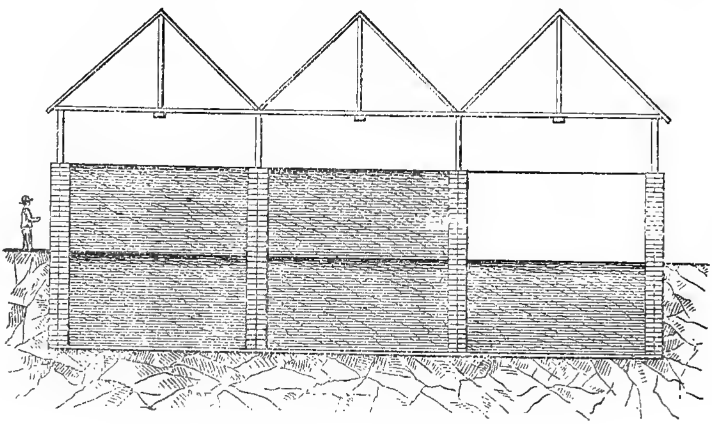
Of course, as previously stated, the doorway should be so placed as to cause the least possible exposure of the contents of the pit to the action of the air, and therefore it should be at the end or narrow way of the pit. The middle of the long wall would be the worst place, because, on cutting into the ensilage there, it would be exposed on both sides.

Opening the Pit.

On opening the silo, as little as possible of the ensilage should be uncovered, only a sufficient number of boards being removed to give room for the operation of cutting to be performed. It should be cut in vertical sections as is done in a hay stack, and as much taken out each day, to the full width of the pit, as is required for the day's consumption. The weights should not be removed from the boards in the uncut portion until absolutely required for the work to be done, as pressure is even more necessary after the opening than before. M. Goffart found the ensilage deteriorate very rapidly after opening when weight was deficient; and one of the American farmers, in reporting to the Board of Agriculture, says: "In opening our silos we took all the stones off; this was a mistake, as we lost about a ton apparently from the want of sufficient pressure to exclude the air." And the loss that went on unseen from fermentation in the pit was probably greater than the visible loss from mouldiness. Another American farmer adopted a much wiser course when, instead of taking the weights off altogether, he took the weights off the boards to be lifted and piled them on the others not yet wanting removal, and so increased the pressure during the opening; and he was of opinion that the ensilage taken out last was better than that taken out first. Whether such was or was not the case, his alteration in the mode of procedure was on the safe side.

Where the weights are removed, and the ensilage is dug out from the surface alone (as is done by some American farmers), the danger is much less than when the pressure is wholly taken off and the mass is cut vertically from the end. But it should only be done where the silo is small and deep, so that the whole surface can be quickly cleared off. In a broad and shallow silo it would be very impolitic to attempt this method.

In hot weather there is much greater liability to deterioration than in the winter months, and the heat affects silos above ground more than those which are below. For this reason M. Goffart, although he acknowledges the advantages of above-ground silos, recommends that silos be built half underground, and he adopts the practice of cutting from the top down to the ground level in cold weather, and leaving untouched for the hotter season the lower portion, as shown in the accompanying illustration. He also recommends that,



SECTIONAL VIEW OF M. GOFFART'S TRIPLE SILO.

in cutting out the ensilage of the lower section, it be begun at the end farthest from door, and carried back towards the entrance; and he considers that in this way the exigencies of the different temperatures will be best met, and excellent condition maintained in the ensilage.

One of the American farmers recommends, for the purpose of facilitating the cutting out the upper half of the contents of the pit, that a layer of boards be placed in the middle of the fodder while it is being packed. There can be little objection to this course; but apparently much the same advantage would be obtained, when the cutting is commenced, by taking the boards removed from the top and placing them underfoot; and the expense of a double set of boards would thus be avoided.

CHAPTER VI.—COVERING UP THE SILO.

Some persons have advised that in packing the fodder in the pit, it should be piled up in the centre at the finish; but the experience of M. Goffart is that such an arrangement is detrimental to good preservation, and he says on this point:

> The filling of the silo should be carried out in such a manner that the layer of fodder should always be horizontal. The trampling down alongside the walls (which ought to be as smooth as possible) is carried on whilst the silo is being filled. A person going constantly round as close as possible to the walls suffices for this operation. The topmost layer in the silo should be made perfectly flat, and not higher than the level of the wall. To ridge it up in the centre is a grave error; the mass cannot be sufficiently compressed, and dry rot sets in, which is not long in communicating itself to the mass below.
>
> I have insisted upon the necessity of strongly compressing the siloed stuff, and I return to it again because this point is decisive for the success of the operation. The greatest compression will always give the best preservation.

The filling having been completed, the covering up takes place. Some of the American farmers put nothing whatever between the boards and the fodder, thinking it unnecessary; and such a course is preferable to the use of anything close and compact, which is likely to mat together and become impenetrable, because, with a layer of this kind, air is shut in which ought to be expelled. M. Goffart says:

> The most important question—and one without which there can be no good preservation—is the covering up of the silos. A layer of dry straw, an inch or two in thickness, should be spread evenly over the green fodder; this straw should be covered with boards, and, finally, upon these boards should be placed heavy materials to the extent of about 100lb. per square foot of surface. Thinnish boards, such as battens, suit better than

thicker deals, because they give more to the inequalities of settlement, which are difficult to avoid. When silos are opened, it is rare not to see a depression towards the centre—that is to say, at the part of the surface which is farthest from the walls, and where consequently there is least resistance to settlement.

But better even than straw, in M. Goffart's opinion, are the "needles" or leaves of pine-trees, where such can be obtained. In the forests in the Sologne district they are in great abundance, and M. Goffart utilises them largely as bedding for his stock, by which means he is enabled to chop up his straw and mix it with the cattle food. As to the use of these pine-needles for covering up the fodder, he says:

The best covering consists of the newly-fallen needles from pine-trees: the great quantity of resin which they contain prevents their decomposing quickly, whilst soft straws, and especially damaged after-maths (which are commonly employed) are rapidly softened and decomposed by the vapour which escapes from the lower layer of maize and converts the stuff above into a mere dungheap.

This mass of dung becomes impermeable, and completely imprisons the vapour which, for want of an outlet, remains at the top of the layer of maize and sets up the mouldiness which soon renders it unfit for feeding beasts.

In short, make use of pine needles if you have them at your disposal; if not, don't cut up the straw that you are about to employ, but use it whole, and choose in preference the hardest you can get, such as will the longest resist the action of moisture. Here rye straw stands in the first rank; next comes wheat straw, and then oat straw; after-math grass should be utterly proscribed.

Never lose sight of the fundamental principles which assure success in ensilage—continued pressure to expel all the air contained in the silo. This air, at the time when you have rapidly carried out the process of ensilage, represents at least one half of the cubic space occupied by the pitted material. Leave this air in contact with the material, and it will end in the whole mass undergoing serious damage.

The vapour which escapes more or less freely from the pitted material, according to temperature of the latter—which is always disposed to rise a little at the upper part of the silo—is equally a cause of deterioration when the vapour is imprisoned. But, on the contrary, it is harmless when it finds an outlet among the stones and bricks which form the covering.

In many localities, where pine-needles are not obtainable, gorse, heather, or reeds may often be got, and would probably answer the same purpose.

CHAPTER VII.—WEIGHTING THE SILO.

THIS is a point on which M. Goffart insists as more essential than any other part of the process, and some of his American disciples far outdo their master, as they state that they put on four or five times as much weight as is recommended in the following extract, the *italics* of which are in the original:

It is indispensable to put on the cover or movable planks of the filled silo about 100*lb. per square foot of heavy matters, such as stones, &c.*

Here I come to the most important point—which I have had the most trouble in determining, and which I have only lately settled. When a silo has just been filled, it is not merely necessary to exclude the outer air, it is requisite in the first place to expel the mass of air which is shut up in it. This is the part which the heavy weights put upon the silos have to perform, and by means of which I attain the desired end.

A layer of clay, which hermetically seals up the pit, is exactly opposed to this object. It is necessary that the air inclosed in the silo should find means of escape between the planks above; it is necessary that great pressure should drive out the air as quickly as possible from the place where its presence would cause most serious mischief.

This great pressure ought to continue for several months, because the trampling down at the time of ensilage, however thoroughly carried out, is not in itself sufficient. At the time when the green fodder is chopped up, it is still living, and endowed with such elasticity that it reacts strongly against the momentary pressure which you have put upon it. It is not the same, however, after a few weeks or a few months; the fodder soon undergoes a softening which diminishes the elasticity, or, in other words, increases its compressibility to a considerable extent.

It is when these physical and chemical modifications are accomplished that the heavy weights, which I have indicated as an indispensable condition to success, produce their salutary effect. They follow the fodder as it collapses, and produce that state of very high density which is necessary to put it beyond reach of deterioration.

In a footnote to the above, M. Goffart says that "the pressure ought not to exceed the limit beyond which it would cause the juice to run out of the maize." In maize there is so much more moisture than ordinarily occurs in British fodder plants, that there is little fear of our ensilage being overdone with pressure. Even with maize, the squeezing out of the juice was quite an exceptional occurrence. M. Goffart says that his silos are not, as a rule, wet at the bottom, but merely moist, even when nothing is put with the maize to absorb the moisture. There was one very marked instance to the contrary, but it arose from quite an exceptional condition of the maize, the cause of which is thus explained :

When maize has been cut before the frosts, is chopped up in a sound condition and put fresh into the silo, it does not easily part with its moisture, even when submitted to very strong pressure. But it is not so when the fodder is too ripe, and has been exposed to rain and frost late in the autumn. Thus, having in October, 1876, for want of sufficient silos, found myself unable to pit the whole of my crop of maize, I was obliged to improvise a new silo in an old building, wherein to store the surplus, and this could only be done at the beginning of December.

The stalks, being touched by the frost, had become limp and broken down. They were difficult to chop up; but the worst of all was, that the chopped maize had only been put in to the depth of about 4ft. when, by reason of the pressure put upon this first layer, the juice suddenly began to run out under the door, and the flow continued for several days. There was thus a serious loss, which I should have avoided by mixing chopped straw with the overripe maize.

Except in this particular case, my maize has never parted with any portion of its moisture; and on taking out the ensilage, the bottom of my silos have been found nearly dry, scarcely moist.

Some American farmers, however, state that the juice of the maize has been squeezed out by 100lb. pressure, and that they therefore intend to use less weight in future; but in the absence of evidence on the point, one cannot say how much of this result may be due to the maize being, like M. Goffart's, in an exceptional condition. And in one case where the bottom of the pit was thought to be swimming with the juice of the fodder, the liquid was found to be due to a leakage of water, which ruined four or five tons of the ensilage.

In connection with this question of excessive weight, the fact ought not to be overlooked that the pressure ordinarily put on the top of the mass is but small in comparison with the pressure undergone by the fodder at the bottom, from which the juice would be most likely to be driven out, if driven out at all. In the instance just mentioned, of the frost-bitten maize, it will be seen that the juice was forced out by the mere weight of the fodder itself, before the pit was full, and consequently before any additional pressure was put on the surface. But in cases where the fodder is in a sound condition, any expression of juice is more likely to result from excessive depth in the pit than from excessive weight on the surface. In many of the American silos the depth is 20ft. or more, the deepest being 25ft. In such a case the pressure on the fodder at the bottom of the mass would be at the rate of half a ton or more to the square foot, without the addition of any weight upon the surface; and a difference of a couple of feet in the depth of the silo would have as much effect on the pressure at the bottom as a difference of 100lb. per square foot in the weight upon the top. This surface pressure is requisite for the purpose of keeping the top layer in sound condition, and thus preventing deterioration from being conducted from the surface downwards; and in shallow pits it is of more importance than in deep silos, where the great bulk of the ensilage is kept in good condition by its own specific gravity.

With regard to the amount of weight essential to the good preservation of the fodder, M. Goffart said, in the *Journal de l'Agriculture* :

> If you ask me what is the weight that I consider indispensable, I reply, put on the utmost possible. The more you compress, the more certain will be the success. A pressure of 200lb. per square foot will ensure perfect preservation. I long contented myself with less weight—60lb. to 80lb. at the most: it was not sufficient. You should never have less than 120lb.

In his book, subsequently published, he frequently mentions 100lb. as the necessary weight; but in the meantime he had altered the shape of his silos so as to remove obstruction to settlement; and a pressure which would be sufficient in a large silo very smoothly cemented and free from angles would not suffice in a smaller silo with greater obstructions. Moreover, a difference in the condition of the fodder when put in the pit may make a considerable difference as to the result obtained by the same pressure. M. Goffart chops his maize into pieces little more than a quarter of an inch in length, and therefore it packs very closely, and leaves in the mass a very small amount of air. The difference produced by a departure from this practice is shown in the following extract:

In 1876 a farmer from the valley of the Loire came to take the dimensions of my elliptical silo, and reproduced it exactly on his own farm. He filled it in autumn, and when he opened it in the course of the winter he took out only a badly-preserved material, which his beasts ate with repugnance. Quite disappointed, he brought me a sample of his maize, which, before putting in the silo, he had cut up in lengths of 2in. or more, or five or six times as large as he had been advised to do. I at once saw the cause of his want of success.

The reason for departing from the advice he received was that it took a long time for his machine to cut up the fodder so small, as he had no steam-power, and he thought he could save time by cutting greater lengths; so he saved his time and spoilt his ensilage, for he had not sufficient weight to compress the fodder under the altered conditions.

The effect produced by pitting the maize whole, with insufficient pressure, is shown by the following remarks of M. Goffart in the *Journal de l'Agriculture*:

One circumstance which most struck me last winter in the numerous visits I paid to the farms where maize is siloed whole is, the rapidity and intensity with which is developed, from the first days, the alcoholic fermentation which has so much attraction for the beasts. Everyone knows that the preservation of maize offers little or no difficulty during the first weeks.

Unfortunately, after alcoholic fermentation (which is shorter in duration according as it is more energetic), comes acetic fermentation, which is much to be regretted, and may bring on inflammatory action among the animals. It greatly diminishes the nutritive value of the siloed vegetables; I have experienced it a score of times in my own cattle-sheds.

The fermentations which fatally and too rapidly succeed to those just mentioned are the more or less putrid fermentations. The hungry beasts will still eat—with marked dislike, however—the maize which has reached this state of decomposition; but be sure that their constitution will not be long in showing visible signs of deterioration. The conclusion I have come to is, that the object to be attained in ensilage is the hindering of every kind of fermentation during and after pitting; in short, the best means of avoiding bad fermentations is to let none of any kind be produced. This result is obtained by a great division of the vegetables and an energetic pressure which expels the last atom of air from the silo.

One may comprehend why the chopped maize keeps so much better than the unchopped. The former weighs only about 20lb. or 22lb. the cubic foot; when chopped small, 45lb. or more is compressed into the same space, or more than double. What an enormous quantity of air must therefore be shut up between the stalks!

By means of heavy pressure, even damaged fodder may be made to produce "brown hay," which is eatable, though far inferior to good ensilage. M. Goffart says:

In September I pitted several loads of second-cut mixed clover. It was largely composed of white clover, birdsfoot trefoil, and hybrid clover, in which there was no want of sugary matters. Unfortunately this crop was too far gone; it was much past maturity, and, having been laid for some weeks, the bottom of the stems had turned yellow. I siloed this with the utmost care, added about 7lb. of salt, and gave most energetic pressure. At the end of December, when it was taken out of the silo, I found before me a blackish clammy mass, devoid of flavour, though looking much like very rotten manure. It was the "brown hay" described by Klappmeyer. The animals ate it without distaste to the last morsel. When exposed to the air, instead of setting up alcoholic fermentation, it soon acquired a slight flavour of butyric acid, but without the animals being less inclined to eat it. If, however, the butyric fermentation is allowed to go on, the animals refuse it altogether. I have proved this nearly a dozen times.

This "brown hay" is still made in Germany and Hungary, but is not an economical product as compared with well-made ensilage. Usually it is made from crops that have been partially dried. When butyric fermentation sets in, it has to be consumed quickly, or it will soon become uneatable, for the reasons above stated.

CHAPTER VIII.—EFFECT OF ENSILAGE ON FODDERS.

THE effect which ensilage will produce on the fodders put into the pit will mainly depend upon the manner in which the process is carried out. Undoubtedly there may be a very great deal of waste if the work is badly done; and it is not surprising that persons who have seen the bad results, and not the good, should utter words of warning or condemnation. If they are to be blamed, it is for drawing general conclusions from too limited an array of facts; for, however true their facts may be, and however bad the results which they have seen, these facts and results do not override other facts and results of an opposite character; they only serve to prove that, although a process may be good in itself, it may often be spoilt in its application. What is the end to be aimed at in the process, and what it is capable of producing, is thus set forth by M. Goffart:

> The end which I have pursued for so many years, and which I have ended by attaining, has always been the same—to preserve for the winter feeding of animals the green fodder on which they feed in summer, in the condition the least removed from that in which that fodder produces its best effects. Well, then, I have solved that problem as completely as possible, in the most absolute way.
>
> My maize, my green rye, my fodders of every kind, have scarcely changed colour after eight or ten months of ensilage. Given as an exclusive food to my animals, they produce exactly the same effects—the same abundance of milk and butter, the same flavour and colour of the latter.
>
> These are the results, determined during many winters, which have warranted me in coming to this conclusion: "The problem is no longer to be solved, it is solved."
>
> These qualities, so important in the grass or summer butters, preserved in the winter or ensilage butters, are in my eyes the veritable touchstone

when one has to determine the respective merits of the different processes of preserving forage. Let a farmer show me the butter which his ensilage gives during the winter, and I shall need no other evidence to decide on his ability in making ensilage. The workman is known by his work.

Fermentation in the Pit.

Fermentation can be no more carried on without consumption of the material fermented, than a fire can be made to burn without consumption of the fuel by which it is fed. In both cases combustion is going on, and the more abundant the supply of oxygen the more rapidly the burning proceeds. If you stop the draught, a fire will languish and die out; and a similar result is produced in the silo if you lessen the supply of air by the imposition of heavy weights. When fermentation runs through its full course of development, most pernicious results may ensue; and it is therefore necessary to "nip it in the bud." M. Goffart remarks on this subject:

In one of my articles, in the *Journal de l'Agriculture* of June 17, 1876, I said: "The end to be attained is, to prevent every kind of fermentation, both before and after the fodder is in the silo; for the way to avoid bad fermentations is to allow none of any sort to be produced."

It is through not having discovered this principle sooner, that so many investigators have, like myself, lost many years in fruitless experiments. We wished to preserve maize by fermentation; that is to say, we turned our backs on the solution of the problem. Fermentation is not a preservative; on the contrary, it is always a step towards more or less putrid decomposition—towards actual destruction.

I have experienced this hundreds of times. When my maize had contracted alcoholic fermentation in my silos (badly managed then, for at first I did not know how to manage them otherwise), I hastened to get the food consumed as quickly as possible, under pain of seeing it pass to acetic fermentation, then soon afterwards to lactic or to putrid fermentation.

These experiences, so often repeated, and always fruitlessly, ended by discouraging me. For a long time I resigned myself to expecting from my silos only a temporary preservation, for a few weeks at the utmost—that is to say, for the time which elapsed between the putting of the fodder into the silo and the appearance of the putrid fermentations.

Many persons seem to think that the course most requisite for the preservation of ensilage, is to make the top of the silo air-tight. But exclusion of air from without is of less immediate importance than expulsion of the air which is within; and if the top of the silo be hermetically sealed as soon as the fodder is pitted, more harm than good will be done, as air will be shut in that ought to be allowed to escape. When the crop is first put into the pit, more than half the space occupied is filled by air; and if the fodder is to be maintained in good condition, this must be driven out as well as kept out; for, unless such is done, a process of slow combustion will go on, which will attack first the most nutritious ingredients of the plant, and, unless checked, will end by destroying the mass so far as its feeding value is concerned. Heavy weights effect the double purpose of driving out air and keeping it out; whereas hermetically sealing the top of the pit, even if it can be done, only effects one purpose, and that the least important. In his early experiments M. Goffart closed the top of his silos with clay, and he thus relates the consequences:

Having successively filled my silos, and had the layers trodden down by persons dancing on them with very great energy, I placed on the surface a layer of straw chaff about four inches in thickness, and on that a layer of adhesive clay carefully beaten down, so as to prevent any communication between the ensilage and the outer air. During the next few days, I closed, every morning, any cracks that were to be found in the covering.

When, at the end of a few weeks, I proceeded to open a silo thus treated, I invariably found a space of an inch or two between the ensilage and the clay covering. No matter how forcibly the maize had been rammed down, there had been a further settlement, and the upper portion had undergone deterioration which would rapidly be communicated to the layers beneath. To prevent such a result, I had no other course but to get my ensilage consumed as quickly as possible.

Subsequently I abandoned the clay as a covering for my silos. Immediately after treading down my mixture of maize and chopped straw, I placed over all a cover made of oak, exactly shaped to fit the silo, and descending with the ensilage as this settled down. This simple change produced a decided improvement, though still insufficient—the mischief was only deferred for a while; but I was upon the right road.

Nowadays I still make use of the same silos, and I obtain complete preservation for an indefinite period of time. The chief point of difference is this: I place upon the cover of my silo, as soon as it is filled, about a hundredweight of stones, &c., for each square foot of surface.

By my former method, the preservation was only temporary and incomplete; by the new method it is unlimited and absolute.

That fermentation can be checked by heavy weights on the fodder is proved by experiment. It is a common thing for ensilage to have an alcoholic or an acid smell when first taken out of the pit. If the alcoholic flavour is very marked, there has been more fermentation, and consequently waste, than is desirable; if there is strong acidity, matters are worse still. That such results may be prevented by due care is shown by M. Goffart's experience:

In April 1877 I opened my last elliptical silo, which contained nearly 100 tons of maize pitted in October 1876—*i.e.* more than seven months before. The whole presented itself as a most compact mass of a brownish green tint; the temperature did not exceed 10° C. (50° Fahr.), and there was no appreciable odour; on being put to the mouth, the maize at that instant was quite tasteless, and the absence of smell and taste produced at first an almost unpleasant sensation.

I took out from the mass a few hundredweights for the next day's rations of my beasts; and scarcely was the maize exposed to contact with the air when it underwent a veritable metamorphosis; the brownish colour became sensibly greener, and a commencement of alcholic fermentation was soon produced, without exceeding the limits which that fermentation ought never to go beyond.

This silo was not completely exhausted till the 10th of August, and the maize remained in good condition to the last day. My 40-days maize had at that date arrived at the stage when it is fit to be cut for fodder; it had attained its full height, and from the month of August my beasts eat it in a green state.

The interregnum of maize, as food for my stock, was only ten days in 1877, and my rye ensilage, scarcely cut, will be consumed in the winter.

My beasts, fed on maize ensilage throughout the winter, drink scarcely anything when let loose in the middle of the day to go and drink at the river which runs through my farm; they nearly all return to their houses without having approached the water.

It must not be inferred, however, that M. Goffart objects to fermentation under all circumstances. His object is to prevent it in the silo, but to permit it in the ensilage taken out of the pit; for he can control it in the latter case, but in the former it cannot be regulated. Within certain limits the fermentation of the fodder is beneficial; beyond those limits it is wasteful, and may become positively injurious. As a few hours will suffice to develope the good qualities of fermentation, there is no need to run the risks arising from its lengthened occurrence in the pit; but M. Goffart considers that these risks would be preferable to no fermentation at all, for he says:

If it were necessary to dispense with fermentation in order to avoid the loss of materials which is undergone in silos, I should prefer to undergo that loss, because I attach the highest value to fermentation, the good effects of which are indisputable; but, fortunately, the two points can be easily reconciled.

The benefits of fermentation are these: Thanks to fermentation, the siloed materials undergo a commencement of decomposition which facilitates the digestion and increases the nutritive or assimilative power. My beasts, especially the milch cows, when they live exclusively on fresh maize during the summer, consume it in very large quantities, and always have the belly greatly developed—which proves that their food has not all the richness desirable, and that they are obliged to make up for the deficiency of quality by excessive consumption. When my beasts eat siloed and fermented maize, the belly decreases, and their ration (which they themselves limit) diminishes in weight, and their general state becomes more satisfactory. Let us, then, not attempt to suppress fermentation, but only to regulate it.

How he regulates the fermentation is to open the mass of ensilage taken from the pit, mix it with the chaff or other food to be given with it, and let it lie until it has heated sufficiently. In warm weather twelve hours may suffice, and in cold weather twice as long may be necessary. In one exceptional instance, where the fodder had been frost-bitten before being put into the silo, fermentatiou did not set in for two days or more. With respect to the effect of leaving it to the second day under ordinary circumstances M. Goffart makes these remarks:

I have said elsewhere that the fodder taken out of the mass ought, before being given to the animals, to be exposed to the action of the air for fifteen or twenty hours, in order to set up alcoholic fermentation. After that time (which may, however, be lengthened or shortened somewhat, according as the external temperature is high or low) the fermentation becomes excessive, and therefore harmful; the spontaneous heating produced in the stuff when it ceases to be compact ought never, if possible, to be allowed to exceed 90° to 100° Fahr.

Two years ago I had no silos on my farm at Gouillon, and on alternate days I had the ensilage taken from my silos at Burtin to feed the cattle on the other farm. On the second day the heat of the ensilage thus carried greatly exceeded the limits that I have just laid down, and the alcoholic vapours came off so abundantly as to show the serious loss which was going on. Acetic acid, too, was not long in also showing itself. In the North of France the beetroot pulp given to cattle in winter is sometimes very acid; and it is to this circumstance that I attribute the poor quality of milk and butter obtained from animals fed upon this food.

Losses by Fermentation in the Pit.

Two celebrated scientific authorities on agriculture expressed, last autumn, opinions that were pretty strongly adverse to the ensilage process; and for so doing they have been rather sharply attacked by enthusiasts in its favour. Those scientific opinions may have been founded, in some measure, on defective samples of ensilage, but it would be wrong to assume that there was no ground for the notes of warning that have been uttered. Instances of serious loss, such as have been set forth by Sir J. B. Lawes and Dr. Voelcker, undoubtedly do occur, though their occurrence may not be a necessary consequence of the process. The endeavour should be to avoid such loss by following the best line of procedure, and not court disaster by setting to work in full faith that precautions are needless, and that everything must come right. Here is a portion of a letter by Sir J. B. Lawes, which appeared in the *Times* of Oct. 26, 1882:

About a year and a half ago I received a bulky volume on the subject of ensilage from the United States. The writer, who was most enthusiastic with regard to the system—which he said would create a revolution in the agriculture of the country—furnished some important statistics respecting the loss which took place in the silo. Indian corn was the substance used, which, according to the author, when put into the silo contained 5 per cent. of ash, as calculated on the dry state; while the ensilage when taken out contained 9 per cent. of ash, calculated also on the dry state. If this destruction of the vegetable matter, which amounts to about 40 per cent., extended equally over the whole crop, it would be serious enough; but unfortunately it is the substances which possess the highest feeding value that are the most easily destroyed. The heat generated, and the smell of alcohol and acetic acid, to which the author also alludes, can have had no other source than the sugar which is found so abundantly in Indian corn at the time of blooming.

Last year I wrote some articles on the subject of ensilage, which were published in the United States, and I then pointed out how serious was the loss of the nutritious portion of the plant which appeared to take place in the silo. I concluded by remarking that, although under the conditions of agriculture that prevailed in the States, ensilage might be profitably used, still I hardly thought that the British farmers, who had to produce the food for their stock at a great cost, could afford to adopt a system which apparently destroyed so large a proportion of the nutritious matter.

It is quite possible that the loss mentioned as occurring in the United States may have been exaggerated; but, at all events, before the process is generally adopted in this country it would be desirable that experiments should be carefully carried out, which would not only test the fact of ensilage being a palatable food for stock, but also settle the important point of its cost as compared with the ordinary process of haymaking; and, further, what was the respective loss of food in each process.

It is beyond question that there is a loss of some of the most nutritious parts of the plant when alcohol and acetic acid are formed by fermentation; and it is beyond question, also, that in some samples of ensilage these products occur in great abundance. But it does not follow, because such facts are stated, that the loss is a visible one, or that the writer means it to be understood that what is left in the pit cannot be eaten. The food may be readily consumed by the cattle, and may be nutritious also; but it will not contain all the nutriment that might have been there had the process been more skilfully carried out; and so far as this loss is allowed to go on, so far will it impair the economy of the process. Such a loss, however, as Sir John Lawes quotes (40 per cent.) is so enormous that the idea of some error naturally suggests itself; and, as the estimate is founded solely on the increased quantity of ash, the probability of error is not very remote, seeing that the accidental admixture of a small quantity of earth with the sample of fodder taken from the pit would materially alter the proportion in the analysis.

Persons not accustomed to consider the effects of fermentation often fail to appreciate the losses that may arise therefrom. What is not apparent to the eye is too often passed over as though it were non-existent; but everyone who is in the habit of burning gas in his house would be aware that a quantity of gas, for which he has to pay, might easily escape without his being any the wiser, so far as his sight is concerned; and so it is with the most nutritious portions of the hay. It may be said, however, that if yon cannot see the escape of gas, you can readily smell it, and stop the leak. True; and in like manner you can smell the alcohol and acetic acid, and thus can trace the source of mischief; but in neither case can you restore the loss. All that you can do is to endeavour to prevent loss for the future—which, in the case of ensilage, will be by adopting a better course of proceeding the next time you fill the silo.

There is one point, however, in connection with ensilage which has not yet been duly considered by our great agricultural authorities, but which, nevertheless, deserves the fullest investigation; and that is, admitting that in all cases there must be some amount of loss in substance (and French chemists of eminence have proved that it is very small in the case of the ensilage made under the skilled management of M. Goffart), yet that loss, if not excessive, may be compensated by the greater degree of digestibility produced in the mass by the ensilage process.

Some articles on "The Chemistry of the Silo" have recently appeared in the *Field*, and some portions of them have been reprinted in our Appendix. In one of these articles, the writer, Mr. F. Woodland Toms, F.C.S., touches on this part of the subject in the following passages:—

The tendency of fermentation to break down and render soluble the fibre of the pitted food is a most valuable feature in ensilage. Comparative analyses by Grandeau and by Lechartier; the results obtained by Dr. Cameron, with the Irish rye-grass experiments; Mr. Sutton's analysis of Lord Walsingham's ensilage—all show this property of prolonged fermentation. The object of digestion is to convert food into a condition that is solnble in the juices of the body; and that portion of the substance which cannot be so dissolved is not only useless but objectionable, as having a tendency to exhaust the animal by labour in vain. It further hinders the digestion of substances that are very nutritious in themselves, by encasing them round, as is seen with seeds which frequently pass unaltered through the animal, whereas, if crushed or husked, they would be very valuable food. The experiments of M. Grandeau and Mr. Sutton indicate that there is more solnble matter in ensilage than there is in the dried or green fodder—reckoning, of course, pound for pound of the dry matter in each. Whether it is always so, when we compare grass or hay with the weight of ensilage that would have been produced if these had been put in the pit, is the great unsettled question, around which turns the whole economical value of the process.

The view, then, that I take of the ensilage process is this—That those who feel inclined to shirk in any way the imposition of the weights necessary to compression will be ill-advised in trying the process at all; for, economically, I do not think their endeavours will prove profitable in the long run. They may see distinctly enough the mouldiness or putrescence that is upon the surface, and may estimate its amount as compared with the mass of apparently sound food that is in the pit; but it will be well for them to bear in mind that they only observe a portion of the mischief, and that this may represent but a minor part of the actual waste, if regard be paid to the loss which has been going on in unseen parts of the silo, in consequence of a defective mode of carrying out the process. If, however, the fermentation be skilfully controlled, I see no reason why the improvement in quality, brought about in the mechanical condition of the food, may not more than compensate for the loss in quantity, considering the very large margin of undigested matter which coarse fodders contain.

Ensilage, has, moreover, the advantage of saving labour, and of being independent of the weather; and these two are in themselves sufficient to counterbalance a considerable amount of the loss that takes place in the silo.

The suggestion in the last paragraph of Sir John Lawes's letter—that experiments should be carefully carried out to ascertain the cost of the process of ensilage as compared with that of haymaking, and the respective loss of food in each process—is undoubtedly a good one. We should bear in mind, however, that we have not merely to compare ensilage with well-made hay, but that well-made hay becomes almost an impossibility with ordinary appliances at times when the ensilage is excellent. Such was the case with grass pitted during pouring rain in the Hampshire experiment of Mr. A. Grant, who says: "The cost of cutting, carrying, and burying the grass was 7*s*. 1*d*. per acre. It would have cost me, perhaps, 1*l*. or more to make the same grass into hay."

CHAPTER IX.—FEEDING QUALITIES OF ENSILAGE.

Some excellent results are recorded as to the feeding qualities of ensilage; nevertheless the evidence is not all on the same side. For example, Sir J. B. Lawes gives, in an article in the *Agricultural Gazette*, the following particulars relative to an experiment carried out in the United States, which goes to show that there was less nutritive matter in 100lb. of ensilage than in 40lb. of turnips, although the solid substance in the former was four or five times as much as was contained in the latter. He says:

In the experiments upon the feeding properties of ensilage carried out at the New Jersey Experimental Station, four cows were selected from a herd for experiment. For a period of twenty-eight days all received exactly the same amount of food, consisting of clover hay, wheat straw, brewers' grains, cotton-seed meal, and turnips. During this time No. 1 gave an average of 23½lb. of milk daily; No. 2 gave 25·1lb.; No. 3, 25·6lb.; No. 4, 24·1lb.

In a second period of twenty-eight days the cows Nos. 1 and 2 were fed with exactly the same food as before; while Nos. 3 and 4 received the same, with the exception that 100lb. of ensilage was substituted for 40lb. of turnips.

Under the same diet as before, Nos. 1 and 2 increased their daily product of milk 1½lb. and 1lb. respectively, but those which received the ensilage showed a trifling decline.

It will be observed that the only change in the diet of the cows Nos. 3 and 4 in the second period was the substitution of 100lb. of ensilage for 40lb. of turnips. The description of turnips used is not stated, but the dry matter in the 40lb. would not amount to more than from 3lb. to 5lb., while 100lb. of ensilage would contain 18lb. of dry matter; and this large increase in food, we find, was followed by a slight decline in milk; and yet ensilage is said to be above all things suitable to the production of milk!

It is difficult to account for such a result; and there is nothing here to explain it, as no analysis is forthcoming to show whether the ensilage was a good or a bad sample. Certainly this evidence is at variance with that of some owners of silos who have reported to the U.S. Department of Agriculture. Here are some examples:

Messrs. Bartow and Sons, Pittsfield, Massachusetts: "We have resorted to root crops for the last five years; we like them very much, but ensilage is better. It does not cost near so much in labour and fertilizers, and gives better results. We never had so good a flow of milk in the winter."

Mr. G. H. Ames, Dracut, Massachusetts: "Ensilage takes the place of roots, and is raised much easier and cheaper. It is about two-fifths the value of good English hay."

Mr. G. H. Hammond, New London, Connecticut: "Cost of feeding on ensilage, as against hay, roots, and meal, 1 to 3. Milk much richer, and an increase of 30 per cent. in quantity."

Mr. G. A. Pierce, Stanstead, Canada: "The condition of the stock fed on ensilage is very good. They commenced to gain as soon as they were fed on ensilage; formerly they had hay, roots, and some grain. It is a great advantage over the system of feeding hay and roots in winter."

Professor J. M. McBryde, Knoxville, Tennessee: "All our milch cows receiving ensilage showed a notable improvement in milk. Butter made from milk of cows, fed on ensilage, of excellent flavour. Three yearling steers fed exclusively on long forage; one weighing 428lb. received a daily ration of 20lb. hay, gained 22lb. in 28 days; another, weighing 457lb., received 10lb. hay and 20lb. ensilage, gained 28lb.; a third, weighing 442lb., received 40lb. ensilage and gained 38lb. Two pounds ensilage gave better results than 1lb. hay. It is plain that animals should be fed on mixed rations of ensilage and matter rich in albumenoids."

As the New Jersey experiments quoted by Sir John Lawes show that 2½lb. of ensilage gave worse results than 1lb. of turnips, and those of Professor McBryde show that 2lb. of ensilage gave better results than 1lb. of hay, must we conclude that there is more feeding value in 1lb. of turnips than in 1¼lb. of hay? or may we suppose it possible that the ensilage used in the New Jersey experiment was not of first-rate quality?

It is hardly to be supposed that Mr. McBryde (who is professor of agriculture at the University of Tennessee) has fallen into the error of judging from a sample of bad hay, because he carried out a long series of experiments with more than twenty animals, and expressly states that the hay and meal were of the best quality. He tested the value of hay alone with ensilage alone; hay with different meals, and ensilage with different meals; and also various mixtures of ensilage with dry forage and food rich in albumenoids; and he gave the tabulated results in an article published in the *American Agriculturist,* and copied into Dr. Thurber's book on "Silos and Ensilage." The following are among results that will be of most interest to British farmers, because, not only is maize ensilage put in comparison with hay, but we have a comparison between maize ensilage and clover ensilage:

Daily Rations per 1000lb. live weight.	The animal gained per cent.
20lb. hay (taken as a standard)	1·8 lb.
10lb. " 20lb. oat straw, 6¼lb. Indian corn meal ...	3·9 lb.
10lb. " 20lb. ensilage (maize), 6¼lb. Indian corn meal	7·2 lb.
20lb. oat straw, 20lb. ensilage, 6¼lb Indian corn meal	8·6 lb.
20lb. hay 6¼lb. Indian corn meal	5·7 lb.
20lb. " 6¼lb. cotton seed meal	5·6 lb.
20lb. " 6¼lb. rice corn meal	7·5 lb.
40lb. ensilage (maize), 6¼lb. Indian corn meal	10·2 lb.
40lb. " " 6¼lb. cotton seed meal	10·1 lb.
40lb. " " 6¼lb. rice corn meal	2·8 lb.
5lb. hay, 6¼lb corn meal, 40lb. maize ensilage	6·25 lb.
5lb. " 6¼lb. " 40lb. clover ensilage	9·03 lb.

