GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

READ—the following paper :—

MEMORANDUM* ON SILOS AND SILAGE.

A silo is a pit, made either above or below ground, or partly in and partly out of the ground, which is, as far as possible, watertight and airtight. It is intended for the storage and preservation of green forage. If it be properly constructed it allows of the least possible change in substance of that which is packed in it. The object with which silos are constructed is to supply the owners of cattle and other animals with the most abundant, cheap and nutritious kind of food for their stock, of making the storage of the article independent of the risks of weather, whether of wet or cold or heat, and of putting the material so stored in such a position as to admit of access to the store in the most convenient manner.

2. The process of storing green forage in silos is called ensilage.

3. Material which has been subjected to the process of ensilage is called silage.

4. All kinds of succulent vegetable produce may be converted into silage. Maize, millet, peas, beans, grasses (even of the coarsest descriptions), green leaves, young bamboo shoots, clover, rye, oats, prickly-pear, rice stalks can all with advantage be preserved by the process of ensilage. There is no objection to mixing various kinds of produce in one silo.

5. The best time for cutting a crop for ensilage is before it arrives at maturity, when it is sweet to the taste and rich in saccharine matter. Immature or overripe produce should not be used for this purpose. Where the rainfall is moderate and does not exceed about 40 inches in the year and where there is a reasonable hope of one-quarter of such rainfall falling in September and October, the material for ensilage is best cut in August. The cutting can, however, be counted on for success, if done even as late as in December. Grass cut and placed in a silo during that month has turned out excellent fodder. The material may be cut with the implement ordinarily used in the locality. In respect of grass which is being cut for a silo, the koorpa (hand hoe) is useful, because it acts as a cultivator by loosening the earth about the roots of the grass.

6. The green crop should be cut whilst wet with dew or rain, and should be thrown into the silo whilst quite fresh. Quick filling of the silo (within 24 hours if possible) seems preferable to slow filling. In many successful experiments, however, the filling has extended over five and six days.

7. Any space above ground, which is enclosed by walls, as for example a room, a hut, a godown, can be used as a silo, provided that the sides are smooth and perpendicular and that air, rain and damp are excluded. Below ground, trenches, pits and holes are equally effective. In Coorg and Mysore silos excavated in the ground will probably be found to be most practicable and economical. It is believed that there is no necessity to line excavated silos with mortar, or to dry them artificially, or to slope their sides, though these practices find favor with some persons of experience. It is best to round off corners slightly.

* This memorandum, which has been drawn up solely in the hope of benefiting planters and other owners of stock in Mysore and Coorg, is based on Mr. Thorold Rogers' "Ensilage in America," on papers received from Sir Herbert Macpherson and from the Revenue and Agricultural Department, and on a note with which Mr. Norman Tod of Alicutty in Coorg has favored me.—C.G.

8. The size of a silo must depend on the amount of available produce near at hand. Where green fodder is fairly abundant a silo of

30 feet long,
12 feet broad,
6 feet deep,

can with advantage be used for every 5 or 6 acres of land. The above dimensions give 2,160 cubic feet, which will store about 500 maunds of 80 lb. each (= 40,000 lb.). For smaller silos the length and breadth, but not the depth, should be reduced. According to some persons a greater depth than 6 feet is desirable in a damp climate.

9. An excavated silo is good not for one year only, but for many.

10. A silo must be completely filled. The filling can be done in rain without risk of injury. The green fodder may be put into the silo either shredded or not shredded, as may be preferred. If unshredded, it will need a greater subsequent pressure, so as to ensure that it lies close and that air is excluded. In the case of an excavated silo, the excavated earth should be used as a covering, and will suffice for the necessary pressure. It is important that the weight of earth so put on should be equally distributed. The height of the earth above the contents of the silo should, if possible, be not less than 4 feet, and the pressure not less than 240 lb. to the square foot. A pressure up to 300 lb. per square foot is the maximum that is desirable. In connection with this it may be mentioned that one cubic foot of moist earth averages about 100 lb. in weight. The object of the weight is to compress the forage, to expel the air, and to prevent later access of air. In a room or other building, the requisite pressure can be effected by means of wooden-sleepers and stones over them. There is no need to place mats or any other material between the contents of the silo and the earth or other substance which supplies the pressure. The edges of earth used as a covering for a silo should be carefully looked at and hammered down, as occasion may require, after the silo has been covered in. Any cracks or crevices which appear should be instantly filled in, so as to keep out air from the silo.

11. Silage is not fit for use in a less period than three months from the date of covering up the silo, and it is better if possible to extend the period up to six months. When a silo is being opened, as little of the weight should be removed from the top and sides as possible. If the consumption is not enough to allow of the silo being emptied at once, the silage should be cut daily, as a hay stack is in England, in such a way as to exclude the air to the utmost from the remainder. Silage is best cut out with a big knife. Sometimes the cutting out involves a considerable amount of force owing to the compressed state of the material.

12. The smell of silage, which is acid and not unlike the smell of a tanyard in character, is never pleasant. Sometimes it is very disagreeable. Many persons have rejected silage as bad merely because of its unpleasant smell. But, notwithstanding the smell, sheep, pigs, horses and cattle have been found to eat it with avidity and to prefer it to other kinds of fodder. Before presenting it to animals, it is generally advisable to shake silage out in the air or sun for a few minutes.

13. Half a cubic foot of silage is a full ration for an ordinarily sized country cow or bullock. One cubic foot is a full ration for a large English cow. The Americans, who practice ensilage extensively, hold that five head of cattle can, under the system of silage, be kept from the same amount of ground as with difficulty sufficed for one head under the old system of grazing and storing of hay. Repeated experiments have proved that silage is more fattening and more nourishing than green or sundried grass. In Northern India the result financially has been to establish that a country cow can be fed on silage at a cost of about Rs. 11 a-year, instead of Rs. 45, which was the cheapest cost under previous management. The experiments in Northern India have been on a very large scale and in many places, and have ended in effecting a great economy in the keep of cattle and ponies belonging to the Commissariat and Transport departments of Government.

14. For those who wish to study the subject of ensilage more fully, the works of Mr. Thorold Rogers (published by W. Swan Sonnenschein and Co., Paternoster Row, London) and Mr. Cox (published at the Field Office, Strand, London) are recommended for perusal.

BANGALORE,
15th April 1886.

(Signed) C. E. R. GIRDLESTONE,
Offg. Resident and Chief Commissioner.

Extract from Brigadier-General Wilkinson's report which might be added :—

"Silage can be made with very little preparation by almost every ryot in India.

"He can take the wild grass near his village at the time when it is most valuable as forage ; just as the seed is beginning to harden another crop will grow long before the rains are over, so that all he cuts and packs into his silo is clear gain to him."

ENCLOSURES.

Letter from Captain S. C. F. PEILE, Assistant Commissary-General, to Major-General Sir H. Macpherson, V.C., K.C.B., K.C.S.I., Commanding Allahabad Division.

As the experiments in ensilage, conducted during 1884-85 at Allahabad in connection with the preservation of grass, were perhaps larger and more comprehensive than any experiments which ever took place at any other one place, I propose submitting a report showing generally the process of this method of the underground preservation of grass, and in detail the contents and outturn of the several silos dug in Allahabad cantonments.

2. Eighty-four silos in all were dug and filled with grass, &c., between 23rd July and 29th October 1884. The dimensions of the majority of these were 30 feet × 12 feet × 6 feet, while the rest were of various sizes.

3. The silos were so situated as to be in the centre of the plot from which it was intended the grass should be cut. This was done to avoid the necessity of engaging carriage to take the grass to the pits, and by these means the only expense incurred in filling the silos was the contract rate of cutting the grass, viz., about 9 pies per maund.

4. It was found by experiment that a field or plot of about five acres of ordinary grass land will fill a silo 30 feet × 12 feet × 6 feet dug in the centre of it. The coolies who cut the grass will carry it and throw it into the pit.

5. The cost of three silos of the above size was Rs. 11, or at the rate of Rs. 1-11-2 per 1,000 cubic feet. In addition to Rs. 3-10-8 for excavating the silo, there is the charge for covering and uncovering it with 4½ feet of earth, which is about Rs. 1-5-4, and hence the total expense connected with a silo 30 feet × 12 feet × 6 feet containing 600 maunds of grass should be about Rs. 5.

6. The principle on which these experiments were carried out, was to find out the very cheapest method of preserving grass, karbi, mothi, &c., so as to bring it within the power of the poorest villager to store food for his cattle. It was with this object that only earth silos were dug, no elaborate means of draining or pressing were attempted, the experiments were conducted in the simplest and cheapest form, and though a small percentage of the silos was not good, yet on the whole the experiment may be deemed to have been highly successful, and, considering that the operations were nothing more than digging a hole in the ground and filling it with grass, it is highly satisfactory that over 40,000 maunds of food so stored should have been eaten and eaten with relish by the cattle (numbering 2,000) and upwards of 1,200 ponies.

7. To examine the financial results of the above operations it will be seen that, roughly speaking, the silos containing these 40,000 maunds of fodder cost Rs. 350 and the cost of cutting the grass was Rs. 1,875, and thus giving even the liberal allowance of 40 lb. per head per bullock per day, it would be possible to feed 80,000 cattle for Rs. 2,225, or, in other words, to forage over 200 bullocks daily for a whole year at a total cost of Rs. 2,225, or at the rate of Rs. 11 per bullock per annum.

8. Now, at the most moderate computation, and giving only 20 lb. per diem, it would cost to feed a bullock on bhoosa Rs. 45 per annum, or more than four times as much as the ensilage. This is taking the rate of bhoosa at eight annas per maund.

9. The only precautions necessary in filling an earth silo are to heap the grass as high above the surface of the silo as the depth of the silo, and then to cover the grass so heaped up with the whole of the earth which has been previously excavated, care being taken to cover a margin of two feet all round the sides of the pit to keep out air and water. With a few exceptions nearly all the Allahabad silos were filled while it was raining hard.

10. When a silo has been covered up, great care must be taken in filling up any cracks or crevices the moment they happen to appear.

11. For the first twenty-five silos that were made an elephant was employed to press the grass, but subsequently the services of the elephant were dispensed with and no pressure, other than the weight of the excavated earth, was used. The latter appears to be quite sufficient and is the least expensive form of pressure that can be applied. It is of course highly important that the weight of the earth so put on should be equally distributed.

12. Another form of pressure that was tried was wooden sleepers; but unless great care is taken in placing the grass evenly, it is very difficult to obtain an equal pressure, as the sleepers, being flat, will naturally press only on the highest points of the grass. Our experience seems to show that the earth pressure is all that is necessary if carefully applied.

13. A most important result was obtained from 12 silos, which were made along the line of rail between Allahabad and Manauri, for though they were filled almost entirely with the coarsest description of grass, viz., kusa, kasa, and ganhra grasses, which make poor hay, yet the ensilage turned out excellent. The coarse grasses came out of the silo soft and succulent, and that they were nutritious and palatable was proved by the condition of the bullocks during the issue of this ensilage, and by the greedy manner in which the animals devoured this fodder.

14. I think also that results proved that, for the purpose of being siloed, grass should be cut either with the "jábao" (small circular scythe) or with the "hassa" (sickle) and not with the "kurpa," for with the latter it is almost impossible to avoid scraping up dirt and roots, which not only make the ensilage gritty and unpalatable, but also tend to cause it to have an obnoxious smell.

15. After opening the silos on the railway, we opened eleven that had been dug on the Fort esplanade. These were formed from the following good grasses; viz., bandari, jenewah, mussel and dhub, and turned out excellent. These grasses had been in the pits about six months, and came out as green as when put in.