In the Appendix is given a very interesting statement of results obtained in an experiment carried out by Professor Henry of the Agricultural Department of the Wisconsin State University. Equal lots of maize were taken from the same field, one half being dried and stacked and the other half put into the silo. At the end of two months a feeding experiment was commenced and carried out for six weeks with four cows, all receiving daily 1lb. of Indian corn meal, 1½lb. of oil meal, and 1lb. bran, with as much dried maize or ensilage as they liked to eat; but the two cows which had ensilage for the first three weeks had dried fodder for the next three weeks, and *vice versâ*. The quantities of milk and butter resulting from the different foods were as follows:

	Milk.			Butter.	
	lb.	oz.		lb.	oz.
Ensilage (*plus* meal) produced	1456	8	......	59	8½
Dried fodder (*plus* meal) produced ...	1322	15	......	53	3½
Increased produce from ensilage	133	9		6	5

There was thus an increase from the ensilage of about 10 per cent. in the milk and 12 per cent. in the butter; and not the least curious feature of the experiment was this—that, although with both classes of fodder the cows were allowed as much as they could eat up clean, the proportion of ensilage eaten was 29 per cent. less than the dried fodder consumed. This is a direct confirmation of M. Goffart's statement (quoted on page 9), that where the fodder is deficient in quality the animals make up for it by excessive quantity, and that when put upon ensilage, which has more nutritive power, they diminish the consumption of their own accord.

In the returns made to the U.S. Department of Agriculture from about a hundred farms on which silos have been constructed, there is a remarkable agreement of opinion as to the advantages of ensilage, although, as might be expected, some attach a higher value to it than others. It is not necessary, however, to go over these returns *seriatim*, especially as they relate almost wholly to maize ensilage. Suffice it to quote from Commissioner Loring's report the following passage, in which the opinions of the whole are summarised:

Ensilage has been fed to milch cows more generally than any other class of stock, and no unfavourable results are recorded. There can be no doubt its greatest value will always be found in this connection. There is a marked increase in quantity and improvement in quality of milk and butter after changing from dry feed to ensilage, corresponding with the effect of a similar change to fresh pasture. A few seeming exceptions are noted, which will probably find explanation in defects easily remedied rather than such as are inherent.

Ensilage has been fed to all classes of farm stock, including swine and poultry, with results almost uniformly favourable. Exceptions are noted in the statements of Messrs. Coe Bros. and the Hon. C. B. Henderson, where it appears that horses were injuriously affected. It should be borne in mind, in this connection, that ensilage is simply forage preserved in a silo, and may vary as much in quality as hay. The ensilage that is best for a milch cow may be injurious to a horse, and that on which a horse would thrive might render a poor return in the milk pail.

In France comparatively little has been done in the way of accurate experiments to determine the relative value of ensilage and other feeding stuffs. An interesting letter from M. Cottu is quoted in the Appendix; but M. Goffart, with all the work he has done and the practical results he shows in various ways, does not appear to have carried out any comparative feeding experiments analogous to those reported from America. He frequently speaks of the profitable use of ensilage; but statements as to the cost of growing maize in France, and the growth of animals fed on it, will not afford information of practical service to English readers. Here is one of his remarks on the subject:

It is for experience alone to determine the question of the feeding value of maize. What I can affirm is, that with me, at Burtin, with the mode of preparation which I carry out, maize, with the addition of one-tenth its weight of oat straw, keeps my animals in perfect condition. I am aware that things are not the same everywhere.

Maize ensilage is undoubtedly an excellent auxiliary in the fattening of beasts; it has the merit of exciting their appetite in the highest degree, and causing them to eat in large quantities the palm-nut cake, which would certainly be more or less distasteful to them if it were not mixed with the maize which has so much attraction for them.

According to my experience fattening would be a very favourable means of utilising maize ensilage. The least favourable method would be to consume it by young growing beasts. As concerns fattening, these conclusions appear to me to be beyond doubt. It is thus that the maize will be employed most profitably, because the attraction which it has for beasts will lead them to consume at the same time certain very rich matters, such as earth-nut and other cake, the taste of which is very repugnant to the animals when given to them unmixed.

In England, with our small amount of experience, it is not to be expected that there would be very much information of carefully-conducted experiments with respect to comparative feeding values; but of general statements, favourable in character, a good number of instances have been published in the *Field* and elsewhere, some of which are reprinted in the Appendix. Thus Mr. A. Grant has made the following remarks with respect to ensilage:

I thoroughly believe in it. It increased the yield of my cows last year, and of course is very cheap food, and saves the cost of making the hay, the cost of saving the crop being merely the cutting and carting. It also has this effect, that the cattle in winter eat a soft damp food instead of a hard and dry one, and this must be an advantage to their digestive organs. . . . . The quality of butter is very good. I tried three cows feeding on crushed oats, linseed cake, and very good hay, and when placed on ensilage, with a little crushed oats, they gave 25 per cent. more butter.

Mr. C. R. Kenyon, in his "Experiences of a Tyro in Wales," says:

Although no trial was made of the feeding value of ensilage in comparison with hay or other fodder, we were satisfied that it was a wholesome and useful kind of food for cattle of any age. A lot of yearling calves were particularly fond of it, and seemed to thrive well on the preserved grass. Milk cows were found to require a little cotton cake, bean meal, or other concentrated food in addition, to keep up the quality of the milk and make rich cream. On the other hand, the butter had more of the colour, if not flavour, of that from grass-fed cows, than was the case before using ensilage.

And Mr. Easdale's letters contain the following statements:

A test as to the production of milk and butter cannot at the present time be easily ascertained, owing to the fact that all the cows calve early in the ensuing spring, and therefore would naturally now be drying off. Exact accounts are, however, being kept, with the result that, even under the circumstances just stated, both milk and butter have increased in quantity during the short time the cows have been fed with ensilage; while the quantity of milk, butter, and cream continues all that can be desired. The quality of ensilage given to each cow per day is about 45lb. weight, plus the ordinary rations of the usual feeding meals or cake. . . . . The butter and cream continue of the very best quality, while the improvement in the general appearance of the cows is most decided.

But by far the most important evidence is that furnished by Mr. Henry Woods, in his lecture before the Wayland Agricultural Society, Norfolk, a portion of which is quoted in the

Appendix. The experiment was carried out on Lord Walsingham's home farm, where five cows were fed on a fixed quantity of crushed oats and bran, with as much as they could eat of coarse fodder, which consisted first of chaff (composed of two-thirds barley straw and one-third hay) and afterwards of gradually diminishing quantities of the same kind of chaff mixed with gradually increasing quantities of grass ensilage. From the table given by Mr. Woods it will be seen that the amount of milk and cream obtained on the last day of each course of feeding was as follows:

		Milk. Quarts.		Cream. Degrees.
All chaff (of hay and barley straw) yielded per day...		68	...	12
One-third ensilage and two-thirds chaff	„	70	...	13
One-half ensilage and one-half chaff	„	71	...	15
Two-thirds ensilage and one-third chaff	„	77	...	16
Three-fourths ensilage and one-fourth chaff	„	82	...	16

This ensilage was made from grass of exceptionally coarse and poor quality, yet as soon as it was given to the cows the flow of milk increased, and there was a continued gradual increase with the augmented proportions of ensilage allowed, till at the end of one month's experiment the result differed from that obtained at the beginning by 14 quarts of milk per day, or an increase of more than 20 per cent. And on two of the cows being deprived of the ensilage for a couple of days, they each gave three quarts of milk less per day. It is even more noteworthy that the quality of the milk was also greatly improved, as shown by the increased amount of cream.

No comparative experiments in cattle-feeding, except for dairy stock, have been carried out in England; but M. Goffart, Baron Corvisart, and others in France, have been enabled to double or treble their number of beasts by means of ensilage; and similar reports come from America. Hence we find records of an abundant supply of farmyard manure, and a considerable increase in the produce of crops.

CHAPTER X.—SUMMARY OF PRACTICE.

[This chapter is only intended to set forth briefly the course suggested to be followed, without entering into the why and the wherefore. References are made, from time to time, to previous pages in which reasons and authorities are given.]

THE silo should be secured from any invasion of water, whether from above or below. (P. 56.) You need take no trouble in trying to make it air-tight at the surface. (P. 81.)

If the silo is situated above ground, in a barn or under a roof, there will be little difficulty in keeping out the water; but if an excavation be made in the soil, precautions must be taken against an influx from below. (P. 57.)

Where liable to infiltration of water, simple earthen pits should be avoided (p. 23); and, at the foot of rising ground, the pressure of subterranean water may even force an opening through cemented floors, unless made of a good thickness.

When silos are constructed wholly above ground, and not inside barns or other buildings, it is desirable, if possible, to give them a northern rather than a southern exposure, and to avail oneself of any shade that is to be obtained. Warm weather prejudicially affects the ensilage, and it tells most on silos above ground. (P. 26.)

The walls of the silos are best made perfectly upright. (P. 28.) If they have an outward slope, proper settlement is obstructed; and more weight is then required to force down the mass at the sides, where compression is more needed.

Walls should be smooth, to facilitate settlement. (P. 21.) When pits are dug in strong soils, where there is no fear of flooding, the walls may nevertheless be smoothly plastered with advantage, or lined with planed boards, set up on end—which is better than having the boards laid horizontally.

When the fodder is cut, it should be got into the silo as soon as possible. (P. 65.) The longer it is allowed to lie and wither in the field, the less likely it is to keep well.

Crops for the silo are best cut when young and succulent. Green rye should be cut about the time when the head begins to be formed, oats when in blossom or in the milky condition, and clovers and grasses as soon as they come into flower.

Grasses, clovers, vetches, &c., need not be passed through the chaff-cutter before being put into the pit, especially if they are young. (P. 69.) But the stronger and more elastic the stems of the plants the more weight will be requisite to compress them. When the crops are allowed to stand till the stems become old and woody, it may be preferable to pass them through a chaffing machine, as they would then pack well with less weight.

It is not necessary, with our ordinary fodder plants, to mix straw, or other dry material to absorb the moisture. (P. 65.) Indeed, such admixture would be likely to do more harm than good, so far as regards the preservation of the ensilage. (P. 66.)

If you have dry fodder that you wish to make more palatable to the stock, a small quantity might, for that purpose, be mixed with very succulent crops; but you must be careful not to add too much, or you may endanger the condition of the whole. (P. 67.) Few of our crops would admit of the addition of a tenth part of dry fodder.

Rain need not prevent the storage of crops in the silo. (P. 68.) More damage is likely to arise from letting the crops lie long on the ground than from pitting them in a moist or even wet condition; but, for all that, an excessive quantity of water should be avoided.

Salt is not required for the purpose of preserving the fodder; but a moderate quantity may be useful to the stock. (P. 74.)

The fodder, on being put into the silo, should be spread evenly, to prevent the occurrence of lumps in some places and hollows in others; and then it should be trodden down, more especially alongside the walls. (P. 79.) Some farmers turn horses or bullocks into large silos, to do the treading; but they cannot get so near to the edges as men, who can do good service by going round sideways with their heels close to the walls. Elsewhere the trampling is of minor importance.

Unless heavy weights are put on the mass after the silo is filled, the previous trampling will have been of small avail. It matters little how the pressure is put on, so that it is sufficient and continuous. It is even more wanted at the end of a long period than it is at the beginning. (P. 88.)

With the best-formed silos and the smoothest walls the weight should not be less than 100lb. to the square foot. (P. 81.) With rougher appliances the weight may be doubled or trebled with advantage. When earth is used it should be piled on to the depth of 2ft. or more, and especial care be given to the trampling down at the edges of the pit.

Between the weights and the siloed fodder there should be a layer of straw—the dryer and harder the better (P. 79); or a layer of pine-needles, gorse, heather, reeds, or some other substance that will not readily mat together, but will allow the air to escape freely as the mass becomes more and more compressed. (P. 80.)

Boards are usually laid upon the layer of straw, &c., before the weights are put on. (P. 75.) They have a decided advantage wherever lumps of stone, barrels of earth, or any rough weighty matters are used. But where the weights consist of matters that pack well together, as evenly-shaped blocks of concrete or cut stone, bricks, square wooden boxes containing clay, &c., the boards may be dispensed with. (P. 63.) Sometimes loose earth is shovelled directly on to the straw; but it is liable to get mixed up with the fodder when the pit is opened. Sand should never be used in this way, as it runs into every crevice. (P. 73.)

The weights should, for the most part, be placed at the ends of the board, close to the walls. If the fodder is well pressed down at the edges, the centre is pretty sure to be all right. (P. 28.)

The boards need not be tongued or made to fit with great accuracy. A few crevices are useful in permitting the escape of air from below, which must be forced out by the weight above if the fodder is to keep well; and if the mass is well compacted, and the weights are kept on, air is not likely to get in afterwards.

When there are several silos, so that the workmen can be transferred from one to another, it is best to fill the silo slowly at intervals, extending over a week or ten days, a foot or two being put day by day into each pit. (P. 71.) By this means the fodder packs closely, and is so well settled down by the completion of the filling, that nearly all the space in the silo will be utilised.

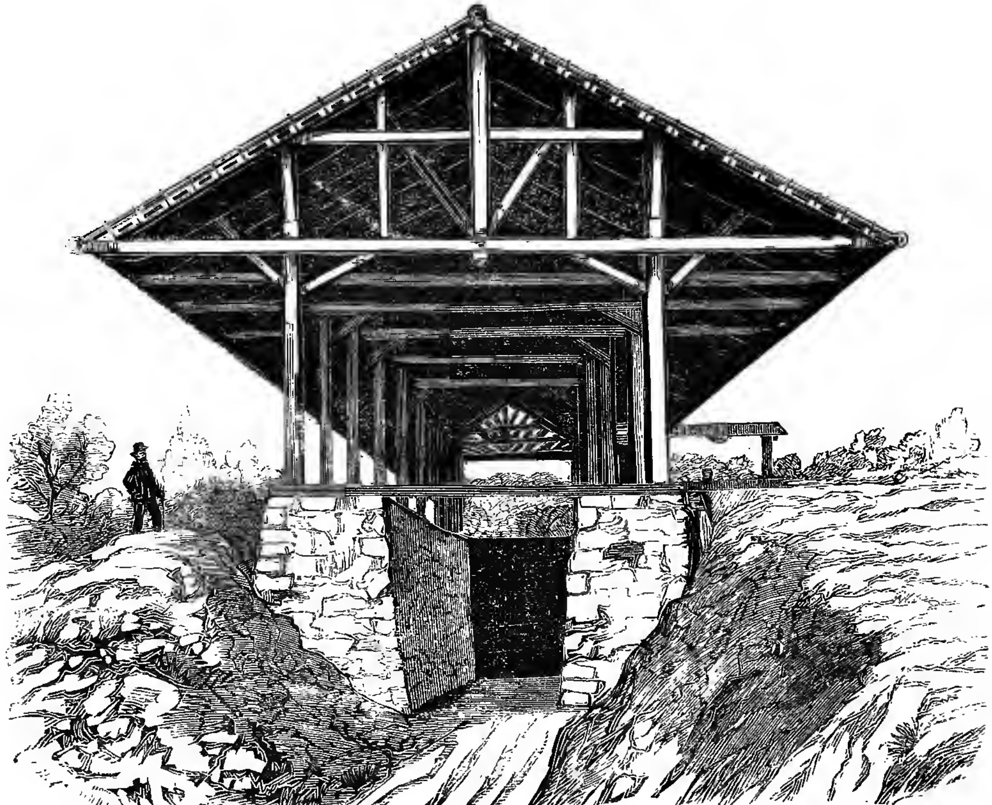
If this course cannot conveniently be adopted, the silo may be filled and the weights put on at once. After the lapse of some weeks, when the mass has settled down, the weights and boards may be taken off and the silo again filled to the brim, after which it may be again covered and weighted. (P. 73.)

The silo may be kept six or eight weeks, or as many months, before being opened.

The ensilage should be cut out from a narrow end of the pit. (P. 76.) The boards and weights should be removed from only a small portion of the surface, and a vertical section made so as to cut out a slice of sufficient thickness for the day's consumption.

The continuance of the pressure during the period of cutting out is most important. If the weights be taken off in advance, mischievous results may ensue. (P. 77.)

The more perfectly the ensilage has kept, the less fermentation will have taken place in the pit. Exposure to the air, under such circumstances, is desirable for a few hours, in order to set up alcoholic fermentation before giving the food to the animals. (P. 90.)



VICOMTE DE CHEZELLES' SILO AND GRAIN SHED.

APPENDIX.

THE SILO OF THE VICOMTE DE CHEZELLES.

This silo—which is, we believe, the largest single silo in the world—has been the subject of articles in the *Times* as well as other journals. It was first brought to the notice of English readers by an article in *The Field,* accompanied by a woodcut, here reproduced. Mr. H. Kains-Jackson has returned to the subject on several occasions; and from his various articles in *The Field* we make the following selections, giving the dates when they appeared, so that anyone may know where to find the complete articles should he wish to refer to them.

(*The Field*, Aug. 5, 1882.)

By the courtesy of M. le Vicomte de Chezelles, I am enabled to give the following particulars as to his large and practical working of the system: Under date, July 31, the Viscount writes me, from near Chaumont-en-Vesin, Oise, that harvest work is in full swing on his estate, and so he has time to send only an account of the principal features of his mode of ensilage. A large photograph accompanies the letter, and the illustration given is on a reduced scale, but sufficiently indicates the construction of the silo. M. de Chezelles writes:

"I cut all sorts of forage with one of Wood's mowers, and five men follow the machine to load the carts, which at once convey the crop to the silo, where a powerful chaff-cutter cuts up the forage as fast as three men can feed it, whilst two other men unload the carts. The above ten men work together, being paid by the job, their wages being commonly about 8*s*. per hectare, the pay varying according to the nature of the crop.

"I so arrange the number of carts and horses, reckoning the distances of the fields from the silo, that there may be a continuous supply furnished to the chaff-cutter, which should work on without interruption, as by this means the ensilage is made regularly and economically in a very few days. As a matter of fact, in this way I have cut, carried, and formed into ensilage the produce of about 170 acres of trifolium, sainfoin, lucerne, tares, and artificial grasses.

" For the silo two men are wanted to level and stow the cut forage as it falls from the chaff-cutter. Twice a day a couple of bullocks or horses are driven over the ensilage, so that it may be trodden down evenly. This work is better done by animals than by men. An occasional sprinkle of salt assists fermentation, and gives a savour that animals appreciate.

" My silo is 72 yards long by 6½ yards wide, and 4½ yards high. It is desirable to raise the layers of forage a yard above the top level of the silo, and this quantity above the surface is inclosed with boarding. By shrinkage and settlement the ensilage soon sinks to the pit level. Directly the silo is full, I at once have it covered as soon as possible with a bed of earth about a foot thick, and the forage is then left for some three months, to become ripe for feeding of stock. It is imperative that rain and air should be excluded.

" For two years I have now successfully fed all my farm animals, consisting of twenty horses, thirty-six bullocks, one hundred and twenty milch cows, ten hundred to twelve hundred sheep and lambs, with this ensilage, mixed with straw and roots ; in the feeding of horses I mix carrots or potatoes with the forage. All the stock have been kept in thriving condition—indeed, they have been wonderfully well whilst fed on this green food stored in pits."

One of the first impressions in reading the above letter was that the scale—nearly 200 acres of crops being saved—brings the subject at once under practical agriculture ; and next that horses can be fed with as much advantage as cows upon ensilage. Hitherto I had regarded the process as more interesting to dairymen than to ordinary farmers. Lastly, in point of expense, reckoned 10*d.* to 1*s.* 3*d.* per ton for reaping, carrying, and cutting (the chaff-cutter should be driven by a steam engine of four to six h.p.), makes the system the most economical of any.

(*The Field*, Nov. 4, 1882.)

I have just visited probably the largest silo in Europe—that of the Viscount Arthur de Chezelles, of Château Boulleaume, Liancourt St. Pierre, Oise, France. It is really a fine yet most economical structure—an excellent barn and perfect silo; a great oblong shed, roofed with tiles, 72 yards long, 6½ yards wide, 4½ yards high from the ground level—an immense cover for the cereal crops of a large farm. The floor is sunk some 12ft., and is paved and drained. The side walls and one end wall are lined with rough stones set in mortar, whilst the front is partly walled up, and a wide door allows the entrance of trucks on rails to come and be filled. This great basement suggested comparison with the hold of a big ship; and in it at present is stowed away the produce of 170 acres of various sorts of forage—cut, carried, and made into green chaff last July—which fills the whole space, excepting where a remnant of last year's ensilage occupies some 16ft. at one end.

The forage was cut by English mowing machines; five men followed them and loaded into carts, which delivered the green stuff at the side of the silo, upon the carriers of a powerful "Albaret" chaff-cutting machine, two men unloading and three men feeding; so that ten men were employed, and these were paid 8*s.* to 16*s.* per hectare (2½ acres), according as the crops were light or heavy. The whole business was so arranged in relays that the work went on uninterruptedly, and the chaff-cutter, driven by 7 h.p. engine, poured out a green stream of food that, like water, soon became level through being trimmed and stowed by a couple of workmen. Twice a day bullocks (here much used for farm work) walked over the mass and gave it compactness. A little salt was occasionally sprinkled on the layers, more to give the fodder an appetising flavour than for any other purpose. When, in a few days, the silo was filled—swallowing up all and whatever the farm could give it—the forage was covered up, without any layer of straw or boards, by a strata of the light sandy soil, some foot and a half thick. Naturally the mass subsided under the weight of earth, and became nicely compressed, but scarcely more than is hay in a large stack.

At this period, to all intents and purposes, the superstructure became and looked simply a great shed with a nice even sandy floor; just the plaec to invite the reception of the cereal crops which—wheat, oats, and some barley—were ripening in the fields. In a short time, from floor to the angles of the roof, the building was filled; and, in evidence of the present season's good corn crop in France, several grain ricks had also to be built.

I fancy there are not three farmers in England who would have had as much faith as had the proprietor of this estate, when he confided the produce of 170 acres of land to this great pit in such conditions; but two years' previous experiments gave confidence, and a large and valuable bulk of property was left in the full expectation that for this coming winter a wholesome and nutritious store of animal food would be available for the 20 horses, 36 bullocks, 120 milch cows, and 1200 sheep that constitute the live stock of the farm at Château Boulleaume. That such expectation was fairly fulfilled I went to see for myself (as I promised I would in *The Field*) at the opening of the silo on the 12th of October.

Previous to my arrival at Liancourt St. Pierre, I had received a letter from M. Georges, the manager of the farm, to say that, owing to the abundance of green keep still in the fields, the opening of the silo would be postponed until November. However, upon the day I had come to see the actual opening, the silo, by the courtesy of the Vicomte, was opened, and on the 12th of October, 1882, I had for the first time a block of new ensilage in my hands. I took it at once to a yoke of Charolaise oxen that happened to be within a short distance, looking, with the great cart loaded with beetroot pulp, a picture from out the canvas of Rosa Bonheur. These bullocks took the ensilage, eating it with relish, as a horse takes a mouthful of hay from the hands. All doubt as to the food being freely taken was therefore at an end. To reach the ensilage, a load or two of the superimposed corn had to be removed; next the stratum of earth was shovelled aside, and the brown-black mass of ensilage below was laid bare. Without the loss of a minute I jumped down into the pit, thrust my hands between the substance with some difficulty, from its compressed state, and found the temperature decidedly high, certainly of blood heat, whilst a smell rather agreeable than otherwise, such as comes from breweries—sweet, alcoholic, and condimental—made itself observed. The heat gave no apprehension, and was not considered objectionable, previous years' experiments proving such condition was unattended by danger. Without further delay, I took, as a geologist takes a fossil specimen from a freshly cut rock-section, three samples of the new ensilage, and a fourth sample of the old (1881) stock, and placed them in separate tin cases, which were only closed with string, since I feared to have them soldered down on account of possible difficulties with the Custom House authorities. The work so far was complete, and the opening of the silo that Thursday afternoon was a success; the food stored there was good provender for the coming winter. The instance, in this present case, is all the more notable, because, whilst different experimentalists have advocated various plans as to method of covering, necessary weight, time and manner of opening, and divers details, here there was an absence of all niceties; here was a working example that all practical farmers could easily follow. Simplicity, efficiency, and economy were the characteristics of the silo-work at Château Boulleaume.

I next put forward a supposed difficulty—namely: that the bulk of ensilage, from which a portion was cut away, must on each occasion be protected afresh, and such portion taken away must be consumed in twenty-four hours, or it would become worthless. Nothing of the sort was to be feared, as I was told, from the experience of last season. The ensilage is simply cut away as wanted, just as a few trusses of hay would be cut from an ordinary stack. If this be a fact [and to-day, Nov. 1, after a lapse of eighteen days, one of the samples on view in the Corn Exchange, Mark-lane, under the clock, on Mr. Gripper's stand, retains sweetness and savour, as many visitors attested], there appears a reasonable probability that in future, cubes of ensilage, instead of being regarded as so much perishable green food, may become a marketable commodity of extensive use for feeding dairy and other cattle, and not, as hitherto, be limited to consumption on the farms where it is produced. Practice has shown the way, and below will be seen what science, through chemical analysis, has to add. An analysis has been made at last, and why it was not made before was told the readers of *The Field*—our Custom House sentinels stopped and challenged the new visitor I had sent to England and thought he was "tobacco" in disguise!

INVICTA.

ANALYSIS OF VICOMTE DE CHEZELLES' ENSILAGE.

THE following tabular statement represents the percentage composition of the samples of fodder, consisting of trefoil, lucerne, tares, and grass, cured on the ensilage system by the Vicomte de Chezelles.

Volatile Matter:			
Water		50·30	per cent.
Free acetic acid		1·20	,,
Alcohol		1·80	,,
Solid Matter:			
Albumenoids*		9·12	,,
Ammonia		0·06	,,
Fatty matter		2·07	,,
Soluble carbo-hydrates:			
Sugar (maltose)	2·94		
Starch and digestible cellulose	2·23		
Pectous substances (gum, mucilage, &c.)	10·32		
		15·49	,,
Insoluble carbo-hydrates (fibre)		14·35	,,
Mineral matter (ash)		5·61	,,

* Containing nitrogen, 1·44 per cent.

The following represents the composition of the substance (when dry) contrasted with two samples of dry lucerne analysed by Dr. Von Wolff, of the Hohenheim Imperial Experimental Station, Germany. The first sample was dried with care on a barn floor; the other (a portion from the same crop) was dried in the field in the ordinary way. During the first two of the four days to which the latter sample was exposed to the atmosphere, it became subjected to the action of a slight shower of rain and to a thunderstorm:

	Ensilage.	Carefully-dried Lucerne.	Field-dried Lucerne.
Albumenoids	18·35	17·00	14·94
Fibre	28·87	31·81	33·90
Fat, Soluble Carbo-hydrates, and Alcohol (if any)	38·95	43·80	44·22
Ash	11·29	7·39	6·94

The above figures so clearly show the high feeding value of this sample of ensilage, that they may be allowed to speak for themselves. I wish only to point out that, contrary to generally accepted opinion, my experiments led me to believe that the sugar formed by the fermentation of ensilage is not "grape sugar" or "glucose," but sugar of malt, or "maltose." The acetic acid, although of course indicative of the loss of nutritious feeding material, is probably not without value as a condiment. Its amount in the above sample is much less than in the specimen of highly fermented hay, the analysis of which was given in my "Chemical Investigation of Hays" (*The Field*, Oct. 14, 1882).

F. WOODLAND TOMS, F.C.S.

7, Busby-place, Camden-road, London, Nov. 2, 1882.

[A careful botanical examination of the above sample of ensilage afterwards showed that, although various crops, as stated in page 107, were stored in the silo, they were by no means equally distributed, and that the sample analysed consisted mainly of clover (Trifolium pratense), with a small admixture of barley and some of the common grasses, such as Alopecurus pratensis, Agrostis albus, Bromus mollis, &c., all cut up into chaff before being put into the pit.]

STATEMENT OF COST OF VICOMTE DE CHEZELLES' SILO.

(*The Field*, Feb. 17, 1883.)

I give below the detailed cost of the silo at Château Boulleaume, Oise, France, the particulars and figures being copied from a statement affixed in the Paris Show at the Paris Exhibition of Ensilage, made by Vicomte Arthur de Chezelles, and appended to drawings and photographs :

	Fr.	ct.			
SILO of 1475 tons capacity, suitable for containing the produce of 250 acres of forage, costing 2fr. 70c. for each ton, or 3989fr. 48c., say sterling			£160	0	0
Excavating and carting earth (1368·80 metres), at 65c.	889	72			
Concrete for foundations and floor	86	40			
Masons' work, 4fr. the metre—435·56 metres	1742	24			
Cartage of stones (dug out from the estate), lime, and sand, 2fr. the metre	871	12			
Wood around the pit, 5 steres, at 60fr.	300	0			
Fixings of iron, and Roman cement	100	0			
	Fr.3989	48	£160	0	0

BARN SUPERSTRUCTURE, to shelter about 20,000 sheaves:

	Fr.	ct.
Elm posts, 11·865, at 86fr. the cubic metre	1008	52
Woodwork of Norwegian pine	2050	43
Carpenter's labour	750	0
Bolts and nails	400	0
Blacksmith's work	180	75
Tiles and laths	1629	0
Laying tiles	235	0
	6253	70

Total cost .... Fr. 10,243 18 say £410

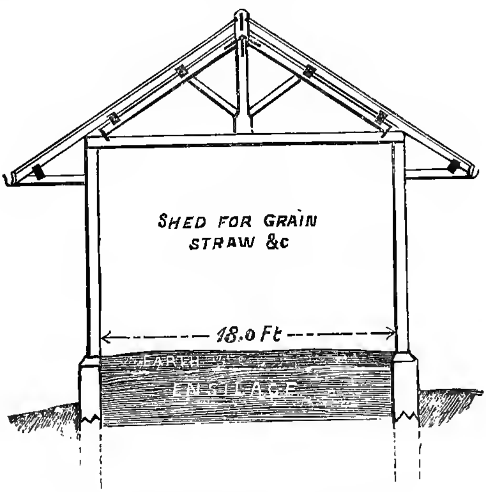
Estimate for a silo that would hold the produce of 125 acres, and without superstructure, 80*l.*

Specification for Building a Chezelles' Silo.

In the specification of the "Chezelles Shed and Silo," the plan is simply reduced in size from the large one previously given, in order to make it suitable to most English farmers. As will be readily seen, the eaves could easily be extended, and the sides inclosed, so as to form a roomy stable or dairy and cow shed at very small cost. This building commends itself as economical and adaptable to most farm purposes.

Specification of Works required to be done in the erection of a grain shed and of a silo for storage of grass, clover, and other green forage.

Excavator.—Excavate to a depth of 9ft. and cart away the soil excavated to such place as shall be directed. The earth in the foundation is to be well rammed down, so as to form a solid level flooring, in a natural bed, and not made up of loose earth. Sand, if found, is to be allowed for by the contractor.



Chezelles' Silo and Grain Shed.

Bricklayer, &c.—Build in Flemish bond the walls and piers, as shown, of best hard well burnt grey stocks, laid in good cement composed of one part of approved cement and three of clean sharp sand, with footings composed of four courses of brickwork. Lay the bottom of the pit with concrete 1ft. in depth, with a layer of asphalte 1in. in thickness on top. Form a drain in the asphalte, and concrete through the centre of the pit the entire length, with a fall from either side of the walls, and a fall of 6in. from the centre towards each end. Provide and lay a damp course, consisting of two courses of unbroken slates, laid, breaking join in cement above footings.

Carpenter and Joiner.—Timbers are to be supplied and fixed of the following scantlings, well seasoned, free from large or dead knots, decay and all other imperfections: Tie beam 8in. by 2in.; king post, 6in. by 4in.; common rafter, 3in. by 1½in.; struts, 4in. by 2in.; ridge plate, 8in. by 2½in.; purlins, 4in. by 4in.; principal rafters, 5in. by 3in. Uprights (posts), 8in. by 6in., are to be placed at distances of 8ft. apart, and to be tenoned into wall-plate as shown. An oak wall-plate to be provided and fixed, size 8in. by 8in., to run entire length of wall.

Slater.—Slate the whole roof, as shown, with sound Bangor Countess slating, on fir laths, and fixed with galvanised nails. Provide and fix a slate ridge.

Founder and Smith.—Provide and fix a cast iron ogee eaves gutter on each side of building, with a fall towards two cast-iron rain-water pipes at either end, as shown. Provide iron ties where shown.

General Remarks.—The whole of the work is to be carried out and finished completely from the time that it is commenced, without stoppage (through the fault of the contractor), and in case anything may have been omitted in this specification, that may or may not be shown in the drawing that is absolutely necessary for the stability of the erection, the same shall be executed by the contractor on written authority being given him.

INVICTA.

ENSILAGE OF CLOVER IN WET SEASONS.

(*Journal d'Agriculture Pratique*, May, 1878.)

MANY agriculturists, having a larger quantity of Trifolium incarnatum than they can make use of in a green state, and, being unable to convert it into dry fodder in this continuously wet weather, ask me if it is too late now (end of May) to put into the silo the surplus clover, which has scarcely done flowering.

The best time to obtain good ensilage from Trifolium incarnatum is to cut it when it is in full bloom, as the plant is then tender. Such has been done in my ensilage at Cerçay this year. I sowed more Trifolium incarnatum than my beasts could consume in the last three weeks of May; about the 15th of May we began to cut it, and we stored it in a silo made in a closed barn. It was filled in to the height of about 10ft., then covered with a layer of straw about 20in. in thickness, on which was placed 6in. or 8in. of earth, beaten down, and on this was piled a quantity of straw in order to supply the required weight. About the middle of July I hope we may begin to consume it, as we did last year.

It is a great thing to be able to store in the silo in spring a supply of fodder against the fearful season of drought which at times parches us up in Sologne, and especially when this early forage is removed from the ground with little trouble and expense, and replaced by other crops, as maize, millet, cattle cabbage, or roots. The feeding of green crops is difficult on dry soils where we can get fodders in spring and autumn, but little, if anything, that can be cut in the height of summer. Such was my position in Sologne, and I long despaired of being able to get over the difficulty; but the ensilage of Trifolium incarnatum has helped me out of my trouble.

In other parts green rye is highly spoken of. It is an excellent green crop, which, with abundance of manure, especially artificial manures, gives immense produce. I have tried rye as recommended, chopping it up small at the time of pitting; but the beasts much preferred Trifolium incarnatum, which, thanks to a spring dressing of superphosphate, came almost as early as the rye. I therefore hold to the clover, but without ceasing to recommend rye or any other fodder which may be preferable under different circumstances. Besides, it is well to have several strings to your bow; and rye has this advantage, that it comes at a time when, being chopped up with hay or straw, it facilitates the transition from dry winter diet to the succulent food of spring.

Rain is of little importance when Trifolium incarnatum is being stored I have put cart-loads into the silo dripping with water, and the fermentation has been none the less perfect.

It is needless to say that, as the ensilage of Trifolium incarnatum has nothing to fear from underground humidity in winter in impermeable silos, it becomes possible to practise it in silos dug out of sound earth. These are the silos generally preferred by small farmers, who do not care to have them built of masonry. As I have often said, such silos would tend to make ensilage popular on farms where, for whatever reason, they are unwilling to construct buildings.

At Cerçay the preference is in favour of buildings, but under these circumstances. They are barns which, being unoccupied from April to August, can be filled with provender that is removed in turn and affords room for the storage of grain crops; and later on, in October, when the cereals are thrashed, these barns become silos again. The buildings are therefore applied to three successive uses, being employed as silos for the maize in autumn, as silos for the trifolium in spring, and as barns for the cereal crops in summer. The building is, in fact, prevented from lying fallow; and such fallows are not the least in importance where, as in commencing an undertaking, one has to consider whether it is better to lock up money in bricks and mortar or to devote it to reproductive improvements, resulting in an increase of the crops. E. LECOUTEUX.

(*Journal d'Agriculture Pratique*, April, 1881.)

The bad weather we had in the spring of 1880, at the time for cutting our artificial grass crops, seemed to afford a good opportunity for making an experiment in the ensilage of fodder on a large scale, and an abundant crop of mixed clover was put into a silo about 200ft. in length, 20ft. in width, and 13ft. in depth. The work was carried on in all kinds of weather, and the clover, when put into the pit, was often dripping with water. We covered the whole with a quantity of straw which we had at hand, and which served as a covering at the same time that it afforded the pressure indispensable to the good preservation of the fodder.

The whole remained in this state until the 10th of March, 1881, when we made the first opening into the silo. We found the clover in a perfect state of preservation, giving off its alcoholic odour; and all the animals to which it was offered rushed at it, from the horses down to the sheep. The horses on the farm eat it chopped up, as also do the cattle and sheep, for the fattening of which it is mixed with pulp and cake; but the store cattle eat it in the rack just as it comes out of the pit. This clover may be cut up for several days; it does not heat in the mass, although retaining all its succulence.

The effect of this food has been as beneficial to the cows as to the rest of the stock. The milk has become more creamy from day to day; and the butter, instead of being pale, has assumed the yellow tint of grass-fed butter. In short, the further we go on the more we are convinced of the excellence of this process of preservation, by which flowers and leaves (so liable to be lost during conversion into hay) are retained by the plant, together with all its nutritive qualities and appetising flavour.

Vicomte R. de Chezelles.

CLOVER STORED IN EARTHEN PITS.

(*Journal de l'Agriculture*, Sept., 1876.)

At the beginning of June, having a large quantity of Trifolium incarnatum which it was impossible for our beasts to consume in a green state, we cut the surplus, and, without allowing it to wither in the sun, we put it into some unwalled earthen pits in which beetroot pulp is stored during the winter. After having well trampled down the fodder in the pit, we heaped on from 1½ft. to 2ft. of earth, sloping it so as to let the water run off. After a few days, a settlement having taken place, we threw on some more earth to close up all cracks through which air might enter. About ten or twelve weeks afterwards, when we knew not what to give the beasts, as the drought had kept back our maize, we decided to open the silo.