16. I then had to open out the silos in new cantonments. These did not turn out so well as those on the railway and fort, and three or four were so bad that they had to be closed again. The smell of this ensilage while in the pit was malty, but when removed and exposed to the air, it became unpleasant, resembling a tanyard in smell. Most of it, however, was greedily devoured by the cattle, though some three or four silos could not be used.

17. The reason the silos in new cantonments were not so good as the others can fairly be attributed to the fact that the grass put into them was immature and young, and from this the following deduction can be made:—Ensilage to be good should be made from grass cut just before it flowers, and this will allow a good second crop to spring up for hay.

18. The transport lines in Allahabad are in every way inconveniently situated, being in what are called the Chatham lines, three or four miles away from the barracks, Commissariat godown and other places in which the bullocks are called upon to work. This necessitates most of the bullocks for duty having to walk four miles before their work is begun, and again to perform a return journey of four miles when their work is finished.

19. Carrying the ensilage to the Chatham lines was fraught with a great deal of inconvenience, for to get there from new cantonments necessitates passing through the greater part of the civil station, the inhabitants of which naturally complained of the smell of the ensilage. As soon as it was found that annoyance was being caused, the issue of ensilage to the animals in the Chatham lines was stopped.

20. Ensilage has a curious smell, very like that of a tanyard, which is unpleasant to anyone unaccustomed to it, but which ceases to be unpleasant after one is used to it. There is nothing to show that the smell is at all unhealthy; on the contrary, the coolies who were employed daily on the silos kept in excellent health, and the siege train bullocks who were fed almost entirely on it, kept well and in very good condition. There was only one death amongst these animals, and that was caused by rinderpest. This epizootic disease spread considerably amongst the new bullocks bought for the proposed expedition to Quetta and caused many deaths. The Commissariat slaughter cattle were fed almost entirely on ensilage, and nothing else, with the most favorable results. I mention this as an idea seemed to have gained ground that the deaths amongst the new purchases were due in some way to the ensilage. This can hardly be maintained in the face of the following facts:—

(*a*) Siege train bullocks fed on ensilage from the time of the first silo being opened to the last being closed, kept well and in good condition.
(*b*) Slaughter cattle same result.
(*c*) Slaughter sheep fed partially on ensilage with good results.
(*d*) Ponies fed on ensilage.

I think it has since been incontestably proved that the deaths among the new bullocks were due to rinderpest, and that this disease was raging in the villages round about Allahabad is well known, and was witnessed by the Major-General and Deputy Assistant Quartermaster-General of the division, who, when out in the district, saw the corpses of many hundreds of bullocks that had been carried off by this disease.

21. I made an experimental silo with wonderfully good results. It was filled in the following manner:—At the bottom was placed about 2 feet of green "mothi," next some rather dry munj, on this came some 2 feet of chaffed sorghum, then a layer of dry karbi, pressed down by about 6 inches of green mothi, and on the top of all a layer of sorghum. This pit was opened on 13th May 1885, after having been covered for six and-a-half months. Two inches of sorghum at the top had to be discarded. The remaining articles came out most excellent, the dry karbi* appearing as juicy and fresh as the green. The animals devoured this ensilage in the greediest manner.

* Cholum stalks.

22. I attach a statement showing the result of each silo in detail, and in conclusion I submit the following summary of what would appear to be the facts ascertained in connection with this most interesting experiment, which was conducted on so large a scale at Allahabad this year:—

(1) It does not appear necessary to go to the expense of building masonry silos, or to take any particular precautions in draining and pressing, as an earth silo seems to fulfil all the necessary conditions, and apparently drains itself if kept air and water tight.
(2) The only pressure that seems to be necessary is that caused by the excavated earth being piled on the grass.
(3) The best time to cut the grass is when it is mature, between 15th August and 1st November; this will give a second crop for hay.
(4) The fact of its raining while a silo is being filled does not appear to do any harm.
(5) The ensilage should be issued green, *i.e.*, as it is taken out of the pit.
(6) Thirty-five lb. of ensilage would appear to be equal to 20 lb. of bhoosa, the ration of a siege train bullock.
(7) Ensilaged karbi forms good food for elephants.
(8) The fact of cutting the grass for ensilage gives a finer and better second crop for hay-making.

* * * * *

I trust that the experiments at Allahabad may in the course of time show the villagers and country people that they have now a sure and safe means at hand for preserving fodder for their cattle, and a cheaper method by far of procuring good fodder than any now in existence; and in conclusion I would point out that the success of these experiments is mainly due to the intelligence and hard work of Sergeant Meagher, of the Commissariat Department, who has not only been out in all weathers, but has taken an intelligent interest in the operations, which has gone far to make them so successful.

Silos dug in new cantonment.

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
23rd July 1884 ...	HOURS. 3	Top 10′ 6″ × 5′ 9″ ... Bottom base 9′ 6″ × 4′ 3″ Depth 4′ 3″	Raining hard.	116 maunds of immature grass.	3 feet of earth.	November 1884.	Ensilage brownish, smell unpleasant issued after being dried.
29th „ „ ...	DAYS. 4	Top 30′ × 12′ ... ... Bottom 28′ 6″ × 12′ ... Depth 6′...	Do. ...	750 do. do.	Elephant pressure and 5 feet of earth.	11th Nov. „	Ensilage green and very wet. A little at top and sides was bad, remainder issued green.
8th Aug. „ ...	2	30′ × 12′ × 6′... ...	Fair ...	650 do. do.	Do. ...	21st April 1885.	Ensilage green and wet, smell unpleasant, but issued and eaten in one day. Top and sides not issued, being bad.
10th „ „ ...	3	28′ × 12′ × 6′... ...	Very rainy.	525 do. do.	Do. ...	22nd „ „	Do. do. do.
12th „ „ ...	4	Top 28′ × 10′ ... Bottom 27′ × 8′ ... Depth 6′ ...	Raining ...	415 do. do.	Do. and 4 feet of earth.	23rd „ „	Ensilage good, green, and wet; scarcely any heat in silo.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Raining night and day.	800 do. do.	Do. and 5 feet of earth.	Not yet opened.	
10th „ „ ...	2	30′ × 12′ × 6′ ...	Raining ...	850 do. do.	Do. ...	Do.	
12th „ „ ...	2	Top 30′ × 12′ Bottom 28′ 6″ × 10′ 6″. × 6′.	Very rainy...	750 do. do.	Do. do. and sleepers laid across.	April 1885 ...	Ensilage on top for 3 feet, bad, wet and jammed up into cakes; color black, smell offensive, heat 105°, not issued.
12th „ „ ...	2	30′ × 12′ / 29′ × 11′ × 6′ ...	Raining ...	750 do. do.	Do. do. no sleepers.	1st February ...	Green, wet, and good; no heat in silo.

Silos dug in New Cantonments—(*Continued*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
12th Aug. 1884 ...	DAYS. 2	Top 29′ 6″ × 12′ / Bottom 28′ × 10″ × 5′ 6″	Very rainy.	650 maunds of rather ripe grass.	Elephant and 5 feet of earth.	May 1885 ...	Ensilage excellent, issued in one day, color green, heat 90°.
13th „ „ ...	2	Top 30′ × 12′ / Bottom 27′ × 8′ × 6′	Fair ...	670 maunds of immature grass.	Do. do.	Not opened.	.....
14th „ „ ...	3	24′ × 10′ × 6′ ...	Raining ...	650 maunds do.	Do. do.	.....	Ensilage excellent, issued in one day.
15th „ „ ...	4	30′ × 12′ × 6′ ...	Very rainy.	640 maunds do.	Do. do.	April 1885 ...	Left open two days after being filled. Little on top of sides bad, otherwise good.
19th „ „ ...	2	32′ × 12′ × 6′ ...	Fair ...	650 maunds do.	Do. do.	May 1885 ...	Very good, no heat.
20th „ „ ...	3	30′ × 12′ × 5′ 9″ ...	Do. ...	700 maunds do.	Do. do.	Do. ...	Very good, 103° Fahr.
21st „ „ ...	4	30′ × 12′ / 29′ × 12′ × 5′ 8″ ...	Do. ...	800 maunds do.	Do. do.	April 1885 ...	Color black, ensilage bad and jammed into cakes. Water must have got into this silo.
21st „ „ ...	2	30′ × 12′ / 26′ × 8′ × 6′ ...	Do. ...	400 maunds do.	Do. do.	May 1885 ...	Good, 105° Fahr.
28th „ „ ...	2	30′ × 12′ / 29′ × 11′ × 6′ ...	Do. ...	700 maunds do.	Do. do.	April 1885 ...	Ensilage good, smell pleasant and sweet, scarcely any heat.
28th „ „ ...	2	32′ × 12′ / 30′ × 8′ × 5′ ...	Do. ...	752 maunds do.	5 feet of earth only.	Do. ...	Green and wet, fair ensilage, 90° Fahr.
30th „ „ ...	3	43′ × 16′ × 6′ ...	Do. ...	1,400 maunds do.	7 feet of earth only.	March 1885 ...	Filled with long coarse grasses. Ensilage excellent, smell sweet, 110° Fahr.
30th „ „ ...	2	30′ × 11′ × 6′ ...	Do. ...	720 maunds do.	5 feet of earth only.	Do. ...	Do. do. do.
3rd Sept. „ ...	5	30′ × 12′ × 6′ ...	Very rainy.	652 maunds do.	Elephant and 5 feet of earth only.	April 1885 ...	Smell unpleasant, heat 85° Fahr. Ensilage fair.

Silos dug in New Cantonments—(*Continued*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
3rd Sept. 1884 ...	4	30′ × 12′ × 6′ ...	Very rainy.	732 maunds of immature grass.	Elephant and 5 feet of earth only.	April 1885 ...	Smell unpleasant, heat 85° Fahr. Ensilage fair.
31st Aug. „ ...	2	30′ × 12′ × 6′ ...	Rainy ...	700 maunds do.	5 feet of earth only.	Do. ...	Do. do. do.
2nd Sept. „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds of nearly ripe grass.	Do. do. ...	May 1885 ...	Ensilage excellent, smell vinous, 95° Fahr.
3rd „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	820 maunds do.	Do. do. ...	21st April 1885.	Ensilage excellent, smell vinous, temperature cool.
5th „ „ ...	1½	30′ × 12′ × 6′ ...	Fair ...	761 maunds do.	Do. do. ...	April 1885 ...	Do. do. do.
5th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	765 maunds do.	Elephant and 5 feet of earth only.	Do. ...	Ensilage inferior, color black and jammed into cakes. Water must have got in or possibly too much pressure.
6th „ „ ...	1½	18′ × 18′ × 9′ ...	Do. ...	1,100 maunds of almost ripe grass.	Earth on top.	3rd April 1885...	Ensilage excellent, pit cylindrical in shape, color green. No heat. The best silo opened.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	707 maunds do.	5 feet of earth on top.	April 1885 ...	Ensilage good, green, and wet. Temperature. 90°.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds do.	Do. do. ...	Do. ...	Do. do. do.
9th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	750 maunds do.	Do. do. ...	Do. ...	Do. do. do.
9th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	800 maunds do.	Do. do. ...	Do. ...	Do. do. do.
21st „ „ ...	7	30′ × 12′ × 6′ ...	Rainy ...	693 maunds do.	Do. do. ...	May 1885 ...	Good, color brown, smell sweet, 108° Fahr.
28th „ „ ...	3	30′ × 12′ × 6′ ...	Fair ...	527 maunds do.	Do. do. ...	Do. ...	Very good, quite different smell, 805° Fahr.
28th „ „ ...	4	30′ × 12′ × 6′ ...	Rainy ...	688 maunds do.	Do. do. ...	27th March 1885.	Made of course grasses, smell very vinous. Heat about 110° Fahr.

Silos dug in New Cantonments—(*Concluded*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
4th Oct. 1884 ...	2	30′ × 12′ × 6′ ...	Fair ...	733 maunds of almost ripe grass.	5 feet of earth on top.	30th March 1885.	Same as above, ensilage drier.
8th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	476 maunds do....	Do. do. ...	April 1885 ...	Do. do.
4th „ „ ..	2	30′ × 12′ × 6′ ..	Do. ...	611 maunds do....	Do. do. ...	29th March 1885.	Do. do.
6th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	633 maunds do....	Do. do. ...	March 1885 ...	Do. do.
4th „ „ ...	5	30′ × 12′ × 6′ ...	Rainy ...	700 maunds do....	Do. do. ...	April 1885 ...	Color brown, ensilage dry and good, smell sweet, heat 110° Fahr.
9th „ „ ...	3	30′ × 12′ × 6′ ...	Fair ...	750 maunds do....	Do. do. ..	Do. ...	Do. heat 130° Fahr.
12th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds do....	Do. do. ...	Do. ...	Do. do.
13th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	Kurbi ...	Do. do. ...	Do. ...	Kurbi, ensilage was excellent, almost the same color as when put in.
24th Sept. „ ...	5	30′ × 12′ × 6′ ...	Do. ...	Bajra, mothi munj	Do. do. ...	Not yet opened ..	.....
29th Oct. „ ...	4	30′ × 12′ × 6′ ..	Fine ...	Sorgham, mothi, kurbi.	Do. do. ...	May 1885 ...	Ensilage excellent, heat 103° Fahr. The best ensilage made ; devoured greedily by animals.

Silos dug in the Chatham Lines.

16th Sept. 1884 ...	3	30′×12′×6′ ...		650 maunds immature grass.	Elephant and 5 feet earth.	April 1885 ...	Ensilage good, all alike, color green, smell vinous, heat 90° Fahr.
21st „ „ ...	4		Rainy ...	700 ripe. ...	Five feet of earth only.		
17th „ „ ...	3			756 do. ...			
22nd „ „ ...	6			550 do. ...			
20th „ „ ...	3		Fair ...	750 do. ...			
24th „ „ ...	2		Rainy ...	706 do. ...			

Silos dug on the Fort Esplanade.

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
Silos dug on the Fort Esplanade.							
11th Sept. 1884 ...	2			737 maunds of mature grass.	Five feet of earth only.	In Feb. and March 1885.	The whole of the ensilage, though composed of coarse grasses, was excellent, light green in color, sweet in smell and greedily devoured by the cattle. Heat 90° Fahr.
13th ,, ...	2		Fair ...	750 maunds do.			
12th ,, ...	2			745 maunds do.			
12th ,, ...	3			768 maunds do.			
13th ,, ...	1	30′ × 12′ × 6′ ...		650 maunds do.		In March and April 1885.	Ensilage excellent throughout green in color. Smell sweet, heat alike throughout about 90° Fahr.
21st ,, ...	1		Rainy ...	716 maunds do.			
23rd ,, ...	2			649 maunds do.			
22nd ,, ...	2			504 maunds do.			
24th ,, ...	1			440 maunds do.			
17th ,, ...	2		Fair ...	618 maunds do.			
20th ,, ...	3			434 maunds do.			
Silos along the Line of Railway.							
3rd Sept. 1884 ...	4		Rainy ...	650 maunds mature grass.	Five feet of earth only.	In Feb. and March 1885.	The whole of the ensilage, though composed of coarse grasses, was excellent, light green in color, sweet in smell and greedily devoured by the cattle. Heat 90° Fahr.
6th ,, ...	4		Do. ...	650 maunds do.			
8th ,, ...	4		Fair ...	700 maunds do.			
12th ,, ...	4		Do. ...	600 maunds do.			
12th ,, ...	3	30′ × 12′ × 6′ ...	Do. ...	550 maunds do.			
16th ,, ...	2		Do. ...	557 maunds do.			
18th ,, ...	2		Do. ...	535 maunds do.			
21st ,, ...	2		Do. ...	591 maunds do.			
23rd ,, ...	2		Do. ...	550 maunds do.			
25th ,, ...	2		Do. ...	565 maunds do.			
30th ,, ...	6	40′ × 16′ × 6′ ...	Do. ...	900 maunds do.			

About 10 silos still remain unopened, as an experiment, to see what they will be like next year. Not included in this statement.

OFFICE OF QUARTERMASTER-GENERAL IN INDIA,

ARMY HEAD QUARTERS,

Simla, 1st July 1885.

Copy of a letter from Major-General Sir H. Macpherson, K.C.B., K.C.S.I., V.C.*—No.* 1*—S, dated Allahabad, 20th April,* 1885.

In the hope that they may be considered worth distributing to Executive officers, I have the honor to forward copies of a compilation of some interesting notes on storing fodder in silos, by Mr. D. J. Macpherson, B.C.S., with a brief notice of some experience at Allahabad.

2. To this should have been added that silos 30′ × 12′ × 6′ cost Rs. 3-10-8 each, that no lining of masonry seems necessary, and that the earth excavated gives all the pressure that is required.

3. The items are—

	RS.	A.	P.
Cutting grass and throwing it into the silo, per maund ...	0	0	9
Proportion of cost of silo covering and opening, per maund ...	0	0	3
Price per maund ...	0	1	0

4. The smell from the silos, opened early in the season, was very disagreeable; the cattle nevertheless eat the contents.

5. The silage now being consumed is far less objectionable, and it is hoped that in the coming crop, when the sweet fermentation has been produced, the fragrance of the grass may be preserved.

Abstract of a Paper by Dr. Augustus Voelcker, F. R. S., in the "Journal of the Royal Agricultural Society of England" for October 1884 *(Vol. XX, Part* 2*), on the Chemistry of Ensilage.*

The paper consists mainly of an account of the chemical composition of 25 illustrative specimens of silage, which had been sent to the Agricultural Society's Laboratory for analysis by Dr. Voelcker; but it contains several observations of a general character on the chemistry of ensilage.

Dr. Voelcker is of opinion that we do not yet possess a sufficient number of data upon which to base a sound theory of the chemistry of ensilage or which would guide the farmer in producing at will either "sweet" or "sour" silage of good keeping quality. Indeed, the operation of ensilage is at present, in a large measure, conducted in a haphazard way, owing to our scanty knowledge of the complicated processes of fermentation, and of similar chemical and physical changes, to which succulent green food is liable under various conditions of temperature, the total or partial exclusion of atmospheric air, or its free admission.

Dr. Voelcker's remarks on special points of importance are, in many cases, found in a disconnected manner among his comments on the analysis of different samples; but in this abstract they are grouped under different heads according to the subject to which they relate.

I.—Regulation of the temperature in silos, with relation to the theory of fermentation.

"In filling silos, most writers on ensilage give directions which are based on Liebig's chemical theory of fermentation; they recommended the thorough consolidation of the green fodder as it is put in, the rapid filling of the silo, and the covering up and weighting of it at once, in order to prevent, as far as possible, the exposure of the fodder to the oxygen of the atmosphere, which is assumed to be the exciting cause of fermentation. Pasteur's recent investigations, however, have greatly enlarged our knowledge of the conditions which favor fermentation. He has shown that oxygen itself is not directly concerned in the process, but that certain living ferments and germs, generating various kinds of bacteria of fermentation, greatly modify the character of the silage produced.

"It would appear that a temperature of about 125° is sufficiently high to kill the bacteria which produce acid fermentation, and if the bacteria are killed, and the silo is covered and weighted, the enclosed mass of green fodder will remain sweet, and be practically preserved under the same conditions as fruits, vegetables, or meats are preserved when canned. If this be the case, it will be at once intelligible that by less packing of the fodder when put into the silo, and extending the time of filling until the temperature rises to a point which is fatal to the bacteria, the resulting silage will be sweet and free from acidity; while sour silage is produced by at once consolidating, covering up, and weighting the green fodder, so as to prevent the temperature rising to the point fatal to the bacteria."

Mr. George Fry of Chobham is the first man who has made accurate observations pointing out the influence of temperature on the production of the aromatic or fruity smell which grass, clover, and similar green produce acquire when put into a silo without any pressure beyond that exercised by the mass of ensilaged green food upon the lower layers. He insisted on the importance of allowing green food, when first placed in the silo, to attain a temperature not lower than 125° and, if possible, as high as 150° Fahrenheit, before applying considerable pressure by means of weights or a layer of sand. By this rise of temperature it passes through a process which he terms "sweet" or "hay" fermentation. This he accomplishes by filling his silos without close packing, and by deferring weighting the mass for two or three days, until the temperature of the silage at a depth of about four feet from the bottom of the silo has risen rather higher than 125° Fahrenheit. He then covers the silage with close-fitting boards, upon which he places weights or sand to a depth of about nine inches whereby the air is excluded and a steady uniform pressure is applied. From his observations it would appear that the too rapid exclusion of air by weighting the silage, as soon as it is put into the silo, prevents the green food from attaining a temperature of 125°, below which he holds that sweet or hay fermentation does not take place, but instead either lactic or acetic fermentation, which results in the production of more or less sour silage. Certainly, by following his directions, silage can be produced which shows not more than a trace of acidity, and as sweet and almost as aromatic as well-made hay. [All this was confirmed by experiments which the late Dr. Voelcker was carrying out at the time he wrote this paper.]

II.—Keeping quality of silage after it is taken out of the silo.

"Sweet" silage, however, keeps only a short time on exposure to the air after being taken out of the silo; whereas well-made "sour" silage may be kept sound for six or nine months, and even longer, when freely exposed to air, without turning mouldy.

At the same time "sour" silage even does not always keep well. So far as a conclusion could be drawn from the experiments he had made, Dr. Voelcker was of opinion that it is likely that the whole difference in the keeping qualities of sour silage depends upon whether the silage had passed through the lactic acid fermentation (which takes place on the more or less complete exclusion of air) or through the alcoholic and subsequent acetic acid fermentation (which proceed with facility only if air has free access). In most cases he found that acetic acid fermentation preceded mouldiness. At the same time our knowledge of the chemical changes which silage undergoes is too imperfect to enable us to pronounce an opinion on the point; and, in another part of the paper, Dr. Voelcker says that he was not prepared "to assign any greater or more marked influence on the keeping qualities of silage to the volatile (butyric or acetic) acids than to the non-volatile (lactic) organic acids." "The proportion of the organic acids in silage varies a good deal in different samples of even the same green fodder, and the nature of the organic acids which are generated in the process of ensilage also varies greatly in different samples. In some cases of well-made silage of excellent keeping qualities, the prevailing acid is non-volatile lactic acid; in other samples which have kept equally well, volatile and aromatic smelling acids, such as butyric and acetic acids, were present in proportions preponderating over the amount of non-volatile lactic acid." "In most cases the greater part of the sugar in green fodder is converted in the silo into various kinds of organic acids, some of which possess strongly-marked preservative properties. * * * Much of the success in preserving green fodder in silos," Dr. Voelcker was convinced, "depends upon its proper state of maturity. Green rye, maize, clover, meadow grass, and, in fact, all kinds of succulent vegetable produce, should be cut down neither too immature nor over-ripe, but just a little before it arrives at full maturity, and when it is sweet to the taste and rich in sugar. Fairly matured green fodder," Dr. Voelcker found, "makes more nutritious silage, and keeps better when removed from the silo and exposed to the air, than silage made from immature green fodder or such food in over-ripe condition."