We were glad to find that our experiment had fully succeeded. A particular odour indicated some amount of fermentation, such as takes place in beetroot pulp, and the fodder came out nice and green, with its flowers beautifully red—in a word, just as it had been put into the silo. An insignificant portion of the clover which had come into immediate contact with the surrounding earth had become dark brown, and was not given to the beasts. The fodder in the interior, on being offered to the cattle, was consumed with avidity, and has rendered us a great service of late.

Here, then, is an important resource for the agriculturist, who very often, during the great heats of summer, knows not how to feed the cattle in his stalls. It is an excellent means of utilising forage of divers kinds when, as iu the past summer, there are abundant crops which come into flower at almost the same time. LOUIS DARBLAY,

Propriétaire-Agriculteur à Chevilly (Loiret).

ENSILAGE OF ROOTS.

M. LECOUTEUX, editor of the *Journal d'Agriculture Pratique*, says, with respect to the ensilage of beetroot or mangold: "It is requisite to cut up your roots in some fashion before being consumed by the stock. If kept whole in pits they are liable to sprout, especially if the winter be mild; and, besides, the necessary quantity will have to be cut up day by day. It is preferable to have them all sliced up in the first instance, and mixed with some straw chaff, and then put into the silo, whence you can take out daily the quantity required for consumption. You will thus have the double advantage of securing better preservation of the crop, and avoiding the inconvenience of setting men and teams to work day after day."

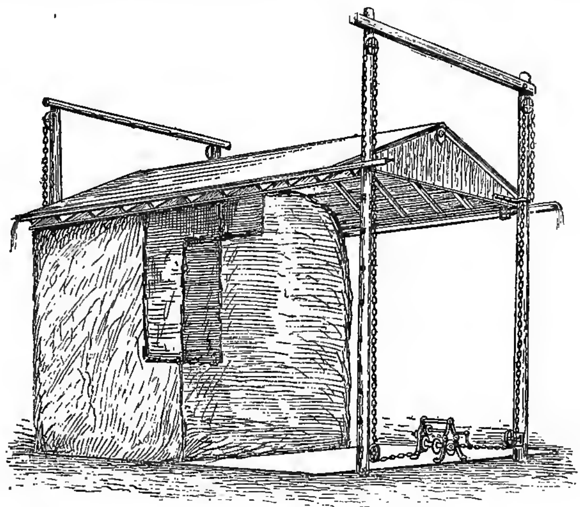
ENSILAGE WITHOUT A SILO.

[The following letter is sent by Mr. H. Kains-Jackson, who was one of the party of agriculturists that paid a visit to Holland in April 1882. The wooden roof alluded to was similar to that represented in the woodcut overleaf, except that the Dutch barn is here shown with a haystack partially cut instead of being full of grass. As regards the mouldiness, if it is a foot deep all over, the proportion of damaged fodder would be considerable; but the larger the stack, the smaller would be the proportion of damage. Supposing a stack to be 20ft. square and 20ft. high, a foot of mouldiness all over would represent about one-fourth of the whole mass; whereas, in a stack of the same height, but 40ft. square, the mouldy portion would be reduced to one-eighth; and so on.]

THE experiment successfully made in Holland of preserving grass in a silo was described last spring in *The Field*, after the return of the Norfolk farmers from their visit. Mr. A. Holland-Hibbert, of Munden, Watford, a friend of Sir Fowell Buxton and Mr. Samuel Hoare, who accompanied the party, now writes to me the following most interesting fact:

"Our mutual friend, Mr. Crommelin, jun. (a young Dutch gentleman studying agriculture on Mr. Van der Breggen's prize farm) was here yesterday, and tells me the farmer is making the whole of his grass into ensilage, and *without a silo*, as it is found a silo is unnecessary.

"The new process is to drive a double line of poles into the ground, to carry a flat sliding wooden roof, which is raised by means of pulleys. The grass is brought and stacked, whilst four horses are unceasingly walked over the mass as it is being built, and some salt is sprinkled over each fresh supply of grass. As the stack rises in height, it is necessary to lower down



and hoist up, morning and evening, the horses, which is done by slings and simple pulley gear, rigged near the stack. Each night the boarded roof is lowered on to the trodden grass, and afterwards weighted. When the required height has been reached, the stack is complete under its weighted wooden roof, which is found to compress the mass satisfactorily.

"In result, when the stack is cut, the bulk is found to be good ensilage, except the portion of the sides, which, from exposure to the air, are mouldy and damaged to the extent of about a foot. Even this portion, however, is not so much spoiled but that the heifers and pigs on the farm can eat it with much relish.

"Of the whole process of ensilage, and its value for stock, Mr. Crommelin speaks very highly, after having seen it used on a large scale."

In comment on the above, the reader may remember that some weeks ago I stated I was about to experiment on a ton of suitable green stuff, whenever the season produced it, by passing it through a powerful press, and making it into bundles of about a hundredweight. The above letter is an encouragement for the experiment to be made as soon as opportunity allows.

INVICTA.

ENSILAGE ON LORD WALSINGHAM'S MERTON ESTATE.

(From *The Field* of Feb. 10, 1873.)

In the Wayland Hall, Watton, Norfolk, on Monday last, Mr. Henry Woods, of Merton, delivered a lecture on "Ensilage: its Origin, History, and Practice,"* to a very large assemblage of landowners and tenant farmers. The paper being an exceedingly long one, and preceded or followed by speeches by the chairman (Sir R. J. Buxton, Bart., M.P.), Lord Walsingham, and several other gentlemen, it is impossible for us to give a full account of the proceedings, and we therefore confine our report to a portion of the lecture which treats of the experiments carried on on Lord Walsingham's estate at Merton. After speaking of the origin and history of the process, and what had been done in other countries, and in various parts of England, Mr. Woods related what had occurred within his own experience:

With a sagacious foresight, which I should have more promptly and readily recognised, Lord Walsingham, upwards of two years ago, expressed his confidence that this new method of preserving our green forage crops was both sound in theory and practicable. He desired that it should be fully investigated, and believed, if a series of trials were entered upon with skill and care, results might be reached that would be of great service to the agriculturist, pointing out to him one way at least of being less at the mercy of such crippling seasons as those experienced in the last seven or eight years. The thing, however, appeared to me as one of those charming "fads" which some good-intentioned landowners, in singleness of heart, take up; seldom with other result than the expenditure of large sums of money, which is worse than useless, because it still further disappoints, disheartens, and discourages them. But Lord Walsingham was not to be influenced against his own judgment, or turned away from the purpose which he contemplated, by any argument that I advanced. Appreciating

* This lecture has since been published with additions, and plans of the buildings, by Messrs. Stévenson and Co., Market Place, Norwich.

keenly the strange and startling vicissitudes through which British agriculture has passed in these latter years, feeling how unreasonable it would be to expect poor heart-sick, half-ruined farmers to incur the risk of "fancy experiments" on their own account—his lordship, whose hand readily responds to any generous impulse, embarked upon a venture which no one rejoices more than myself has been, so contrary to my expectations, a grand success.

In the month of July, 1881, we had a small silo constructed on the ground floor of a granary. Its internal measurements were 8ft. 4in. long, 4ft. wide, 4ft. 4in. deep. In August we made our first experiment, which was a sharp and trying one. I had read that chaff made from grass in a damp state could be put into silos with the certainty of its becoming good ensilage, and this assertion I decidedly tested. The chaff with which I experimented was made in equal parts from second-crop red clover and rank-grown succulent grass, cut from a pasture which had been heavily folded with cake-fed sheep. The grass and clover were both cut and carted in a drizzling rain. The chaff when made was at once put into the silo. It was salted at the rate of 1lb. of common field salt to 1cwt. of grass chaff, and was trodden down as firmly as possible. A layer of salt, in thickness about an inch, was placed on the top of the mass. It was covered with two wood shutters, upon which we spread a layer of bran, 9in. in depth. The whole was weighted with large stones, weighing together about three-quarters of a ton. After the lapse of about three months we opened our little silo. We found some of the contents to be useless. The upper portions of the ensilage, to the extent of a third of a foot, were in a state of decomposition, and unfit for feeding purposes. Decomposition was also at work at the bottom of the silo. Its extent was some four or five inches. But beyond these upper and lower layers, although so wet that water could be squeezed out of it very easily, the chaff was quite green and fresh, and had a strong aromatic and acid-like smell. At the outset the cows when offered the food did not take kindly to it; but in the course of two or three days they manifested a fondness for it, and ate it freely. Our success, however, was only partial, though the result of the trial was by no means unsatisfactory, and caused me to waver in my unbelief. Other experiments, on a much larger scale and somewhat different plan, were arranged. We naturally determined to profit by the lessons of our first trial. We had learnt that it is not advisable to cut and cart grass for ensilage in so wet a state as we had done ours; and further, that we should not put a layer of salt on the top of the mass.

We determined to convert one bay of a clay-built barn, at Merton, into silos. This is how we did it. Across the bay front we put up a 14in. brick wall to within 3ft. 10in. of the tie beam, and two division walls of the same description, which gave us three silos, each 14ft. 4in. in length, 6ft. 3in. in width, and 9ft. 3in. in depth; the cubic space being sufficient for at least fourteen or fifteen tons of ensilage; but there is no reason why two feet more brickwork should not be added to the height of the walls, so as to make room for three tons additional, or seventeen or eighteen tons in each silo. The barn floor was laid with asphalte some years ago, and therefore the silos required no new bottom. We covered the walls with cement plaster, composed of Portland cement and well-washed road silt, in the proportion of three of cement to one of silt. This coating, which was about half an inch in thickness, answered well in every respect, and showed, I think, that even clay-built barns are easily convertible into good silos. I ought to state that to prevent the brickwork being displaced in the filling process, a 2½in. plank, 14in. wide, was properly secured to the wall tops, and to facilitate the emptying of the silos a well-made 1½in. boarded door, protected by a coating of hot tar and pitch, was inserted in one corner of the front wall of each silo. The frames of the doors were set on the inside, so that the doors opened inwards to the partition walls, and the apertures were hermetically sealed by means of 4in. brickwork on the front sides. The total cost of these three silos did not exceed 30*l*.

It was my serious intention that the experiments we made should not err on the side of leniency. With this object I used coarse common grass for the test. (Referred to in the Analysis as No. 1.) Two of the silos I directed to be filled with grass taken from an oak wood, known as Merton Wood. For some years I was in the habit of giving the grass to any respectable person who liked to cut it for litter. During the past few years no one has cared to have it. They have said, "It is such poor stuff, if it once gets wet after being cut there is little chance of getting it dry again; it is then useless even as litter." You may therefore conclude that if the ensilage system, when applied to grass of this coarse and common character, has been at all successful, much greater things are to be gained from a finer and better sort of material. The ensilage in the third silo, I may add, was from grass grown in a rough meadow. (Referred to in the Analysis as No. 2.)

The silos were filled uninterruptedly, in the course of three or four days, early last July. Although the weather was dull and sunless, there was no rain. The grass was loaded on to waggons as it was cut, and conveyed direct to the chaff-cutter. Amongst each cwt. of chaff 2lb. of common field salt was distributed. Let me here say, once for all, that a great deal depends upon the treading and ramming process. The more effectually this is done the better will be the ensilage. When the silos were quite filled, the chaff having been as well-trodden and rammed down as possible, the contents were covered with wood shutters, and over these we spread a bed of coarse bran, about eight inches deep. For weights we used a lot of clean flint stones, in wicker skeps, which cost a shilling apiece, and which will last for years before requiring to be renewed. The pressure, which we carefully distributed over the whole surface, was little more than a ton and a half in each silo, which contained, as I have before stated, about fourteen or fifteen tons of cut grass. Three weeks after the filling of the silos the ensilage had shrunk to about a third of its original depth. We then removed the weighted baskets and bran covering, again filled the silos to the top, and replaced the boards, bran, and skep-weights. Little labour and no difficulty attended this operation. The skeps were lifted on to the partition walls, while the bran was put temporarily into sacks. An accurate and detailed account of all the expenses incurred for the filling was kept by the farm bailiff. The amount did not exceed 8s. 6d. per ton, or 12s. 9d. per acre, the crop averaging about one and a half tons per acre. There was but slight heat, and no mouldiness visible when the shutters were removed to refill the silos; and it is also a fact worthy of notice that in the ensilage now used from them there is nothing to indicate where the later filling began. With regard to the cost of making ensilage of grass, as compared with that for the same weight of hay, we had no actual data to guide us to a definite conclusion. But I was desirous of getting some reliable practical estimate, and through the kindness of Mr. W. Biddell, M.P., of Lavenham Hall, Suffolk, and Mr. T. Gayford, of Wretham, Norfolk, gentlemen of great experience and ability as valuers, I have received particulars which enable me to state that in an average season the cost of making one and a half tons of grass into hay, stacking, and afterwards cutting into chaff, is from 25s. to 26s. per acre. From this it will be seen that our ensilage was produced at a saving of 50 per cent. on the cost of ordinary haymaking and chaff cutting.

Five months elapsed (Dec. 11) before we opened No. 1 silo. On removing the covering the thermometer registered 61°. This temperature obtained to a depth of about two feet, when there was a considerable fall, and still lower down it was quite cold. We fetched the ensilage over the top, until we had cut down a section sufficiently large to admit of the sealed door being opened; after which it was carried out through the doorway in the usual manner. Now, as to the quality of the ensilage. As you have seen, the grass we packed was very inferior to that used for the small Trial Silo in 1881-82. Yet there was such a marked superiority in the quality as to strike all of us with surprise. This improvement I attribute to three causes, viz.—not having cut or carted the grass in a wet state; using about 2lb. of salt instead of 1lb. to each cwt. of grass; not putting a layer of salt beneath the shutters before closing the silos. This year the ensilage is nicely moist; but no water can be squeezed from it, and it is quite free from mould. When first given them, the horses, cows, and young stock ate it readily, and have since continued to do so. The horses, to which we give one-third ensilage to two-thirds chaff, are doing remarkably well. This is especially true of one horse, a notoriously bad feeder, very squeamish as to its food. The team-man tried it with ensilage mixed with straw chaff, and now the "bad-doing brute," as the man described it when attention was called some time since to its low condition, feeds well, and is visibly improving. It should be understood, by the way, that the horses have the same allowance of corn now that they had before mixing ensilage with their chaff; but there is not one on the farm fed with it that does not eat it with relish.

VALUE OF ENSILAGE FOR DAIRY COWS.

In the early part of last year, when we gave ensilage to our cows, the dairymaid was so forcibly struck by the improvement in the colour of the butter, that early in November she asked me to allow one of the silos to be opened, in order that the cows might be fed with some of the ensilage food, so as to be sure of butter of superior quality and colour during the expected visit of their Royal Highnesses the Prince and Princess of Wales to Lord and Lady Walsingham. In case of any failure, however, I hesitated to grant the request, and finally decided that no ensilage should be introduced into the dairy until after the royal visitors' stay had terminated. But, in order to ascertain the effect of the ensilage on the cows, Lord Walsingham suggested, shortly before opening the silos, that the milk and cream, before and after the ensilage feeding, should be carefully tested, and the results tabulated. For this purpose I selected five pedigree shorthorn cows, which dropped calves on July 27, Oct. 27, Nov. 24, and two on Nov. 30, 1882. Previous to giving ensilage, each cow was daily fed with 6lb. of crushed oats and 3lb. of bran, mixed with chaff (composed two-thirds of barley straw and one-third hay). The five animals yielded, on Dec. 10, 68 quarts of milk, which the lactometer showed contained 12 degrees of cream. We commenced feeding with ensilage on Dec. 11, and the following tables give the daily diet and yield from Dec. 14 to Jan. 10. Besides the proportions of ensilage and chaff, the oats and bran were given as before in each instance.

$\frac{1}{3}$ Ensilage, $\frac{2}{3}$ Chaff.			$\frac{1}{2}$ Ensilage, $\frac{1}{2}$ Chaff.			$\frac{2}{3}$ Ensilage, $\frac{1}{3}$ Chaff.			$\frac{3}{4}$ Ensilage, $\frac{1}{4}$ Chaff.		
Date.	Milk.	Cream.	Date.	Milk.	Cream.	Date.	Milk.	Cream.	Date.	Milk.	Cream.
1882.	Qts.	Deg.	1882.	Qts.	Deg.	1882.	Qts.	Deg.	1883.	Qts.	Deg.
Dec. 14	70	13	Dec. 21	71	14	Dec. 28	72	15	Jan. 4	78	16
,, 15	70	13	,, 22	70	14	,, 29	72	15	,, 5	80	16
,, 16	70	13	,, 23	70	14	,, 30	74	15	,, 6	80	16
,, 17	70	13	,, 24	71	14	,, 31	74	15	,, 7	81	16
						1883.					
,, 18	70	13	,, 25	70	14	Jan. 1	76	16	,, 8	82	16
,, 19	70	13	,, 26	70	14	,, 2	76	16	,, 9	82	16
,, 20	70	13	,, 27	71	15	,, 3	77	16	,, 10	82	16

It will be observed that on Dec. 14, three days after the ensilage was first given, the milk had increased by two quarts with a rise of one degree in the cream. This went on until the 20th. On the 21st the cows gave seventy-one quarts of milk with fourteen degrees of cream, the latter showing another rise of one degree. On the 22nd and 23rd, and the 25th and 26th, they seem to have fallen back to the extent of a quart of milk per day, which was probably owing to the cold wet weather which we experienced at that time; but, on the 27th, the lost quart was recovered, the supply again reaching seventy-one quarts and the cream making a further advance to fifteen degrees. The quantity rose on the 28th another quart (seventy-two quarts) and on the 30th and 31st seventy-four quarts were registered, with no change noted in the state of the cream. New Year's day brought us seventy-six quarts and sixteen degrees of cream. On Jan. 4 another quart was gained; on the 5th and 6th eighty quarts were given; on the 7th, the return rose to eighty-one quarts; and on the 8th to eighty-two; these figures continuing to be recorded down to Jan. 10, when the test ended, and when the greatly improved quality of the cream had undergone no change. You will, therefore, see that when the month's trial concluded we had raised the milk return by fourteen quarts per day, and the quality of the cream to the remarkable extent of four degrees. You will further observe from a study of the tables that the increase in the quantity of milk, and improvement in the quality of the cream, correspond with an increased amount of ensilage given to the cows.

Before I turn from this branch of my subject, let me state that Lord Walsingham's trials have already borne fruit. His lordship's example is to be followed by a fine old English gentleman, who combines with a sound practical business mind a kind-hearted disposition, that makes him a model landlord. Lord Tollemache, of Helmingham, last week travelled all the way from his estate in Cheshire to inspect the Merton silos and their contents. He is specially interested in dairy-farming, and, being satisfied of the utility of the system, he has determined to at once construct four overground silos under one roof on the Merton plan, each to hold from twenty-five to thirty tons of ensilage. On Saturday evening his lordship wrote me as follows: "After seeing the silos and ensilage at Merton, I am more than ever satisfied of the importance of introducing that system, especially in a dairy county like this. Many thanks for the box of ensilage you kindly put up for me, which I intend to open for some leading tenants to see and examine the contents."

A Trial with Ewes.

Ensilage having been proved thus valuable as a food for dairy stock, it is only reasonable to suppose that sheep may be advantageously fed upon it. Still, experimental knowledge is demanded in this as in other cases. I am, therefore, glad to report that so experienced and well-known a flock-master as Mr. Thomas Gayford, of East Wretham, Thetford, has kindly undertaken to feed a small number of his sheep on ensilage, which I have supplied to him twice a week. From sixty ewes, which had been taken from the flock to get them forward in condition before lambing, he ran out ten for the trial. On the first day he served out to them, with other food, a peck of ensilage. At the outset they were evidently shy about taking it, but still they cleared it all out before night. The next day the same quantity was given, and eaten with less hesitation. On the third day the allowance was raised to two pecks, and it was consumed without any squeamishness whatsoever. At the end of a week the daily ration was raised to three pecks, and then and since they have evidently relished it, preferring it to fresh, sound turnips. As far as can be judged, the food agrees with them admirably. At all events the appearance of their coats has visibly improved, they have gained in condition, and they continue to do well all round. The shepherd reports most favourably of the food, and I regard his testimony as especially encouraging, because my knowledge of his class leads me to regard them as a very careful, cautious set of men, who are exceedingly slow in forming opinions of new methods, and rather disposed to look with disfavour than otherwise on any departure from the orthodox routine of feeding the flock. It is, of course, too early to tell what the influence of the ensilage will be upon the milk of the ewes. That can only be determined after lambing; but, by parity of reasoning, it ought not to fall behind what we have experienced with our pedigree cows. It is also to be especially remarked, that if sheep eat the food thus readily in such a mild, open season as the present, they would certainly do so during a severe winter, and in a cold, protracted, late spring—the time of all others when flockmasters most require a succulent, palatable food for their ewes.

Milk Analysis.

We were naturally anxious to test the quality of our ensilage milk by analysis, and on Jan. 9 we sent two samples to Mr. Francis Sutton, F.C.S., of Norwich, who, besides holding the position of County Analyst, is Analyst to the Norfolk Chamber of Agriculture, and whose high attainments are so widely known that I need not say another word about his qualifications. No. 1 sample was the milk of cows not ensilage-fed; No. 2 came from the five cows, the subjects of the test. The following is Mr. Sutton's report:—

	No. 1.	No. 2.
Pure fat	2·76	3·11
Sugar, casein, albumen, &c.	9·37	9·82
Water	87·87	87·07
	100·00	100·00
Mineral matters (ash)	0·70	0·75
Specific gravity at 60°	10·30	10·32

This analysis, you will observe, is in favour of the No. 2 (ensilage) milk in every respect. Whilst in pure fat there was an increase of 0·35, and in sugar, casein, albumen, &c., of 0·45, there was a decrease of ·80 water. Mr. Sutton also writes to me as follows: "From my examination of the ensilage, so far as it has now gone, I should be quite prepared to believe in its value as a milk-producing food owing to the great proportion of soluble nutrition in it. These results have fairly surprised me, and when you get them I feel sure they will have the same effect upon yourself."

It is a striking fact, not to be passed over, that two cows which had been fed with ensilage, on being deprived of the food for a couple of days, gave three quarts of milk less each day.

Analyses of the Ensilage.

As to the constituent properties of our ensilage, it would be beyond the province, and also the competency, of a layman to speak. Lord Walsingham, gratified as he might well be with the milk-pail returns of the cows, was extremely anxious to get as full and exhaustive analyses of the ensilage as possible. We therefore sent two sets of samples of the food to Mr. Sutton, and samples of hay made from grass of the same description as the ensilage, for the purposes of comparison. The first set (Nos. 1) consisted of ensilage made from grass, which I have described as grown in the wood, and hay from the same kind of grass. The second set (Nos. 2) comprised ensilage made from the coarse grass grown in the meadow near the wood, and hay made from grass cut in the same meadow. The results of the analyses are set out in the following table:

Analysis of Two Samples of Hay and Two Samples of Ensilage.

General Composition—Natural State.					Dried at 212° Fahr.			
	Hay No. 1.	Hay No. 2.	Ensilage. No. 1.	Ensilage. No. 2.	Hay. No. 1.	Hay No. 2.	Ensilage. No. 1.	Ensilage. No. 2.
Water	22·20	24·90	74·30	65·95				
Soluble organic matter	8·21	9·75	6·24	9·17	10·55	13·00	24·28	27·00
Soluble inorganic matter	4·05	3·15	1·78	1·88	5·20	4·20	6·92	5·55
Insoluble organic matter	61·04	58·50	16·91	22·18	78·50	77·85	65·80	65·05
Insoluble mineral matter	4·50	3·70	0·77	0·82	5·75	4·95	3·00	2·40
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Detailed Composition—Natural State.					**Dried at 212° Fahr.**			
Water	22·20	24·90	74·30	65·95				
Albumen and protein substances soluble in water*	0·73	0·88	1·60	2·12	0·94	1·17	6·22	6·23
Insoluble protein compounds†	5·03	7·09	1·41	1·43	6·46	9·45	5·49	4·20
Sugar, gum, and extractive matter soluble in water	7·48	8·87	4·64	7·05	9·61	11·85	18·06	20·73
Oil, wax, and chlorophyll, &c.	1·29	1·34	0·72	0·89	1·54	1·80	2·80	2·60
Digestive fibre	20·80	19·80	8·28	10·62	26·73	26·35	32·24	31·17
Indigestible woody fibre	33·92	30·27	6·50	9·24	43·74	40·25	25·26	27·14
Soluble inorganic matter	4·05	3·15	1·78	1·88	5·20	4·20	6·93	5·53
Insoluble mineral matter	4·50	3·70	0·77	0·82	5·78	4·93	3·00	2·40
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
*Containing nitrogen	0·115	0·149	0·255	0·336	0·149	0·186	0·992	0·990
†Containing nitrogen	0·755	1·120	0·221	0·226	1·020	1·490	0·860	0·665
Total percentage of nitrogen	0·910	1·260	0·476	0·562	1·169	1·676	1·852	1·655
Equal to total protein compounds	5·760	7·970	3·010	3·557	7·400	10·63	11·72	10·47

I take it that the satisfactory nature of these results is plain to the meanest capacity. But Mr. Sutton has rendered us, and I may say the whole agricultural community, essential service by appending a singularly lucid and able report to his analyses. The importance of his conclusions, in their probable bearing upon the ensilage controversy, could scarcely be over-rated. As to what those scientists who have formed hasty and dogmatic opinions upon confessedly insufficient data may have to say to it, and how far they may hereafter be constrained, by the hard logic of facts, to modify their views, we have nothing to do. They are matters into which it is not needful, nor would it be profitable, for us to enter now. In giving publicity to this report, all I would venture to observe, by way of note or comment, is that my practical experience in the management of live stock, extending beyond a generation of time, thoroughly confirms what Mr. Sutton has so intelligently expressed.

"REPORT ON THE ANALYSES OF HAY AND ENSILAGE.

"County Analyst's Office, Eastern Counties Laboratory,
London-street, Norwich, Jan. 17, 1883.

"The two samples of hay consisted of a variety of grasses, many of them of a coarse description and of poor quality, and were destitute of the sweet smell and taste which always accompanies well-made meadow hay of good quality.

"The texture of No. 2 was, however, preferable to No. 1, and the grass of a somewhat finer description.

"Both specimens of ensilage were, on the contrary, highly odoriferous from the development of the essential oils peculiar to the various grasses, and had also a vinous smell accompanied with a slight but pleasant acidity.

"The smell of essential oils was so persistent that after handling the ensilage for some time it became very difficult to remove the smell by washing. On distilling some of the material with water, these essential flavours were carried over into the distillate, but, though powerful, the quantity of actual oil was too small to be separated.

"The hay treated in precisely the same manner gave no trace of essential oils, or any flavour whatever except that of decaying grass.

"In addition to the detailed analyses recorded in the tables, the ensilages Nos. 1 and 2 were both examined for the amount of acidity; this was found to be very much the same in both samples, and, taking it as acetic acid, the proportion was found to be respectively 0·34 and 0·36, or about one-third of a per cent.

"The alcohol was estimated in No. 2 ensilage, and amounted to 0.055 per cent. by weight, or about one-tenth of a per cent. of proof spirit.

"These proportions are very small, and they arise, of course, from the conversion of a small proportion of saccharine matter in the original grass, but their development is open to no objection when kept within moderate limits; on the contrary, they add to the fragrancy and taste of the substance, and undoubtedly render it more acceptable and probably more digestible as a food.

"If the effects of the silo were only to render what would otherwise be a tastleless, dry forage into a fragrant, appetising, and succulent food, it would be a decided step in advance; but the analyses will show that much greater changes of a beneficial nature occur during the process. These changes are especially shown in the large proportions of soluble flesh-formers and fat-producers as compared with the hay.

"For instance, in the case of No. 1 ensilage, the soluble albumenoids (or flesh-formers) are increased more than six times, and in No. 2 more than five times; while, in the case of sugar, gum, and extractive matters, the proportion is nearly doubled in both instances.

"The digestible fibre is also increased fully 20 per cent. in both samples of ensilage.

"These facts are of great importance, and well worth the attention of all stock-feeders, as it is evident that the occurrence of these nutritious constituents in a really soluble form is so much labour of mastication and digestion saved to the animals who are fed on such food, as compared with dry hay.

"The change induced by the silo is, in fact, a partial digestion or limited fermentation; and undoubtedly such food will prove much easier of digestion and assimilation than crude hay.

"There are apparently two anomalies in the figures of analysis which it may be proper to notice. The first is the apparent increase in fatty matters in the ensilages as against the hays; this probably arises from matters like chlorophyll, &c., which are converted into a less soluble form in the process of drying through which the hay has passed.

"The second is the amount of nitrogen in No. 1 ensilage as compared with its hay.

"The total protein compounds (flesh-formers) are recorded as being 4 per cent. higher. This can hardly be the fact, as, of course, the silo has no power to originate nitrogenous constituents; it can only modify them. The difference probably arises from one of two things—either that the sample of ensilage taken for analysis contained rather more of the seed vessels or other richer nitrogenous portions of the plant than the corresponding sample of hay, or it may be due entirely to the different periods of growth.

"In conclusion, it is abundantly evident, so far as these analyses can show, that the silo has produced a succulent, easily-digestible food, full of aroma and nutrition, from a very poor quality of grass.

"FRANCIS SUTTON,

"Chemist to the Norfolk Chamber of Agriculture."

IRISH EXPERIMENTS WITH ENSILAGE.

(*The Field*, Jan. 13, 1883.)

PROFESSOR CARROLL has issued his official report on some experiments carried out on the model farm of the Albert Institution, Glasnevin, in accordance with the desire of the Lord Lieutenant of Ireland (Earl Spencer), who frequently visited the farm while the experiments were in progress. The full report was published in the *Irish Farmers' Gazette*, from which we make a few extracts. After referring to certain adverse opinions on the subject of ensilage, Professor Carroll says:

I am of opinion that the successes of the Continental and American farmers are sufficient to warrant our trying it on an extensive scale in these countries, and the measure of success of our experiments at the Albert Farm strengthens my opinion on this point.

Referring to the opinions adverse to its adoption here, I would suggest, First, as regards our cultivated plants not being suited for ensilage. There can be no doubt that grasses of various kinds are well adapted to the process, and on a large range of soils—especially peat—Italian rye-grass yields a large produce. Rye, too—a crop which may be profitably cultivated on our poor, cold soils—is well suited to the system. I believe that many of the indigenous grasses—notably fiorin (Agrostis stolonifera)—will be found to yield a large quantity of suitable fodder, and that if the system were adopted much green fodder now lost would find its way into the silo, to be profitably consumed by cattle. Doubtless, too, we should find that if the silo became an institution a large introduction of forage plants would take place—many varieties of the sorghum being particularly suited to the system—and more attention might also be given to the cultivation of maize in the districts suited by climate for its growth.

Again, it may be found by future experiment that the costly system of root-growing may give way before a less expensive system of growing other provender for ensilage, and that the produce of grass or other ensilaged fodders may exceed in nutritive matter a much heavier crop of roots. These are matters for future experiment, to be carried out under the direction of practical and scientific men.

Respecting the opinion that the chemical changes which take place during the slight fermentation of the fodder are injurious to it as food, I cannot help thinking that this opinion has been arrived at in too summary a manner.

I may say that I consider the matter has the largest interest for the dairy farmer, foreign experience having shown that ensilage has increased the yield of milk in dairy cows very considerably, and that the objectionable flavouring of milk and butter which results from the consumption of roots is avoided where ensilage is substituted.

The information as to the *modus operandi,* given below, is not so complete as is desirable. There is nothing to show what, if any, weight was put on the fodder ; yet it is difficult to see how the silo could otherwise be made air-tight. The experiments were as follows :

On the 25th of July the fodder was cut.

No. 1. Lucerne and straw chaffed and put into a silo about five feet deep, and lined with boards, so as to make it air-tight and water-tight.

2. Comfrey and lucerne chaffed, with a very small proportion of oat straw, and put into a similar silo.

3. Italian rye-grass, not chaffed, packed tightly into a silo.

4. Italian rye-grass, not chaffed, packed tightly into a silo which was simply a pit dug in the ground, without any protecting casing or lining.

5. Italian rye-grass packed tightly on the surface of the ground, and covered with about eighteen inches of earth in a manner similar to a "potato pit."

On the 9th of October the silos were opened, and the following was the result :

In numbers 1, 3, and 4 the fodder had a temperature of about 75° Fahr. ; it was apparently in good condition, having a smell somewhat like fresh brewer's grains. The cows on pasture, as well as those which were being house-fed, ate this food with avidity.

In number 2 the comfrey and lucerne were quite spoiled ; the colour had not been much altered, but the smell was most offensive, and the mass appeared to be quite putrid.

No. 5, the Italian rye-grass, was quite dry, but mouldy, and perfectly unfit for food.

The particulars of the analyses are not so clear as could be wished, the two specimens of ensilage not being identified with the experiments to which they belong. Thus, ensilage No. 1 and No. 2 cannot have come from silos No. 1 and 2, and would appear to be samples of the Italian rye-grass from silos 3 and 4. The difference between them as regards water and other ingredients probably arises from the one having been kept in a water-tight silo, and the other in an unlined hole dug in the ground but there is no evidence to show which is which. Dr. Cameron says:

The specimens of ensilage were in a state of fermentation when they were brought for analysis. The specimens were at once subjected to a temperature of 212°, and kept thereat till dried, which prevented further fermentation.

It is noticeable, first, that the albumenoids are less in the ensilage than in the original grass; that the water is much the same in quantity in all the samples; that the amount of soluble non-nitrogenous matter is greater in the ensilage than in the grass from which they had been prepared; that the amount of ash is greater in the ensilage than in the grass.

COMPOSITION OF ENSILAGE AND OF THE GRASS FROM WHICH IT WAS MADE.

100 parts contain—	Grass when cut.	Ensilage No. 1.	Ensilage No. 2.
Water	68·20	66·50	68·10
Albumenoids (nitrogenous substances)	2·83	2·76	2·60
Non-nitrogenous substances, soluble in acids and alkaline solutions	13·42	15·20	14·82
Insoluble in ditto	11·73	11·37	10·13
Fats	0·76	0·77	0·75
Mineral matter (ash)	3·06	3·40	3·60
	100·00	100·00	100·00

As it may interest some of our readers to compare these analyses with those which appear in other pages, we have recalculated the percentage on the *dry substance* only, when the variation in the solid matter will be more readily seen than when the differing quantities of water are included.

100 parts of dry substance contain—	Grass when cut.	Ensilage No. 1.	Ensilage No. 2.
Albumenoids	8·90	8·24	8·15
Non-nitrogenous substances:			
Soluble	42·20	45·37	46·46
Insoluble	36·89	33·94	31·76
Fats	2·39	2·30	2·35
Ash	9·62	10·15	11·28

It will be observed that there is a decrease in the albumenoids; and a decrease also in the insoluble carbo-hydrates, which are frequently designated "indigestible fibre." Here a portion has evidently been rendered digestible, as the ensilage contains a larger percentage of soluble carbo-hydrates than the grass did when cut. Unfortunately, in these as in the general run of agricultural analyses, there is no information as to the nature of the changes that have taken place, as all the soluble non-nitrogenous substances are lumped together in one batch. Whether, and to what extent, starchy matters have been changed into sugars, sugars into alcohol, and alcohol into acetic acid, cannot be seen; and yet it is most probably owing to these changes that the forage is rendered, to the animals which feed on it, so palatable as it evidently is.

A SCOTCH EXPERIMENT WITH VETCHES, &c.

(*Glasgow Herald*, Feb. 19, 1883.)

On Saturday about thirty members of the Glasgow Agricultural Society met in the offices of Messrs. Inglis and Todd, the Secretaries, in St. Vincent-street, and drove to the farm of Whitehill, near Maryhill, tenanted by Mr. Imrie, where a silo was to be opened. The experiment at Whitehill is, we believe, the first that has been made in Scotland. Like many other farmers Mr. Imrie had seen various references to ensilage, and the benefits it was fitted to confer on the farmer, and being of an experimental turn of mind, he thought he would try what he could do in a rough way. He had previously arranged to build a pit to hold draff for the use of the cattle during the winter months, and this he determined to utilise for a trial of the ensilage process. The silo is about 11ft. long, 9ft. broad, and 10ft. deep, and is partly under ground. It is built of brick and lime and pointed with cement, and at the bottom there is a drain with a sort of trap. Mr. Imrie had read that wet grain could be utilised in the manner proposed, and on a rainy day at the end of September or beginning of October he cut down a quantity of fully half-ripe vetches, corn, and beans, put them through the chaff-cutter, and converted them into what is known as "mashlam." Dripping wet, he put the material into the pit, and tramped it all down firmly. This operation was continued next day, and the same tramping process was resorted to in order to bind the material together. As the "mashlam" was not sufficient to fill the silo, Mr. Imrie placed on the top a layer of beans and corn, which were fully ripe, and had been dried and stacked before being put through the chaff-cutter. He also mixed about half a hundredweight of salt with the forage. After the mixture had undergone a thorough tramping, a covering of about two feet of heavy clay was put on, and the silo closed. Whether from insufficient weight or from some other cause, the ensilage became depressed all round the sides of the pit, leaving a slight cone in the centre. In this condition the silo was allowed to remain till Saturday—Mr. Imrie taking care, of course, that any cracking or opening of the clay was at once closed.

The opening took place on Saturday, and the strong flavour that was emitted as the process of turning off the clay went on told that a change of some sort had come over the forage stored therein. The top layer, which was that of ripe corn and beans cut up by the chaff-cutter, had a strong sour odour, but after that was removed, and the layers of half ripe mashlam were reached, there was a perceptible diminution in the strength of the odour, and it was admitted that the ensilage was pretty fresh. Some of the farmers present thought the flavour was that of English hay, while others thought it was rather stronger, and more resembled draff. It had evidently undergone a slight fermentation, and at one of the sides there were signs of heating, and that somehow or other moisture had managed to find its way through the clay into the pit. Of course, Mr. Imrie explained that the material was placed in the pit in the worst possible condition. The best test, however, was to see whether the cows would eat it. Unfortunately, through inadvertence, the servants had been allowed to give the cows their midday meal, and in these circumstances it was just a question whether any of them would look at it. A portion was placed before several cows, and though one or two did not seem to relish it others ate it at once, and seemed to like it.