"The addition of *salt*, it would appear, is unnecessary, if not somewhat injurious, to the keeping qualities of silage.

III.—Influences which determine the general quality of silage.

"That there are great differences in the quality of the silage made from different kinds of green food, or even from the same food made on different farms, or on the same farm in different seasons, admits of no doubt. These differences are attributable in a great measure to the quality of the original green food, as regulated by its composition, and more especially by its state of maturity; but they are also, no doubt, influenced by the conditions under which the silage is made, because the variable conditions must result in corresponding modifications of the process of fermentation." Dr. Voelcker, however, had no doubt that silage of a uniform and desired quality would be produced with certainty, when the influence of these differences in the original composition of the green food, and of the varying conditions of filling the silo and applying pressure to the green food, has been more thoroughly understood than it is at present.

Regarding the state of maturity, however, at which green fodder should be silaged, there is little room for question. We have already seen how this affects the keeping qualities of the silage after exposure to the air on taking it out of the silo; but it has also an important bearing on its nutritiousness. "Generally speaking, well-rippened nutritious grass or clover, when under conditions favorable to the production of either sweet or sour silage, makes a better, more nutritious, and wholesome food than immature or over-ripe green food, which originally is either so immature as to contain hardly any sugar, or else so over-ripe as to have become insipid and woody." "Immature green food, as a rule, does not keep well when put into silos:" the sugar in it is not fully formed, which in the silo becomes converted into various kinds of organic acids, some of them possessing marked preservative properties. Over-ripe stringy green food abounding in cellular fibre, on the other hand, often keeps extremely well in the silo, as the bulk of it consists of such matters as cellular and woody fibre which do not perish rapidly; but it never makes really good nutritious silage, because the constituents upon which the nutritive qualities of the food mainly depend, and which are most liable to suffer changes by fermentation, are present only in small proportion. "Good, well-matured green food will make first-class silage if the process of ensilage is properly carried out, whilst innutritious, immature or over-ripe woody grass or clover, or similar green food, by no kind of fermentation nor modification of the process of ensilage, can be possibly converted into a really good food. Ensilage may render such food more palatable and improve its physical condition, in consequence of which it may become more digestible; but it can never change it into really good and nutritious provender.

"Well-made silage, in conjunction with decorticated cotton cake, produces abundance of good and rich milk."

IV.—Alleged loss of albuminoid nitrogen during ensilage.

It is true that, as a rule, the nitrogen in silage occurs not only in the form of *albuminoids*, but also in very variable proportions as *amides* (non-albuminoid); but as green food, especially when rather immature, also contains amides in considerable proportions, the question of the alleged reduction of albuminous nutritive compounds into innutritious amides can be settled only by a series of careful *quantitative* analysis of the fresh green food, and of the silage produced from it. This has not yet been systematically undertaken. The analysis of silage which have been made disclose very great variations in the relative proportions of albuminoid and non-albuminoid nitrogen*; but without analysis also of the green food from which the silage was made, we cannot determine whether a reduction of albuminoids took place.

* From 5 to 49·2 per cent. of non-albuminoids.

V.—Loss sustained by green fodder during ensilage.

No quantitative experiments to determine the loss which green fodder undoubtedly sustains during the process of ensilage have been made in England; but a number have been made in Germany by Weiske, Schulze, Moser, Maercker, Mayer, and Brockema, and all disclose a considerable loss of food-constituents. The loss is not confined merely to the sugar and carbo-hydrates (which, during fermentation, are broken up, their elements being re-united into new combinations, which, being partly gaseous, pass away altogether), but extends also to the albuminous compounds, and even to the woody fibre. That the loss is greater in making sour than sweet silage can hardly be doubted. In the preparation of sweet silage, active fermentation does not take place, and in consequence the sugar and carbo-hydrates are not subjected to the action of the prolonged series of fermentative processes that results in the production of sour silage.

It may be observed here that "the drainage liquids from silage made from succulent green food, when too great a weight is placed on the top, is rich in albuminous and soluble non-nitrogenous food-constituents, and therefore ought not to be allowed to run to waste."

VI.—The presence of alcohol in silage.

Dr. Voelcker did not detect even traces of alcohol in any of the samples of silage he analysed; but he accounts for this by the circumstance that they were all, when received by him, in a comparatively advanced stage of preparation, in which most were strongly acid: and he believes that all the samples in which he found from ½ to 1 per cent. of acetic acid (that is, samples of sour silage, for sweet silage is nearly free from acid) had passed through alcoholic fermentation. When sweet vegetable juices enter into alcoholic fermentation, their sugar is converted more or less completely into alcohol and a number of by-products; the alcohol in its turn yields aldehyde by the abstraction of a definite proportion of its hydrogen; and, by the oxidation of the aldehyde, acetic acid is then formed. At a certain stage of the process of ensilage, the silage often smells strongly of aldehyde.

(Signed) DUNCAN J. MACPHERSON.

Dehri,
1*st April* 1885.

Abstract of a paper to Clifford Richardson, Assistant Chemist, U. S. Department of Agriculture, in the "Journal of the Chemical Society" for January 1885 entitled Notes on the Chemical Alterations in Green Fodder during its Conversion into Ensilage.

Experiments with "grass, mangles, and maize show that in the conditions existing in silos a large portion of the albuminoids are converted into non-albuminoid nitrogenous substances, whilst in the ordinary drying of fodder no such change seems to take place.

"In the samples of silage which the writer examined there was a comparatively large amount of ammonia combined with the acids produced by fermentation, acetic and lactic, which of course is lost in drying the specimens for analyses. In the results, this produces an apparent loss of nitrogen in the ensilage itself: it is at any rate a loss of nitrogen of nutritive value." This loss is relatively compensated for by the large loss of carbo-hydrates, so that in the figures showing the results of analysis neither loss is prominent, and they are at first glance deceptive.

Alcohol, though never absent from any of the samples analysed, was present in such small quantities as to be distinguished only by the iodoform test.

Lactic acid has always been detected, but never in large quantity. Acetic acid is the chief acid in silage.

In examining analytical results, it is to be remembered that a primary cause of differences in the composition of silage is the great variation which is observable in the composition of the green fodder itself. In the case of green maize, this variation is very great; and although it is largely due to the period of growth at which the stalks are cut, yet there are often marked differences in composition in those of the same stage of development, even in the same field.

As to the nature of the fermentation, the writer made some observations. "In but one sample out of many examined has any trace of *saccharomyces* been found. As a rule, the juice expressed from the fresh ensilage is swarming with *baculus subtilis*, together with some species of *bacterium* and *micrococeous*. No signs of the ordinary lactic or viscous ferment have been observed. The fermentation does not appear, therefore, to be of an alcoholic nature, or similar to any with which we are well acquainted. Analysis show the presence of an insufficient amount of alcohol, gum, or free acid for any of the usual forms of fermentation."

Most of the paper is taken up with the actual figures of the several analysis.

DEHRI,
1*st April* 1885.

(Signed) D. J. MACPHERSON,
Bengal Civil Service.

NOTE.

The lesson to be learnt from this paper is not to fill the silo rapidly; if an opinion may be hazarded regarding a subject on which we are so much in the dark, it is suggested that filling a silo to contain 600 maunds should extend over eight days.

It may be mentioned that 84 silos in the Allahabad cantonments, containing between 40,000 and 50,000 maunds, have been entirely successful, and Government cattle are now consuming 500 maunds daily of this silage, never leaving a blade.

From the information given in this paper, and the little experience gained, it would seem that not more than two crops should be siloed. The first between the 15th August and 15th September, the second between the 15th September and end of December.

Some grass cut and siloed in December at Allahabad has turned out excellent fodder.

The best economy seems to be to dig the silo in the middle of every four to six acres.

ALLAHABAD,
10*th April* 1885.

(Signed) H. MACPHERSON, Major-General,
Commanding Allahabad Division.

No. 28.

CIRCULAR MEMORANDUM

Addressed to General Officer Commanding Divisions and Districts.

Forwarded for information and guidance of Officer Commanding Cantonments in connection with the management of grass operations.

(By Order.)

(Signed) C. M. MACGREGOR, Major-General,
Quartermaster-General in India.

Sir Herbert Macpherson's Silo in the Allahabad Fort.

A subterranean chamber, which, 300 years ago in the time of the renowned Akbar, probably served for the imprisonment of State prisoners, was selected for the purpose, in August last. Sunk in solid masonry foundations, it was only necessary to build up two or three openings, which in more recent times had been made for purposes of light and access, to convert it into a most useful silo, at once thoroughly water and air-tight. Every facility for accomplishing this was afforded by Major Swinton, Commanding at the Fort, and the cost came to Rs. 32.

The grass, selected for the experiment, grew handy inside the fort, on the slope of the ramparts, and throughout the main ditch. It was the first crop grown entirely by the monsoon rain, and in particular that from the ditch was of such forced growth that it might almost be described as rank grass. Two varieties predominate, "janewar" (*andropogen bladii*) and "unjun" (*pennisitum cenchroides*). Of dhoob (*cynoden dacty lon*), very little is to be found within the fort, and what there is has evidently been introduced, the constant tendency being for the varieties "janewar" and "unjun" to overgrow and extinguish it. Both "janewar" and "unjun" are first-rate fodder grasses, the latter being reputed "one of the best of all the wild grasses for forage, both for cows and horses." (Steuart). The grass was cut during the 19th, 20th, and 21st of August, and cast into the silo daily as cut through an aperture knocked in the upper part of the outer wall near the roof of the chamber. Cutting took place with the *hussia* and *dharanti*, and not with either the *khurpa* or *jhabhao*. The labor was paid for by the day, as the operation being experimental, it was thought desirable not to prolong the filling in beyond a few days. This made the cutting more expensive than would have been the case had the quantity cut been paid for by weight, at the usual rate of 3 pice per maund. A few coolies were inside the silo to spread the grass evenly as it was thrown in, but beyond this there was no compressing of the grass at the time of filling in. Considerable stress is laid by Professor Thorold Rogers and other writers on ensilage, on the necessity of chaffing the fodder to be stored, and of adding salt to it, and this is probably the first experiment tried in India, where grass has been ensilaged without these precautions. Much of the grass was two and three feet long, and of strong luxuriant growth, and that taken from the fort ditch was moist and even dripping wet when put into the silo. Other grass again taken from the raised interior of the fort was of a light, fine description, and semi-dried by a hot sun, ere it could be cast into the pit. When filled, the silo measured 17½ feet long, 14½ feet wide, and 11 feet deep. On the top of the grass two or three maunds of bhoosa (white) was spread, giving a dressing of about an inch in depth, and over the bhoosa 75 old wooden sleepers were laid horizontally, as close as they could be, but owing to the irregularity of many of the sleepers, numerous interstices occurred between them. Care was taken not to lay them too close to the sites of the silo, so that they could not bind against the walls as the contents settled. Upon the sleepers were placed 28 tons of round shot (cannon ball). Including the weight of the sleepers, the average weight was 280 lb. to the superficial foot. Opinions vary greatly as to what amount of weight should be used, but it may probably be accepted that for unchaffed strong Indian grasses, it should not be below 200 lb. to the square foot, and may advantageously be as much as 300 lb. The object of the weight is to compress the forage, to expel the air, and prevent its further access, and it is therefore manifest that in the case of unchaffed or unshredded fodder a great weight will best obtain these results.