Though not so successful as could have been wished, the experiment was sufficient to show that the process could be carried out even in this country. It was admitted that Mr. Imrie had placed insufficient weight on the silo, and the drain in the bottom of the pit was deemed to be an evil, as through it air may have reached the stored material. Another thing against the ensilage was that the vetches, beans, and corn were half ripe before being cut, and that an experiment in which the pit was made completely air and water tight, the crop green and not damped by rain, would be most successful. Under the circumstances in which Mr. Imrie made his attempt, the result was considered very satisfactory, and likely to lead to other experiments being made next year.

ENSILAGE OF GREEN RYE IN ESSEX.

(*Agricultural Gazette*, Nov. 20, 1882.)

A COVERED yard, in itself one of the best agricultural economies of recent adoption, is, in the instance to which we are about to refer (as an example of a still more recently advocated economy) enclosed on two adjoining sides by a cow byre; and immediately adjoining this, along one side of the square which we are describing, there are a succession of five cubic tanks, made of concrete, each of them 12ft. by 14ft., and 12ft. deep. They cost 150*l*. altogether. The concrete, some 6in. thick, provides a ceiling as well as walls and floor, and there is a manhole in the centre over each. These tanks are so many silos.

A crop of rye, just coming into ear last June, about eighty tons in all, was cut into chaff (about ¾in. stuff) in the field, bagged and brought to these tanks, there filled in as rapidly as possible, and trampled down by man and boy as the work was going on. The whole took seven days to do, and the manholes were well covered up with puddled clay, one after the other, after as much as possible had been crammed into the silo to which each belonged.

When we visited the farm, last Tuesday, one of the silos had been already emptied. Twenty-four cows had been having a bushel a day apiece of the ensilage, along with a couple of cartloads of white turnips, spread on the pasture where they were daily turned, and a truss of hay to every four in the covered yard where they lay at night. The cows looked well, and were doing well, yielding various quantities of milk, from fifty-two pints a day (?) just newly calved, to little more than a gallon as they were drying off, after being nine months at the pail. The second silo—there is a doorway in the separating wall of concrete—was then being used, each being gradually emptied over its whole surface from the top downward.

The day's portion had been taken out, and was lying on the floor of silo No. 1, as we could see by the light through its manhole, which had been opened. It looked like chop of rather heated hay: it handled as straw-chaff which had been damped, and got nearly dry again, might handle: it smelt not disagreeably of the slight fermentation it had undergone; and it tasted—well!—the cattle had just had their feed, but they were still standing before their well-cleaned troughs, and a skep of the stuff being placed before them they readily, after an experimental sniff, and greedily attacked it. The whole contents of the tank, except about 6in. of the top layer, when first opened is good fodder. That and some 2in. or 3in. round the wall was mouldy: the rest was wholesome, palatable fodder. There was no heat in the mass, though any quantity of it loosely thrown together heated readily enough.

Here, then, was an unquestionable example of success in ensilage. A crop of rye grown for spring fodder was got off in time for the intended turnip crop to follow it. The last unused portion, which would have had to stand as grain, and upset the system of cultivation on the farm, was retained for its intended use by this means; and provided, five months after date, uncommonly good cow food without any anxiety about harvesting or haymaking. Mr. Edmund Gibson, of Saffron Walden, to whose farm we are referring, is strongly of opinion that only green stuff of the kind of this almost strawy rye is available for use in this way. We confess we had expected, on opening a silo some six months after it had been filled, to find a mess not very pleasant either to handle or to smell; and probably green clover, comfrey leaf, lucerne, and other succulent growths, treated in this way, would end in a rather unpleasant mess to handle, whether palatable or not to live stock; but rye cut in the stage just before the ear is fully formed has already a quantity of woody fibre, and would dry almost as straw, certainly as very coarse hay; and trampled together without being dried, in a pit afterwards hermetically sealed, it comes out looking, smelling, tasting, handling as we have just described—very good stuff indeed, according to the verdict which the cattle give, and they are the only jury whose verdict need be sought.

Dr. Voelcker's analysis of the ensilage in this case shows that there is rather more than 72 per cent. of water still present in the stuff, and only 2·13 per cent. of ash; thus indicating that no great loss had taken place since the month of June, when the pits were filled. The presence of 8 per cent. (? 0·8) of lactic acid was, we presume, the most noteworthy illustration of the change of composition that had been experienced. There was 2 per cent of albuminous compounds containing 0·3 of nitrogen, and there was 12·8 per cent. of mucilage and digestible fibre, and 9·7 per cent. of woody fibre.

ENSILAGE OF TRIFOLIUM IN KENT.

Messrs. Carter and Co. of High Holborn, writing to the *Agricultural Gazette* of Jan. 29, 1883, as follows: "A few days since we visited Mr. Hoare's silo at Pagehurst Farm, Staplehurst, and had some interesting conversation with Mr. Austen, the bailiff, a thoroughly practical and well-informed man. The capacity of the silo may be described as two 10ft. cubes, separated by a wall of the same material as the surroundings walls, the contents being about 50 tons of trifolium, the produce of three acres The crop was carted straight to the chaff-cutter, and, being chaffed, was trodden well down in the silo, no interval being allowed. There is a drain from the silo, but Mr. Austen has never seen anything come from it, nor has he observed any sign of heating. The ensilage is cut out with a hay knife, and cuts like a good solid hayrick. It comes out nice and moist, and no cattle have yet refused it, although if fed upon it exclusively for a considerable time, they are apt to tire of it, so that it is mixed with chaffed hay, and makes very good feed. Mr. Austen thinks there is certainly more fodder in the ensilage than in the same crop made into hay. If such a succulent plant as Trifolium incarnatum can be made into good ensilage, there seems but little reason for doubting that any of our forage crops may be as successfully treated."

ENSILAGE OF GREEN OATS AT ORWELL PARK.

Mr. Henry Woods, in his Norfolk lecture, gives the following particulars of Colonel Tomline's silo: "One other case nearer home; from Colonel Tomline's model farm, Orwell Park, in the neighbouring county of Suffolk. In the early part of last year a silo, 26ft. in length, and 12ft. in width and height, was built under the side of a hill, with an opening at each end; one for filling, which was on the ground level, and the other for extracting the fodder. The walls and floor were of concrete (the former a foot or more in thickness). In July, the produce of eleven acres of oats, in the green state, was passed through the chaff-cutter, and stored in the silo; eight men being engaged upon the work, which was carried on in showery weather, and completed on August 12. The covering consisted of three loads of grass and one load of straw, and planks weighted with boxes filled with stones, bricks, and shingle—about 15 tons altogether. On the 1st of December the silo was opened. The outer coating of the ensilage was mouldy and rotten, but beneath it was bright, cool, and moist, and gave off a strong alcoholic odour. It was mixed with about an equal quantity of chaff, and given to the stock. Some took to it at once, others, more fastidious, at first touched it daintily, but they soon acquired a taste for it, and ate it with avidity. With regard to the effects of the food upon the cows, Mr. Henry Stevenson, the farm bailiff, reports as follows: 'The milk which the cows gave was vastly improved, the cream was thicker, and the butter came out a beautiful rich, natural colour, and of very fine flavour, rivalling in sweetness that which is produced from cows fed on the finest pastures in the early spring.'"

EXPERIENCES OF A TYRO IN WALES.

(*The Field*, July 22, 1882.)

My attention was first called to the subject by reading accounts of its successful practice in the United States, as described by various correspondents of the *Farmers' Review*, a capital little paper published at Chicago, and sent to me by a friend in Illinois. Accordingly, while waiting for the weather to clear up for haymaking last summer, the men were set to work to dig a large and deep pit in the stackyard, near the edge of a bank which dipped abruptly down to a stream below. The subsoil here appeared to be a stiff clay, and this, in addition to the favourable situation for drainage, constituted one of the chief reasons for selecting the spot as the site of my silo, as it is called.

I hoped that the clay might prove sufficiently firm and cohesive to enable me to dispense with a lining of stone or brickwork. Such, however, was not the case; for, after getting down to a depth of eight or nine feet, the sides, owing probably to the heavy and continued fall of rain, commenced to slip in here and there. A facing of brick or stone work was absolutely necessary, and accordingly two or three truck-loads of common red bricks were procured, and masons engaged to lay them in cement and sand, mixed to a proper consistency with water. The facing was only one brick thick on two sides and part of the third, but where the sides showed the greatest inclination to cave in, two courses of bricks were laid. Great care was taken to form the pit perfectly rectangular, and to carry the walls up plumb, in order that the lid, to be described presently, might not be prevented from moving evenly downward as the contents subsided. At each of the four corners the brickwork was continued upwards in the form of pillars, to support a light roof. When completed, the dimensions of the silo or vault (inside measurement) were as follows: Length, 11ft. 9in.; width, 10ft.; and depth, 11ft.

I ought to mention that, a little water having been met with near the bottom of the pit, the foundations of the four walls were made to do duty as drains likewise, by the expedient of placing the bricks of the lowest courses on their edges, so as to leave a space of about 2½in. between them. The next course being laid over, and at right angles to them, formed a cover to the narrow gutter or drain thus created, and on this the brick wall or facing was built. An outlet for the water was made by cutting a short drain (afterwards tiled and refilled) from the stream already mentioned to the lowest corner of the foundation. Slate flags laid on mortar, and joined together with cement, formed a good floor to the pit, which by these means was kept quite free from water, without allowing any air to leak in from the drain—a most important matter; indeed, my excuse for entering so minutely and at such length on the construction of the silo, is the paramount necessity of making it thoroughly air-tight; in fact, this is the main condition of success.

At last, on the 24th of September, 1881, after many interruptions to the work by reason of the very unsettled weather, which caused the hay harvest to "drag its slow length along" from the beginning of July to the end of September, all was ready, and we commenced to fill the large tank-like receptacle with cut grass from some four or five acres of good meadow, which had been reserved for the purpose, and which, from being shut up so long, was a very heavy crop. The grass was mostly cut by a two-horse mowing machine, and at once collected into heaps or cocks and carted home. Here it was cut up by a Bentall's chaff-cutter, geared to one inch cut and driven by water power, as fast as three or four men could feed and clear away from it. Other men, provided with large baskets or hampers, carried the cut stuff away to the silo, where it was spread evenly about and well trampled down by a woman and three or four boys, with now and then the assistance of an extra man or two when the grass was being thrown in very rapidly. In this manner about nineteen cartloads of grass were stored away. The lid or cover was then put on. This is constructed of 1½in. planks, and made in sections of about 3ft. 10in. in width; the planks ploughed and grooved and strongly battened, with the battens projecting, so as to overlap and cause all the sections, under equally distributed weight, to move downward together. A quantity of spare bricks were deposited equally over the surface of the lid, and the whole left to settle down. In a couple of days the green stuff had subsided considerably, and by fixing up a sort of movable frame of planks around the top of, and flush with, the brickwork, we were able to cram in seven loads more grass. The lid was then finally put on, and brickbats and stones heaped on top to a considerable depth—probably three tons weight. When the mass had settled down below the level of the pit mouth, the temporary frame was removed. Thus, twenty-six cartloads of grass, estimated to weigh from twenty to twenty-four tons, were pitted by Oct. 4.

Although most of my friends took a kindly and even enthusiastic interest in the experiment, such an unusual method of preserving grass for winter consumption was looked upon by many of my less educated neighbours as the height of folly, and their remarks on the whole proceeding were far from flattering or encouraging. It was not without some display of firmness even, that my own men could be induced to commence digging the pit—partly, no doubt, from a laudable desire to save their master's credit, and partly, perhaps, from fear of themselves sharing in the ridicule which the project would be likely to excite. Curiously enough, though the prophets of evil all predicted the certain failure of the experiment, they were by no means so unanimous as to the cause of failure; for while some maintained that the grass would be sure to heat and take fire, others as confidently asserted that it would be sure to rot and turn to manure. One of the extra hands, who was assisting to throw in the cut stuff, remarked to the foreman that "he was not very well off, but he dare bet the master all the money he had that the grass would all be found perfectly rotten when the pit was opened in winter!"

As it was so late in autumn when the silo was filled, we did not open it until Feb. 6, an interval of rather more than four months, in order to give the plan a thorough trial. At last the eventful moment arrived, and as the men commenced to raise a section of the cover, we noticed some dark mouldy-looking stuff round the edges; whereupon my honest Welsh foreman, who had hold of one corner of the lid, ceased lifting, and at once began to bring to my remembrance how he had always warned me that the grass would be sure to "spooil." "It certainly does not look very encouraging, so far," I said; "but lift the lid right off, and then we shall see what has happened to it." In a few moments the heavy section was completely removed, and then a loud exclamation of "Well, *diawk!*" from the man expressively announced his astonishment at perceiving the true state of affairs. Except for a little distance round the sides and about the edges, at top, the grass was perfectly preserved, and little change in appearance from what it was when pitted. On being handled it gave out a strong though not unpleasant odour, reminding one of the smell of steamed hay, only more pungent. Cattle quickly took to it, and, as they became more accustomed to its peculiar flavour and smell, appeared to relish it greatly.

Although no trial was made of the feeding value of ensilage in comparison with hay or other fodder, we were satisfied that it was a wholesome and useful kind of food for cattle of any age. A lot of yearling calves were particularly fond of it, and seemed to thrive well on the preserved grass. Milk cows were found to require a little cotton cake, bean meal, or other concentrated food in addition, to keep up the quality of the milk and make rich cream. On the other hand, the butter had more of the colour, if not flavour, of that from grass-fed cows, than was the case before using ensilage.

There was one drawback to the complete success of the experiment; the edges of the mass of cut grass were mouldy and unfit for food, for a thickness of several inches from top to bottom of the pit. In some parts not more than an inch or so next the brickwork was spoilt, while in other places the damage extended to a foot in width. There are two theories which might perhaps be advanced to account for this state of things. First, that the pit is in too damp a situation; and, secondly, that the brickwork, being only pointed and not covered with Portland cement, may not possess a sufficiently smooth surface to insure the regular settlement of the contents. I incline to the latter as the most plausible conjecture, and it is borne out by a statement of M. H. Cottu's (of Indre-et-Loire, France) in the *Agricultural Gazette* last year. He says, in describing his pit, "the sides are perfectly vertical, the four corners being slightly rounded; the whole is coated with Portland cement, thus insuring a perfect settlement of the contents, upon which depends the preservation of the fodder." Probably, however, it is the two defects above-mentioned, conjointly, that cause the mischief in this case. To remedy one of them, at all events, I purpose having the brickwork coated with cement before proceeding to refill the pit. Unless a perfectly dry gravel or sand bank is to be found in a convenient situation for the proposed silo, I am convinced that it would be better, in a comparatively damp climate like ours, to construct it entirely above-ground; of course, taking care to make the walls sufficiently strong by means of buttresses or other contrivances, to prevent any danger of their being forced outward by the pressure from within. I will only remark, in conclusion, that, as the process becomes better understood, it must prove of considerable advantage to owners of stock in Great Britain, as it has already done elsewhere. When it is considered that, by such a simple process, the heaviest grass or other forage crops can be preserved for winter use in the wettest of seasons, its value is plainly perceived.

Brynllwydwyn, Machynlleth. C. R. KENYON.

FEEDING EXPERIMENTS IN FRANCE.

(*Agricultural Gazette*, Sept. 5, 1881.)

SEEING that the question of "ensilage" is being discussed, I take the liberty of sending you the results of a constant and exclusive use of this mode of using food during the past six years. I have preserved in silos, with perfect success, all kinds of forage plants, both separately and mixed with cereals, maize, &c., cut green. I give further on the analysis made at an agricultural laboratory, with regard to its nutritive character. In my opinion, the principal advantage of this method is to enable you to regulate the feeding of animals in a perfectly systematic manner, and in accordance with the scientific and physiological rules.

Before using the contents of the silo, a sample of the material is taken and analysed, and the ordinary allowance is made up with concentrated food (meal, oilcake, grain) in such a manner as to meet and obviate the inevitable differences in the value of the same fodder for one year to another, and also so as to make the ration up to that degree of strength necessary for its intended purpose. Thus there is no waste, and only so much added food used as is necessary. My pits are three metres deep, two metres wide, and ten metres long (= 10ft. by 6½ft. by 33ft.) ; the sides are perfectly vertical, the four corners being slightly rounded ; the whole is coated with Portland cement, thus ensuring a perfect settlement of the contents, upon which depends the preservation of the fodder. The forage, wet or dry, is brought from the field where it has been cut with the mowing machine, and it is cut up as soon as possible, and gradually trodden down by the women who are in the pit to spread it out evenly.

The pit, when once filled, is covered with a layer of chaff or straw some 3in. or 4in. thick ; over all you place planks cut to the size of the pit, which are covered with stones to the weight of 500 kilogrammes a square metre (100lb. per square foot). For the working of the pit, you uncover and empty its contents according to the rate of consumption. During the chaffcutting a little salt is added—not to preserve it, but to provide food ready salted to the animals, and to avoid the trouble of renewing the piece of rock salt otherwise given.

I have thus pitted rye, oats mixed with vetches, sainfoin, lucerne, maize, beetroot, and, lastly, Jerusalem artichokes, leaves and tubers separately. I do not doubt the success of a pit of red clover ; and as to the statement that maize will not grow in England, I think that my latitude (47° 20′) is not so very far from yours, and I get maize measuring from 9ft. to 10ft. high ; I have seen it the same height in Normandy (48° 30′), at M. le Comte Rœderer's, where I went to see the practice of ensilage. I sow towards June 15, when there is no fear of frost, and I cut at the beginning of October each year, and I have previously had upon the same ground a cut of rye, oats, or vetches, cut and pitted green about May 20, the manure being put on at the time the cereal is sown, one hectare of seed thus producing in a year as much as 140,000 kilogrammes of green fodder (= nearly 56 tons per acre).

If maize cannot be grown successfully in England, certainly Jerusalem artichoke would succeed. Its culture is of little expense, and its yield considerable; and preserving it at the end of October, as soon as the flowers appear and the leaves, you have an excellent food which cattle like, and which is equal to maize in the value of its nutritive richness. In December the tubers are taken out, washed, cut up over the pit, and mixed with a small quantity of straw, and chopped up so as to absorb the juice.

Here, then, are the analyses of different pits, all having perfectly succeeded in preservation, and all being consumed with the same eagerness by the animals. The calculation is made upon a hundredth part of the analysed matter :

	Oats and Vetches.	Maize. 1877.	Beetroot. 1877.	Rye and Vetches. 1878.
Water	69·000	83·000	76·340	70·966
Ash...........................	4·540	1·335	2·050	3·000
Nitrogenous matter.........	2·330	1·187	1·900	3·125
Fat...........................	1·300	0·476	0·450	1·260
Non-nitrogenous matter ...	13·690	9·616	13·270	10·999
Cellulose	9·140	4·386	4·500	10·650
Nitrogenous matter .... / Non-nitrogenous matter ...	$\frac{2·330}{16·940} = \frac{1}{7·2}$	$\frac{1·187}{10·806} = \frac{1}{9·0}$	$\frac{1·900}{14·395} = \frac{1}{7·5}$	$\frac{3·125}{14·299} = \frac{1}{4·5}$

	Sainfoin 1878.	Artichoke leaves. 1879.	Artichoke tubers. 1879.	Maize 1880.
Water	74·490	65·100	78·500	77·750
Ash...........................	2·870	3·980	2·610	1·760
Nitrogenous matter.........	4·570	2·380	1·620	0·980
Fat...........................	0·610	0·430	0·230	0·380
Non-nitrogenous matter ...	11·390	20·780	14·780	13·900
Cellulose	6·070	7·330	2·260	5·230
Nitrogenous matter .... / Non-nitrogenous matter ...	$\frac{4·570}{12·950} = \frac{1}{2·8}$	$\frac{2·380}{21·855} = \frac{1}{9·18}$	$\frac{1·620}{15·355} = \frac{1}{9·4}$	$\frac{0·980}{14·340} = \frac{1}{14·9}$

Here is the case of a ration made up with concentrated food to the desired strength for a full-grown beast, the value of the fodder being calculated after the tables of Gohren:—

	kilo.		kilo.	
Ensilage of Rye	40	Nitrogenous matter ...... =	2·023	$\frac{2·023}{8·19} = \frac{1}{4·1}$
Malt.....................	3	Non-nitrogenous matter =	8·19	
Palm-nut cake.........	6·500	Fat .... =	0·732	$\frac{0·732}{2·023} = \frac{1}{2·8}$
"Touraillon" (?) ...	2	Nitrogenous matter ...... =	2·023	
Straw	3	Total dry matter .... =	17·123	

The cost of the ration is 49c. (= 4¾d.) a head per diem.

	kilo.		kilo.	
Ensilage of maize (1880)	45	Nitrogenous matter ...... =	1·846	$\frac{1·846}{9·550} = \frac{1}{5·1}$
Malt	2	Non-nitrogenous matter =	9·550	
Palm-nut cake	1	Fat .... =	560	$\frac{560}{1·846} = \frac{1}{3·01}$
"Touraillon" (?)	3	Nitrogenous matter ...... =	1·846	
Straw	2	Total dry matter .... =	16·798	
Bran	1			

The cost of this ration is 63c. (= 6*d.*) a head per diem.

All the rations of concentrated food are weighed at each meal. Finally, to prove the excellence of this *régime* here are the successive weights for eight days of two sorts of beast brought up on this preserved food.

A.—Heifer calved March 22, 1880; weighed at birth 43 kilos. (95lb.); weaned at two months (May 30), she weighed 136 kilos. (299lb.). Here are the weekly weights from that time: 139, 144, 155, 160, 167, 173, 187, 197, 205, 218, 230, 242, 250, 260, 266, 281, 296, 295, 304 (Oct. 24), 309, 313, 314, 319, 330, 335, 340, 349, 350, 360 kilos. (January 9, 1881). To-day the beast weighs 528 kilos. (1162lb.), aged 16 months.

B.—Bull calved June 27, 1880; weighed at birth 66 kilos. (145lb.); weaned at two months (Aug. 29), he weighed 143 kilos. (315lb.) His weights are as follows: 152, 162, 170, 176, 184, 200, 205, 216, 225, 232, 240, 243, 251, 258, 270, 275, 281, 284, 298 kilos. (Jan. 9). He was not weighed January 16 or 23, 1881. Again on January 30: 305, 324, 327, 334, 341, 351, 363, 381, 389, 405, 410, 430, 448, 447, 455, 465, 470 kilos. (May 29, 1881). The animal is sold now at a show; I get 600fr. (24*l.*) for it.

Upon the whole, "ensilage" is, in my opinion, the most economical, the most scientific, and the most remunerative way of keeping animals; it lessens the labour, one man being sufficient to attend to twenty-eight cattle. It gives the animals a uniform food, and consequently they are in perfect health; I have never for six years had any illness in my stalls. Finally, with regard to the preservation of fodder, it is invaluable.

H. Cottu.

Au Châteaux de la Touche, par Azay-le-Rideau,
Indre-et-Loire, August 20, 1881.

[The metre is = $39\frac{1}{3}$ inches, hectare = 2·47 acres, kilogramme = 2·2lb.; 2500 kilos per hectare are almost exactly 1 ton per hectare, so that, by multiplying the number of kilos by 4, and striking off four 0's the number of tons per acre is readily estimated.]

EXPERIMENT ON THE FEEDING PROPERTIES OF ENSILAGE.

(From the *Field* of Feb. 10, 1883.)

The following particulars of an experiment carried out by Professor W. A. Henry, of the Agricultural Department of the State University of Wisconsin, are quoted from the American *Cultivator and Country Gentleman*—except that for the sake of more easy comparison, we have set out the figures in tabular fashion, and have calculated the percentages appended below:

"To-day (Jan. 10) Professor Henry spoke on ensilage. Beginning his experiments last year with a prejudice against the new system of securing fodder crops, he has been converted to its favour by the logic of facts. During the past season an experiment was made with a wooden silo built in a side hill at a cost of $18, being built of old lumber, of which no account was made. Thirteen rows of maize were cut on Sept. 6, and put into the silo, making 21,000lb. of ensilage. The same number of rows of maize were cut and shocked. In November and December four new milch cows were selected; two of them were fed on ensilage for twenty-one days, and the other two were fed on the dried fodder, which had been under cover ever since it was well cured. At the end of twenty-one days the cows were changed, and those fed on ensilage before were now fed on fodder, and *vice versâ*.

"During this test each cow, whether on ensilage or dried fodder, received 1lb. of Indian corn meal, 1lb. of wheat bran, and 1½lb. of oil meal at each feed, morning and evening. Each cow had all the ensilage or dried fodder she would eat up clean. The cows were fed, watered and milked at the same hour each day, and every means was used to make the test complete and fair. The results in milk, and in butter churned therefrom, were:

	Milk.		Butter.	
	lb.	oz.	lb.	oz.
Ensilage (*plus* meal) produced	1456	8	59	8½
Dried fodder (*plus* meal) produced	1322	15	53	3½
Increased produce from ensilage	133	9	6	5

"The test continued forty-two days. At the rate the food was consumed, the thirteen rows of maize cut into fodder would have lasted forty-eight days, while the thirteen rows made into ensilage would have lasted 67½ days."

Thus, the ensilage increased the produce of milk by 10 per cent.; and the butter-making quality of the milk was also enhanced, the total quantity of butter from the ensilage being nearly 12 per cent. more than from the dried fodder, or about 2 per cent. increase on equal quantities of milk. And it appears that the proportion of maize eaten in the form of ensilage was 29 per cent. less than that consumed in the dried condition.

ENSILAGE—A TRIAL WITH EWES.

(*The Field*, March 24, 1883.)

Sir,—Will you kindly allow me to make known through the medium of *The Field* the result of feeding in-lamb ewes on ensilage?

In the lecture which I delivered on Feb. 5, before the Wayland Agricultural Association, I gave a carefully tabulated statement of the effects of a supply of ensilage food to five of Lord Walsingham's shorthorn cows, showing that, in the course of a month's trial, the daily milk return increased by fourteen quarts, while the proportion of cream, registered by lactometer, showed the astonishing increase of 4°, being 16° as against 12°.

Desiring that the independent opinion of some reliable person should be obtained as to the effect of the ensilage on in-lamb ewes, I induced Mr. Thomas Gayford, of Wretham, near Thetford, who is widely known as a thorough man of business and as an eminently practical flockmaster, to undertake a trial on ten ewes, which were, with one exception, taken indiscriminately from a lot which had been selected from the general flock because they were low in condition. The ewe which formed the exception referred to was a notoriously bad milker, and it was desired to see what effect the ensilage would have on this particular ewe.

I am glad to be able to report that the result of the trial has been most satisfactory; and I venture to think that it would be almost impossible, judging by the facts elicited by Mr. Gayford's experiment, to over-estimate the importance of ensilage to flockmasters, and particularly in a severe winter, or in a late sterile spring, when ewes urgently need a succulent, palatable food. Writing one day last week, Mr Gayford says:

"The effect of the ensilage food on the milk of the ewes is most decided. The two which first lambed were (to use the shepherd's own words) 'smothered with milk'; and another, which I examined just after she had lambed, had a famous bag; and the milk was as golden in colour and as rich looking as if it came from the udder of a fresh-calved Alderney cow. The remainder of the ewes under trial all did well, and it is particularly noteworthy that the ewe which had always given so little milk on her previous lambings improved so much under the ensilage food, as to give as much milk as any ewe in the general flock fed in the usual way.

"The extremely satisfactory result of feeding the ten trial ewes on ensilage, as regards their milking condition, has made me, as a flockmaster of thirty years' standing, to feel what a boon this new food will undoubtedly prove to be to flocks of breeding ewes on large tracts of light land in the eastern counties, and doubtless in other counties also. The large quantity and rich quality of the milk of the ewes under trial, after the past exceptionally mild winter, surely indicates how great will be the value of ensilage in a severe winter, when we are at our wits' end to procure a minimum supply of succulent food for our ewes. I have known many winters and springs when there has been unavoidably heavy loss and expense incurred from the impossibility of providing any succulent food, and until now nothing has been found to supply this indispensable requirement for nursing ewes. It appears to me that this introduction of ensilage comes most opportunely, for never, during the present century, has the success of light-land farming depended so much upon sheep as now, nor have sheep ever been of more, if of so great, value."

With regard to the financial side of the question, my practical correspondent writes: "When the fact is generally understood that ensilage can be secured at about two-thirds of the cost of hay, that its production is almost wholly independent of the weather, and that the grass on the parts of the fields near the fences may be converted into ensilage, leaving the better drying portions and centre for hay, surely it will be true wisdom for flockmasters at least to give the matter a fair trial during the coming season." On the cost of silos Mr. Gayford adds: "I was talking yesterday at Bury St. Edmunds market with a very practical man, who held, like many others, the erroneous idea that silos must be made either underground, or with very strong thick walls to withstand the swelling from the supposed fermentation. This is one of the errors that lead farmers to suppose that silos are extremely costly in their construction, and the more widely your pamphlet is read and this nonsense dispelled, the better."

Seeing that breeding sheep are the sheet anchor of the light-land farmers, that it is only on these they can rely with any hope of success in these most disastrous times for agriculture, the foregoing testimony of such an experienced flockmaster to the merits of ensilage as a succulent food for sheep seems to me to be of great importance.

Merton, Thetford, Norfolk, March 20. HENRY WOODS.

SOUR-KROUT.

In articles, lectures, and books about ensilage, one almost invariably finds the remark, that this is only "sour-krout." The same thing has been said again and again by writers and speakers in other countries as well as our own, and here is M. Goffart's rejoinder, made years ago:

"People never fail to say, more or less benevolently, 'It is only sour-krout you are making: others did that long before you!'

"If I do make 'sour-krout,' or something resembling it, I make it without cabbages and without brine, and with all kinds of forage; and it costs but a tenth part of a farthing per pound. It is sour-krout brought within reach of animals that are very grateful for it. This sour-krout is an agricultural revolution.

"But, be it observed, it is unfermented sour-krout. It is chopped fodder kept in its natural state, and in which fermentation is not developed till the very moment of consumption. I do for fodders what is done in good silos where beetroots are preserved. In the North they do not wish their roots or pulp to ferment: they would lose their good qualities. In my silos the maize and other fodders do not ferment; they only enter into fermentation, when exposed to the air, a few hours before being given to the beasts."

DR. VOELCKER ON ENSILAGE.

The opinions of Dr. Voelcker, F.R.S., on all matters connected with the chemistry of agriculture, are so highly deserving of respect, that we should scarcely fulfil our duty if we omitted from these pages his remarks about ensilage. We do not quote his original letter to the *Times* on this subject, because his later expressions go more fully into the matter, and are the result of further experience and deliberation. At a general meeting of the Royal Agricultural Society of England, Dec. 7, 1882, the subject of ensilage was brought up, and we quote from the *Agricultural Gazette* the report of what was said :

Sir J. H. Maxwell inquired if the council had entertained the desirability of promoting ensilage.

The Secretary replied that Dr. Voelcker would refer to the subject in his report, to appear in the next issue of the journal.

The Chairman (the Duke of Richmond) said they should be happy to hear any remarks Dr. Voelcker could give them on the present occasion.

Dr. Voelcker said he should be most happy to state briefly his opinions, as he considered the whole question lay in a nutshell. They must first have a suitable material for ensilage, to ensure good quality. On the Continent maize was the principal substance placed in silos. Ensilage was pretty much the same thing as the sauer-kraut of Germany—a very old material indeed. The material for the silo had to be cut into small bits and tightly trodden down, when a fermentation ensued, occasioning the generation of lactic acid. The loss sustained in nutritive value by the process depended on the original substance and how the process was conducted. There must be a certain proportion of dry substance in it, or the ensilage might be bad. Some had recommended that with succulent foods chopped straw could be mixed; but probably no large quantities of straw could be spared in this country for the purpose. Further, the question resolved itself very much into the relative costs of preserving food in this way and that of ordinary harvesting, and it was a doubtful matter whether meadow grass would be available for the silo, unless, by overstanding, the stalks were sticky. Green rye, if not cut too young, was an available article; but he considered that in all cases there must be twenty per cent. of dry matter. He would observe, also, that ensilage was not so necessary in this country as on the Continent, because they had abundant root crops here for winter food. He had only one other remark to make, which would show that he had no prejudice against ensilage. In some parts of Scotland which did not ripen grain crops thoroughly, he thought oats might be profitably cut ere being quite ripe, and, after being passed through a chaff-cutter, would form an admirable material for ensilage. In some cases it had been found profitable to convert oat crops into hay, and he certainly thought their conversion into ensilage might be still more conducive to benefit.

Sir J. H. Maxwell begged to thank the learned professor for his observations, and said he had land in Dumfriesshire which often failed to ripen the oat crops, and he had such great hopes that they might derive benefit in converting them to ensilage, that perhaps he should be one of the first to make trial of the silo system.

At a meeting of the Society of Arts, on Jan. 31, 1883, Dr. Voelcker went more fully into the subject, after a paper on "Ensilage in the United States" had been read by Mr. J. E. Thorold Rogers, M.P. A full report of the paper and the discussion thereon is given in the *Journal of the Society of Arts* of Feb. 2, 1883, from which we quote Dr. Voelcker's remarks, with such of the observations of others as led to further replies :

Dr. Voelcker said the paper would no doubt lead to experiments with this process, which he quite agreed was very valuable for Americans, also in France, and in parts of Germany, where it had been in practice for a considerable time. He had lately analysed various kinds of ensilage—clover and rye, and, quite recently, some ensilaged maize stalks from Canada. It was this last which was always meant by ensilage in America, some qualifying term being used if any other material were referred to. He had with him a sample of maize stalks which was put into the silo last October, taken out the middle of last month, and sent to him direct from Canada. It was perfectly sound, though it had a peculiar flavour, by no means unpleasant. It smelt strongly of acid, and the acid was principally acetic and butyric; there was no alcohol present, because the sugar which had given rise to these organic changes had entirely disappeared. This production of acid was an essential element in the process; if sufficient acid were not produced, it would not keep, but turn mouldy like any other food put into a pickle jar with insufficient or poor vinegar. In this Canadian ensilage he had found as much as 1¼ per cent acid, about ⅛ per cent. being lactic. The proportion of water varied considerably—in the maize from Canada it was 85½ per cent.; and no doubt, if other food not so rich in sugar, and containing much moisture, were put into a silo, it would spoil altogether. Hence it was recommended by M. Goffart that a certain proportion of cut straw should be mixed with the green food.* In ensilaged

* Dr. Voelcker is misinformed as to what M. Goffart has said on this subject, as will be seen by reference to his remarks quoted on pp. 66-68.

clover he only found 79 per cent. of water, and in rye ensilage as little as 72½ per cent. This showed that no certain rule could be laid down that the product must contain such and such a quantity of water, for it depended on what the other constituents were. The more sugar there was present the less need to put anything with it; but if it were poor in sugar, some dry food must be added if you wished to preserve it. Disregard of these conditious had sometimes led to failure. He was sorry to seem in any way to oppose this method, but the circumstances of England were different from those of America. This was the only way of preserving maize stalks; you could not make them into hay economically, but in the form of ensilage they formed a very valuable food, especially for milch cows. They all knew how valuable acid food was for this purpose; every dairy farmer availed himself of brewers' grains when he could get them, but he did not feed his cows entirely upon them, because he knew that by so doing the milk would become watery and the cows poor; he gave them with the grains some cake, or Indian corn, or pea meal; and it appeared that the American farmers also gave some dry food. He had never known of cattle being kept profitably on green food alone. However valuable ensilaged maize and other green food might be to Americans, he questioned whether it was of the same importance to the English farmer; nay, he questioned whether, in average seasons, with the expense of erecting silos and the occasional use which we could make of them, food preserved in this way would be as remunerative as in America. He could not subscribe to the doctrine that green food put into silos underwent no change; nor did it seem possible that the albuminous matters should increase without the destruction of some part of the substance itself, because it must come from something; and, unfortunately, neither white of egg nor any other flesh-forming substance could be produced artificially. If the albuminous matter in the ensilaged food increased, it could only be in a similar manner to that in which the ammonia salts in rotten dung increased in proportion to the amount in fresh manure. One ton of fresh manure became enormously reduced in bulk in becoming rotten, but at the same time the proportion of ammonia increased, simply because other substances in the shape of gaseous products went away into the air. With regard to the fermentation, he was quite agreed that the quantity of carbonic acid which went away was not perceptible to an ordinary observer; but at the same time if it were true that the albuminous matter increased, and also the mineral matter, as appeared in most of the analyses, it was pretty clear that something in an invisible form went away; probably more or less of the material itself was dissipated in the form of gaseous product during the process of acid fermentation. This would not be altogether a disadvantage, if it could be shown, as perhaps it might, that the amount of digestible matter increased. The woody fibre in green food, especially when over ripe, certainly became more digestible in the ensilaged mass. This would be a great advantage in the use of the food, and probably explained the success which had attended its use. The loss of substance would be counterbalanced by the greater digestibility of food. This pointed to the propriety of instituting experiments with the view of thoroughly explaining the changes which the green food underwent. If green food could be preserved, at all seasons, in a fickle climate like the English, it would be an immense advantage to the farmer. He had some photographs representing the silos on the estate of the Count Arthur de Chezelles, at Boulleaume, Oise, of a most elaborate construction, and he must say he did not see how such silos could ever pay. A silo need not be such an expensive affair, and if experiments were to be made, it was important that the expense of the erection should be kept as low as possible.

Mr. George Fry said he had been astonished at Dr. Voelcker's analysis of the Canadian maize, and thought it would have been different had he analysed it fresh. He believed the quantity of acetic acid would not have been so great had fresh ensilage been analysed.