The silo was left for a period of 23 weeks, or nearly six months. It was opened on the 29th of January of this year, in the presence of Colonel Badcock, C.B., Deputy Commissary-General. An attempt to open it at the top, by removing some of the sleepers, proved unsuccessful: the grass had solidified so compactly that it was found impossible to extract it, and even an iron pointed crowbar could not be driven into it. This corresponds with experiments made in America, of which it is recorded the fodder had to be dragged out by hooks harnessed to horses. One of the bilt-up openings in the wall was therefore broken down, and the ensilage cut into with an American hay knife. The whole of the sleepers and shots were subsequently removed, when no further difficulty was experienced in issuing out the ensilage, which came away in sheets. The uppermost layers were of a darker hue and drier than what was found below. The color of the grass would be correctly described as a rusty brown, although portions of it were of a yellowish green shade. This latter color was met with in the interior of the silo, where also the grass was much the most moist, so much so that it would be correctly described as reeking with its own juices.

The grass had a strong, acid and vinous smell, which it retained for fully 48 hours after removal from the silo. It was distinctly noticeable passing carts carrying the ensilage to the cattle lines, and anywhere within 50 yards of the opened silo; it more resembled the smell of an empty beer hogshead than anything else. Considerable fermentation had evidently taken place, and a thermometer thrust down into the grass itself registered 110° Fahr. When opening the silo the precaution was taken of letting down a lighted candle to the surface before any one was permitted to descend, but no effect on the light was visible, and no inconvenience whatever was experienced either by Europeans or natives who remained for hours in the pit.

The following explanation, why fodder ensilaged keeps and why it becomes acid, is offered by Mr. Barras, Secretary to the Central Agricultural Society of France. He writes:—"Fermentation, decay, rot, and fire, are all identical. The only difference is in the degree of speed with which the combustion goes on. They, all alike, depend on the presence of oxygen, and cease when this active agent is removed. The process of combustion, whether slow or rapid, consumes oxygen and gives out carbonic acid gas. The fermentation consumes the small amount of oxygen which is contained in the mass of ensilage, and liberates an amount of carbonic acid gas which takes the place of the oxygen. The fermentation in its incipient stage is arrested for want of oxygen; none can get at it from the top, for the compression which is constantly going on is all the time forcing the gases out, and when there is ever so slight a flow out none can possibly flow in. Then as carbonic acid gas is heavier than the atmosphere, the sides and bottom of the silo being tight, and as the carbonic acid cannot leak out, the air cannot get down into the space occupied by the carbonic acid any more than air can get into a jug filled with water, or any other heavy liquid, until the water or other liquid is poured or leaks out. The ensilage is thus immersed in a bath of carbonic acid gas. Further fermentation under such circumstances is an impossibility."

The silo, when originally filled in, measured 11 feet in depth, so that in six months it had sunk nearly half. In American experiments chaffed fodder subsided usually one-fourth; but where coarse rank grasses are cast in as they come, and no attempt made to lay them out regularly and evenly, or to tread them down with men or bullocks (which, however, might easily be done), no doubt the subsidence will always be found to be nearer one half than one-fourth.

The first issue of the ensilage to the Government siege train bullocks at Allahabad was made on the 30th January, and continued for a week. In all 361½ maunds were issued, at the rate of 20 lb. per bullock per diem. These bullocks are bred on the Government Farm at Hissar, and such a thing as "ensilage" has never been placed before them. They ate it readily. The most of it was put through the chaff-cutter, and given as a feed morning and evening with the ration of gram, but the bullocks as readily devoured it when given in the state in which it came out of the silo. Mules took to it less readily, whilst horses required a considerable degree of coaxing to be got to eat it at all. Milk cows and calves went at it greedily the instant it was thrown down before them: goats would not look at it. Through the cordial co-operation of Major Elliott, the Deputy Assistant Commissary-General of Transport, the experiments in feeding were fully and satisfactorily carried out, and it has now been practically demonstrated that common grasses ensilaged form an agreeable and valuable change of diet to the Government cattle during the months when only dry fodder is procurable, which at Allahabad is for a period of about eight months in the year.

The total outturn of the silo was about 365 maunds, which gives a little over 18 lb. to the cubic foot, an average far below the 45 to 50 lb. to the cubic foot, which, it is reported, was the density of silos in America, in which however the fodder had been finely chaffed as well as trodden in. This would perhaps account for the disparity.

This experiment is of great value, because by it is demonstrated, for the first time in India, the entire feasibility of preserving the rank vegetation, which arises over all lands with the first burst of the monsoon, for future use many months afterwards, when the rains are over, and a tropical sun has once more burnt up the land. In order to compare the methods of preserving grass during the monsoon season by ensilage and by converting it into hay, at the same time as the silo was filled a large quantity of the same grass was cut in the fort for hay. Great difficulties were experienced in getting it sufficiently dried for stacking. A large quantity was destroyed by rain, and of that stacked (about 430 maunds) from ¾ths to ⅘ths of the weight of the green grass had evaporated in the process. At this season the grasses contain an enormous percentage of water which is not lost by the process of ensilage, but which, of course in the process of conversion into hay, wholly disappears. This stack of hay was cut into and issued during December; much of it was black and mouldy; and the whole of it was very inferior quality hay, and was scarcely eatable until mixed with sweet new hay, made of grasses fully matured, and reaped in the months of October and November. The experiment of making hay during the monsoon was also tried at Allahabad in 1882, and was not successful viewed as to expense and quality. Probably, throughout the North-West, two crops of grass can be got off most lands watered only by the monsoon rains, provided the first crop can be preserved, and this the system of ensilage secures. By simply casting into a silo, thousands of maunds of succulents grasses may be annually secured throughout these provinces as provision for the times of terrible fodder scarcity, which overtake the village cattle with each recurring hot weather. Before the result of the experiment became known, every native with whom I spoke on the subject was confident that the rank immatured jungle grasses sprung up by the first rains would never keep good for six months. Unquestionably great difficulty and expense and loss of weight is experienced in making hay of such, but in casting it in and pressing it in a silo everything is simple and inexpensive, and the result highly gratifying.

The need for securing grass, when it is abundant, may be estimated by the fact that at the present time, at Allahabad, a half-maund bundle of chiefly roots of grasses grubbed up with the "khurpa," in the "kachar" land of the Ganges, or from neighbouring "jheels" (and therefore unwholesome and likely to cause colic, anthrax, &c.) fetches four annas, whilst good hay commands Re. 1 a maund. Allowing fairly for all expenses, any quantity of green grass could be "ensilaged" at Allahabad during the monsoon season at a cost of from 2 to 3 annas a maund. The nutritive value of ensilage lying midway between that of green grass and hay, its present market-rate would be 12 annas a maund.

In a future paper we hope to give an account of a silo that has been constructed in an open field, merely by digging a pit, and which, at the time of writing, has been shut up for upwards of half a year.

ALLAHABAD,
18*th February* 1884.

(Signed) G. WINGATE, Captain,
On Special Duty.

Memorandum by His Excellency the Commander-in-Chief of the Madras Army.

Silo is the Spanish for a pit. The Royal Agricultural Society have ruled that the contents be called "Silage."

Where the fodder is fairly luxuriant, a silo should be dug in every 5 or 6 acres of the following dimensions:—

$30' \times 12' \times 6' = 2{,}160$ cubic feet to contain about 5,000 maunds = 40,000 lb.

2. The silo once dug is good for all time, the earth excavated gives the pressure that is wanted. A cubic foot of earth weighs 60 pounds, so that allowing an average of 4 cubic feet over the pit, there will be a pressure of 240 lb. on each square foot.

3. At Allahabad where eighty-four silos were filled in 1884, it was not found necessary to line the pits with mortar or to dry them artificially, nor is it necessary to slope the sides.

4. When the rainfall is from 35 to 40 inches and there is a reasonable hope of one quarter of that quantity in September and October, the fodder, *i.e.*, grass should be cut in August. If this is done as a rule, there will be an increased crop in October; the koorpa* is a more useful implement than the sickle or hook. The koorpa acts as a cultivator by loosening the earth about the roots of the grass.

* Hand hoe, in tamil "Pulvettie."

5. Experience has not yet determined whether the silos should be filled and covered over at once, or whether the operation should be prolonged for, say, five or six days. The smell of silage that was packed rapidly, when wet, was very disagreeable, but cattle do not seem to mind the smell and devour the stuff greedily.

6. It is believed that many people have given up silage as bad, merely because the smell was very unpleasant.

7. At Allahabad when failure was almost courted, thirteen hundred ponies and some two thousand Government bullocks were fed for some four months on silage and never left a blade.

8. A good book on silage is published by the Field Newspaper compiled by the Sub-Editor Mr. Cox—price, 4 shillings.

9. The silage consumed at Allahabad represented a clear profit to the State of Rs. 17,000.

10. The Americans, who have gone beyond the stage of experiment, are convinced that five head of cattle can be kept with the assistance of silage where it was difficult to maintain one head on the old system of grazing and storing of hay.

11. If the consumption is not sufficient to empty one silo at once, the silage can be cut daily as is done with a hay-stack in England.

12. In upwards of 500 reports, in the United Kingdom, almost unanimous testimony is afforded as to the favorable effects of silage upon the health of stock, while in many instances unstinted praise of its value is recorded.

13. I shall be glad to answer any number of questions on this very important and interesting subject.

OOTACAMUND,
30*th June* 1886.

(Signed) H. MACPHERSON.

Order—dated 9th July 1886, No. 573, Revenue.

Miscellaneous.

His Excellency the Governor in Council having had under consideration the very important question of the means of providing, in an economical manner, during the hot season, fodder for the cattle and sheep of the agricultural population, deems it desirable that careful experiment should be made, by selected officers, in view to determining whether this end cannot be successfully attained by means of ensilage; the merits and cheapness of which have now been definitely shown by extensive trial and inquiry in both Europe and America and, to a minor degree, in Northern India. He, therefore, resolves to publish the papers read above and to direct that the officers marginally noted be supplied with copies of them, and that the Director of Revenue Settlement and Agriculture, who will debit the charges so incurred to the head of "Improvement of Trade and Agriculture," shall place at the disposal of each the sum of Rs. 50.

W. H. Glenny.	W. J. Tate.
Hon. H. St. A. Goodrich.	T. M. Horsfall.
G. McWatters.	J. W. F. Dumergue.
L. R. Burrows.	J. Andrew.
E. C. Johnson.	H. G. Turner.
H. R. Farmer.	A. W. B. Higgens.
M. R. Weld.	H. W. Foster.
F. A. Nicholson.	J. W. Johnstone.

2. Each officer entrusted with silage experiments, will, in carrying them out, be careful to attend to the instructions given in the "Memorandum on silos and Silage," and he will keep a record in the forms A and B, which should be transmitted to the Director of Revenue Settlement and Agriculture, to whom the general supervision of the experiments made will be entrusted, and who will, at their conclusion, collate and submit to Government the results obtained, with such remarks as may appear to him necessary.

3. A portion of the grants made can, where ryots will not lend their cattle and sheep for experiment, be devoted to the purchase, or hire, of animals upon which to make trial of the merits of feeding upon silage. Where weights, at different periods of feeding, can be definitely ascertained, they should be carefully recorded in form B, but where this cannot be done, it will be easy for the officers conducting the experiments to note whether the animals increase in condition or not, and whether the quantity and quality of the milk of cows improves. It is desirable that trial should be made with ponies as well as cattle and sheep.