Dr. Voelcker did not think the proportion of acid would be increased by keeping; besides, he considered it a useful feature. In ensilaged rye he only found 72½ per cent. of water; but it would depend very much on the conditions of the green rye. If there were more sugar, greater maturity iu the plant, there would be more acid formed; if the maize were not so mature, not so sweet, there would be less acetic acid formed. He had grown maize in England, and also sorghum, but the crop depended very much on the season; one year it was a beautiful plant, 7ft. high; and next it was only about three feet, and cattle would not look at it. Two years ago he grew maize on the experimental farm, but it came to nothing; it was too uncertain a crop for this climate.

Mr. Darby said he should like to ask Dr. Voelcker about Mr. Gibson's rye, which he believed he had analysed, and declared to be equal to green rye.

Mr. Pearce asked if he understood Dr. Voelcker aright, that the whole of the sugar in these substances was dissipated or destroyed. He thought he had seen analyses, in which the quantity of sugar was stated, especially of glucose.

Dr. Voelcker said the ensilaged rye, as he had mentioned, contained about 72½ per cent. of moisture; he did not know what it contained in its original state, but it was quite possible it might get even better, and yet lose something. If he knew what quantity was put in to begin with, he could tell what was lost. You may put in a certain quantity, some of which would disappear, and what you took out might be better in quality. He had compared it with the average quality of green rye, and found it just as usual. With regard to the sugar, he did not conceive it possible that a material, which had passed through alcoholic fermentation, and, subsequently, acetic fermentation, should retain any glucose, which was liable to undergo change. There was probably about as little sugar in ensilage as in sour beer.

Mr. Pearce asked if the sugar really underwent the alcoholic fermentation in this process; because it seemed to him the conditions necessary to alcoholic fermentation, heat, and the presence of air, were absent.

Dr. Voelcker said the presence of acetic acid was not conceivable without a previous alcoholic fermentation. In a certain stage you could absolutely smell the alcohol. The temperature was quite as high as was necessary.

ANALYSES OF RYE AND MAIZE ENSILAGE.

(*The Times*, March 21, 1883.)

SIR,—I have lately received from Boston, United States, two parcels of ensilage, consisting of rye and maize respectively, which were produced last summer, and which have been analysed for me by Dr. Voelcker. They were shipped on Jan. 24. Both were in good condition, but the maize ensilage keeps better than the rye, because, in Dr. Voelcker's opinion, the maize when cut contains more sugar, and, therefore, when fermented, more organic acid.

The results of the analysis are as follows:

	RYE.	MAIZE.
Water	75·19	82·40
Percentage of dry substance soluble in water	4·08	5·75
Fatty matters and chlorophyl	0·86	1·59
Butyric and other volatile organic acids	0·11	0·22
Lactic acid	0·02	0·26
Soluble extractive matters	1·10	2·58
* Soluble albumenoids	1·01	0·50
Soluble mineral matters	0·98	0·60
Percentage of dry substance insoluble in water	20·73	11·85
† Insoluble albumenoids	0·75	0·76
Digestible cellular fibre	8·41	5·43
Indigestible fibre	11·08	5·14
Insoluble mineral matters	0·49	0·52
	100·00	100·00
* Containing nitrogen	0·16	0·08
† Containing nitrogen	0·12	0·12

Dr. Voelcker thinks the rye ensilage was cut a little too late, and dwells on the importance of cutting the green food when it contains the *maximum* amount of sugar.

The ensilage not required for analysis was used at Woburn, and the manager reports that the cattle liked it much, and seemed to do well upon it. Dr. Voelcker thinks that the ensilage will prove "specially useful" to milking cows in winter.

I regret that space does not allow me to insert the whole of his remarks.

I remain, yours faithfully,

House of Commons. W. FOWLER.

THE CHEMISTRY OF ENSILAGE.

UNDER the title of "Facts about Fodder," some articles by Mr. F. Woodland Toms, F.C.S., have been published in *The Field*, and, when the series is completed, it will probably be reproduced in book form. Certain of these articles have treated on the chemical effects and deterioration produced by rain during hay-making, by fermentation in the stack, &c.; and others have had reference to effects arising from the storage of green fodder in pits, both with regard to the increased digestibility of the fodder resulting from the process, and the waste that may take place if the process is carried out in a slovenly way. From the last-mentioned articles we here make a selection, giving chiefly those portions which have not been anticipated by information already included in the foregoing chapters of this book.

(*The Field*, Feb. 27, 1883.)

History acquaints us with the fact that, in times of famine, contagious diseases spring up readily and spread with unusual rapidity; and if we be now, as scoffers suggest, suffering from "ensilage fever," our susceptibility to its attack may fairly be traced to the unhealthy and impoverished state that has been brought about by repeated failures of the food-getting processes upon which we have hitherto relied. There can be little doubt, I think, that the majority of the experiments made, or about to be made, in this country with respect to ensilage, have had their origin in a painful experience of the shortcomings of the ordinary process of haymaking, rather than in any prior conviction of the innate merits of the silo. And to persons who are thus influenced there undoubtedly comes a very appropriate warning in the cautions of those respected authorities, Sir J. B. Lawes and Dr. Voelcker.

What we need is not merely a change, but an improvement—a relief from ever-impending mischief; and now, in the lull between last year's tentative experiments and the coming season's more active operations, it is fitting to sum up and review what we have learnt. It seems to me that some such summing-up is especially desirable, because, from a want of a standard of comparison, some persons have styled their experiments "a success," whereas their products, when passed through my hands, have proved distinctly inferior to others which have been described in no more glowing terms. Moreover, there have been statements made public which I either know to be wrong from my own observations, or I judge to be so from the teachings of authorities of experience abroad. . . . .

No one, I think, who has paid any attention to facts recently brought forward will deny that, by burying in pits, green fodder may be maintained in a remarkably good state of preservation for months together. The preservation is never absolute or perpetual; but to obtain the best results it is necessary to tightly pack the green fodder into large smooth-walled silos, and to maintain the mass under a continued pressure.

[Various details of M. Goffart's practice were here alluded to, but they are set forth more fully in the early chapters of this book.]

A very acid product is not the ideal to be worked up to in making ensilage. In the product that has undergone least change, alcohol and acids are only found in very minute quantities. To obtain the best result, the expulsion of air is necessary, and this is secured by heavy weighting. The "sour fodder" of the Germans and Hungarians, obtained by burying green food in pits with small precautions, is, there is reason to believe, very wasteful, from the fermentation being carried to excess. M. Goffart has "civilised" the primitive "sour fodder" process, and made it worthy of the recognition of modern agriculturists by pointing out the advantage of weights (and well-constructed silos to permit the weights to have full effect) in reducing fermentation to a minimum, and thus preserving the food in a condition most approaching its natural state when freshly cut. Its distinctive marks are, that the temperature is kept low, and the proportion of acid and alcohol remains exceedingly small.

During the last few months I have seen some eight or nine specimens of ensilage, and noticed very considerable difference between them. The difference was certainly only of degree, but I believe that degree was sufficiently wide to constitute the difference between a success and a comparative failure, economically speaking, though all were eatable and free from mould. The most successful specimens—*i.e.*, those that most resemble the freshly-cut plant—had been subjected to considerable pressure; the others were faulty in this respect.

It seems generally admitted that, other things being equal, a crop well supplied with sugar is better adapted for ensilage than one less richly furnished. And it is even more certain that, working with the same material, vast differences may exist in quality of ensilage according to the care expended in expelling and keeping out the atmosphere. By the use of weights M. Goffart has now, he says, no difficulty in preserviug for eight months or more crops which previously he was unable to keep many weeks when he sought to hermetically seal the silo by a covering of clay. He says, too, that the waste by heating or fermentation is very greatly reduced.

It has been a matter of surprise to men of science, quite as much as to farmers, that vegetation can, by such simple means as pitting, be preserved to so great an extent from the decay common to dead organised substances. Among the many more or less satisfactory explanations which have been given, that of Professor Lechartier appears to merit most attention, from the suggestiveness of his experiments, and his high position as an authority on fermentation.

By a very long series of researches on fruit, seeds, roots, and leaves, this investigator has shown that, when these substances are detached from the plants that bear them, life is not extinct in the cells of which they are composed; and that, if maintained out of contact with the air, this life will go on for a considerable period consuming sugar, and giving rise to alcohol and carbonic acid gas. The evolution of gas slackens after a time, and finally ceases altogether. This kind of fermentation is a proof of vitality in the plant, and is distinguished from the fermentation of decay by the fact that none of the germs that favour putrefaction are found when examining the pulp microscopically. When, however, the evolution of gas stops, the cells are really dead, and, being so, are liable to very rapid destruction when in contact with the atmosphere. So long, however, as the air is excluded, and no fermenting germs penetrate to the interior, the fruit remains dormant, and subject to no further change. Thus, Lechartier has kept pears suspended in closed jars for eight or nine months, and shown at the end of that time that they maintained their colour, and tasted merely like mellow fruit; but, on being exposed to the air, they very quickly became "sleepy" and rotten, and the leaves soon acquired the normal appearance of dead leaves.

Now, Lechartier considers that the facts he has proved to hold good with regard to fruit, seeds, and leaves kept out of contact with the oxygen of the air, find their analogy in green fodder placed under pressure in pits. He has made miniature silos with glass bell-jars containing fodder pressed down by a wooden disc weighted with lead, and so arranged that he could, from time to time, extract the gas for analysis; and he has also sealed up fodders in flasks, and compared their composition before and after fermentation.

He shows that the first action that takes place is the complete absorption of the oxygen in the residual air of the pit—which doubtless is the cause of the brief heating observed when a silo is being filled. During the first week or two (a period varying somewhat according to the composition of the crop, atmospheric conditions, and mode of pitting) there occurs a free evolution of carbonic acid gas, which is succeeded by a greatly diminished outflow lasting over several months. So long as this continues, the fodder remains in a state of good preservation; and, with liberal weighting, a very small evolution of gas is capable of resisting the pernicious tendency of the atmosphere to penetrate into the interior.

The rate of disengagement of this gas, and therefore its efficiency as a preservative, may be gathered from the following figures, obtained with Lechartier's miniature silo. It will be evident that heavy weights are even more requisite at the end of the experiment than at the beginning:

		Hourly per kilogramme.
12th of November	—Gas discharged	37·7 cubic centimètres.
22nd	"	14·1 " "
25th	"	5·4 " "
6th of December	"	5·2 " "
28th	"	2·7 " "
From Feb. 21 to March 1	"	0·25 " "

On the 1st of March there was no gas; the cells had lost all activity, and mould may therefore be afterwards expected to appear on the surface, and decay begin to prey upon the ensilage.

If I understand Lechartier aright, he contends that, while the vegetable cells are still alive, they will not grow mouldy and decay. That, when severed from the living plant, each constituent cell possesses a certain vitality in itself, or power of doing work; and that it cannot be considered dead till it has expended that power. That, in the presence of air, the cells live and act with considerable energy, and exhaust their powers early. Out of contact with air, however, they live more sluggishly, and take a far longer time to consume the same amount of sugar; indeed, the process becomes so slow that the sugar is not all consumed when the silo is opened. This is proved by the analyses of Barral, Lechartier, and myself, and by the heating and formation of alcohol that takes place on exposure to air. The vital energy being longer in expending itself, the time is postponed when the moulds and other parasites can begin to prey on the dead residue, and set up their characteristic and generally offensive fermentations. The above, though it sounds somewhat theoretical, is not without experimental proof, for Lechartier has found that the vital action, which will go on for months in a properly-weighted silo, does actually cease in a very few days if air be drawn through the ensilage.

Perfect fruit and undamaged leaves, kept out of contact with air, furnish us, one would think, with "ensilage" under theoretically perfect conditions; yet even here some loss of substance and considerable modifications in the constituents of the fruit occur; and loss of substance is in the same way inevitable to ensilage, even when made in the best constructed silo. It is the price one must pay for the vitality that enables the ensilage to resist putrefaction.

How slight this loss may be reduced to we do not know with precision, for no experiments have been made contrasting the weight and composition of that put into a silo with the weight and the composition of that which was taken out.

This is to be regretted, for it deprives us of the best way of ascertaining the economic value of the method. We do possess, however, comparative analyses of ensilage, made by wasteful methods, and these I will produce in the next article. They teach a useful lesson to those who adopt such methods, and show, on a magnified scale, the changes that go on. The losses that occur are due to fermentation, which may vary very greatly in extent in the same substance according to the way in which it is pitted; and, as the fermentation varies, the loss will naturally vary in a corresponding degree. M. Barral, who is a chemist as well as permanent secretary of the National Agricultural Society of France, mentions that maize ensilage, differing in the silos employed, possessed temperatures respectively of 46°, 16°, and 10° C. (115°, 60°, and 50° Fahr.), and the degree of acidity was respectively equivalent to ·792, ·544, and ·099 per cent. of sulphuric acid. He says, "It is the maize that has been maintained in the silo at the lowest temperature that contains by far the least acid. It is that one which, in my opinion, has been preserved in a state most resembling maize at the time it was cut." Deductions that are true of one specimen of ensilage, made in one kind of silo, are, however, not necessarily true with respect to that which is made in a different way; but at several of the agricultural colleges in America the professors are working at this subject experimentally, and we may hope shortly to obtain some statistical results.

(*The Field,* March 3, 1883.)

The nutritious qualities of ensilage, like those of hay, must of course mainly depend on the substance from which it is made; but over and above this, its value is modified by the mode of curing. Fermentation, in a greater or less degree, is inseparable from ensilage; and such fodder, therefore, is characterised by containing small quantities of alcohol, and acetic and other organic acids. It does not appear that in small quantities they do any harm; indeed, they seem to be beneficial rather than otherwise, and they prove so attractive that many animals will renounce green grass, hay, meal, and other good foods, to feed on the ensilage.

It is not probable that any of our ordinary English fodder crops, even if inefficiently stored, will develope as much acidity as beetroot and starch refuse, or even so much as maize ensilage sometimes produces; and as such food is tolerated by cattle, we need hardly disturb ourselves on the score of acidity in our own specimens. Even if it should prove excessive, it can always be neutralised by a little powdered chalk being mingled with it after taking it out of the silo. Still, the acetic fermentation should be resisted as much as possible, for such fermentation signifies the consumption of material that is more useful than the resulting product; besides which, the latter is the forerunner of an objectionable kind of fermentation called butyric. By this latter acid a very unpleasant odour is given to the mass; and, although cattle can even put up with this in small quantities, yet they recoil from it in the end, and fall off in their feed. M. Goffart met with this objectionable kind of fermentation in some of his earlier experiments. It arose when he attempted to store crops that had been beaten down and become yellow and decayed at the foot. He finally succeeded in rendering eatable even such crops as these, but he had to double or treble the weights, and the product resembled the "brown hay" of the Germans rather than that kind of ensilage in which M. Goffart delights.

The Americans, who generally seemed to have followed Goffart's directions very closely, appear to have been singularly fortunate in their experiences; for Commissioner Loring, of the U.S. Department of Agriculture, sums up the results obtained by nearly one hundred farmers, who have reported to him, in these words: "The condition of stock fed on ensilage, both as to health and gain in weight, has been uniformly favourable." This refers not only to maize ensilage, but also to the many other green crops they have experimented on. Considering that the Americans are themselves only novices, this speaks much for the simplicity of the process, and is an encouraging testimony of what we may ourselves expect.

I have read carefully through these 100 American reports and have watched for some time past the opinions expressed in American, French, and German periodicals; and, considering the ordinary tendency of mankind to grumble, and the natural liability to fail when trying a new process, I have been fairly astonished at the small amount of complaint from those who have tried the process and can speak from their own personal experience.

It seems to be taken for granted among users of ensilage that the forage is improved, rather than deteriorated, by a slight alcoholic fermentation; and this is what M. Goffart aimed at when he first commenced working. He soon found, however, that, in the silo, the fermentation is apt to overstep the mark and degenerate into acetic and lactic fermentation, which are to be avoided, because they are wasteful, and finally into butyric fermentation and putrefaction, which is, of course, positively objectionable. Consequently, as Goffart found it impossible to hit off the happy mean in the silo, he now strives to stifle fermentation entirely, so long as the fodder remains there. He finds he can readily obtain the desired amount of fermentation by a few hours' free exposure to the air previous to feeding.

Fermentation always has the result of producing new substances at the expense of existing constituents; and as some of these new substances are gaseous, fermentation always implies a certain loss in weight.

If animals digested and converted to useful purposes the whole of the food they receive into their system, then undoubtedly loss in weight would be an unmixed evil; and if, again, the loss fell on the easily-digested parts, and left the other constituents untouched, then this would make matters even worse. But luckily (and this is a most important matter) we have evidence to prove that such is not the effect of fermentation on well-made ensilage. There the loss which occurs falls most markedly on the substances that possess the smallest feeding value. Owing, as I believe, to the action of the water present, fermentation does not produce precisely the same effect on ensilage as upon hay. Fermented hay shows an increase of woody fibre over prime hay, whereas fermented ensilage has commonly a much smaller percentage of fibre than the substance from which it is made. Fermentation apparently acts in a very thorough manner upon ensilage; it not only converts sugar into alcohol, and acetic and other acids, but it also converts the starchlike bodies into saccharine substances, and reduces insoluble woody fibre into soluble bodies somewhat allied to starch. Sugar, starch, digestible and indigestible fibre, have chemically all the same percentage composition; but the last is of small feeding value, and is even actively injurious, for it may encase round substances that are in themselves very easy to assimilate, and thus prevent their being acted on by the digestive powers of the animal.

Commissioner Loring says: "There are indications that some materials have their value enhanced by the fermentation of the silo, while in others there is a loss;" and I think, when we shall have tested this question more thoroughly, that the value will be found to be most enhanced in substances containing a considerable amount of indigestible matter.

The constituents of grain are naturally digested by the animal with very considerable completeness. If, therefore, we attempt to ferment them, we shall find—as Sir J. B. Lawes showed in the case of malted barley—that the slight improvement in digestibility produced is more than overbalanced by the loss in weight. Such results, however, are not on the same footing with coarser foods, as grass for instance; for here a very considerable amount of indigestible and rejected matter exists, and a loss of weight which would be wasteful with grain, might turn out a good investment as regards grass, from the greater scope for improvement that is possible. From the following table it will be seen that, with inferior hay, the animal may not assimilate one half of what is given him. Could we but manage to make one pound of this poor hay go as far as an equivalent weight of young pasture grass, we could apparently submit to any amount of loss short of one-fourth, and still obtain a balance of profit.

Food.	Proportion of each constituent digested by the animal out of 100 parts supplied.				
	Of organic matter as a whole.	Of albumenoids.	Of fat.	Of soluble carbohydrates.	Of fibre.
	per cent.	per cent.	per cent.	per cent.	per cent.
Pasture grass	62·1	68·8	13·4	65·8	57·0
Meadow hay (very good)	51·7	64·3	23·5	56·9	42·6
Meadow hay (ordinary)	46·3	58·4	18·8	51·7	37·3
Maize (soaked grain)	90·9	77·6	68·0	93·9	100·0

The above are the results of actual experiments carried out on a horse by Professor von Wolff, the grass used being cut at various times from the same field. It will be seen that the animal never succeeded in digesting the theoretical amount even of the soluble compounds present; and it would appear that the great obstacle that prevented this was the fibre. There was nearly double as much woody fibre in the oldest hay as was contained in the younger specimen; and it would, of course, be more consolidated and resistant. When the animal was fed on soaked maize—which contains scarce a tenth of the fibre contained in hay—the digestion of the various constituents immediately became very complete indeed.

In the same way I believe that if the woody fibre of grasses can be rendered soluble or disintegrated not only will a larger proportion of it be digested, but other substances previously locked up will be more readily acted on.

An experiment, which can only be explained on some such principle as the above, is one by Professor Henry, of the Agricultural Department of the Wisconsin State University, already referred to in *The Field* of Feb. 10 [reprinted here on page 142].

Another observation, equally difficult to explain away, is contributed by Mr. O. B. Potter to the American *Cultivator*. A field of pearl millet had inadvertently been allowed to attain so large and hard a growth that the cows wholly rejected the stalks, and would eat nothing but the leaves when the millet was offered to them green. By way of experiment, one-fourth of the crop was cut and put into a silo, the remainder of the field being cured by drying in shocks in the ordinary way. This last was found so nearly worthless for feeding dry that it was used for litter in the barn-yards and for covering ice in an icehouse; whereas that which was preserved in the pit was opened and fed in April. The cows ate it all, leaf and stalk, eagerly, without any loss or waste, and, Mr. Potter says, it was fully equal in value to the same quantity of the best maize fodder preserved in the pits.

The following experiment by Colonel Le Grand B. Cannon, of Burlington, Vermont, U.S., is interesting, because maize ensilage is contrasted with an approximately equal amount, reckoned dry, of ordinary hay and also of hay and roots. I say "approximately," because the actual proportion of ensilage was rather under than over the mark; for average hay contains about 15 per cent. of water, so that 20lb. of hay would have about 17lb. of dry matter, and the average proportion of water in maize ensilage is said to be about 82 or 83 per cent., so that the quantity of dry matter in the ensilage given to these beasts would probably weigh about 15lb. Colonel Cannon says:

"I fed ninety three-year-old steers, divided into three lots; cattle and feed weighed monthly.

"*First Lot.*—Fed 20lb. hay with 3lb. grain daily, run in yard with shelter.

"*Second Lot.*—Kept in warm stable and stanchions, fed 17½lb. hay, one peck mangolds, and 3lb. grain.

"*Third Lot.*—Fed 85lb. ensilage, with 3lb. grain. This lot gained ¼lb. a day more than No. 2, and ½lb. more than Lot 1. The cost was 5 per cent. in favour of ensilage."

The feeding was kept up for five months and a half, and Colonel Cannon adds: "The cattle fed as stated were in better health and condition than others fed on the chopped hay and grain. I consider ensilage profitable, and believe it entirely healthy, taking the place of roots. It is easily digested, as is shown by the uniform temperature of the animals and the condition of the skin and hair."

[A very extensive series of experiments by Professor McBryde, of Tennessee University, was here referred to, but these are already quoted from on page 97.]

Of the value of ensilage for dairy purposes the evidence is remarkably strong. Commissioner Loring sums up the hundred reports sent to him him in the words: "There can be no doubt its greatest value will always be found in this connection." But in illustration of this good effect on milk-production it is not necessary to go so far as America, as a very admirable example has recently been furnished us at home by Mr Henry Woods, in his account of the experiment on Lord Walsingham's estate, quoted at considerable length in *The Field* of Feb. 10. [Here followed particulars summarised on page 101, and given more fully on p. 119 *et seq.*]

The above facts are quoted because they are statistical results obtained by actual analysis, and therefore are of much greater value than any indefinite statement teeming with adjectives. They suggest, too, the kind of experiments that may advantageously be carried out during the extended trial which the system will probably undergo before long in this country.

(*The Field;* March 10, 1883.)

THE main conditions for successfully making ensilage are, as we have seen, simple and few. Nevertheless a feeling is abroad that if it be already so simple, it might be made simpler still; and many who, a few months ago, would deny the possibility of preserving crops in the green condition in any way whatever, are now developing a tendency to complain of the labour of putting on weights, or of the necessity of making a receptacle at all. The number who think thus are, it is to be devoutly hoped, small, for they are dangerous disciples.

Ensilage, let us never forget, though new to us, is very old in itself, and there is little which we are likely to devise during our noviciate that has not been tried before; so that it is scarcely too much to say that what is not recommended may reasonably be presumed to have failed. At any rate, it will be far wiser to fully avail ourselves of the experience of workers on this process abroad, and to turn neither to the right nor the left in the conditions so simple yet so important that they lay down, than it will be to venture on unknown paths in search of improvements. First let us endeavour to do as well as our teachers are doing; improvements may be attempted afterwards.

To make good ensilage, it is necessary, not only to prevent air getting in, but to drive out all air that is already inclosed in the mass. The only practicable way of doing this on the large scale is energetic compression. The early experimenters started without weights, but, finding their importance, have little by little increased them; so that, if we begin with small weights, we shall be simply retrograding, not advancing. In the same way they began with holes in the earth, and now prefer well-built silos. Silos of masonry or wood are useful, because they facilitate the practical working of the process. They are easier to fill and to empty, are cleaner and more permanent, and in short, more convenient. They can also be made watertight, which doubtless is an advantage; but, best of all, they have smooth and regular sides, so that the mass slips down the walls without much friction, and thus the mass becomes compressed with little effort. So far as the preservation of the food is concerned, large and smooth-walled silos are, to my mind, mainly useful as economisers of weight. One can make, it appears, as good ensilage in an earthen pit as in the most expensive silo; but far greater weights must be used to produce the result, for the mass clings to the irregular sides with obstinacy, and is difficult to compress. It is, under any circumstances, necessary to put the heaviest weights round the edge of the silo; the centre will almost take care of itself.

Ensilage has been made, I am well aware, without any artificial weights being placed on the top: but this does not rebut the advisability of having recourse to weights—for in such cases the whole contents of the pit are not well preserved, but only the lower parts that are compressed by the mass above. The upper part and sides, which are not compressed, are generally mouldy and of little value; while even the preserved parts show, by their high acidity, that they would have been much improved if weights had been used. On the score of preservation, deep silos are obviously more to be recommended than shallow ones, and, owing to the smaller surface, less weight is necessary on the whole mass.

For the process to be economical, we must save the top and sides as well as the kernel; and it is to preserve these outer parts that weights are required. Goffart now manages, it is said, to keep the top and sides of his silos almost entirely free from mould, whereas formerly the loss used to amount to 15 per cent. or more.

Mouldiness is a form of waste that every farmer can understand; but there is another variety of waste which also exists, but which it is most difficult to make apparent, because it is not obvious to the eye. It does not occur to him that solid matter can "evaporate" and pass off into the air, even from those portions which he considers to be of good quality. If freshly cut plants containing one ton of solid matter be buried in a pit, under no circumstances is it possible that a ton would be taken out; but the more perfectly the air is excluded, the nearer to a ton the mass will weigh.

An experiment conducted by Professor Moser, of the Agricultural Experimental Station at Vienna, illustrates this fact in a very forcible way. He buried bundles of maize No. 1, of known weight (6000 grammes) at depths of 17in. and 34in., in a "grube" or earthen silo familiar to that country, also another lot of maize No. 2, and when the siloes were opened he re-weighed these bundles and ascertained the loss of each constituent of the fodder. The following give the absolute weight in grammes obtained from each bundle:

	Fresh Maize No. 1.	Ensilage 17in. deep.	Ensilage 34in. deep.	Fresh Maize No. 2.	Ensilage No. 2.
Water	4761	1215·5	2846	4603·2	3886·4
	—	—	—	—	—
Albumenoids	54·0	39·0	36·5	58·8	38·6
Fat	45·6	39·6	39·0	55·2	53·5
Soluble carbo-hydrates	649·2	350·4	273·5	734·4	326·8
Fibre	400·2	386·5	379·0	462·0	404·0
Ash	37·8	40·0	37·0	38·4	39·5
Sand	52·2	39·0	44·0	48·0	70·3
Total solid matter, dry	1239·0	894·5	809·0	1396·8	932·7

In Hungary the method for preparing "sour fodder," as they call it, is to dig a long trench in the ground, and fill in the fodder, not only up to the level, but far above it, and then to cover the whole over with earth. There is a constant tendency, under these circumstances, for the earth to crack round the sides, and air gets in accordingly. Considering, too, that the French and Americans, with their more perfect silos and heavier compression, still consider it necessary to cut up a large-stalked plant like maize into half or quarter-inch lengths, it is not surprising that Professor Moser met with such a wasteful result when using a bundle of unchopped maize.

Another German experiment is that by Professor Weiske, on sainfoin. The first half of this table shows the composition of the dry matter in fresh sainfoin, as compared with an equal weight of dry matter in ensilage made from the same sainfoin; and it might be assumed, from a hasty glance at the two sets of figures, that there is a considerable increase in some of the constituents; and, although some loss is obvious in others, yet there is nothing to indicate that the total is any way diminished. This is owing to the fact that, although you know the weight of the ensilage as taken out of the pit, you do not know what the fodder weighed when it was put in. The second half of the table supplies this deficiency, for it shows the weight of the dry matter in the fresh fodder on being put into the silo, and the weight of what remained, when it was taken out in the form of ensilage.

	Composition of 100 parts of dry matter in		100lb. of the dry matter of the fresh fodder yielded		Gain or Loss.
	Fresh sainfoin.	Ensilage.	When put in silo.	As taken out of silo.	
Albumenoids	18·56	20·44	18·56	15·53	— 3·03
Fat	2·89	6·02	2·89	4·57	+ 1·68
Soluble carbohydrates	38·60	30·88	38·60	23·47	— 15·13
Fibre	33·93	35·18	33·93	26·74	— 7·19
Ash	6·02	7·48	6·02	5·50	— 0·52
	100·00	100·00	100·00	75·81	

Here it will be seen that, although the fat is increased, there is, on the whole, a loss of 24 per cent. of dry matter in the ensilage; and the right-hand column will show in what way the loss is apportioned. This table marks in a very instructive manner the importance of comparing ensilage with its *equivalent* of the green stuff it was made from, instead of taking equal weights of each, as is usually done.

From the consideration of analyses like the above, I am convinced of Goffart's wisdom in insisting on heavy weights. If ensilage does prove a failure, this is the direction in which its defects must be looked for. At the same time, it must be borne in mind that none of the foregoing analyses apply to well-made ensilage—at any rate, to the extent there set down—since heavy weighting did not form a feature of the experiments quoted. They therefore mainly apply to those who refuse to recognise the importance of great pressure. M. Goffart asserts, and M. Barral, the chemist, supports him, that the above is by no means a fair representation of what takes place in well-made ensilage; and M. Grandeau, another eminent French chemist, shows by the following comparative analyses of fresh and siloed maize from M. Goffart's farm at Burtin, that the amount of alteration is relatively small:

MAIZE.	Water.	Sugar.	Albumenoids.	Soluble carbo-hydrates.	Fat.	Fibre.	Ash.	Acid.
Natural	81·28	0·58	1·22	10·41	0·25	4·98	1·29	0·00
Ensilage	81·28	0·15	1·24	9·58	0·36	4·91	2·25	0·23

From a study of the above analyses it will be evident that, whether the loss in ensilage be great or small, it always is in the same direction; that is to say, it always falls heaviest on the members of the closely-allied group—the sugars, starches, and cellulose (fibre or cell-substance). As much of the starch and a portion of the cellulose are destroyed to produce successively sugar, alcohol, carbonic acid, and, if air be present, acetic acid also, the nitrogenous substances, being more stable bodies, appear by contrast to rise in amount. The ash receives a similar apparent increase, as well as an actual increase, frequently, from dirt or added salt. The fat is the only substance that really is in larger absolute amount after pitting; it appears to be formed, or something like it, by the changes undergone during fermentation.

The tendency of fermentation to break down and render soluble the fibre of the pitted food is a most valuable feature in ensilage. Comparative analyses by Grandeau and by Lechartier; the results obtained by Dr. Cameron, with the Irish rye grass experiments; Mr. Sutton's analyses of Lord Walsingham's ensilage—all show this property of prolonged fermentation. The object of digestion is to convert food into a condition that is soluble in the juices of the body; and that portion of the substance which cannot be so dissolved is not only useless but objectionable, as having a tendency to exhaust the animal by labour in vain. It further hinders the digestion of substances that are very nutritious in themselves, by encasing them round, as is seen with seeds, which frequently pass unaltered through the animal, whereas, if crushed or husked, they would be very valuable food. The experiments of M. Grandeau and Mr. Sutton indicate that there is more soluble matter in ensilage than there is in the dried or green fodder—reckoning, of course, pound for pound of the dry matter in each. Whether it is always so, when we compare grass or hay with the weight of ensilage that would have been produced if these had been put in the pit, is the great unsettled question, around which turns the whole economical value of the process.

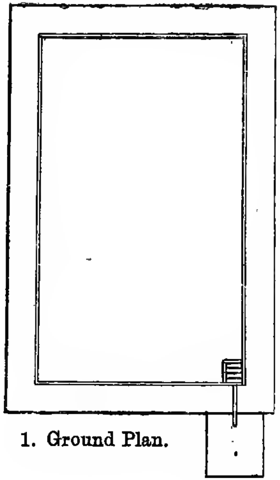
The view, then, that I take of the ensilage process is this—That those who feel inclined to shirk in any way the imposition of the weights necessary to compression will be ill-advised in trying the process at all; for, economically, I do not think their endeavours will prove profitable in the long run. They may see distinctly enough the mouldiness or putrescence that is upon the surface, and may estimate its amount as compared with the mass of apparently sound food that is in the pit; but it will be well for them to bear in mind that they only observe a portion of the mischief, and this may represent but a minor part of the actual waste, if regard be paid to the loss which has been going on in unseen parts of the silo, in consequence of a defective mode of carrying out the process. If, however, the fermentation be skilfully controlled, I see no reason why the improvement in quality, brought about in the mechanical condition of the food, may not more than compensate for the loss in quantity, considering the very large margin of undigested matter which coarse fodders contain.

Ensilage, has, moreover, the advantage of saving labour, and of being independent of the weather; and these two are in themselves sufficient to counterbalance a considerable amount of the loss that takes place in the silo. Of the profitableness of ensilage in the United States, Commissioner Loring's report says, "Not a doubt exists, certainly not a dissenting opinion;" but, of course, a large amount of this unanimity lies in the fact that American farmers can grow a cheap crop like maize, and store it up as they never could do before.

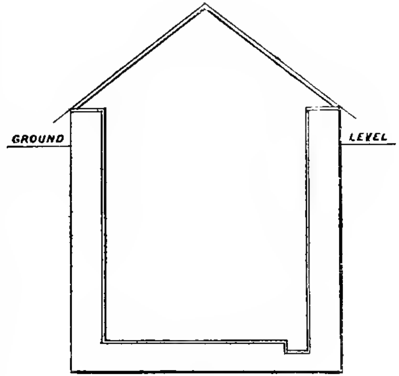
It is much to be hoped that those who make experiments on ensilage this year will, for the benefit of their fellow agriculturists, keep records of the cost and results of their trials; and, if they do go so far as to have analyses made, let them always endeavour to make them comparative, either by sending hay made from forage cut at the same time, or by having a sample of fresh grass analysed at the time when it is put in the silo. Whether ensilage be for our good, or be harmful, it is alike needful that we should quickly know its real nature; and a deep debt of gratitude will be owing to those pioneers who shortly propose to test it.

F. Woodland Toms, F.C.S.

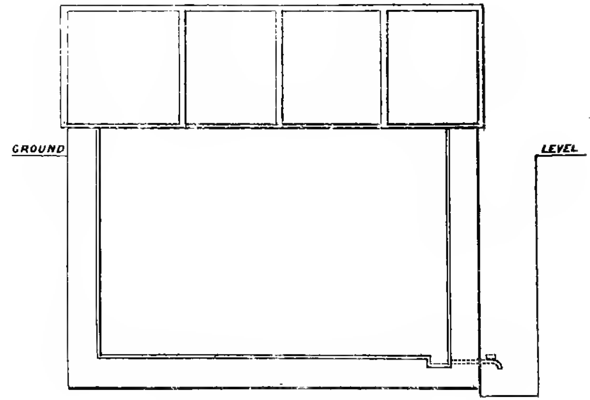
7, Busby-place, Camden-road, London, March 7, 1883.



1. Ground Plan.

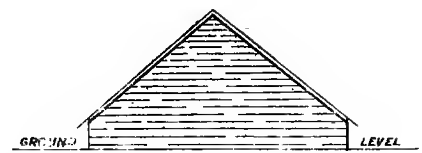


2. Cross Section.



3. Longitudinal Section.

4. Side Elevation.



5. End Elevation.

THE EAST COWTON SILO.

SILO AT EAST COWTON, YORKSHIRE.

MR. THOS. EASDALE, dating from the Pepper Arden Hall Estate Office, East Cowton, Northallerton, wrote some letters on this subject in *The Field* of December, 1882, and January, 1883, the particulars of which we here bring together.

The preservation of green food for the use of cattle during winter having engaged a considerable amount of public attention for some time past, I feel sure that many of your readers will be interested to learn that a most successful experiment has been carried out close to this place by a neighbour of mine, who cordially permits the leading facts to be stated. They are as follows:

Some time in the early part of this present year, a copy of Mr. Bailey's book on the subject came to hand, which, after a careful perusal, was subjected to a searching discussion, in which it was my privilege to join. After all the *pros* and *cons* were well thrashed out, it was decided that a thorough trial should be given to the system so eloquently advocated by Mr. Bailey. It was also resolved that to this trial all possible intelligence should be applied, and that no reasonable trouble or expense should be spared.

The silo—the plan of which is a simple oblong, 12ft. in length, 7ft. wide, and 8ft. deep—was built during the month of June and early part of July, and was filled with grass during the latter part of August and beginning of September.

After sufficient additions had been made to the contents and the arrangements for compressing the grass were carefully adjusted, the whole thing was closed up on the 14th of September.

It was the intention at that time that the silo should not be opened until Christmas; but a friend, who was deeply interested in the experiment, called on the 25th of November, and would hear of nothing else but that the pit should be opened while he was here. My neighbour having consented, the thing was done; the result being—even to those of us who were believers throughout—a most agreeable surprise. The whole mass of ensilage was found to be in a perfect state of preservation, and gave forth a most pleasant aroma not easily described.

The cattle, on the first day of being offered it, were, as was expected, rather dainty, but on the second day took it eagerly, and by the end of the first week they had become as fond of it as they are of the best oilcake—in fact, they now eat it ravenously.

A test as to the production of milk and butter cannot at the present time be easily ascertained, owing to the fact that all the cows calve early in the ensuing spring, and therefore would naturally now be drying off. Exact accounts are, however, being kept, with the result that, even under the circumstances just stated, both milk and butter have increased in quantity during the short time the cows have been fed with ensilage; while the quality of milk, butter, and cream continues all that can be desired.

The quantity of ensilage given to each cow per day is about 45lb. weight, plus the ordinary rations of the usual feeding meals or cake.

Chopping of the grass was dispensed with. A man with a horse and cart followed two scythes; he forked the grass into the cart from the swath, and from this cart the grass was again simply forked into the silo.