4. His Excellency the Governor in Council desires that the utmost publicity should be given to the experiments made; that the people, generally, should be afforded every opportunity of watching operations, in every stage; and that any who may wish to try silos themselves, should be given help and advice.

5. In addition to the experiments now ordered, His Excellency in Council considers that it would be of benefit if the Forest Department constructed a few silos in the reserves to which the people resort, or are likely to resort, for grass, and that, where any disposition to take the silage for use is shown, it should be given gratis until the ryots have learned to appreciate its value. In no case should silage be sold by any officer conducting experiments, without the previous sanction of Government.

Form A.

Silos dug out in

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.

Form B.

Statement showing the results of feeding with ensilage.

District.	Officer conducting experiment.	Description of Animals.			Period during which fed.		Quantity in lb. per diem given to each animal.	Whether with other food or not. If with other food, nature and quantity to be stated.	Results and remarks.
		Cattle.	Horses or Ponies.	Sheep or Goats.	From.	To.			

Note.—Where possible, the weight of animals at the time of commencing the experiment and at its conclusion should be noted in the remark column.

(True Extract.)

(Signed) J. F. PRICE,
Ag. Secretary to Government.

To the Board of Revenue.
„ the Director of Revenue Settlement and Agriculture.
„ the Public Department.
„ the Educational Department.
„ the Military Department.
„ the Public Works Department.
„ the Government Botanist.
„ the Accountant-General.
„ the Editors' Table.

Exd. W. J. Lewis.

200 Copies.

No 1996 W a/10 th August 1886

Communicated to Superintending Engineers for information.

Sgnd/ C. S. S.

Govt. of {1886} Madras.

REVENUE.

Issued

Recd. *Encl.*

G.O., 9th July 1886, No. 573.

JULY.

To
The Supdg. Engrs
& Chief Engr for Irrigation

Ensilage.

Orders passed on papers regarding experiments to be made with —.

With orders

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

READ—the following paper:—

MEMORANDUM* ON SILOS AND SILAGE.

A silo is a pit, made either above or below ground, or partly in and partly out of the ground, which is, as far as possible, watertight and airtight. It is intended for the storage and preservation of green forage. If it be properly constructed it allows of the least possible change in substance of that which is packed in it. The object with which silos are constructed is to supply the owners of cattle and other animals with the most abundant, cheap and nutritious kind of food for their stock, of making the storage of the article independent of the risks of weather, whether of wet or cold or heat, and of putting the material so stored in such a position as to admit of access to the store in the most convenient manner.

2. The process of storing green forage in silos is called ensilage.

3. Material which has been subjected to the process of ensilage is called silage.

4. All kinds of succulent vegetable produce may be converted into silage. Maize, millet, peas, beans, grasses (even of the coarsest descriptions), green leaves, young bamboo shoots, clover, rye, oats, prickly-pear, rice stalks can all with advantage be preserved by the process of ensilage. There is no objection to mixing various kinds of produce in one silo.

5. The best time for cutting a crop for ensilage is before it arrives at maturity, when it is sweet to the taste and rich in saccharine matter. Immature or overripe produce should not be used for this purpose. Where the rainfall is moderate and does not exceed about 40 inches in the year and where there is a reasonable hope of one-quarter of such rainfall falling in September and October, the material for ensilage is best cut in August. The cutting can, however, be counted on for success, if done even as late as in December. Grass cut and placed in a silo during that month has turned out excellent fodder. The material may be cut with the implement ordinarily used in the locality. In respect of grass which is being cut for a silo, the koorpa (hand hoe) is useful, because it acts as a cultivator by loosening the earth about the roots of the grass.

6. The green crop should be cut whilst wet with dew or rain, and should be thrown into the silo whilst quite fresh. Quick filling of the silo (within 24 hours if possible) seems preferable to slow filling. In many successful experiments, however, the filling has extended over five and six days.

7. Any space above ground, which is enclosed by walls, as for example a room, a hut, a godown, can be used as a silo, provided that the sides are smooth and perpendicular and that air, rain and damp are excluded. Below ground, trenches, pits and holes are equally effective. In Coorg and Mysore silos excavated in the ground will probably be found to be most practicable and economical. It is believed that there is no necessity to line excavated silos with mortar, or to dry them artificially, or to slope their sides, though these practices find favor with some persons of experience. It is best to round off corners slightly.

* This memorandum, which has been drawn up solely in the hope of benefiting planters and other owners of stock in Mysore and Coorg, is based on Mr. Thorold Rogers' "Ensilage in America," on papers received from Sir Herbert Macpherson and from the Revenue and Agricultural Department, and on a note with which Mr. Norman Tod of Alicutty in Coorg has favored me.—C.G.

8. The size of a silo must depend on the amount of available produce near at hand. Where green fodder is fairly abundant a silo of

30 feet long,
12 feet broad,
6 feet deep,

can with advantage be used for every 5 or 6 acres of land. The above dimensions give 2,160 cubic feet, which will store about 500 maunds of 80 lb. each (= 40,000 lb.). For smaller silos the length and breadth, but not the depth, should be reduced. According to some persons a greater depth than 6 feet is desirable in a damp climate.

9. An excavated silo is good not for one year only, but for many.

10. A silo must be completely filled. The filling can be done in rain without risk of injury. The green fodder may be put into the silo either shredded or not shredded, as may be preferred. If unshredded, it will need a greater subsequent pressure, so as to ensure that it lies close and that air is excluded. In the case of an excavated silo, the excavated earth should be used as a covering, and will suffice for the necessary pressure. It is important that the weight of earth so put on should be equally distributed. The height of the earth above the contents of the silo should, if possible, be not less than 4 feet, and the pressure not less than 240 lb. to the square foot. A pressure up to 300 lb. per square foot is the maximum that is desirable. In connection with this it may be mentioned that one cubic foot of moist earth averages about 100 lb. in weight. The object of the weight is to compress the forage, to expel the air, and to prevent later access of air. In a room or other building, the requisite pressure can be effected by means of wooden-sleepers and stones over them. There is no need to place mats or any other material between the contents of the silo and the earth or other substance which supplies the pressure. The edges of earth used as a covering for a silo should be carefully looked at and hammered down, as occasion may require, after the silo has been covered in. Any cracks or crevices which appear should be instantly filled in, so as to keep out air from the silo.

11. Silage is not fit for use in a less period than three months from the date of covering up the silo, and it is better if possible to extend the period up to six months. When a silo is being opened, as little of the weight should be removed from the top and sides as possible. If the consumption is not enough to allow of the silo being emptied at once, the silage should be cut daily, as a hay stack is in England, in such a way as to exclude the air to the utmost from the remainder. Silage is best cut out with a big knife. Sometimes the cutting out involves a considerable amount of force owing to the compressed state of the material.

12. The smell of silage, which is acid and not unlike the smell of a tanyard in character, is never pleasant. Sometimes it is very disagreeable. Many persons have rejected silage as bad merely because of its unpleasant smell. But, notwithstanding the smell, sheep, pigs, horses and cattle have been found to eat it with avidity and to prefer it to other kinds of fodder. Before presenting it to animals, it is generally advisable to shake silage out in the air or sun for a few minutes.

13. Half a cubic foot of silage is a full ration for an ordinarily sized country cow or bullock. One cubic foot is a full ration for a large English cow. The Americans, who practice ensilage extensively, hold that five head of cattle can, under the system of silage, be kept from the same amount of ground as with difficulty sufficed for one head under the old system of grazing and storing of hay. Repeated experiments have proved that silage is more fattening and more nourishing than green or sundried grass. In Northern India the result financially has been to establish that a country cow can be fed on silage at a cost of about Rs. 11 a-year, instead of Rs. 45, which was the cheapest cost under previous management. The experiments in Northern India have been on a very large scale and in many places, and have ended in effecting a great economy in the keep of cattle and ponies belonging to the Commissariat and Transport departments of Government.

14. For those who wish to study the subject of ensilage more fully, the works of Mr. Thorold Rogers (published by W. Swan Sonnenschein and Co., Paternoster Row, London) and Mr. Cox (published at the Field Office, Strand, London) are recommended for perusal.

BANGALORE,
15th April 1886.

(Signed) C. E. R. GIRDLESTONE,
Offg. Resident and Chief Commissioner.

Extract from Brigadier-General Wilkinson's report which might be added :—

"Silage can be made with very little preparation by almost every ryot in India.

"He can take the wild grass near his village at the time when it is most valuable as forage ; just as the seed is beginning to harden another crop will grow long before the rains are over, so that all he cuts and packs into his silo is clear gain to him."

ENCLOSURES.

Letter from Captain S. C. F. PEILE, Assistant Commissary-General, to Major-General Sir H. Macpherson, V.C., K.C.B., K.C.S.I., Commanding Allahabad Division.

As the experiments in ensilage, conducted during 1884-85 at Allahabad in connection with the preservation of grass, were perhaps larger and more comprehensive than any experiments which ever took place at any other one place, I propose submitting a report showing generally the process of this method of the underground preservation of grass, and in detail the contents and outturn of the several silos dug in Allahabad cantonments.

2. Eighty-four silos in all were dug and filled with grass, &c., between 23rd July and 29th October 1884. The dimensions of the majority of these were 30 feet × 12 feet × 6 feet, while the rest were of various sizes.

3. The silos were so situated as to be in the centre of the plot from which it was intended the grass should be cut. This was done to avoid the necessity of engaging carriage to take the grass to the pits, and by these means the only expense incurred in filling the silos was the contract rate of cutting the grass, viz., about 9 pies per maund.

4. It was found by experiment that a field or plot of about five acres of ordinary grass land will fill a silo 30 feet × 12 feet × 6 feet dug in the centre of it. The coolies who cut the grass will carry it and throw it into the pit.

5. The cost of three silos of the above size was Rs. 11, or at the rate of Rs. 1-11-2 per 1,000 cubic feet. In addition to Rs. 3-10-8 for excavating the silo, there is the charge for covering and uncovering it with 4½ feet of earth, which is about Rs. 1-5-4, and hence the total expense connected with a silo 30 feet × 12 feet × 6 feet containing 600 maunds of grass should be about Rs. 5.

6. The principle on which these experiments were carried out, was to find out the very cheapest method of preserving grass, karbi, mothi, &c., so as to bring it within the power of the poorest villager to store food for his cattle. It was with this object that only earth silos were dug, no elaborate means of draining or pressing were attempted, the experiments were conducted in the simplest and cheapest form, and though a small percentage of the silos was not good, yet on the whole the experiment may be deemed to have been highly successful, and, considering that the operations were nothing more than digging a hole in the ground and filling it with grass, it is highly satisfactory that over 40,000 maunds of food so stored should have been eaten and eaten with relish by the cattle (numbering 2,000) and upwards of 1,200 ponies.

7. To examine the financial results of the above operations it will be seen that, roughly speaking, the silos containing these 40,000 maunds of fodder cost Rs. 350 and the cost of cutting the grass was Rs. 1,875, and thus giving even the liberal allowance of 40 lb. per head per bullock per day, it would be possible to feed 80,000 cattle for Rs. 2,225, or, in other words, to forage over 200 bullocks daily for a whole year at a total cost of Rs. 2,225, or at the rate of Rs. 11 per bullock per annum.

8. Now, at the most moderate computation, and giving only 20 lb. per diem, it would cost to feed a bullock on bhoosa Rs. 45 per annum, or more than four times as much as the ensilage. This is taking the rate of bhoosa at eight annas per maund.

9. The only precautions necessary in filling an earth silo are to heap the grass as high above the surface of the silo as the depth of the silo, and then to cover the grass so heaped up with the whole of the earth which has been previously excavated, care being taken to cover a margin of two feet all round the sides of the pit to keep out air and water. With a few exceptions nearly all the Allahabad silos were filled while it was raining hard.

10. When a silo has been covered up, great care must be taken in filling up any cracks or crevices the moment they happen to appear.

11. For the first twenty-five silos that were made an elephant was employed to press the grass, but subsequently the services of the elephant were dispensed with and no pressure, other than the weight of the excavated earth, was used. The latter appears to be quite sufficient and is the least expensive form of pressure that can be applied. It is of course highly important that the weight of the earth so put on should be equally distributed.

12. Another form of pressure that was tried was wooden sleepers; but unless great care is taken in placing the grass evenly, it is very difficult to obtain an equal pressure, as the sleepers, being flat, will naturally press only on the highest points of the grass. Our experience seems to show that the earth pressure is all that is necessary if carefully applied.

13. A most important result was obtained from 12 silos, which were made along the line of rail between Allahabad and Manauri, for though they were filled almost entirely with the coarsest description of grass, viz., kusa, kasa, and ganhra grasses, which make poor hay, yet the ensilage turned out excellent. The coarse grasses came out of the silo soft and succulent, and that they were nutritious and palatable was proved by the condition of the bullocks during the issue of this ensilage, and by the greedy manner in which the animals devoured this fodder.

14. I think also that results proved that, for the purpose of being siloed, grass should be cut either with the "jábao" (small circular scythe) or with the "hassa" (sickle) and not with the "kurpa," for with the latter it is almost impossible to avoid scraping up dirt and roots, which not only make the ensilage gritty and unpalatable, but also tend to cause it to have an obnoxious smell.

15. After opening the silos on the railway, we opened eleven that had been dug on the Fort esplanade. These were formed from the following good grasses; viz., bandari, jenewah, mussel and dhub, and turned out excellent. These grasses had been in the pits about six months, and came out as green as when put in.

16. I then had to open out the silos in new cantonments. These did not turn out so well as those on the railway and fort, and three or four were so bad that they had to be closed again. The smell of this ensilage while in the pit was malty, but when removed and exposed to the air, it became unpleasant, resembling a tanyard in smell. Most of it, however, was greedily devoured by the cattle, though some three or four silos could not be used.

17. The reason the silos in new cantonments were not so good as the others can fairly be attributed to the fact that the grass put into them was immature and young, and from this the following deduction can be made:—Ensilage to be good should be made from grass cut just before it flowers, and this will allow a good second crop to spring up for hay.

18. The transport lines in Allahabad are in every way inconveniently situated, being in what are called the Chatham lines, three or four miles away from the barracks, Commissariat godown and other places in which the bullocks are called upon to work. This necessitates most of the bullocks for duty having to walk four miles before their work is begun, and again to perform a return journey of four miles when their work is finished.

19. Carrying the ensilage to the Chatham lines was fraught with a great deal of inconvenience, for to get there from new cantonments necessitates passing through the greater part of the civil station, the inhabitants of which naturally complained of the smell of the ensilage. As soon as it was found that annoyance was being caused, the issue of ensilage to the animals in the Chatham lines was stopped.

20. Ensilage has a curious smell, very like that of a tanyard, which is unpleasant to anyone unaccustomed to it, but which ceases to be unpleasant after one is used to it. There is nothing to show that the smell is at all unhealthy; on the contrary, the coolies who were employed daily on the silos kept in excellent health, and the siege train bullocks who were fed almost entirely on it, kept well and in very good condition. There was only one death amongst these animals, and that was caused by rinderpest. This epizootic disease spread considerably amongst the new bullocks bought for the proposed expedition to Quetta and caused many deaths. The Commissariat slaughter cattle were fed almost entirely on ensilage, and nothing else, with the most favorable results. I mention this as an idea seemed to have gained ground that the deaths amongst the new purchases were due in some way to the ensilage. This can hardly be maintained in the face of the following facts:—

(*a*) Siege train bullocks fed on ensilage from the time of the first silo being opened to the last being closed, kept well and in good condition.
(*b*) Slaughter cattle same result.
(*c*) Slaughter sheep fed partially on ensilage with good results.
(*d*) Ponies fed on ensilage.

I think it has since been incontestably proved that the deaths among the new bullocks were due to rinderpest, and that this disease was raging in the villages round about Allahabad is well known, and was witnessed by the Major-General and Deputy Assistant Quarter-master-General of the division, who, when out in the district, saw the corpses of many hundreds of bullocks that had been carried off by this disease.

21. I made an experimental silo with wonderfully good results. It was filled in the following manner:—At the bottom was placed about 2 feet of green "mothi," next some rather dry munj, on this came some 2 feet of chaffed sorghum, then a layer of dry karbi, pressed down by about 6 inches of green mothi, and on the top of all a layer of sorghum. This pit was opened on 13th May 1885, after having been covered for six and-a-half months. Two inches of sorghum at the top had to be discarded. The remaining articles came out most excellent, the dry karbi* appearing as juicy and fresh as the green. The animals devoured this ensilage in the greediest manner.

* Cholum stalks.

22. I attach a statement showing the result of each silo in detail, and in conclusion I submit the following summary of what would appear to be the facts ascertained in connection with this most interesting experiment, which was conducted on so large a scale at Allahabad this year:—

(1) It does not appear necessary to go to the expense of building masonry silos, or to take any particular precautions in draining and pressing, as an earth silo seems to fulfil all the necessary conditions, and apparently drains itself if kept air and water tight.
(2) The only pressure that seems to be necessary is that caused by the excavated earth being piled on the grass.
(3) The best time to cut the grass is when it is mature, between 15th August and 1st November; this will give a second crop for hay.
(4) The fact of its raining while a silo is being filled does not appear to do any harm.
(5) The ensilage should be issued green, *i.e.*, as it is taken out of the pit.
(6) Thirty-five lb. of ensilage would appear to be equal to 20 lb. of bhoosa, the ration of a siege train bullock.
(7) Ensilaged karbi forms good food for elephants.
(8) The fact of cutting the grass for ensilage gives a finer and better second crop for hay-making.

* * * * *

I trust that the experiments at Allahabad may in the course of time show the villagers and country people that they have now a sure and safe means at hand for preserving fodder for their cattle, and a cheaper method by far of procuring good fodder than any now in existence; and in conclusion I would point out that the success of these experiments is mainly due to the intelligence and hard work of Sergeant Meagher, of the Commissariat Department, who has not only been out in all weathers, but has taken an intelligent interest in the operations, which has gone far to make them so successful.

Silos dug in new cantonment.

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	HOURS.						
23rd July 1884 ...	3	Top 10′ 6″ × 5′ 9″ ... Bottom base 9′ 6″ × 4′ 3″ Depth 4′ 3″	Raining hard.	116 maunds of immature grass.	3 feet of earth.	November 1884.	Ensilage brownish, smell unpleasant issued after being dried.
	DAYS.						
29th „ „ ...	4	Top 30′ × 12′ ... ... Bottom 28′ 6″ × 12′ ... Depth 6′...	Do. ...	750 do. do.	Elephant pressure and 5 feet of earth.	11th Nov. „	Ensilage green and very wet. A little at top and sides was bad, remainder issued green.
8th Aug. „ ...	2	30′ × 12′ × 6′... ...	Fair ...	650 do. do.	Do. ...	21st April 1885.	Ensilage green and wet, smell unpleasant, but issued and eaten in one day. Top and sides not issued, being bad.
10th „ „ ...	3	28′ × 12′ × 6′... ...	Very rainy.	525 do. do.	Do. ...	22nd „ „	Do. do. do.
12th „ „ ...	4	Top 28′ × 10′ ... Bottom 27′ × 8′ ... Depth 6′ ...	Raining ...	415 do. do.	Do. and 4 feet of earth.	23rd „ „	Ensilage good, green, and wet; scarcely any heat in silo.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Raining night and day.	800 do. do.	Do. and 5 feet of earth.	Not yet opened.	
10th „ „ ...	2	30′ × 12′ × 6′ ...	Raining ...	850 do. do.	Do. ...	Do.	
12th „ „ ...	2	Top 30′ × 12′ Bottom 28′ 6″ × 10′ 6″. × 6′.	Very rainy...	750 do. do.	Do. do. and sleepers laid across.	April 1885 ...	Ensilage on top for 3 feet, bad, wet and jammed up into cakes; color black, smell offensive, heat 105°, not issued.
12th „ „ ...	2	30′ × 12′ / 29′ × 11′ × 6′ ...	Raining ...	750 do. do.	Do. do. no sleepers.	1st February ...	Green, wet, and good; no heat in silo.

Silos dug in New Cantonments—(*Continued*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
12th Aug. 1884 ...	2	Top 29′ 6″ × 12′ / Bottom 28′ × 10′ × 5′ 6″	Very rainy.	650 maunds of rather ripe grass.	Elephant and 5 feet of earth.	May 1885 ...	Ensilage excellent, issued in one day, color green, heat 90°.
13th „ „ ...	2	Top 30′ × 12′ / Bottom 27′ × 8′ × 6′	Fair ...	670 maunds of immature grass.	Do. do.	Not opened.	.....
14th „ „ ...	3	24′ × 10′ × 6′ ...	Raining ...	650 maunds do.	Do. do.	.....	Ensilage excellent, issued in one day.
15th „ „ ...	4	30′ × 12′ × 6′ ...	Very rainy.	640 maunds do.	Do. do.	April 1885 ...	Left open two days after being filled. Little on top of sides bad, otherwise good.
19th „ „ ...	2	32′ × 12′ × 6′ ...	Fair ...	650 maunds do.	Do. do.	May 1885 ...	Very good, no heat.
20th „ „ ...	3	30′ × 12′ × 5′ 9″ ...	Do. ...	700 maunds do.	Do. do.	Do. ...	Very good, 103° Fahr.
21st „ „ ...	4	30′ × 12′ / 29′ × 12′ × 5′ 8″ ...	Do. ...	800 maunds do.	Do. do.	April 1885 ...	Color black, ensilage bad and jammed into cakes. Water must have got into this silo.
21st „ „ ...	2	30′ × 12′ / 26′ × 8′ × 6′ ...	Do. ...	400 maunds do.	Do. do.	May 1885 ...	Good, 105° Fahr.
28th „ „ ...	2	30′ × 12′ / 29′ × 11′ × 6′ ...	Do. ...	700 maunds do.	Do. do.	April 1885 ...	Ensilage good, smell pleasant and sweet, scarcely any heat.
28th „ „ ...	2	32′ × 12′ / 30′ × 8′ × 5′ ...	Do. ...	752 maunds do.	5 feet of earth only.	Do. ...	Green and wet, fair ensilage, 90° Fahr.
30th „ „ ...	3	43′ × 16′ × 6′ ...	Do. ...	1,400 maunds do.	7 feet of earth only.	March 1885 ...	Filled with long coarse grasses. Ensilage excellent, smell sweet, 110° Fahr.
30th „ „ ...	2	30′ × 11′ × 6′ ...	Do. ...	720 maunds do.	5 feet of earth only.	Do. ...	Do. do. do.
3rd Sept. „ ...	5	30′ × 12′ × 6′ ...	Very rainy.	652 maunds do.	Elephant and 5 feet of earth only.	April 1885 ...	Smell unpleasant, heat 85° Fahr. Ensilage fair.