My letter on this subject having brought forth very numerous inquiries from all parts of the country, including Scotland and Ireland, I have endeavoured as far as possible to cover the various questions put.

1. *Kind of grass used.*—Commenced with ordinary grass from roadside; then some of a stalky nature, and finished with strong aftermath.

2. *State of grass when put in silo.*—Some dry, other portions wet with dew, and other portions partially wet with rain.

3. *How put in?*—Thrown in with a fork, then shaken out, in order as far as possible to maintain a level surface; and the grass well trodden down.

4. *How much put in at each filling.*—Two feet depth, when trodden solid.

5. *Use of the weighting apparatus.*—After each filling, the planks and weights were put on with the greatest care.

6. *Kind of weights.*—The weights were the same throughout the whole operation—viz., wooden boxes, 12in. square and 15in. high. They were filled with puddled clay, and weighed 100lb. each. The boxes are placed close together, and always so as to cover the junctions of planks, but without any idea of their excluding air by overlapping or otherwise.

7. *Covering boards.*—One inch and a quarter thick; their length equals the breadth of silo.

8. *Straw between planks and grass.*—No straw or any other material was placed between the grass and the covering planks.

9. *How long between each filling.*—Three days, with the weights on.

10. *Amount of sinkage.*– Not yet exactly ascertained, but probably a little more than one-half; or, in other words, 14ft. was put in, and the depth of the ensilage now is 6ft. 4in.

11. *Foreign substances mixed with grass.*—From 14lb. to 16lb. of common salt was supplied to each filling, but no other substance of any kind was added to the grass. Whether the salt is actually necessary remains to be seen: and next year one silo will be filled without it.

12. *If airtight, and how?*—No means other than the weighting apparatus were used to make the silo airtight; nor was any attempt made in any way to hermetically close it.

13. *How is air excluded?*—By compression only.

14. *Heating.*—Not the slightest appearance of heating has been at any time observable in the mass.

15. *Chopping of material.*—This was dispensed with, because it would save labour and implements, and was considered unnecessary. We cannot think that any loss of space is occasioned thereby.

16. *How long closed?*—The silo was closed for two months and eleven days.

17. *Colour of ensilage.*—The colour of ensilage when taken out of silo was a "pale yellow green."

18. *How much removed at once?*—Just sufficient for a day's consumption is taken out of the silo at once, and no change of colour or smell has been noticed, even after being exposed for three or four days.

19. *How left after cutting?*—The silo is cut into for each supply, and the cut face left as you would that of a haystack.

20. *Quantity of grass put in.*—About fourteen cartloads—that is, two at each filling.

21. *What quality of grass should be used, and at what stage of growth should it be cut?*—From experience here, we say, "The better quality the grass, the better the ensilage;" and, as the aftermath portion has come out as good as the other, it should follow that grass of any age may be successfully used.

22. *Other crops.*—My neighbour intends to operate (in a second silo) next year, on tares, oats, and prickly comfrey.

23. *Material for building silo.*—The walls (14in. thick) of silo are built with good bricks and mortar, and faced with a coating of cement. The floor is made of bricks covered with cement.

24. *Is the silo sunk or not?*—The silo here is 8ft. deep, 7ft. of which are below the surface of the ground. Our experience has, however, suggested several important improvements, a description of which, to be clearly understood, should be accompanied with plans to illustrate.

25. *How drained?*—The silo was well drained all round, and under, but not "into."

26. *Should floor be level?*—Give it a fall of 1in. for its whole length, and at one corner of lowest end make a small shallow well, 9in. square by 3in. deep, from the bottom of which take a small pipe to a tap outside.

27. *How covered in?*—With a simple roof resting on the silo walls.

28. *Cost of construction.*—This can be easily ascertained, and would depend to some extent on local circumstances. There would be so many cubic yards of excavating, so many yards of brickwork and cement plastering, and, lastly, a plain substantial roof of some kind. It has been determined that the next silo erected here shall be roofed over, and an arrangement made whereby the weights can be raised and lowered with a block and pulley, so as to ease the manual labour. An improvement in the weights is also contemplated.

29. *Cost of filling.*—This will depend very much on how far the land on which the grass grows is from the silo. After this it is only a matter of carting to the silo and filling in as mentioned under heads 2, 3, 4.

30. *Ration for each cow.*—From 35lb. to 50lb. per day, according to size of beast and quantity of other food given.

31. *Quality of butter and cream, and condition of cattle.*—The butter and cream continue of the very best quality, while the improvement in the general appearance of cows is most decided.

32. *Utility of silo.*—It is obvious that silos virtually perform at once the functions of the three existing operations—viz., first, hay-drying; secondly, stacking; and, thirdly, that of a stacking barn. Moreover, they will, when fairly well built, last fifty years or more; so that, practically, no future expense need be incurred beyond that of filling them annually.

33. *Analysis.*—This is beyond my province, but I shall be glad to forward a sample to Professor Voelcker or any other analytical chemist for analysis.

34. *Weight of ensilage.*—One cubic foot was put on scale, and it weighed $43\frac{1}{2}$lb., thus showing that our silo contained, when opened, rather over 10 tons. Comparing this with head No. 20 shows that little or no loss of weight can have taken place under the operation.

There can be no doubt of the great importance of this subject to every agriculturist, more especially to grass farmers. One of my correspondents in Ireland says that he and his father had 300 acres of meadow to save last summer; and, owing to the extraordinary wetness of the season, a great portion was lost. To such gentlemen silos will be the greatest boon imaginable. They can cart to them all the grass from shady and damp places round woods, &c., leaving that on the more open and upland places to be made into hay.

Being urged by some friends to offer my services in connection with this question as far as my duties here will permit, I shall be glad to arrange for furnishing plans and particulars for silos, and also to give instructions and personal superintendence when required. THOS. EASDALE.

Estate Office, Pepper Arden Hall, East Cowton, Northallerton.

ANOTHER YORKSHIRE SILO.

(*Agricultural Gazette*, Feb. 12, 1883.)

The following is an account of an experiment made by my brother and myself last summer, hoping thus to help in deciding the real value of the system, and aiding, if possible, by giving our experience, anyone thinking of trying it themselves.

I have long looked for some discovery which should insure the farmer against the heavy losses regularly sustained by the bad harvesting of forage crops consequent on our uncertain climate, and often thought that some method of preserving grass in its green state would best meet this end; and some ten or twelve years since I made some small experiments by hermetically sealing grass pressed into tins, and should have carried the trials further, but was discouraged by the condition in which it came out, and the bad smell given off, though I now find that it had some resemblance to ensilage. I was delighted, however, two years since, when

I first heard of M. Goffart's trials and success in France, and those of his followers in America, and I determined to try it at once.

Last year the Earl of Wharncliffe kindly offered to build us a silo, and we came to the conclusion that the easiest and cheapest method would be to make it in an existing stone barn. We, however, selected rather an old one, and excavated the rock in the bottom to a depth of about 6ft., in order to get sufficient depth for the pit. From the bottom of this excavation we built thin inner walls—excepting in the front, which was very bad and was rebuilt—filled with grout or thin mortar, our object being to get solid air and waterproof wall, and also straight and perpendicular ones, as the old ones were not so. We thus saved the expense of building an entirely new barn and roof, and cattle shed or lean-to which is attached. The walls are faced with cement, and the floor is constructed by laying a thin cover of 2in. or 3in. of lime concrete coated with cement, and the whole whitewashed two or three times with cement without sand. This is important, as it gives a very hard, smooth, waterproof surface. I am building some liquid manure tanks on the same principle, and they seem to answer admirably. Wells or water tanks are made in this way in America, and will hold water any length of time.

The silo thus constructed would have been 29ft. long by 14ft. wide, but we thought it best to divide it, for convenience in filling, by a partition wall a foot wide—of course faced with cement on both sides. This gives us two pits, each 14ft. square by 15ft. deep.

On Aug. 12 (a dry day) we put in as it was mown, unchopped, a very heavy crop of natural meadow from about five acres of land. We had three or four men inside tramping and spreading the grass evenly; it, however, filled both pits to the top. On this we placed some bad hay, and then weighted with about 30 ton of stone, equal to 12 or 13 cwt. per square yard, without boards or planks. Next morning it had sunk about 6ft., and went on sinking for about a fortnight, and now stands about 5ft. 6in. high from the bottom. In about a week after filling it had begun to ferment, and was slightly warm, but never attained a high temperature.

We opened it in the beginning of January, and, except a few inches on the top, it is perfectly preserved quite to the wall sides and bottom, some near the wall sides being nearly as green as when put in. The bulk of it is about the colour that slightly sweated hay would be if wetted. It has a smell peculiar to itself and all other ensilage. It is perfectly clear of mould, or any signs of putrefaction, and quite cold, but if lightened and exposed long to the air will again begin to ferment and heat. Thus if the weight is taken off the edge where it has been cut away from, it will begin to heat and smell like sweating hay, and the cattle seem to like it well when warm, but it will shortly begin to dry and mould.

We are feeding it to seven cows which calve early in the spring, and are therefore naturally fast losing their milk; yet they improved considerably for three weeks after coming from hay. The milk has a slightly altered flavour from that of hay, but the butter is very good in flavour and colour, much better than hay butter. The cattle are extremely fond of it, and this is a good test of its quality. They all ate it without hesitation from the first. Horses will generally eat it at once, and sheep after a short time. I think it at any rate equal to if not better than the best hay, though I should certainly hesitate to say that it is as good as green grass.

Now Dr. Voelcker in a letter to the *Times* states that grass of fair average quality cannot be preserved in silos without the admixture of chopped straw; and without the admixture of chopped straw or similar dry material, grass placed in silos, according to his experience, derived from the examination of samples, turns into a sodden mass of repulsive smell and taste, more resembling rotten farmyard manure than feeding material. Dr. Voelcker can never have seen any real ensilage, or I cannot conceive how he could make such a statement as this. Sir John B. Lawes is even more emphatic in his denunciation of the system than Dr. Voelcker. How men of such well merited and high scientific reputation can lend the weight of their names to try to put down the scheme before it has been fairly tried is past comprehension.

I could certainly show Dr. Voelcker a sample of grass ensilage without straw—and being grass off old meadow land it is very succulent—which can neither be described as a sodden mass, nor has the slightest resemblance to rotten farmyard manure, nor any semblance of putrefaction.

The statement that it must contain a certain percentage of dry matter seems to me absurd, since the success of the process depends upon getting as much of the air excluded as possible by pressing the grass solid. And the more succulent it is the more solid it will go, and the more effectually the air will be excluded. And dry matter must contain air in its empty pores, and if much dry straw were mixed with it, it would certainly heat and go mouldy. The less air and the sooner fermentation will stop. That fermentation is stopped by want of air, is proved by the fact that it at once starts up again as soon as the air is readmitted.

Dr. Voelcker quotes Professor Güsman, of Massachusetts, as stating most decidedly that in his judgment there has been no improvement over the old plan of making hay when the sun shines. If it is no improvement on the plan of making hay when the sun shines, it is certainly an improvement on making it when it does not shine: and this, sad experience has taught us, we are oftener trying to do than the other.

With our ordinary hands, horses, and machinery, we put in silos about five acres of heavy grass, and did some haymaking as well in a day. The rest of our hay, about 100 acres, took us five weeks, and a lot of it got spoiled into the bargain, though last hay harvest time was considered better than an average. At the rate of ensilage we should have done in less than three weeks, as most of our land had much lighter crops. Other things equal, the saving of labour, and loss by bad weather would certainly be a very great saving in favour of ensilage.

Your correspondent, Mr. W. A. Gibbs, gives some estimates of the cost of silos, but they seem to me to be far too high. We have not yet made a statement of the cost of ours, but I think it will be much below Mr. Gibbs' estimates. I do not think it all necessary for the silos to be entirely sunk in the ground, and they would be quite as effective if entirely out of it if strongly built and cemented. Nor is any concrete necessary, and I should say that nothing would make a better floor than bricks paved in mortar and coated with cement; stone or flags would also do. A great advantage may be gained for filling them by building them in hill sides, so as to bring the top level with the ground at the back side, and it also affords fall for drainage of the walls. I believe that many existing stone barns can be converted into silos by simply cementing the walls and laying down floors. A better mode of pressing wants devising. We shall try a much heavier pressure next year.

It is also quite unnecessary to chop grass for ensilage; a little more pressure will do just as well. The object of chopping is only to make it pack closer, or, in the case of maize, to make it more eatable.

Hawes, North Yorkshire. GEO. BRODERICK.

COST OF SILOS IN DURHAM.

(*The Field*, Feb. 3, 1883.)

THE American estimates for building a silo are not of much use in guiding us as to the cost in this country. This must vary, to a certain extent, in every locality, and must depend on the cheapness or dearness of materials. The land in this neighbourhood consists principally of strong clay, and ironworks exist where slag can be generally obtained gratis. I have obtained estimates which I think may be useful to those situated, as I am, within reach of such material; and, as an experiment, I have determined to build one a little larger than the one at Cowton, but in such a manner as to be able easily to double it if necessary.

The size I have fixed upon is 15ft. in length, 7ft. in width, and 8ft. in depth. The contract price is as follows:

1. IF BUILT OF RUBBLE SLAG, SAND, AND CEMENT.	£	s.	d.
55½ cubic yards excavating, 1*s.* per yard	2	15	6
49 superficial yards of slag rubble, mortar composed of fine cement and ground slag provided by contractor, 2*s.* 6*d.* per yard	6	2	6
11⅝ floor, 10in. thick, 2*s.* per yard	1	3	4
50⅛ yards of skimming to walls and floor, with cement plaster, 8*d.* ...	1	13	5
105 square feet 2in. battens, to cover ensilage	1	15	0
Roof, including wall plates, 187 square feet, 6*d.* per foot	4	13	6
Concrete blocks for weighting ensilage, bolt and eye to each block, 12 tons weight	11	0	0
Patent block and sheave running on iron rail	5	0	0
Cartage of materials	6	0	0
	40	3	3
If excavating and carting be done by owner, less	8	15	0
Total	£31	8	3

2. If Built of Concrete Walls 15in. Thick, and Floor 12in. Thick.

	£	s.	d.
Concrete walls and floor	9	2	6
(The other charges the same)			
Total cost in concrete	£34	4	11

3. If Built in Brick.

	£	s.	d.
Excavating less quantity owing to thinner walls	2	3	0
62⅔ yards 9in. brickwork inside course, walled in cement, at 4*s*. 6*d*. per yard, inclnding bricks	14	2	0
50 yards in cement plastering, at 6*d*.	1	5	0
Boards to cover ensilage, carrying weights	1	15	0
Roof	4	13	6
Concrete blocks	11	0	0
Sheave, patent block, and iron rail	5	0	0
Cartage	4	0	0
	43	18	6
Less excavating and cartage	6	3	0
Total	£37	15	6

That these prices are not imaginary, I may mention that the contractor whom I shall employ will build a silo for anyone at the price given above.

Having studied the difficulties of weighting, and the expense thereof, I have determined to make my weights of concrete. At the ironworks you can always get what are known here as "runners"—that is, where there is a large mixture of iron in the slag. These lumps are very heavy. I intend to put one or two of these into each square of concrete. I shall have each weight made about 5cwt. They will have an eye let in below the surface of concrete block so as not to protrude. Over the centre of the silo, say 6ft. high, I shall fix a common railway rail double the length of pit, on which will run a sheave, to which will be attached a patent block. Each weight, when raised above bank, will be run along iron plate on sheave clear of silo, and packed one on the top of another out of the way. The roof will rest on brick wall on the top of one side of silo, raised say 3ft., and will incline like a cucumber frame, so as to keep its water at a safe distance from silo. Your experienced correspondent, Mr. Easdale, from whom I have learned the little I know of ensilage, thinks that I am wrong in not cutting a drain to carry off the water from the bottom of silo. In my case it would be a very serious expense, and I cannot but think that a concrete wall 15in. thick, and floor 12in., should and would turn any water at the back or bottom of silo—at any rate, I mean to try it without a drain. I hope to secure Mr Easdale's services to give a lecture, and answer questions and give information on some Stockton market day, in order that this new system may be thoroughly ventilated. It ought to be generally known that this gentleman's services can be secured to draw plans, specifications, and to advise generally on the building of silos.

Chas. Henry Ford.

Bishopston Vicarage, Ferry Hill, co. Durham, Jan. 27, 1883.

EXPERIENCES OF ENSILAGE IN HAMPSHIRE.

Mr. A. Grant, a gentleman living in Hampshire, having written in the *Field* a brief account of his experiments with ensilage, received so many letters asking for further information that he found it impossible to reply to them all. He therefore sent for publication the following particulars, which we have much pleasure in laying before our readers. We may add that the ensilage, an analysis of which is given in the article, is by far the best sample of grass ensilage that we have seen:

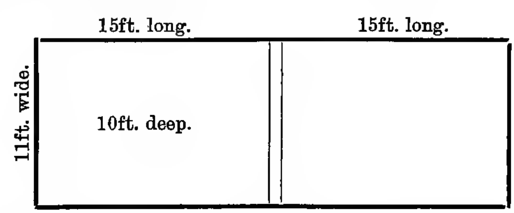
Having read of the ensilage system as practised in France and America, I thought that, as gooseberries are preserved in bottles of water, so grass under pressure in cemented tanks would practically be under water, on account of the quantity of fluid pressed out of it, and filling the space between each blade. This, I believe, is really what occurs in ensilage.

In the autumn of 1881 I ensilaged $4\frac{1}{2}$ acres of hop clover and Italian rye grass (a miserable crop), and it made capital fodder in a small experimental silo 6ft. by $6\frac{1}{2}$ft. by $6\frac{1}{2}$ft.

Encouraged by this experiment, I ensilaged in the summer of 1882 about 70 tons of meadow grass with perfect success; 5 acres were cut and carried in heavy rain. This portion cuts out much darker in colour than that carried in fine weather; but it is equally good fodder.

I likewise pitted a few loads of Trifolium incarnatum. Some of this also was cut and carried in rain. The cattle (mine are mostly pure-bred Channel Island) ate it all, but it was put in a very small pit, and with insufficient weight upon it, and it was not as good as other samples of ensilage which I have seen.

My pits are built as follows:



The outside walls are $4\frac{1}{2}$in. brickwork, run over with cement; the cross wall 9in. work. The roof is corrugated iron, built as a lean-to to the cow-house wall. A door leads from the feeding passage into the ensilage shed. I have also a small experimental pit.

My weights are concrete, 9in. by 9in. by 18in., made of gravel dug in excavating the pits. They weigh from 100lb. to 120lb. each. Before filling the pit, some of these blocks are stacked on the top of the walls of the pit, so that I get a temporary wall all round, say 3ft. high, practically giving that extra depth to the pit, and costing merely the trouble of stacking the blocks.

I then fill the grass to the top of this temporary wall as fast as possible, trampling it well in, and as soon as it is quite full I lay on a few planks, in any direction, and place on them a few tons of blocks. The grass has now a depth of 13ft. Next morning it will have sunk to 9ft. The pit is then refilled to the top of the temporary wall, thus securing another 4ft. in depth of grass—altogether, say, 17ft.

I now place about 3in. of hedge trimming, fern, straw, &c., on the grass; the top 3in. are sure to rot, so you may as well lose rubbish as good grass. Thereon I place the boards, each one as long as the pit is broad, and 2in. thick by 9in. wide; their use is merely to give the weights a level bearing. I then place a row of weights all round the outside of the boards, and throw on earth, heavy stones, old iron, anything to make weight. The mass immediately begins to sink, and, as fast as the surface of the weights sinks below a tier of blocks, I roll that tier on as additional weight, and so keep adding weight, till I have about 3cwt. to the superficial foot. The 17ft. of grass will gradually sink to about 6ft. or 7ft. Then, if I have another meadow or a second-cut clover, &c., in about two months later I take off the weights, boards, and rubbish, and proceed as before, getting in as much as possible.

In cutting out the fodder, I remove 2ft. only of weights, boards, and rubbish, and proceed as with a hay rick, shaking the grass well with a pitchfork after removal. After the first cut of 2ft., which will give the labourer room to work in, I cut the stuff in breadths of only 1ft., so as not to expose the same surface longer than is necessary.

The surface of a cut will keep sound about a fortnight, but this depends somewhat on the amount of weight there is upon the ensilage. If the weight is not sufficient, the air will penetrate into the face of the cut.

With Mr. Easdale's permission, I will copy his convenient arrangement of question and answer on various points connected with the subject:

1. *Kind of grass.*—I have used hop clover and rye grass, meadow grass, Trifolium incarnatum. I prefer "seeds;" but anything green will make ensilage.

2. *State of grass when put in.*—Mostly dry, but some very wet. I should prefer it dry, but the wet does not seem to injure it in the least.

3 and 4. *How put in, and how much at once?*—As much as you possibly can; the more the better. I tip the carts, and let the grass fall into the pits.

5. *Use of the weights.*—Put some weight on whenever you stop work; and when the pit is full, put on as much as possible. You cannot put on too much.

6. *Kind of weight.*—Concrete blocks 9in. by 9in. by 18in., earth, iron, paving stones, &c,

7. *Covering boards.*—2in. thick, length equals the breadth of the pit.

8. *Straw between grass and boards.*—I think 3in. of this saves 3in. of good grass.

9. *How long between each filling?*—Immaterial, if the weights are on.

10. *Amount of sinkage.*—Nearly two-thirds.

11. *Foreign substances mixed in.*—I have tried bran, but it is useless; it came out apparently the same as it went in, though of course wet. I now use nothing at all with the grass.

12 and 13. *If air-tight, and how is air excluded?*—There is nothing to make the pit air-tight except the compression by the weights.

14. *Heating.*—None observable; but there must be a little at first, as there undoubtedly is fermentation—probably before the compression is complete.

15. *Chopping of material.*—This may be necessary with maize and other woody foods, but is certainly a useless labour and expense with grasses and clover.

16. *How long closed?*—Various times; from two to eight months.

17. *Colour.*—Pale yellow green; that carried in rain is dark greenish brown. The flowers of the hop clover are still bright yellow; the red of the Trifolium incarnatum turns purple. The smell is something like that of a brewhouse.

18. *How much removed at once?*—Enough for three days' use. No change takes place under a week's exposure. I should make a silo according to the number of cows; thus, one 10ft. deep and 15ft. broad would give a slice 1ft. broad, containing 150 cubic feet—three days' allowance for fifty cows.

19. *How left after cutting?*—Just like a hayrick.

20. *Quantity of grass put in.*—With a small one-horse machine cutting, a one-horse rake sometimes raking, and two horses in the carts, I cut and carry about five acres per day.

21. *Quality of grass.*—I always for ensilage or hay cut very early.

22. *Other crops.*—Next year I hope to pit winter vetches and rye, spring vetches and oats, "seeds" and meadow grass.

23. *Material of buildings.*—4½in. brickwork run over with cement; the floor ought to be very strong, at least 9in. thick, as it had to stand the downward pressure of an immense weight, and also, if there is any present, an upward pressure of water in the soil. This broke up the floor of one of my silos.

24. *Is the silo sunk?*—Mine are altogether beneath the level of the ground, for convenience in tipping the grass out of the cart. You might throw the excavated soil up all round and build the walls more strongly; you would then require a broad ramp for the carts, and in some situations a higher roof.

25. *How drained?*—I should drain into a dead well, if the nature of the soil permitted.

26. *Should the floor be level?*—Just enough run to take away the slight ooze from the grass; but the drain into the dead well should be stopped up when the pit is about to be filled, and only opened when you cut the fodder out. You should, therefore, begin to cut at the deeper end, so that the labourer may work without the inconvenience of the ooze.

27. *How covered in?*—With light corrugated iron. I shall try Willesden paper another year.

28. *Cost of construction.*—This depends on the local cost of labour, the nature of the soil, and the thickness of wall necessary to retain the soil.

29. *Cost of filling.*—I cut and carried this summer five acres at 7*s.* 2*d.* per acre; in such a season this would have cost 1*l.* to make into hay. I thus saved nearly a rent on this poor land. This was the only field in which I noted the expense.

30. *Rations per cow.*—About 50lb.

31. *Quality of butter.*—Very good. I tried three cows feeding on crushed oats, linseed cake, and very good hay. When placed on ensilage, with a little crushed oats, they gave 25 per cent. more butter.

32. *Utility.*—As Mr. Easdale says, silos perform three operations—making hay, stacking it, and thatching. I find them very useful, whether empty or full, for storing straw, chaff, &c.

33. *Analysis.*—Mr. F. Woodland Toms sends me the following analysis and notes:

Volatile Matters:		
Water[1]	70·37	per cent.
Acetic acid (free)	0·20	,,
Alcohol	0·08	,,
Solid Matters:		
Albumenoids*	4·14	,,
Fatty matter	0·80	,,
Soluble Carbo-hydrates:		
Sugars	0·55	,,
Starchy matters	3·58	,,
Pectous compounds, (gum, mucilage, &c.)	8·56	,,
Insoluble carbo-hydrates (fibre)	9·49	,,
Ash	2·23	,,
	100·00	

* Equal nitrogen (all calculated as albumenoids), ·654 per cent.

He remarks that this Romsey ensilage "is, like the French, a very valuable feeding stuff. In composition, its dry matter closely resembles that of hay of good quality; indeed, the albumenoids, or flesh-formers, are considerably higher than in Dr. Voelcker's averaged analyses of hays—doubtless owing to the fact that it was cut so young."

In the following table, furnished by Mr. Woodland Toms, he gives Dr. Voelcker's statement of the average opposition of (absolutely dry) hay deduced from twenty-five analyses, and places it in comparison with ensilage, the three columns showing the composition of the *dry substance* in each. Where no figures are given to sugar, starch, gum, &c., in the hay column, these ingredients were not separately estimated in Dr. Voelcker's analyses, but were grouped together as one item, which is here given as "non-nitrogenous extractive matter;" and, in the analyses of the samples of ensilage, it will be seen that the separate items are totalised and stated in parentheses, for the sake of comparison.

	Hay, average of 25 samples.	Grass ensilage, grown at Romsey.	French ensilage, (clover and grass).
Albumenoids	9·88	13·97	18·35
Ammonia	—	—	0·12
Non-nitrogenons extractive matter	48·09	(43·77)	(37·22)
viz., Acetic Acid	—	0·67	2·41
Alcohol	—	0·27	3·62
Sugars	—	1·86	5·92
Starchy matters	—	12·08	4·49
Gum, mucilage, &c.	—	28·89	20·78
Fibre	31·80	32·03	28·87
Fatty matter	2·99	2·70	4·15
Ash	7·24	7·53	11·29
	100·00	100·00	100·00

In Dr. Voelcker's conversation at the last half-yearly general meeting of the Royal Agricultural Society, he is reported by the *Agricultural Gazette* (Dec. 25, 1882) to have said, "I do not think ordinary meadow grass at all suited for ensilage, as it does not contain a sufficient quantity of dry matter. . . . You must have at least 20 per cent. of dry matter. . . . In the case of ordinary grass thus preserved, you must leave them in the land until they become woody, but then you lose the best part of the grass." Without presuming to criticise such an authority as Dr. Voelcker, I would point out that, according to the above analyses, my ensilage (which was ordinary meadow grass, cut young) and that grown in France (which was chiefly clover, with a little grass), are both said to be superior to the ordinary run of hay; and there is no doubt that it is cheaper to pit grass than it is to make hay.

Dr. Voelcker went on to suggest oats, cut when the grain had formed but was still quite milky; and Sir John Maxwell thought he might try them. Last summer I grew a field of oats expressly for the purpose; but I did not pit them, on account of the enormous quantity of charlock which came up among the oats, and which I was afraid would give a taste perhaps to the butter.

I would also point out the advantage of ensilage in securing late second cuts of various green foods, such as lucerne, giant sainfoin, seeds, &c., at a season when there is little chance of successful haymaking. Mangold wurzel is always said to be a poor food till the middle of February at the earliest. Next year in May I am going to pulp a few tons and store them in a pit, as the French do with the pulp of the sugar beet. I shall then feed them to the stock when the cattle commence to lie in at night—perhaps in November. I tried a little maize last year, but it did not grow sufficiently to make it worth while to pit it; some grew about 8ft. high, but the chief part, though in garden soil and abundantly manured, only reached about 3ft. My pigs ate most of it, and the cows had the rest.

Ensilage is by no means the new dispensation that some American writers allege it to be; but it is a useful help to many farms, and it will add to, not supersede, better known ways of preserving forage.

Cattle generally take to it at once; but I think a certain amount of other food, such as crushed oats, ought to be given to cows when kept almost entirely on it.

Working horses generally appear to like it, but I have never tried to keep one even partially on it. It is said in America to be good food for ewes.

CLOVER ENSILAGE v. CLOVER HAY.

(*The Field*, Jan. 20, 1883.)

SIR,—I inclose you the analyses made by Dr. Voelcker, F.R.S., of the produce of the same field of clover and rye grass.

The hay was made in the beginning of July from the first cut, the ensilage in the beginning of September from the second cut. The hay was got up in showery weather, and was consequently not of first-class quality. The ensilage was cut and pitted the same day without being chopped, and I have been feeding it to cattle for a month. They eat it greedily.

Composition of a Sample of Clover Hay made July, 1882 (first cut)	
Moisture	18·01
*Albuminous compounds (flesh-forming matters)	13·01
Acetic acid	·60
Mucilage, extractive matters, digestible fibre, &c.	40·25
Indigestible woody fibre (cellulose)	22·01
Mineral matter (ash)	6·12
	100·00
*Containing nitrogen	2·08

Composition of a Sample of Ensilage, made September, 1882, from same field as clover hay (second cut)	
Moisture	79·05
*Albuminous compounds (flesh-forming matters)	2·21
Lactic acid	1·20
Mucilage, extractive matter, digestible fibre, &c.	9·33
Indigestible woody fibre (cellulose)	6·35
Mineral matter (ash)	1·86
	100·00
*Containing nitrogen	·35

Roughly speaking, one ton hay equals four tons of ensilage. A. VOELCKER.

I have now been trying experiments with ensilage for seven years, and I believe it to be a good fodder when made of the proper materials.

If your correspondent makes ensilage of mangold or turnip pulp by simply pitting the pulped roots, I should advise the inhabitants of the adjoining parishes, if residing to leeward of the pits, to clear out for a few days when the pits are opened. The odour will astonish the neighbourhood. ARTHUR J. SCOTT.

Rotherfield Park, Alton, Hants, Jan. 16, 1883.

[To compare analyses of fodders, as above, where one contains about 80 per cent. of moisture, and the other less than 20 per cent., is not very easy. We therefore recalculate the results, after omitting the water. The percentages then stand as follows:

HAY.		ENSILAGE.	
*Albumenoids	15·87	*Albumenoids	10·55
Acetic acid	0·73	Lactic acid	5·73
Mucilage, digestible fibre, &c.	49·10	Mucilage, digestible fibre, &c.	44·53
Indigestible fibre	26·84	Indigestible fibre	30·31
Ash	7·46	Ash	8·88
	100·00		100·00
*Containing nitrogen	2·54	*Containing nitrogen	1·69

[We shall be glad to know what amount of weight was put upon the fodder in the silo. Of course, a fair comparison cannot be made between clover cut in September and that cut in July; but, beyond this, it looks as if a considerable amount of fermentation had been going on in the ensilage. This can only be prevented by the expulsion of the air which is in the fodder at the time it is put in the pit. It does not suffice to prevent the external air getting in; that which is already in must be driven out, and without heavy weights this cannot be done.—ED.]

SIR,—Your note in *The Field* of Jan. 20, on the probable cause of the inferiority of the clover ensilage analysed by Dr. Voelcker for me, as compared with the hay, is probably correct in attributing it to insufficient weighting. The weight was applied by means of the plan figured in the illustration of the letter of "Aquarius" viz., a weight at the end of a lever (see p. 195); when the fodder had sunk in the pit beyond the action of the lever, the weight ceased to act, as it rested on the ground.

Certainly a continuously acting weight is desirable, but I would not advocate expensive permanent weights, such as cast iron or blocks of concrete as suggested in your columns. I should be inclined to use weights that could be utilised in other ways, such as bags of corn or coals, mangold or swede turnip roots, billets of wood, or any other material that could be made use of for other purposes. A. J. SCOTT.

Rotherfield Park, Alton, Hants.

COST OF HAMPSHIRE SILOS IN CHALK.

In page 35, in reference to building in concrete, we advised that persons intending to attempt that work themselves should first obtain a book treating on the subject. One of the books mentioned was written by Mr. T. Potter, clerk of works to Lord Ashburton. Since making that remark, we have seen in the *Hampshire Chronicle* of March 10, a letter by Mr. T. Potter commenting on a paper on ensilage read before the Botley Farmers' Club by Mr. Willan. We have not seen Mr. Willan's paper, but some information contained in Mr. Potter's letter is worth quoting.

"The cost of silo construction must in a measure depend, as Mr Willan says, upon the nature of the soil to be excavated and the price of materials and labour, but by far the most important factor in the calculation is the size of the silo, and when we get a range of capacity from the one owned by the Vicomte de Chezelles, measuring 215ft. long and 19ft. broad, to those used in Holland 12ft. by 12ft. and 9ft. deep, all comparison as to cost, for practical purposes, must be at an end.

"Assuming, for instance, that two silos are about to be built, the lesser 10ft. square and 10ft. deep, and the larger 20ft. square and 10ft. deep, also that the walls are to be of concrete 9in. thick, the bottom of concrete 6in. thick, costing 14*s.* per cubic yard, the walls faced internally with Portland cement at 1*s.* per superficial yard (and the excavation is in chalk soil costing 9*d.* per cubic yard and these figures should be a close approximation for Hampshire silos in chalk soil), we should get the following result:

Cost.	Capacity in Cubic feet.	Cost per Cubic foot.	Remarks.
Large silo......£29	4000	1¾d. nearly	Exclusive of roof or compression appliances.
Small silo......£14	1000	3½d. nearly	

"With regard to roofs nothing could be more suitable than galvanized iron, but, instead of the ordinary 'principals,' or main rafters, curved ribs formed of three thicknesses of 9in. by ¾in. board nailed together are the best in every way. This kind of roof principal was adopted for the annexes and other portions of the South Kensington Museum previous to the permanent buildings being erected. A waggon load of timber would construct a roof of this kind 60ft. by 30ft., and the total cost of wood, iron, and labour need not exceed 2*l.* per square of 100 superficial feet, while single spans up to 30ft. or 35ft. are as easy of construction as smaller ones.

"Instead of rivets, which are usually employed to fasten these plates together, what are known as 'galvanized gutter bolts and screws' are far preferable, as they enable the roofing to be removed without damage; and this is an advantage with buildings of a somewhat experimental character.

"It is also suggested by Mr. Willan, in his paper, that the walls of silos should lean somewhat outwards, or, as is technically described, 'batter.' For an economic distribution of materials, having regard to strength, this is a proper form of construction; but its disadvantages are, that planks of a right length to fit the first or bottom deposit of ensilage materials, are considerably too short for the top, and that the materials, not being able to sink straight down, have to shift towards the centre; in fact, during a settlement, they are undergoing two different motions, and become entangled or bound—the result of which is, that a great deal of the compressive power is lost, and the friction of the side walls is increased the more the ensilage sinks."

SLATE FOR SILOS.

(*The Field*, Feb. 24, 1883.)

SIR,—We beg to call your attention to the use of slate for covering ensilage and lining sides of silos.

Slate is far cleaner, sweeter, cheaper, and more durable than any other similar material; is not friable, and is quite unaffected by atmospheric influences.

The slabs for covering ensilage should be about two inches thick, in sizes that can be conveniently moved by workmen; and can be made with galvanised iron rings for more convenient handling. Two-inch slabs give a pressure of 30lb. to 40lb. per square foot. Should more weight be required, a second layer can be added, or the pressure may be augmented with stones or other heavy substance.

For lining silos a much lighter slab can be used; and the smoothness of the slate allows the cover to fit closer, and sink more regularly, than when a concrete or other rough surface is used.

JOSEPH BRINDLEY and Co. (Limited).

61, King William-street, City.

[No doubt, in some respects slate would be admirable. For smoothness of surface, it would be preferable to concrete for lining the walls; but, although it is not friable, would it not be rather liable to fracture? And as regards its being cheaper, that necessarily remains to be proved.—ED.]

SIR,—I have noticed, with interest, in *The Field* of Feb. 24, a letter from Messrs. J. Brindley and Co., on the use of slate for silos, and your comments thereon. From experience in the use of slate for cattle feeding and drinking troughs, I am of opinion that slate is not liable to fracture, and that it stands rough usage admirably.

The suggestions to use slate slabs for silos seems excellent, and if the cost compares favourably with other methods, I shall feel inclined to avail myself of it.

JAMES DALZIEL.

Grove Hill, Thornhill, N.B., March 5.

INFLUENCE OF SILOS UPON MEAT PRODUCTION.

(*The Field*, March 10, 1883.)

THE system so long practised abroad of storing green fodder in pits, has evidently now taken some hold on the British agricultural mind. This fact was publicly shown by the great interest taken in the question when it was discussed last week by the practical members of the Croydon Farmers' Club, to whom the subject was almost entirely new, as well as in the local inquiry and investigation that followed Lord Walsingham's valuable experiments, as carried out and expounded by his agent, Mr. Henry Woods. I candidly confess that I with many others, thought some time since that the subject was a topic of the day more celebrated for its novelty than for its promise of ultimate practical utility. But now I as willingly admit that the pioneers who have so freely placed their views before the public are worthy of every consideration and encouragement by practical men.

Let us, then, see how we have stood in past years, and how we may stand in future years, if this system of pitting fodder turns out as successfully as it now promises to do. In almost every year there is a dearth of green food for farm stock, either in spring or autumn, and not unfrequently in both seasons. In the first season this is due to the roots having become exhausted before rye and tares, clover and grasses, have sufficiently grown; and, in the second, the summer produce has been eaten or dried up before crops of rape, buckwheat, and early turnips are mature enough to be eaten with economy and profit. Now, if any heavy green crop grown in the spring can be inexpensively stored and held over till the autumn, and then, if not wanted, further held over till the ensuing winter or spring, why the command of the farmer over the management of his live stock in adverse seasons will be such that a new power will be created in regard to the production of animal food, and all the products yielded by live stock.

Much has been said about the climate of this country not being so suitable for producing crops for silos as is the climate on the Continent of Europe and in the United States; but it seems to me that our climate and soil are as suitable as any for producing an abundance of nutritious green food. Take rye for example, as our earliest crop; then take the mixed crop of winter tares and winter oats; then the second or "catch" crop of spring tares and oats after the early crop of rye. Rye-grass again is a vigorous plant that may be cut more than once or twice a year. All these plants if the land be suitably cultivated for them, and a judicious kind and quantity of fertilisers be applied to the soil, will produce a great weight of green food that is known to be of the most digestible and nutritious kind.

The stalks of maize or Indian corn (which seems to run in the head of some critics and prejudiced persons as the only plant suitable for this purpose) are, weight for weight, much less nutritious than the crops above-mentioned, although they may produce heavier crops per acre, where climate and soil are both suited to them. Maize, to be grown profitably, ought to be in a climate where an absence of frosts at night is a certainty. In England, therefore, it can only be sown with safety at the beginning of June. This being so, however, any one who may have been persuaded in favour of maize may readily try a crop of it after the first crop of rye, as the soil which has been so cropped can be speedily made as good a seed-bed for maize as any one need to wish for.

But in England three heavy crops of our well-known and well-tried plants as above mentioned may be grown in an ordinarily prolific year. Two out of the three of them may certainly be calculated upon as producing a heavy yield in a year that may not be altogether favourable as regards rain and sunshine. As this is undoubtedly so, the question about putting land down to permanent pasture is settled, for many times the value of grass per acre, even on old pastures, may thus be grown at a trifling extra cost for seeds, tillage, and extraneous manure. Thus, too, the truism that more value of meat can be made on arable farms by the crops intervening the crops of cereals, may in this way be more than verified; for, while arable farms cannot now be profitably cropped with cereals and roots alternately, they may be made to yield live stock abundantly by the adoption of this promising system of silos and ensilage; and the extra manure that will be thus made will cause the occasional crops of roots and cereals to be correspondingly increased.

This discovery, or coming innovation, if it be not already established, really looks something like a godsend for the owners and occupiers of heavy land farms; for while they have been great losers by wet seasons, aud the low price of cereals from foreign competition, the prices of beef and mutton have greatly increased, and the present high prices are likely to be maintained, if not exceeded. Under this system, too, sheep may always have a firm and clean bed to lie upon, which seldom the case when they are exposed to the difficulties attending the consumption of roots. With an abundance of the crops mentioned, both sheep and cattle may be kept sleek and growing while the crops are green, and in the event of a few weeks drought, either in summer or autumn there will be an adequate supply of ensilage in store to preserve their sleekness, and maintain their growth unchecked.

Now, which is the shorter or quicker plan for testing this system, so that farmers generally may have full faith and confidence in it? British farmers are still distinguished for acting up to the expressive, if not elegant, axiom, "Never buy a pig in a poke." Well, there are two ways of doing this. One is for landowners to build or construct silos on their estates, which can be done to begin with for less than 100*l.*; and the other is for each farmer to make a small pit for experimenting with, which can be done for less than a 5*l.* note. In the former case tenants and neighbours would of course be invited to watch proceedings and listen to explanations; while in the latter case the tenant-farmer would be simply making an experiment for himself, but of which, no doubt, a few neighbours would avail themselves, if they did not imitate their more enterprising friend.

For landowners and large farmers a number of suggestions have appeared in these columns. These particulars will no doubt be further discussed, and in a few weeks (in due time for the next crops of rye, rye and tares, winter oats and tares, spring tares and oats, and so on) some trustworthy plan will be settled upon. Any way, the whole thing may be reduced to the cost of a few pounds more or less. This system is not like the costly practice of steam cultivation and ploughing, which requires a large first outlay, and then the continuous wages of men, and the cost of coal and wear and tear. Here we have merely to construct a pit, and the cost of the first step in the system is done with ; while all the advocates of the system agree in saying that the storage of the vegetable will cost less to deposit in and take out of the silo than it would to make the same value of produce into hay.

Some authorities say that the cost of treating green produce in a silo is only half what it is if made into hay, while the risk of damage in the former case is far less than in the latter. But these are mere details that may be left out of our present considerations. We may view this subject as a broad question. That question is, Can the superabundance of green food which may be produced in May and June be preserved for use in the time of an autumn's or winter's dearth? That is all we want to have proved ; everything else will follow. As advocates and experienced experts say this can be done, it certainly behoves landowners generally to imitate Lord Walsingham, with a view to convince themselves and their tenants and neighbours, of the practicability of this modern system, as proposed, for increasing the number of domestic animals and the quantities of their products.

As to experiments by individual farmers, this may of course be done, as I have intimated, at a small cost. If a barn or other building of the homestead cannot be utilised, a hole may be dug in a dry corner of a field or pasture, and the inside lined with slates, the joinings thereof being made air and water tight by an inside plastering with Portland cement. Then, after the fodder has been placed in it, trodden down in the way that has been frequently explained, and covered over with soil or boards, weighted with stones, chalk, or some such heavy substances, trusses of straw or loose straw may be placed over it and lightly thatched, when the whole thing will be done. Space for two or three cartloads will suffice for these isolated experiments, as the object, of course, will only be for individual farmers to convince themselves as to whether it will be worth their while to at once invest in the construction of silos of an adequate size for increasing the produce of live animals on their farms.

Another plan for carrying out these tests on a more extensive scale would be for farmers' clubs and agricultural societies (county and local) to institute experiments under the supervision of a committee of management.

A few weeks ago a paper was read before the Croydon Farmers' Club on the advisability of trying experiments with manures and new kinds of cereals, roots, and potatoes, with a view to test what or which was best for the climate and soils within the range of the members of the club. Many of the suggestions made were worthy of being carried out; but they were of minor importance as compared with this great question—for the best result of those suggestions could only make a difference of a few pence in the pound. But, if this silo system can be satisfactorily established, it will increase the profit on all farms very largely, and on many farms cent. per cent. will not be the outside of the increase.

Agricultural societies may advisedly in many cases divert their funds with a view to help to test a promising system like this; for what is wanted is improved means for increasing and maturing the animals we can already breed, and make of the finest quality for market and consumption, providing we can secure a constant supply of succulent and nutritious food for them. It is useless or profitless to have to resort to or depend on the supplies of the cheap foreign cereals, corn, and pulse, which are now generally obtainable. If these have to be largely depended on, the animals produced for market are sure to make a return that will be a great loss to the feeder of them. Animals that have to be tested by scales and weights when they enter into consumption as animal food, must have had a large amount of home-grown green food or roots to end in a profit to their breeder and feeder. And if in "hard times," as in the cases of long winters and droughts and cold springs, there is not so much green food for them as may be called a good salad, then a large loss to the breeder and feeder must be the result. Silos and ensilage promise to provide against this common eventuality as the result of adverse months and seasons.

There is no mistake about the importance of this subject. Every stock-owner will remember that almost every year there has been a pinch for a greater or less length of time. I myself remember buying some hoggets (yearling sheep) at 17*s.* 6*d.* each in April, the same animals having cost more money as lambs when food was plentiful in the previous November. In the autumn of 1868 or 1869 I saw ewes bought in Lincolnshire and elsewhere at high figures, and in the following May the ewes with their lambs were worth no more than the ewes cost. Lambs that year were sent to London by thousands, simply because there was not the ghost of a bit of salad for them to eat in the autumn. The cookshops in London had their windows placarded that year with "lamb and mint sauce" down to the middle of November. That year was the beginning of our present scarcity of sheep.

W. W. G.

(*The Field,* March 17, 1883.)

Sir,—Allow me to supplement my letter of last week by saying it is advisable for landlords or farmers who contemplate building silos to sow at once a few acres with special crops for filling them.

The best crops to be now sown are undoubtedly spring tares mixed with oats of a vigorous habit of growth; black Tartarian are well suited for this purpose. The more suitable quantities would no doubt be one bushel of tares and two bushels of oats. This would leave room enough for oats to grow with strong and succulent stems, while the tares will grow well up them, and not get lodged and sour at the bottom. Maize stalks, wherever grown, would not be equal in digestibility or nutrition to such English food as may be thus produced. Wheat and tares, or wheat and peas, would produce an equally valuable mass of nutritious and palatable vegetation.

This method of "catch" cropping has a great advantage for farmers of light and heavy land, apart from the ensilage contemplated. It is a great mistake to suppose that the old-fashioned plan of ploughing light land again and again in the spring for a crop of turnips increases or developes the resources of the soil; so it is to think that long or "dead" fallows, with frequent ploughings, form the best system for increasing the fertility of clay soils. Ploughing and cultivating these soils add nothing as food for plants to them. They are deficient in organic or vegetable substances; they, therefore, do not need the oxygenation which is beneficial to soils containing much humus, and which is, of course, promoted by lightening up the soil by the plough and cultivator. But what these soils do need is an addition of vegetable substances, to ferment and decompose in them, and subsequently supply following crops with food that otherwise would be absent. The fermentatiou thus indnced will do far more to develope the crude compounds of these soils than a season's suu and air will effect. The "catch" crops above mentioned are admirably adapted for this purpose, so that really, while crops for ensilage are being grown, the land occupied by them is being made more fertile. Growing crops on these soils, too, is in itself cheaper than the cost of ploughing and cultivating bare fallows in the old-fashioned way.

A word on these crops as I have seen them grown around London, where green crops are valuable for town horses and cows. Autumn-sown rye is the first crop, for which a heavy dressing of manure is put on to force an early yield and save delay afterwards. No more manure is required for the next crop. As the rye is mowed off, the land is ploughed with a five or six inch furrow, and spring tares and one or other of the above-named cereals are drilled in. This second crop will be in good order for cutting in June or July, according to the character of the soil. As this second crop is cut off, white turnips or swedes are drilled in, a little artificial manure being placed under the rows to give them a start. Excellent crops of the latter may be thus grown in ordinary seasons for winter and spring feeding. As will be seen, the large amount of roots and green stumps of the rye and oats and tares that will be thus deposited cannot fail to produce a large amount of food for the future crop of cereals, potatoes or whatever it may be advisable, according to the soil, to sow after them.

W. W. G.

ENSILAGE CONGRESS AT NEW YORK.

(From the *New York Tribune*, Jan. 25 and 26, 1883.)

About sixty gentlemen, most of whom are practical farmers, organised the Second Ensilage Congress, by electing as President Francis Morris, of Baltimore, the first man who built a silo, or fodder pit, in America. Mr. J. B. Brown was elected secretary. Mr. Brown, after a brief address—in which he eulogised the merits of the ensilage system—which he declared was destined to prove the salvation of Eastern farmers—unveiled a bust of Auguste Goffart, the French inventor of the system, which was greeted with loud applause.

Scattered on tables near the platform were specimens of ensilage and of butter made from the cream of the cows fed on it; and the farmers examined the samples closely, testing them by the sense of taste as well as smell, although the odour sent forth by the preserved fodder reminded the untutored nose of sour-kraut and whisky combined.

The first person who addressed the congress was Mr Alfred A. Reid, a farmer, who lives near Providence, Rhode Island. He said that his cows, calves, steers, and working oxen had steadily improved while feeding upon ensilage. He had siloed clover, rye, and grasses, as well as maize, but his experience was that maize made the best ensilage.

The Rev. William Ormiston gave his experience in constructing a silo and producing ensilage on his farm at Whitby, on Lake Ontario, near Toronto. He built a silo fifty feet long and twenty feet wide, and walled the sides with stone twenty inches thick, and put in it maize, clover, and even weeds, and the ensilage, when the silo was opened on June 1, was found to be as sweet and green as when the fodder was first packed. The horses, cows, and hogs ate it greedily. Cattle prefer it to turnips or dry fodder, and the milk of the cows seems to be improved by it.

The question as to whether wooden silos were as good as stone or concrete occupied a good deal of attention. Mr. Moore, of Rockwell County, and Mr. Percy, of Chatham, New York, related their experiences with wooden silos, and pronounced in favour of them, declaring that they had succeeded in producing excellent ensilage in them, and that the fodder was almost as thoroughly protected against frost as that inclosed in masonry.

Mr. W. A. Strong, of Golden's Springs, said that it was a mistaken notion that the silo must be air-tight in order to preserve the fodder. The only thing required was to have sufficient pressure. It costs him only 2½ cents a day to feed a cow on ensilage, and with this he mixed a little brewers' grains.

The question of the amount of pressure necessary to preserve the fodder was discussed for some time. Mr. Smith, of Syracuse, who is a large importer of Holstein cattle, and feeds these valuable animals almost entirely on ensilage, said that the first silo that he constructed was of brick, and that he used a pressure of 300lb. to the square foot. The result was that the walls of the silo burst.

Dr. Ormiston said that he had used 100lb. to the square foot, but he thought that was too much weight, and he was going to try less.

Mr. Reid, of Providence, said that on one of his silos he used four screws to obtain the proper pressure, and on the other 15,950lb. of stone, which was equal to about 66½lb. to the square foot, and he found this pressure to be about what was required to secure good ensilage.

Mr J. W. Walcott, Boston, who owns a large farm near Boston, and a hotel in that city, said that the entire cost of his ensilage, with which he fed 104 cows, was little over $2 per ton. He sold 1000lb. of ensilage butter a week, and received 65 cents a pound for it. In the matter of silos, it makes no difference whether they cost $25 or $25,000. One will preserve your ensilage as well as the other. The only thing required is continuous pressure. "I believe," he said, "that a pile of corn in the open air can be perfectly preserved if weight enough is placed on the top to expel the oxygen. I use about 130lb. of weight to the square foot, and I never uncover any part of my silo until I want to use the ensilage."

Mr. Morris, the President of the Congress, said that he had always used earth silos, and any farmer could make them by simply digging a pit, filling it with fodder, and covering it with two or three feet of earth. This was the best silo, because it was the least expensive.

The cost of producing ensilage was the subject of much discussion, and the figures given differed widely. Mr. J. M. Brugler, of New Brunswick, N.J., found that 353 tons cost him $6.25 per ton; Mr. C. E. Benedict, of Holyoake, Mass., said that his ensilage cost him a trifle less than $5 a ton, and Mr. W. H. Gilbert, of Richland, N.Y., declared that he raised and packed 415 tons at an average cost of $1.40 per ton.

On the second day of the Congress there was a free discussion of the value of ensilage, the best method of growing the crops and filling the silos, the cost of the preserved fodder, and the best crops for the purpose.

Mr. Legrand B. Cannon, of the City, said that his experience with ensilage was very limited, and confined almost exclusively to its effect in fattening cattle. He purchased ninety shorthorn cattle and experimented with them on his farm in Vermont last winter, treating some as the New-England farmer treats his stock, and feeding others on ensilage. It cost him 10½ cents per day for each animal fed on hay, and 8 cents per day for each animal fed on ensilage. The economy of ensilage over hay was thus $480 during a period of six months. The gain in weight of the cattle fed on hay was 5 per cent., and the gain of those fed on ensilage was 11½ per cent., the gain in condition of the ensilage-fed cattle being fully 20 per cent.

Mr. Orlando B. Potter said that his experience of last year had been repeated this year on his farm at Sing Sing, and he had made no change in his experiments except to increase the quantity of ensilage and decrease the amount of grain fed to his cattle. He had also added hay to the contents of his silos, mixing it with his ensilage, and he found that if he mixed more than 10 per cent. of hay it injured the ensilage. He considered that silos under ground were superior to those built above ground; and the best covering for them was eight or ten inches of earth. His ensilage was slightly acid, but there was nothing offensive about it, and he frequently placed it in his mouth and chewed it. The fermentation which takes place is about equal to the first process of digestion.

Mr. Potter asked if any person present had fed ensilage to hogs with success.

President Morris answered that he had given ensilage to hogs, and that they grew fat on it. He wanted no better food for them.

Mr. George T. Powell, of Ghent, N.Y., said that he had had two years' experience of feeding ensilage to sheep and hogs. Three years ago he fed sheep on the best clover hay, and the gain in weight was 23½lb. per head when he shipped them to New York. He fed a number of merinos on ensilage a year ago. Their average weight in the fall was 75lb., and their average weight in the market in March was 92lb.

Mr. Benedict, of Holyoke, Mass., testified to the adaptability of ensilage as food for hogs. He is feeding sixty-five hogs on this preserved fodder, and they relish it and are rapidly growing fat on it.

Mr. Powell, in answer to a question as to the effect of ensilage on horses, said that he had fed his five horses on maize ensilage with grain and hay. With one exception they all like it; and the horse that does not seem to like it particularly well manages to eat his ration all up during the day. "My horses," he said, "never looked better than they have since I have fed them from the silo."

Mr. W. W. Merriam, of Somerville, N.J., said that Prof. Cooke, of the New Jersey Agricultural College, claimed that dry stalks properly treated prove as good fodder as ensilage; but he did not agree with the Professor. He (Mr Merriam) owns the largest eighteen months old New Jersey heifer that he has ever seen, and she has been raised entirely upon ensilage.

Mr. Linsley, of Morris County, N.J., exhibited a specimen of butter made from cream taken from the milk of cows which were fed entirely on ensilage. The milk increased from 15 to 20 per cent. in quantity, and very materially in quality, within one week.

Mr. W. H. Truslow believed that maize was the best material for making ensilage. He had tried sorghum on the farm of the late Samuel Remington at Cazenovia, but he found that the rind was tough and sharp, and cattle do not like it. He thought clover contained too much nitrogen to make good ensilage. Hungarian grass, he said, makes excellent ensilage.

Mr. Brown offered the following resolution, which was unanimously adopted: "The Ensilage Congress, assembled in New York, Jan. 25, 1883, desire to express to M. Auguste Goffart, of France, their appreciation of the great value of the system of ensilage discovered and introduced by him. They recommend to the farmers of the United States its universal adoption as the cheapest and best method of preserving fodder crops."

A vote of thanks was then passed to Mr. Brown for his labour n presenting the advantages of ensilage to the public, and the Congress adjourned *sine die*, after authorising the president and secretary to take steps to effect a permanent organisation for the future.

VISIT TO AN AMERICAN SILO.

(*The Field*, July 22, 1882.)

LAST year, when in America, I made a special expedition to the centre of the dairy district of the State of New York, namely, to Little Falls, in Herkimer County, some three or four hours' journey west of Albany—the State capital. I went, fortunately, armed with letters of introduction to Mr. X. A. Willard, who contributes the dairy portion of the *Country Gentleman*, and who on this subject is one of the greatest authorities in the States, and also to Messrs. Whitman and Burrell, who are not only manufacturers of dairying implements, but who have taken up so warmly the subjects of "ensilage" and "lard" cheese, both of which have been publicly alluded to quite recently.

Messrs. Whitman and Burrell pitted Indian corn, which they cut in September quite green and hauled to the silo. It was then cut up by a machine like a chaff-cutter into pieces about a quarter of an inch long, and evenly distributed through the silo and trodden down. These silos were 20ft. deep by 27ft. by 16ft., and were built of stone, and made thoroughly watertight with Portland cement, and, of course, well roofed in. Upon the ensilage are placed wide planks, say, three of 11in. wide by 2in. thick, and braced together, then a layer of earth, and upon this heavy stones to about 200lb. to each square foot of surface. This will sink under the pressure to a depth of three-quarters of the original bulk. After three or four weeks' time has elapsed, the ensilage is ready for use. The covers are removed piecemeal, and the fodder is cut out with a hay knife, and fed to the cows as it is wanted; in fact, the farmers cut out their silos at Little Falls in the same way that our farmers manipulate their hay ricks.

Now for a few statistics to show the result. Messrs. Whitman and Burrell pitted 212 tons of green corn produced on 7 acres of land, and upon this they kept thirty-five cows for six months, showing that they gave them 67lb. apiece of this food per day, for we must recollect that the American ton is 2000lb. Now a cubic foot of ensilage, well-pressed, weighs 47lb. to 50lb., provided that the prescribed weight of stone is applied; and as it requires 6 tons (5 tons 7cwt. of our weight) to keep one cow for six months, it is only required to multiply the number of cows you have by six, in order to give you the number of tons capacity needed for a silo. For example, if a silo is 24ft. long, 16ft. wide, and 20ft. deep, its capacity is 7680 cubic feet; multiply by 47 (as 1ft. cube of ensilage weighs 47lb.) and you have 360,960lb. or 162 tons, which will amply feed thirty cows, giving each 17½cwt. a month. Indian corn, by reason of its luxuriant growth, is especially suited for ensilage. I do not think that ensilage alone would be a perfect food for cows in milk; cake or bran should be given as well.

H. PENRY POWELL.

SILOS AMONG THE ANCIENTS.

(*The Field*, Jan. 20, 1883).

The two words "silo" and "ensilage" have recently come into prominence in connection with a particular mode of storing farm produce. It will interest some to learn that the practice they refer to has long been followed in various parts of the world.

Ensilage is a French form, and may mean either what is stored in a *silo* or the act of storing it; therefore no more need be said of it.

The word *silo*, which is found in some of our dictionaries, also occurs in French, Italian, and Spanish, and denotes a kind of cave, well, or pit sunk in the ground for the storing of grain, &c. The Spanish also have the verb *ensilar*, which signifies the putting of corn in a silo to preserve it. In the Latin, the word *sirus* or *syrus* is to be found; and in Greek we meet with *siros*, both being the same in sense as silo, and only older forms of that word. Where the term originated we cannot say; but possibly one of the Latin writers is correct in ascribing it to what he calls "the barbarians."

Pliny, in his Natural History, book xviii., chap. 30, after describing mowing machines worked by cattle, and other processes during and after harvest, mentions that corn is well preserved in trenches which they call *siri*, as in Cappadocia and in Thrace. In Spain and Africa, he says, they are specially careful to have these in a dry soil, and spread chaff or stubble underneath, and the grain is laid up with the ear. Thus protected it will suffer no harm; and Varro observes that corn thus stored will keep for fifty years, and millet for a hundred. Pliny is indebted to Columella and Varro for most of his information. Vitruvius, who refers to the same kind of thing, calls the silo a vault. Quintus Curtius alludes to the custom as prevalent in the Caucasus. To the foregoing, Nonius and other ancient Latin authors might be added, especially Tacitus, of whom more anon.

Among the Greeks who speak of the silo or *siros* are Euripides, Theophrastus, Hesychius, and Suidas. In the Greek language there was also a curious word, *siromastes*—a kind of instrument with an iron point or prong, for probing the corn pits or silos to see if contraband or other improper goods were secreted in them. This was also used in time of war—for instance, to find out whether hidden pits existed to catch unwary horsemen, and so forth. It seems to have often proved a serviceable weapon as a lance or javelin; and in this way it is spoken of in the Greek version of the Old Testament. Thus, in 2 Kings xi., 10, Jehoiada is represented as giving the centurions the *siromastæ* of David. The same use of the word appears in Numbers xxv., 7; Judges v., 8 (in some copies); 1 Kings xviii., 28; and Joel iii., 10. Even if the Greek translators were wrong in their rendering of the Hebrew, it is evident that they were familiar with the name of the instrument, the etymology of which is so clear and suggestive.

That the ancient Hebrews did bury or cover their corn is evident from Jeremiah xli., 8, where we read that certain men saved their lives by saying, "Slay us not, for we have treasures in the field, of wheat, and of barley, and of honey." Possibly some other text points to the same thing; but it may be well to quote a short passage from the article "Barn," in Cassell's Bible Dictionary. The writer says: "In ancient times it (the barn) was almost always underground; and from numerous specimens of such repositories yet to be seen in Syria, we find that it consisted of an opening above, which gradually became larger as the excavation deepened. When it was not in use the aperture was closed and covered with earth, but when it was empty it was left open."

It may be here observed that the foregoing description naturally reminds us of the ancient pits in our own country, as in Kent and Essex, which some, like Camden in his "Britannia," have thought were intended for a similar use by our remote ancestors. Camden illustrates his idea by referring to a passage in the "Germania" of Tacitus, where we are told that the Germans had underground pits, which they covered with dung, and which served both for a refuge in winter and as a receptacle for crops (chap. 16).

That the practice was ancient and wide spread we have seen, and that it is no novelty in modern times will be made apparent. The silo is said to be still in use in Sicily; and as regards eastern lands the evidence is abundant. In Cobbin's Condensed Commentary on Jer. xli., 8, the following occurs: "In Barbary, when the grain is winnowed, it is lodged in subterraneous repositories, two or three hundred of which are sometimes ogether, the smallest holding 400 bushels (Shaw). They are in great numbers near Aleppo (Russell). There are deep pits at Rama in the Holy Land, designed for holding corn (Le Bruyn). Three large vaults at Joppa were used for the laying up of grain (Ranwolff.)" In Conder's "Tent Work in Palestine," in the chapter on the Fellahin we read, "The corn is stored in underground granaries, which are carefully concealed, and form traps for the unwary horseman. These granaries (Metâmîr) are often under the protection of the Mukâm, and are therefore excavated near that building. They are circular wells some four or five feet deep, and the mouths are closed with clay like that used for the house roofs." Tyrwhitt Drake and Burton also mention silo-like holes found in Syria. We understand that the practice is followed much further east, at Merv and in Turkestan, for example. Mr. W. G. Browne, who travelled in Egypt, &c., in the years 1792-1798, when describing harvest operations in Darfur, gives the following interesting details: "When threshed, which is awkwardly and incompletely performed, they expose the grain to the sun till it becomes quite dry. After this a hole in the earth is prepared, the bottom and sides of which are covered with chaff, to exclude the vermin. This cavity or magazine is filled with grain, which is then covered with chaff, and afterwards with earth. In this way the maize is preserved tolerably well." (2nd edit., 1806, p. 321.) This carries us further into the

S.E. of the African continent, and nearer to the equator than any other example I have found. Nearer home we are told that in some parts of Ireland oats are stored in a similar fashion; and we have all become familiar with the laying-up of potatoes, turnips, and other roots in this country by covering them over with earth.

The earliest date at which I have yet found the actual word "silo" is 1569, when it occurs in the margin of a Spanish Bible, at Jer. xli., 8. Here, while rendering the *matmonim* by *thesoros*, *i.e.*, "treasures," the margin reads "silos escondidos," or "hidden silos."

The Hebrew *matmonim* is represented in the Chaldee Targum of Jer. xli., 8, by the word *matmorin*, from a verb meaning to hide or lay up. This is to all intents and purposes our own "matamore," the Oriental equivalent for silo. This matamore occurs in several European languages, as well as in Arabic, &c. In searching for examples of ensilage, a large addition to their number may be made from travellers in the East, if the *matamore* is not lost sight of.

Further inquiry would no doubt lead to the discovery of many other cases, as well ancient as modern; but the above may serve as a fair sample of the practice, and the extent to which it has prevailed, and still exists. The subject is interesting, and probably will be investigated more thoroughly by those who have the inclination, the leisure, and the books.

B. H. C.

ENSILAGE OF SPROUTED OATS.

THE *Agricultural Gazette* of March 26, 1883, gives the following particulars from Mr. C. A. Kemble of East Harptree, near Bristol, relative to the pitting of oat-sheaves damaged by wet. The first portion is quoted from a letter sent by Mr. Kemble to friends invited to be present at the opening of the silo; and to this is appended a statement of the condition of the fodder when the silo was opened:

"On Sept. 9, 1882, I commenced cutting twenty-five acres of oats (Black Tartars). Owing to the wet season which followed, I was unable to harvest this crop in the usual manner; I determined, therefore, by way of experiment, to adapt and fill a silo pit with oat-sheaf chaff. I sent my teams to the field on Nov. 6, and on that date began to fill the pit, cutting the straw to chaff about 1in. in length. By this time the oat sheaves were in a thoroughly sodden condition, and the corn in them had so generally 'sprouted,' that apparently all was worthless except as manure. We continued cutting and filling at intervals, and trod in the final chop on Nov. 11. Nine loads were cut up in this way, which I estimate at 13½ tons.

"While filling the pit I carefully mixed with this wet chaff 3 cwt. of salt and 100lb. of 'Simpson's spice.' Having filled the pit, I had a layer of dry straw laid on the chaff, then boards fitted over the straw; again over this I spread layers of sawdust and oat cavings—all this to exclude the air—then, by way of pressure, I placed several tons of freestone on the top. The silo pit in which I have made this experiment is a stone and brick-walled room with concrete floor, measuring 16ft. by 9ft. by 10ft. At the present time there is a depth of about 7ft. of ensilage.

"C. A. Kemble."

This pit was opened on March 14, in the presence of a large number of the leading agriculturists of the district and other distinguished visitors. Amongst those we noticed Sir John Heron-Maxwell, Bart., of Springkell, N.B., who it may be remembered brought this subject prominently forward at the general meeting of the Royal Agricultural Society last December. After the covering boards, &c., had been removed, it was found that a very little of the preserved fodder was fusty, and this only so slightly that it need not be wasted. Breaking further into the pit, a fragrant odour soon pervaded the homestead in which the experiment was tested, for a cloud of hot vapour escaped from the ensilage, and reminded one, by its smell, of a newly heated hayrick. An ordinary thermometer was plunged as far as a man's arm could reach towards the centre of the mass, and registered 110°. Some of the ensilage was immediately carried to cattle and horses, and was readily eaten by them.

[This may be regarded as a highly satisfactory experiment in utilising almost worthless oat-sheaves; but the result would probably have been still better had the sawdust and oat-cavings been dispensed with, and two or three times as much stone piled on the boards. The former served to shut in air, which might have been advantageously driven out by the latter. This imprisoned air will doubtless account for the high temperature, which indicates an excessive amount of fermentation, and a corresponding waste of material. See *ante*, pp. 80 and 81.]

CEMENTING INSIDE OF SILOS.

Sir,—On reading Mr. C. R. Kenyon's letter in the *Field* [reprinted on p. 139], I notice he says that he found his grass mouldy and unfit for food for some inches round the edges of the mass, and he surmises that this was caused either by the brick sides not being coated with cement or by the damp. I certainly think if he had coated his tank with cement he would have found the grass keep better. It seems to me a mistake to build the silos of brick, which is porous, and admits not only moisture but air also from the adjacent soil, and these combined would cause the grass to get mouldy at the edges. I would suggest to any of your readers who may be inclined to try the plan that they build their silos of cement concrete, faced up on the inside with almost neat cement, and let the bottom be of the same material. They will then have a silo perfectly impervious to either moisture or air, and they can build it at any convenient place, no matter what the nature of the surrounding soil. Six parts of gravel or broken stone to one part of cement will be best for the concrete, the facing to be made of half cement and half clean sand.

Little Island, Cork. Edgar Hall.

ADVERSE VIEWS.

UNDER the head of "The Ensilage Fever," Mr. T. Duckham, M.P. for Herefordshire, has published in the *Hereford Times* a letter, which has been copied into various other journals, and which runs as follows:

"The great interest which has been excited throughout England respecting ensilage induced me to write to a friend in America, on whose judgment I can with confidence rely, to inquire the result of his experience with it, as I knew he had resolved to give it a fair trial. The following is a verbatim copy of his reply: 'The ensilage fever, and I can tell it by no other name, is confined to the theoretical farmers mostly, although there are those who have gone into it merely to thoroughly test its value as a forage feed. We have fed ensilage in greater or less quantities for three seasons as a substitute for roots. But the cost is too great for the nutritive value it contains. In the first place, the fodder must be entirely free from dew or wet when cut and put into the silos, or it will be worthless. With the facilities the British farmer possesses for raising and feeding roots, I can see no advantage by ensilaging green food.' My friend lives in the State of Maine, and was desirous of obtaining a substitute for roots if possible."

It is not to be supposed that any process will be carried out by everybody with an equal amount of success; and it is possible that Mr. Duckham's friend has been less successful than others. If he has found that "the fodder must be entirely free from dew or wet when cut and put into the silos, or it will be worthless," it looks as if his arrangements were defective, because other persons have found that under similar circumstances their ensilage has been perfectly good. If some men can pit wet fodder, and get good results (*see* pages 68 and 114), it shows that the wet alone will not make it worthless; and if others pit wet fodder and it is spoilt, it does not prove that the wet was the cause of failure—the result may be merely due to bad management, which will also damage fodder that is not wet.

From America we get an objection to ensilage that is amusing from its intensity of dislike. A correspondent (W.) of the American *Cultivator* says: "It not only ruins the vitality of everything fed on it, but leaves the calves of cows in such a state that they cannot live on new milk after they are born. It not only scours the cows most of the time, but also the calves. I have seen cows made so drunk on ensilage that they could not stand up, and still people will say that there is no alcohol in it."

This letter produced a number of replies in the same journal in opposition to W.'s assertions, and one writer quaintly remarked: "I have never detected any signs of intoxication in any of my cows. It is true they do wink at me and roll out their tongues in a peculiar manner, but I have attributed these actions as a desire for more ensilage, not as a result of overfeeding. The only animals I have that get drunk are the negroes; but as they do not eat ensilage, I cannot give ensilage credit for it."

But, assuming W.'s facts to be true, and that his cows have been made drunk by the great quantity of alcohol in his ensilage, it shows how badly the silos were managed. To produce a large quantity of alcohol in the silo, there must be excessive fermentation and waste, the nutritious properties in the fodder being in great measure destroyed.

In connection with the difference of quality in ensilage, it may not be amiss to quote the following remarks by M. Goffart:

"I said on this subject on Jan. 12, 1876, at a meeting of agriculturists: 'Don't lose sight of the fact, that in the preservation of materials in the silo, there are numberless grades corresponding with the most different nutritive values; the state of division of these materials, and the chemical modifications they have undergone, may make a difference of half of their nutritive value.' I take this opportunity of reproducing these words because they reply to the too numerous communications which I daily receive. One says: 'I can't use more than half ensilage in my rations, or my beasts would perish.' Another says: 'A third is the utmost that my beasts can take in their food.' Another asserts that they will scarcely take a quarter. 'Good heavens, gentlemen,' I reply, 'make good ensilage, and all that would be changed, as it has been with me. My first attempts at ensilage were no better than yours; little by little I have made better ensilage, and have fed my stock better with it. In that lies the whole question.'"

FEEDING HORSES ON ENSILAGE.

WITH regard to the feeding of horses on ensilage, it will be well for beginners to proceed cautiously, as various statements have been made in America as to these animals being injured by it. On referring to page 99 it will be seen that the subject is alluded to in the report of the United States Department of Agriculture; and here is an extract from a letter in the American *Cultivator and Country Gentleman:*

"Ensilage is becoming quite popular, and may be profitable under some circumstances; but, from the experience of three of the four dairymen who have recently fed it in this vicinity, I should be unwilling to feed it to horses. One gentleman lost three horses last year of a strange disorder, and, after consulting veterinary surgeons, and experimenting, after much deliberation, he could account for it in no other way but as the result of feeding ensilage. This winter two farmers who have taken the silo fever, and expressed themselves well satisfied with it, have each lost two horses, and a post-mortem examination of one of the horses, by a veterinary surgeon, developed a very diseased condition of the stomach and bowels. The veterinarian was called to treat one, and from the symptoms began the treatment for cerebro-spinal meningitis, and ordered the ensilage to be discontinued and other food substituted. The horse improved, and was thought to be so nearly well that he was put upon his former feed; but two or three days after the renewal of the ensilage feed, the horse sickened and died. Perhaps these cases are not sufficient to be entirely convincing, but they are, to say the least, very suspicious."

In some samples of ensilage, where an undue amount of fermentation has gone on, a very large quantity of acid has been formed; and it is possible that in such cases the fodder may not be so well suited to the digestive organs of horses as to those of cows, and that the differences of opinion expressed as to the suitability of ensilage for the former animals may be accounted for by the fact of the process having been carried out more perfectly by some experimenters than by others. Certain it is that many persons have fed horses on ensilage without experiencing ill results. The Vicomte de Chezelles is in the habit of doing so, as will be seen by reference to pages 108 and 116; and, in page 122, a quotation from Mr. Woods' lecture gives an account of a small experiment on Lord Walsingham's estate. But, as in many other cases, the fullest information is from America. The official report, already alluded to, contains several favourable records; but the most complete is the following, from Capt. A. H. Sweny, of West Troy, New York:

"Fed all my brood mares and colts last season with perfect success; never gave a particle of hay as long as the ensilage lasted—three months. Gave horses 40lb. of ensilage and 4lb. fine feed, which is more than enough. Some I gave nothing but ensilage, 50lb. daily; they did well, but did better with 40lb. ensilage and 4lb. fine feed. They were too fat, if anything, but in splendid condition and very healthy. As to profitableness, the profit is very large. I consider my two silos (which cost $500) are worth $10,000. I would rather pay interest on that than give them up."

Captain Sweney is evidently an enthusiast—which, however, he is not likely to have been if ensilage always gave bad results with horses. His ensilage is evidently good; but, as we before remarked, it is well for beginners to proceed cautiously, and make sure of the goodness of their product. There is some sound sense in the following passage from a letter written by Mr. G. W. Farlee to the American *Cultivator*:

"I think the advocates of ensilage make a mistake here, in claiming too much for it. Many are strong believers in the value and economy of corn ensilage for feeding cattle during the winter months, and I am among that number. Now, if we are right in the conviction, let us labour to get the idea and practice adopted by the farmers in the country in connection with feeding cattle and sheep. If it is good for horses and pigs, time will show it; but in the meantime I do not want anyone to experiment on my horses. I cannot see that the slightly fermented condition of ensilage can do any harm to cows and sheep, but it may to horses. . . . My suggestion is that we confine ourselves to solving the problem as it applies to cows for the present. Let the horses munch their hay, and the pigs sup their slops; they will receive attention later on."

SUBSTITUTES FOR WEIGHTS IN COMPRESSING ENSILAGE.

VARIOUS suggestions on this subject having been made, we reprint most of what has been said in *The Field,* though we cannot state that we have as yet seen anything that we should rely on as an improvement on the concrete blocks, stones, and other heavy matters used for the purpose.

SIR,—Would it not be easy and a great improvement to substitute some form of mechanical pressure to the covers of the silo? As recommended by your correspondents, weights are placed on boards, which seems to me a clumsy way of proceeding. My idea would be something of the following. Let the green stuff in the silo be covered in the usual manner, but have iron rods coming up from the bottom of the silo at intervals, the top end of which will be tapped for screw nuts. When the silo is as full as it can be trampled down, place other boards across those covering the contents at right angles, catching the ends of, say, half a dozen boards a foot wide. Any reasonable amount of pressure can thus be applied. After a few days, when more fodder is wished to be placed in the silo, the screws can be slackened, the boards removed, and, when filled up, more pressure applied.

Of course the iron rods must be well fastened to the bottom of the silo in flags or heavy stones. This is merely a rough suggestion. There are many ways of doing this, perhaps, better; but I think some plan of the sort would be better than merely pressing down with soil or barrels filled with stones. A SOLDIER.

[This method has been tried in America, but does not appear to find many advocates. The report of the U.S. Department of Agriculture says: "Screws are used by some instead of weights. The objection to them is that they are not self-acting, like gravity."]

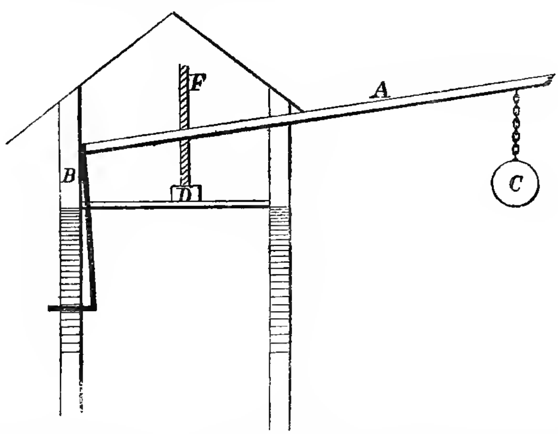
SIR,—"A Soldier's" idea of compression by nut and screw is theoretically good, doing away, as it would, with much expense and trouble in moving the necessary weights; but I think in practice he would find his idea would not suit. He could screw down his boards, in the first instance, as far as material in silo would allow; but then he has made no provision for the "ensilage" sinking. The pressure which with weights would be continuous with the nut screw would cease as the "ensilage" sank. If, however, a strong spiral spring was adjusted, with the necessary "washers" between the nut and the boards, a continuous pressure (at least as long as the compression of spring lasted) would exist.

CORSAIR.

SIR,—I am making preparations for two silos, each 40ft. long and 12ft. wide, and am therefore much interested in the amount of weight required to compress my grass, and the most simple way of managing it. The idea of leverage therefore suggested itself, and I think can be applied without much trouble or expense.

My earliest idea, suggested by Mr Easdale's first letter, was to make use of petroleum barrels (which are to be got for two or three shillings each), cut in half and filled with earth well puddled. This I soon saw would be inconvenient; but I then thought of another way of utilising them, which was to fill the barrels as they stood with earth or gravel, and laying down one, two, or three "tramways," of two beams or planks each, across the covering bands of the silo, and so apply as much weight as might be required. By using stones packed with earth in the shape of mortar, each barrel would weigh nearly half a ton. Their form would make them easily movable, either in the silo when in use, or when it required to be emptied.

Finally, the idea of leverage suggested itself, which may, I think, be simply carried out in the way shown on the sketch of transverse section sent herewith. In this A represents the lever, made of a larch pole, fixed to the wall, B, by an iron rod, which would be turned into the masonwork so low down as to give the counterpoise required for the weight, C. D, a beam, say five feet long, is laid transversely to the floor



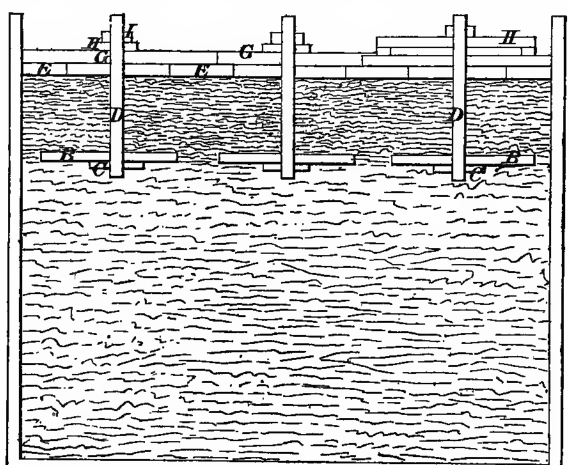
of planks, and E is an iron upright passing through a mortise in A, with holes for a pin, which would regulate the height. It is clear that any amount of pressure which the flooring would bear without curling up at the ends could be applied in this way. The beams, D, which would follow one another along the length of the flooring, would be made of any rough timber sawn down the middle, and, being in short lengths, easily removed as a fresh cut was required.

The absence of pressure after the grass had got fairly settled into "cake" would, I think, not make any difference. Should the concentration of pressure on a single beam be thought objectionable, it would be easily modified by laying down two, four or five feet apart, with a crossbar for the fulcrum to rest on. AQUARIUS.

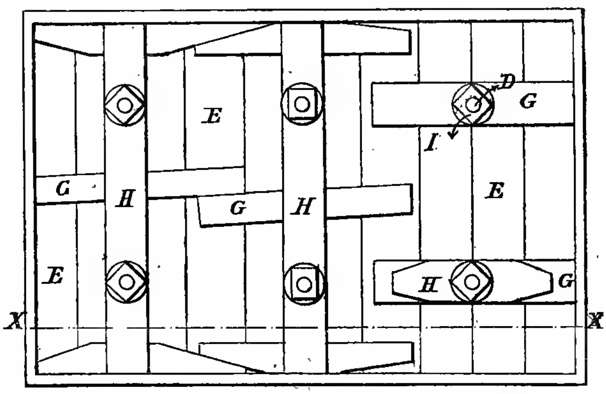
["Aquarius" does not say how many levers he proposes to use. A silo of the dimensions stated would have a surface of 480 sq. ft., and, at 1cwt. per sq. ft. the weight required would amount to 24 tons. Supposing the lever to be 24ft. long, and the force applied in the middle of the silo, as shown in the figure, 8 tons would have to be suspended at the end, to give the required pressure. It would be applied, too, where least serviceable, viz., in the centre—the pressure being most wanted close to the walls. The absence of pressure after settlement does make a difference; and the unsatisfactory result in Mr. Scott's experiment (*see* p. 179), appears to be due to this very cause.—ED.]

SIR,—As there has been a great deal of discussion lately upon the best methods of weighting ensilage in the pit, I have sent you the drawings and description of an invention patented by Dr. Bailey, for utilising the weight of the ensilage itself to compress the mass in the pit.

The plan adopted is to compress a layer of the ensilage four or more feet thick on the top of the mass by means of bolts having threads and nuts at the top; on the lower end of the bolts are heads and washers.



When the silos are filled to within about four feet as high as is proposed to fill them, plank is placed crosswise in the silo, with holes through which the bolts pass, having the heads and washers on the under side. Across this plank are placed short pieces of plank crosswise of the planks C C C, two of which, having holes in the centre, are placed so that the bolts D D D pass through them. One or more short pieces are placed across the planks C C C between the two bolts. At equal distances bolts with planks C C C and B B B are placed as described above, at such distances apart that each bolt will compress about twenty-five to thirty-six square feet area. When the bolts, with the planks C C C and B B B, are in position, the filling of the silo is resumed. When it is full to the tops of the bolts the plank cover E E E, is laid crosswise in the silo, provided with holes or notches, so that the screw ends of the bolts can stick up through it. Short pieces of joists, G G G, and about two feet longer than the distances between the bolts, are placed on each end of the plank



covering, also one piece in the centre of the silo. Equidistant between the bolts, these joists lap about two feet, so that they form a continuous stringer on each side of the silo and lengthwise through the centre. A plank, H H H, with holes through it of sufficient thickness to make a stiff spring, is then placed crosswise, resting at each end and in the centre upon the sticks or joists, G G G, so that the bolts will pass up through the holes. Upon the top of the plank are washers. Nuts I I I are screwed down on the bolts D D D. By turning the nuts down, a layer of the ensilage, lying between the plank covering, E E E, and the planks, C C C and B B B, is compressed to any desired degree of solidity. This layer will weigh from 50lb. to 60lb. to the cubic foot; therefore a layer of 4ft. in thickness will press upon the mass below with the pressure of at least 200lb. to the square foot, and be sufficient to exclude the air and prevent fermentation.

The advantages of this method are that there are no bolts in the way at filling, all labour of handling heavy weights is avoided, the side walls are relieved of pressure, and therefore need not be built so strongly as for ordinary weights, and the bottom part of the ensilage is not compressed too much (as sometimes at present takes place, squeezing out some of the juices). The pressure brought to bear upon the top 4ft. of ensilage by compression of the bolts, is sufficient for its preservation, and should any of the juices be pressed out they are taken up by the mass below, so that nothing is lost. A. B. R.

[The idea of compressing the topmost layer of fodder as a means for weighting the rest of the mass, is ingenious, but we doubt whether it would answer in practice. It seems to us that when the screws are set to work, the fodder, on being compressed between the planks, will swell out where there are no planks, viz., in the intervening spaces and at the sides. If the compression were great, the fodder at the sides might be driven so forcibly against the walls as to resist any descent. If the bolted mass did sink down, its base would not have the regularity of form shown in the sketch, but would rather resemble the surface of a couch or easy chair, where the stuffing is compressed under the buttons and is puffed out in the intervening spaces. Under such circumstances there would be a succession of hollow places in the silo, which would be reservoirs of air and centres of decomposition. The effect of placing heavy weights on the top should be, first, to drive out the air abounding in the fodder when put in the silo, and afterwards to prevent any new supply from coming in. The bolted mass would probably serve the latter purpose very effectually, but it would also prevent the escape required in the first instance, and thus would shut in the great agent of destruction. If, instead of attempting to make the whole surface into a single block, a number of smaller independent blocks were made, with the boards underneath as complete as on the top, and each block trimmed smooth round the edge by a hay knife, they could be packed together all over the surface, and could be unscrewed one by one as the mass of ensilage underneath was required to be uncovered. We think this would remove the objections above indicated; but whether there would be any saving in the trouble and expense of lifting ordinary weights remains to be proved.—Ed.]

Sir,—Regarding the pressing of ensilage, the following plan seems to me an easy and efficient way of doing so. Say the silo is 12ft. by 30ft., then have thirty galvanised tanks, each 6ft. long by 2ft. broad and 4ft. 3in. high, with large rings at each end, to pass a pole through for lifting. When the silo is full, place on boards, and on them the empty tank; two tanks placed across the silo would cover the 12ft. Let the tanks be connected with catches, to keep them all in place during the sinking of the ensilage, then fill the tanks with water from a hose or pump. When the ensilage is required for use, draw off the water with a syphon or pump from one or both of the tanks, at the end you wish to begin at, disconnect the empty tank, and lift it off. The pressure per square foot would be about 250lb.; the empty tanks would weigh about 224lb. each.

Of course, the above plan would be of no use where water was not at

hand; but on many farms silos could be built in such a situation as to utilise any water power available for the purpose. The tanks ought to have the rivet heads inside, for close packing. W. T. M.
Uffculm, Devon.

SIR,—I quite agree with your correspondents who think that some means may be adopted for applying the needful pressure to ensilage, without resorting to the clumsy and laborious method of lifting on or off many tons of stones, &c., whenever the silo is filled or emptied.

If I were abont to construct a silo, I would try the effect of something of this kind. Along the top of each of the two longer walls I would place a wooden or iron beam (disused rails from a railway would serve the purpose, if obtainable), secured so as to withstand an upward pressure, and raised just enough from the coping to admit of the insertion, between wall and beam, of the ends of a stout plank, stretching across the silo from wall to wall. This cross-plank I would use as a fulcrum (if I may so term it) from which to apply pressure to the boards covering the ensilage—the force being applied by means of a portable "jack-screw" or "lifting jack," standing on the boards, and worked up to the cross-plank, thereby driving down the board and the fodder below.

The side walls of the silo I would previously provide with sets of holes to admit stout pins, so that, on the jack forcing down one of the boards, pins could be inserted at each end to prevent its rising again. This could be done in the course of a few minutes, and then the jack could be removed to the next board, the cross-plank shifted over it, and the process repeated, till at length all the boards would be pressed and pinned down.

I would not, however, attempt to give the full amount of compression at one time, because there is at first a certain amount of natural elasticity in the fodder which would increase the labour; and the work would, I think, be more easily and effectually done by commencing with a moderately good pressure, and giving further compression at intervals of a day or two, as the fodder loses its elasticity, forcing the boards down each time an inch or two to a lower set of holes, and then shifting the pegs.

This could be repeated from time to time, until the mass of ensilage showed no signs of further collapsion.

I should work the jack close alongside the walls, and not in the centre of the cross-plank; for, in the first place, it is at the edges that most pressure is requisite, seeing that mouldiness always begins at the outside, and the greater the pressure there the less the amount of damage; secondly, if the force were applied in the centre, the boards would certainly bend upwards at the ends, and not only would the pressure be unequal, but it would be greatest where least wanted and fail where most required. I should be disposed to slip one end of the board under pegs placed in readiness in one of the walls, and then press down the opposite end of the board, by means of the jack, until the other pins could be inserted; or else (and this probably would be a better arrangement) have two jacks, one at each end of the board, and tighten them alternately, until it was brought down to the required level.

I am inclined to think that such a mode of compression would be more beneficial than covering up the entire surface of the ensilage evenly from the first. The advantage of the covering is obtained, not merely by preventing any entrance of air, but (more important still) by ejecting that already in it—which is the most fertile source of mischief. It does not suffice to exclude air by hermetically sealing the surface of the silo, for that would imprison what is within, and a kind of slow combustion, detrimental to the nutritious qualities of the fodder, would continually go on; but by beginning the compression at one end of the silo, and extending it to the other, the air would be gradually driven out as the work proceeds.

It is essential to keep tightening up as long as there is any collapsibility in the mass, or a new supply of air will get in; and a continued pressure is desirable to the last, it being very advantageous when the silo is opened, as the exposure of a loose mass to the atmosphere produces rapid decomposition, which does not occur with that which is closely compacted. The pegs should be drawn from only one board at a time, as the ensilage is required to be cut out: and if the pressure were still so great as to prevent the ready removal of the pins, the jack could be re-applied, so as to give the necessary relief.

T.

(From the *Hampshire Chronicle.*)

Some suggestions have been made as to the use of screws, levers, and similar contrivances, but dead weights appear to find most favour, possibly from the very simplicity of the arrangement, while any proposition as to mechanical appliances seems to imply both outlay of capital and skilled labour.

Although, however, the application of so many pounds per superficial foot or yard sounds like a trifling affair, it is quite a different matter when a silo of considerable size has to be weighted. Mr. Willan says: "I fancy that the weight required to make good ensilage is between 200lb. and 240lb. per superficial foot, or thereabouts," and taking the small sized silos of Mr. Gibson, of Saffron Walden, simply as an illustration, which measure 13ft. long, 13ft. broad, and 12ft. deep, and hold 40 tons of ensilage, we shall find that the superficial area is 169ft., and at 200lb. per foot the compressive weight needed for this one silo is 33,800lb., or over 15 tons. This would not be such a very serious item after all, if, when the weights were once deposited in place they could remain there till the ensilage was needed for use, but those who have had experience in these matters state that the pressure should be first placed on 3ft. in depth of ensilage materials, then removed and another 3ft. materials added, and so on to completion.

Of course ropes and pullies may be employed to lessen the labour, but the fact must remain that the primitive principle of obtaining compression by applying stones, old iron, casks filled with earth, &c., is a serious item in the labour cost.

Articles of this description are naturally more difficult to handle than if square shaped and of uniform size and gravity, and therefore concrete blocks are, it is stated, often used; but concrete blocks, with the materials at moderate cost and each block having an iron ring or hook attached to haul in and out of the silo by, cannot be made for less than 12*s*. per cubic yard, or 8*s*. to 9*s*. per ton, and in most cases more, and the sum of 6*l*. to 7*l*. at least is therefore incurred for weights for every 40 tons of ensilage, exclusive of pullies, ropes, and other apparatus for hoisting and lowering them.

It is strange that no one has suggested the use of hydraulic pressure to economise the labour of compression. An "hydraulic jack" capable of exerting a strain at any one point of six tons costs 5*l*., weighs but 68lb., is portable, the pressure can be applied in a few seconds by one man, and at as many different places as provision has been made for the thrust of the jack, which, of necessity, must be equal to the strain exercised.

A rough beam or two thrown across the silo and fixed down, or better still, iron uprights built in the walls with projecting feet for the head or claw of the jack to rest against, would answer the purpose, but cost more; in fact, the first would, no doubt, equal that of the dead weight principle, but the gain would be in the time saved when the silo was required to be opened, or when the pressure was needed, and also in the immense pressure available. T. POTTER.

Northington, March 5, 1883.

Numberless plans to obtain compression by mechanism are already put forth. Every friend you meet (who is endowed with a mechanical turn of mind) at once buttonholes you with a whispered confidence to the effect that he can beat you all to nothing in the matter, and it is quite affecting to notice his look of compassion on your evident scarcity of brains. It is best to let such run on to the full length of their tether, and then introduce some factor which they had never dreamt of, and which experience has shown to be essential; when, lo! their castle of cards is at once demolished. Seriously, Sir, as far as I can see, nothing, so far, can supersede the separate weights; they are automatic, certain, and safe, with the minimum of attention required.

Our boxes of puddled clay are to be superseded by something more compact and easier to handle. We think of using pig-iron, as run from the blast furnace, we supplying them with a model from which to make a mould. The area of each will still be one foot super; but the length and breadth of the new weights will conform to the width of the covering planks, so that the removal of one row of weights shall set free either one or to planks as desired. Two sunk handles (like that in a square 56lb. weight) would be cast in the upper side of each. THOS. EASDALE.

PORTABLE SILOS.

Sir,—In *The Field* of March 3, you give an account of the meeting at the Croydon Farmers' Club, where you mention that I exhibited a new system of silo building, which was favourably received. It has been suggested to me that if I would make the details of my system public it would be as well, and I now proceed to do so.

I would make all silos portable, so that they can be shifted or enlarged, or converted to other uses, if desired.

The construction should be so simple that any agricultural labourer of average intelligence can erect them or take them down.

No part should be heavier than one man can lift; and the various parts should be of such a nature that they can be sent by rail, or carted on an ordinary farmer's cart, and should be stowed away until wanted, in the least available space.

Now, my method of erection is as follows: Having decided where to erect the silo, level the ground, or if already level, place on it a raised platform of earth not less than 12 or 18 inches high, so as to keep the bottom out of the wet. Then lay down plates of ordinary 4ft. by 3ft. quartering, with mortices throughout 3ft. apart, centre to centre. Insert uprights all one size—say for example 8ft. long—with a tenon each end in the plate. Drive a head plate in the top of the same length as the bottom plate, and the framing is complete. The walls are now formed by screwing slabs of concrete 3ft. long, 2ft. high, and 1½in. thick, with a hole in each corner, to the wood uprights. The screws can be galvanised if desired. The joints can be formed by a piece of tarred cord laid in as the work proceeds, or a rush as used by coopers will do as well. These slabs can be procured from W. H. Lascelles and Co., 121, Bunhill-row, at 4d. per superficial foot, as advertised. They weigh about ¾cwt. each, can be sent by rail or road any distance without packing, and can be stacked outdoors. They are water, fire, and frost proof.

If the foundation is soft, a row of these slabs can be put under the plate, or the entire bottom can be paved with them; although I do not think this would be found any advantage.

For weighting, the slabs can be laid flat on the ensilage, and earth, stones, or any other material at the farmer's disposal, can be placed on the top.

For roofing I would use hurdles thatched, having a fixed ridge on each of the plates to lay them on; any part can then be uncovered, and the silo can be roofed in like a rick when it is filled.

To prevent the walls bulging, I would have a half-inch hole bored through the centre of each mortise and tenon, and I propose to buy bolt ends with nuts at a cost of 3*d*. each, to which any country smith could weld a half-inch rod, making a bolt the length of the width of the silo, with a nut each end.

These bolts can be put either 3ft., 6ft., or 9ft. apart, as found necessary, and will do for the top plate or the bottom plate; they also tie the uprights to the head and sill plates.

The concrete slabs should be inside, the quartering showing outside; the tarred cord or rush in the joints makes the whole affair air and water tight; and the wood does not come into contact with the wet grass.

The wood can be whitewashed or tarred, and the appearance of the structure would be unobjectionable.

Now the materials required are—the plates from the saw, mortised 3ft. apart; uprights same size as plates, or stiffer if desired, tennoned each end to fit upright; tie rods, with a bolt and nut at each end, to keep sides from pushing out; and slabs of concrete, 3ft. by 2ft. by 1½in. thick, to form floor if found necessary (which would be laid on solid earth), to form walls by screwing to woodwork, and to form weights by putting a layer on the ensilage. Any man who can use a hammer and saw can put it up; any part can be carried on a man's shoulder any reasonable distance. It is a tenant's fixture, and can be used for other purposes as well as for stowing green food.

These structures I would put up in the winter time, when the men have little to do. If the ground is frozen, so much the better for the carting and getting across the country; and I would suggest that, as carting is very expensive during the hay-making season, it would be a good plan to make several silos, each close to the crops, so as to save carting the heavy wet food at the most busy season, for this might be done when there is little else to do, and the food is much drier and lighter.

W. H. Lascelles.

[If sketches of such silos could be given, with estimates of cost, we have no doubt they would be of interest to many of our readers.—Ed.]

Sir,—Acting on your suggestion in *The Field* of March 17th, that I should give sketches of my proposed silos, with estimates of their cost, I now propose to follow up my letter of that date by supplying your readers with the information you suggest.

I remember, when a boy, being told that the country people in Devonshire had a method of preserving gooseberries green for a long time, by burying them in tightly-corked bottles at the foot of a tree. Now, the bottle is the silo, the cork is the cover, and the ground being drier at the root of a tree than elsewhere, would be about the best place to put them.

The difficulty in giving estimates for silos consists in the fact that no one seems to know exactly what he wants; and the larger the silo the lower the price per cubic foot.

I will therefore take an experimental silo, and give first a sketch and price for it, and will make it 15ft. long and 12ft. wide. As regards the height, I fancy 10ft. will be found convenient for filling and emptying, although if it is made higher it will be cheaper in proportion in the first cost; yet we must be careful this saving is not more than counterbalanced by the extra cost afterwards.

The general appearance will be something like the sketch opposite (Fig. 1); and you will see I have indicated thatch for the roof, which might be reed, heather, straw, or whatever is cheapest and handiest. Boards, tiles, or slates will do where thatching material cannot be obtained. I may add that the silo is supposed to be standing on a raised platform of earth, 12in. or 18in. high, as stated in my previous letter, instead of a sharply-defined slab, as shown in the engraving.

Construction.

The wood framework, before the concrete slabs are screwed on, will have an appearance something like that shown in Fig. 2. It consists of deal, all of one size (4½in × 3in.), the horizontal plates all mortised 3ft. apart, centre to centre, each mortice being 3in. by 1in., and quite through the plate.

By this arrangement the plate can be bought all ready with the mortices made; any length will come in; it can be kept in stock and cut off as it may be wanted. Fig. 3 is a sketch of this plate. The vertical pieces are the exact height of the silo side, whatever may be found most convenient. I have taken them at 10ft., and they have a tenon each end 4½in. long, 4½in. wide, and 1in. thick, as shown by Fig. 4. These uprights or vertical pieces should be all alike, so that they, too, like the plates, could be kept in stock; and the putting up the wood framework of a silo would become as simple a matter as putting up the shutters of a shop.

The corners I would arrange as shown by Fig. 5. By this contrivance, the necessity of having special corner pieces is avoided. It will be noticed that I have shown an iron square at the corner. I would have three of these at each corner, about 12in. each way, of wrought iron, say 2in. by ½in., with four 3in. by ½in. coach screws in each square. The centre one might be somewhat shorter.

The sill-plate I would keep up from the ground by putting blocks of stone or broken slabs under it, to protect it from the wet; and the lower edge of the bottom slab should be rather below the bottom edge of sill plate, as shown in Fig. 6.

A more simple, but less neat-looking plan to form the walls of silos will be to use the quartering without mortising and tenoning, simply bolting or nailing the joint, as in Fig. 7. I have shown a 6in. ⅝ bolt, cost about 3*d.*, but two 5in. wrought nails might be used instead. Although this plan is not so neat-looking as the one first described, it is really more scientific, and it has the great advantage of saving one portion of the process necessary, and thereby reducing the cost, and at the same time increasing the strength of the structure.

To tie the structure together, I have bored holes through the plate and tenon, through which oak pins should be driven; and, about 6ft.

FIG. 1.

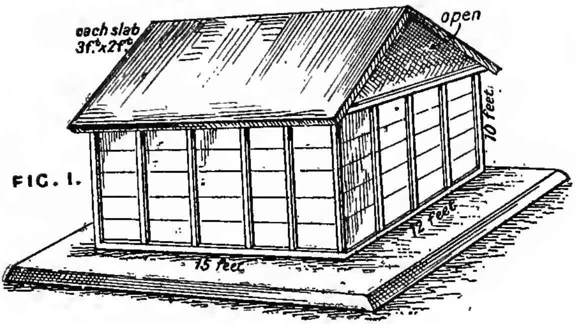


FIG. 2.

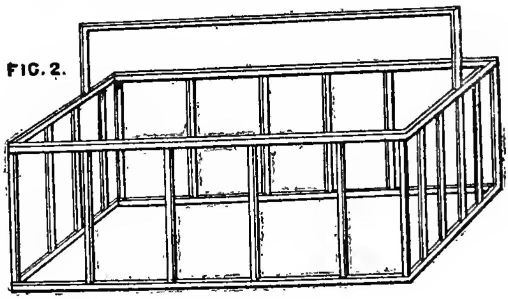


FIG. 6.

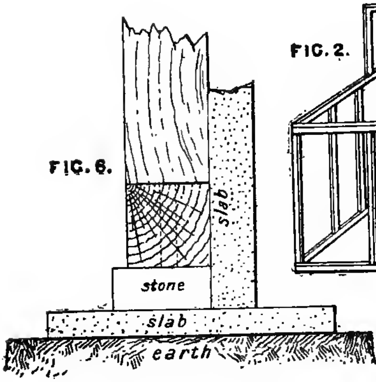
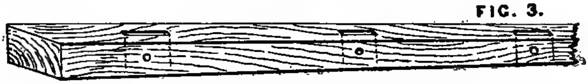


FIG. 3.



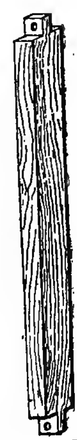
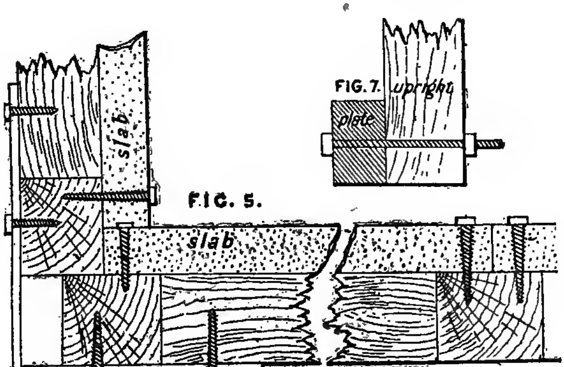


FIG. 4.

FIG. 7.

FIG. 5.



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or 9ft. apart, bolts should be carried across the silo as tie-rods, both at the top and bottom, with a nut at each end.

Although I have specified the uprights as 4½in. by 3in., the size can be increased if found necessary. A 9in. by 3in. deal, with the edge towards the slab, for great silos, or where much pressure is expected, would be better; or iron might be used instead of wood, without affecting in any way the principle of construction.

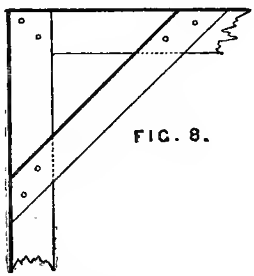

FIG. 8.

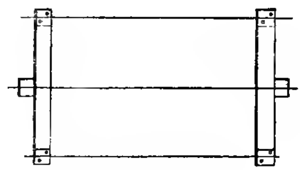

FIG. 9.

A corner-tie, formed by a piece of quartering (Fig. 8) halfened down on the top and bottom plates, would stiffen the structure, and could be used in many cases instead of the iron squares; and an additional tie-rod with plates could be added to the centre of the silo walls (Fig. 9).

WEIGHTING THE ENSILAGE.

This is an item of expense, indispensable I fear, but most difficult to meet. We are told of earth being piled up to a weight of 500lb. to the foot. Now, as a cubic foot of dry mould weighs about three-quarters of a hundredweight, that means a heap 5ft. or 6ft. high. Then we hear of cement casks, filled with mould, hoisted into position, blocks of stone, with pullies and lines for lifting, and all sorts of schemes and dodges to get over the difficulty. The problem, I take it, is this. When the wet grass or other green food parts with its water through contact with the air, plants of a fungous nature are formed and produce decay; but if the air is forced out by the compression of the material, and the continued action of the weights prevents the formation of new air-spaces, the fungus cannot grow and the material is preserved.

The actual weight required will vary according to the material compressed, but the results of American experiments would seem to show that it varies from about 1cwt. to 5cwt. for every square foot.

Now, the concrete slabs I propose to use for the walls weigh just about 1cwt. to the cubic foot, so if they are packed close together to a height of 3ft., they will give 3cwt. to the foot pressure; and as each slab weighs about ¾cwt., they can be carried up a ladder and put in position without difficulty by one man; in fact, I have already used them in this way for testing the strength of concrete floors.

Having, therefore, filled the silo to the eaves plate, and having bolted a fillet to the uprights to lean the slabs against, cover the ensilage with slabs—broken ones will do—form a floor, and commence the weighting as in Fig. 10. Stand the slabs on edge against the fillet, working from the centre towards the outside on either side to equalise the pressure until the whole is covered, then lay strips of wood on the top edge of the slabs, and pile again until the requisite pressure is attained.

The object of putting the slabs on their edge instead of on the flat, is to prevent damage or breakage, as, if they are laid flat, the bottom slab has to sustain the weight of all the others, whilst, if placed on edge, the weight to be carried will be much less. The fillets placed on the top edges are to prevent the risk of slipping; and it makes the whole affair much safer. To calculate the weights, reckon thirty slabs to a ton, and it will not be far wrong.

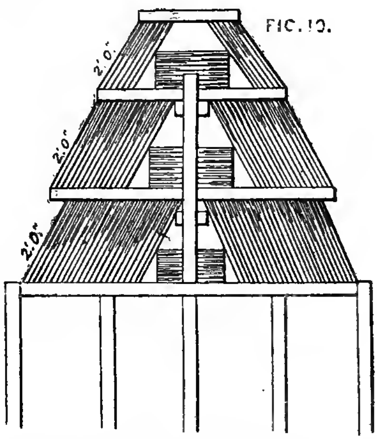

FIG. 10.

To keep the rain off, the top can be thatched; or the slabs might be so placed as to throw the water off without any other covering.

As the ensilage will shrink considerably, it is of course highly necessary that the weight of slabs should follow it, and therefore the bolts which are used for cross-ties must have no slabs on them; they must come inside the head plates as well, unless the ensilage is piled well above the eaves plate, which in practice will, I think, be found the best plan.

Although I recommend the slabs to be placed on edge, it must not be supposed they are easily broken. They are now being used in the West Indies for Coolie barracks, put up by native labourers; and I have a letter from a cocoa planter in Trinidad, in which he informs me they were landed on his plantation with a breakage of less than 5 per cent., although sent from London quite loose, being carried as ballast at a very cheap rate.

Strength of Silos.

How strong should the walls of a silo be? is a question that has not, I think, been subjected to the test of experiment. We read of walls 2ft. thick; I have seen engravings of model silos where they are shown much thicker; then we are told of 18in. as a fair or proper thickness.

Now, as the slabs I am proposing are only 1½in. thick, either the silos already made are a great deal too thick, or mine are a great deal too thin. The question is, which is right?

Although we talk about silo and ensilage, which are very grand terms, the silo is simply a barn and the ensilage potted green stuff; and a silo charged with ensilage is just a tank filled with green food with a weight on the top to keep the air out. If the contents were grain, a pressure on the top would cause pressure on the sides, and strength to counteract it would be wanted. If you put a heavy weight on a sack of corn, and the sack is rotten, you may burst your sack and waste your corn.

With grass the case is different; the fibres which cross and recross in every direction tie the whole mass together, and no amount of pressure would cause a truss of hay to bulge. The shrinkage would take place not only vertically, but laterally, and I very much question whether, after the first day or two, there is any pressure whatever on the sides. Indeed, I should not be at all surprised to hear of a lath of wood being pushed down at any part of the structure between the sides and ends, and its contents.

If my reasoning is sound, the thick walls are more than useless; they are extravagant and wasteful, and tend to prevent a most promising experiment from being generally put into practice.

But it must be understood that these remarks apply to cases where grass, clover, and similar crops are potted whole, and not to those which are cut up so small that they more resemble the corn in the sack above mentioned.

Cost of Silos.

We will now see what the cost of the structure I have been describing will amount to, and to make the matter quite clear, I will take the silo I have drawn (Fig. 1), and see what it contains.

There are in the side six posts, and in the end five, eleven in all; as there are eleven on the other side and end, this makes twenty-two; and as each is 10ft. long, this gives 220ft. of post. There are 27ft. of sill plate, and the same quantity of head plate on oue side and end, or 54ft. in all; add 54ft. for the other side and end, we have 108ft. of plate. The side contains twenty-five slabs, and the end twenty, or forty-five in all; add forty-five for other side and end, and we have ninety slabs in silo. The price will be then somewhat as follows:

	£	s.	d.
220ft. of post at 4*d*.	3	13	4
108ft. of plate at 4*d*.	1	16	0
90 slabs each 36in. by 24in.	9	0	0
Screws for ditto	0	3	0
12 iron squares for corners, bolts, cross ties, and tarred cord for joints	1	15	0
	£16	7	4

And the cubical contents would be found by multiplying the length 15ft. by the width 12ft. which gives 180ft., then by the depth, which gives 1800ft. as the contents of the silo when quite full. If we divide this by 27, the number of feet in a cubic yard, it gives a little over 66½ cubic yards as the contents of this silo; and as an ordinary builder's cart contains a yard, it would take 66½ loads of that size to fill it.

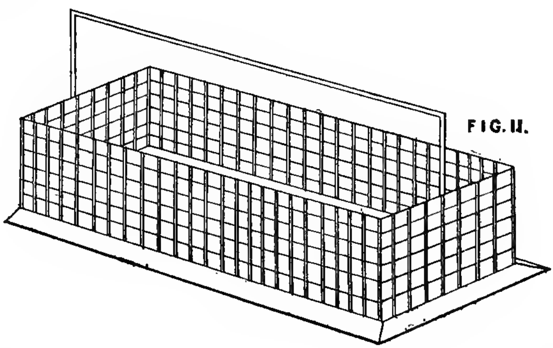

FIG. 11.

But for farm purposes much larger silos would be found desirable, and we will therefore see what a silo 60ft. long, 24ft. wide, and 12ft. high would cost. Now, such a building would contain 17,280 cubic feet, or 640 yards, or one-horse loads, of fodder.

Here (Fig. 11) is the sketch of such a structure, the details are the same as the small building. There are sixty posts, each 12ft. long or 720ft. of posts, and 168ft. of plate or 888ft. run of quartering in all, and it would cost as follows:

	£	s.	d.
888ft. run 4½in. × 3in. morticed and tenoned plate and post at 4*d*.	14	16	0
336 slabs, each 36in. × 24in., at 2*s*.	33	12	0
Screws	0	15	0
12 iron squares for corners, bolts, cross ties, and tarred cord for joints	5	15	0
	£54	18	0

If the plates are not mortised, and posts not tenoned, a reduction of 25*s.* can be made from the first estimate, and from the second in proportion.

If we now compare this price, 54*l.* 18*s.*, for the slabs and quartering of the walls of a silo to contain 640 yards, with the previous estimate, 16*l.* 7*s.* 4*d.* for the slabs and quartering of a silo to contain 66½ yards, we shall find that the cost for the large silo is equal to 1*s.* 8*d.* per yard, and the small silo about 5*s.* per yard, showing that the larger the silo the cheaper the cost.

The railway rate, cartage to the ground, making the platform, and putting up the structure, must be all added; but as they are matters which will vary very much, I have left them to be added according to circumstances. I might, however, mention that I have succeeded in obtaining special low rates for the conveyance of these slabs by the railway companies, which, however, vary, so that no fixed rate can be here quoted.

Now we come to the weighting. It would take 729 slabs to put a pressure of 3 cwt. to the foot on the small silo, because there are 180ft. superficial contents, and three times that gives 540ft. cube, which is equal to 729 slabs; now, as these would cost 72*l.* 18*s.*, and might be used any number of times, I think, if we put 7½ per cent. of their cost or 5*l.* 10*s.*, it would be fair. In any calculation you may make, don't leave out this weighting, for hitherto it has, so far as I know, been found indispensable, and any calculation which ignores it is false and delusive. So we may say, in round numbers, 23*l.* for our small silo, which is equal to about 6*s.* a yard, or a one horse cartload.

This cost can be reduced if any cheap weighting materials, such as stones, bricks, earth, &c., are at hand, and can be used instead of the slabs.

I have now given all the information in my power, and I hope I have succeeded in conforming to the request you appended to my letter in *The Field* of March 17. W. H. LASCELLES.

[On the principle already laid down (page 45), the capacity of the small silo above mentioned would be 36 tons, and the cost (taking only the sum of 16*l.* 7*s.* 4*d.*, without carriage or weighting) would be a fraction over 9*s.* per ton. The capacity of the larger silo would be 355 tons, and the cost (54*l.* 18*s.*) would be 3*s.* per ton.—ED.]

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