Silos dug in New Cantonments—(*Continued*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
3rd Sept. 1884 ...	4	30′ × 12′ × 6′ ...	Very rainy.	732 maunds of immature grass.	Elephant and 5 feet of earth only.	April 1885 ...	Smell unpleasant, heat 85° Fahr. Ensilage fair.
31st Aug. „ ...	2	30′ × 12′ × 6′ ...	Rainy ...	700 maunds do.	5 feet of earth only.	Do. ...	Do. do. do.
2nd Sept. „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds of nearly ripe grass.	Do. do. ...	May 1885 ...	Ensilage excellent, smell vinous, 95° Fahr.
3rd „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	820 maunds do.	Do. do. ...	21st April 1885.	Ensilage excellent, smell vinous, temperature cool.
5th „ „ ...	1½	30′ × 12′ × 6′ ...	Fair ...	761 maunds do.	Do. do. ...	April 1885 ...	Do. do. do.
5th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	765 maunds do.	Elephant and 5 feet of earth only.	Do. ...	Ensilage inferior, color black and jammed into cakes. Water must have got in or possibly too much pressure.
6th „ „ ...	1½	18′ × 18′ × 9′ ...	Do. ...	1,100 maunds of almost ripe grass.	Earth on top.	3rd April 1885...	Ensilage excellent, pit cylindrical in shape, color green. No heat. The best silo opened.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	707 maunds do.	5 feet of earth on top.	April 1885 ...	Ensilage good, green, and wet. Temperature. 90°.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds do.	Do. do. ...	Do. ...	Do. do. do.
9th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	750 maunds do.	Do. do. ...	Do. ...	Do. do. do.
9th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	800 maunds do.	Do. do. ...	Do. ...	Do. do. do.
21st „ „ ...	7	30′ × 12′ × 6′ ...	Rainy ...	693 maunds do.	Do. do. ...	May 1885 ...	Good, color brown, smell sweet, 108° Fahr.
28th „ „ ...	3	30′ × 12′ × 6′ ...	Fair ...	527 maunds do.	Do. do. ...	Do. ...	Very good, quite different smell, 805° Fahr.
28th „ „ ...	4	30′ × 12′ × 6′ ...	Rainy ...	688 maunds do.	Do. do. ...	27th March 1885.	Made of course grasses, smell very vinous. Heat about 110° Fahr.

Silos dug in New Cantonments—(*Concluded*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
4th Oct. 1884 ...	2	30′ × 12′ × 6′ ...	Fair ...	733 maunds of almost ripe grass.	5 feet of earth on top.	30th March 1885.	Same as above, ensilage drier.
8th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	476 maunds do....	Do. do. ...	April 1885 ...	Do. do.
4th „ „ ...	2	30′ × 12′ × 6′ ..	Do. ...	611 maunds do....	Do. do. ...	29th March 1885.	Do. do.
6th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	633 maunds do....	Do. do. ...	March 1885 ...	Do. do.
4th „ „ ...	5	30′ × 12′ × 6′ ...	Rainy ...	700 maunds do....	Do. do. ...	April 1885 ...	Color brown, ensilage dry and good, smell sweet, heat 110° Fahr.
9th „ „ ...	3	30′ × 12′ × 6′ ...	Fair ...	750 maunds do....	Do. do. ..	Do. ...	Do. heat 130° Fahr.
12th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds do....	Do. do. ...	Do. ...	Do. do.
13th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	Kurbi ...	Do. do. ...	Do. ...	Kurbi, ensilage was excellent, almost the same color as when put in.
24th Sept. „ ...	5	30′ × 12′ × 6′ ...	Do. ...	Bajra, mothi munj	Do. do. ...	Not yet opened ..	.....
29th Oct. „ ...	4	30′ × 12′ × 6′ ..	Fine ...	Sorgham, mothi, kurbi.	Do. do. ...	May 1885 ...	Ensilage excellent, heat 103° Fahr. The best ensilage made ; devoured greedily by animals.

Silos dug in the Chatham Lines.

16th Sept. 1884 ...	3	30′×12′×6′ ...	Rainy ...	650 maunds immature grass.	Elephant and 5 feet earth.	April 1885 ...	Ensilage good, all alike, color green, smell vinous, heat 90° Fahr.
21st „ „ ...	4			700 ripe. ...	Five feet of earth only.		
17th „ „ ...	3			756 do. ...			
22nd „ „ ...	6			550 do. ...			
20th „ „ ...	3		Fair ...	750 do. ...			
24th „ „ ...	2		Rainy ...	706 do. ...			

Silos dug on the Fort Esplanade.

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
Silos dug on the Fort Esplanade.							
11th Sept. 1884 ...	2			737 maunds of mature grass.			
13th „ ...	2		Fair ...	750 maunds do.			
12th „ ...	2			745 maunds do.			
12th „ ...	3			768 maunds do.			
13th „ ...	1	30′ × 12′ × 6′		650 maunds do.			
21st „ ...	1	...		716 maunds do.			
23rd „ ...	2		Rainy ...	649 maunds do.			
22nd „ ...	1			504 maunds do.			
24th „ ...	2			440 maunds do.			
17th „ ...	2		Fair ...	618 maunds do.			
20th „ ...	3			434 maunds do.			
Silos along the Line of Railway.							
3rd Sept. 1884 ...	4		Rainy ...	650 maunds mature grass.	Five feet of earth only.	In Feb. and March 1885.	The whole of the ensilage, though composed of coarse grasses, was excellent, light green in color, sweet in smell and greedily devoured by the cattle. Heat 90° Fahr.
6th „ ...	4		Do. ...	650 maunds do.			
8th „ ...	4		Fair ...	700 maunds do.			
12th „ ...	4		Do. ...	600 maunds do.			
12th „ ...	3	30′ × 12′ × 6′	Do. ...	550 maunds do.			
16th „ ...	2		Do. ...	557 maunds do.			
18th „ ...	2		Do. ...	535 maunds do.			
21st „ ...	2		Do. ...	591 maunds do.			
23rd „ ...	2		Do. ...	550 maunds do.			
25th „ ...	2		Do. ...	565 maunds do.			
30th „ ...	6	40′ × 16′ × 6′	Do. ...	900 maunds do.	Five feet of earth only.	In March and April 1885.	Ensilage excellent throughout green in color. Smell sweet, heat alike throughout about 90° Fahr.

About 10 silos still remain unopened, as an experiment, to see what they will be like next year. Not included in this statement.

OFFICE OF QUARTERMASTER-GENERAL IN INDIA,

ARMY HEAD QUARTERS,

Simla, 1st July 1885.

Copy of a letter from Major-General Sir H. Macpherson, K.C.B., K.C.S.I., V.C.—*No.* 1—*S, dated Allahabad, 20th April,* 1885.

In the hope that they may be considered worth distributing to Executive officers, I have the honor to forward copies of a compilation of some interesting notes on storing fodder in silos, by Mr. D. J. Macpherson, B.C.S., with a brief notice of some experience at Allahabad.

2. To this should have been added that silos 30′ × 12′ × 6′ cost Rs. 3-10-8 each, that no lining of masonry seems necessary, and that the earth excavated gives all the pressure that is required.

3. The items are—

	RS.	A.	P.
Cutting grass and throwing it into the silo, per maund	0	0	9
Proportion of cost of silo covering and opening, per maund ...	0	0	3
Price per maund ...	0	1	0

4. The smell from the silos, opened early in the season, was very disagreeable; the cattle nevertheless eat the contents.

5. The silage now being consumed is far less objectionable, and it is hoped that in the coming crop, when the sweet fermentation has been produced, the fragrance of the grass may be preserved.

Abstract of a Paper by Dr. Augustus Voelcker, F. R. S., in the "Journal of the Royal Agricultural Society of England" for October 1884 (*Vol. XX, Part* 2), *on the Chemistry of Ensilage.*

The paper consists mainly of an account of the chemical composition of 25 illustrative specimens of silage, which had been sent to the Agricultural Society's Laboratory for analysis by Dr. Voelcker; but it contains several observations of a general character on the chemistry of ensilage.

Dr. Voelcker is of opinion that we do not yet possess a sufficient number of data upon which to base a sound theory of the chemistry of ensilage or which would guide the farmer in producing at will either "sweet" or "sour" silage of good keeping quality. Indeed, the operation of ensilage is at present, in a large measure, conducted in a haphazard way, owing to our scanty knowledge of the complicated processes of fermentation, and of similar chemical and physical changes, to which succulent green food is liable under various conditions of temperature, the total or partial exclusion of atmospheric air, or its free admission.

Dr. Voelcker's remarks on special points of importance are, in many cases, found in a disconnected manner among his comments on the analysis of different samples; but in this abstract they are grouped under different heads according to the subject to which they relate.

I.—Regulation of the temperature in silos, with relation to the theory of fermentation.

"In filling silos, most writers on ensilage give directions which are based on Liebig's chemical theory of fermentation; they recommended the thorough consolidation of the green fodder as it is put in, the rapid filling of the silo, and the covering up and weighting of it at once, in order to prevent, as far as possible, the exposure of the fodder to the oxygen of the atmosphere, which is assumed to be the exciting cause of fermentation. Pasteur's recent investigations, however, have greatly enlarged our knowledge of the conditions which favor fermentation. He has shown that oxygen itself is not directly concerned in the process, but that certain living ferments and germs, generating various kinds of bacteria of fermentation, greatly modify the character of the silage produced.

"It would appear that a temperature of about 125° is sufficiently high to kill the bacteria which produce acid fermentation, and if the bacteria are killed, and the silo is covered and weighted, the enclosed mass of green fodder will remain sweet, and be practically preserved under the same conditions as fruits, vegetables, or meats are preserved when canned. If this be the case, it will be at once intelligible that by less packing of the fodder when put into the silo, and extending the time of filling until the temperature rises to a point which is fatal to the bacteria, the resulting silage will be sweet and free from acidity; while sour silage is produced by at once consolidating, covering up, and weighting the green fodder, so as to prevent the temperature rising to the point fatal to the bacteria."

Mr. George Fry of Chobham is the first man who has made accurate observations pointing out the influence of temperature on the production of the aromatic or fruity smell which grass, clover, and similar green produce acquire when put into a silo without any pressure beyond that exercised by the mass of ensilaged green food upon the lower layers. He insisted on the importance of allowing green food, when first placed in the silo, to attain a temperature not lower than 125° and, if possible, as high as 150° Fahrenheit, before applying considerable pressure by means of weights or a layer of sand. By this rise of temperature it passes through a process which he terms "sweet" or "hay" fermentation. This he accomplishes by filling his silos without close packing, and by deferring weighting the mass for two or three days, until the temperature of the silage at a depth of about four feet from the bottom of the silo has risen rather higher than 125° Fahrenheit. He then covers the silage with close-fitting boards, upon which he places weights or sand to a depth of about nine inches whereby the air is excluded and a steady uniform pressure is applied. From his observations it would appear that the too rapid exclusion of air by weighting the silage, as soon as it is put into the silo, prevents the green food from attaining a temperature of 125°, below which he holds that sweet or hay fermentation does not take place, but instead either lactic or acetic fermentation, which results in the production of more or less sour silage. Certainly, by following his directions, silage can be produced which shows not more than a trace of acidity, and as sweet and almost as aromatic as well-made hay. [All this was confirmed by experiments which the late Dr. Voelcker was carrying out at the time he wrote this paper.]

II.—Keeping quality of silage after it is taken out of the silo.

"Sweet" silage, however, keeps only a short time on exposure to the air after being taken out of the silo; whereas well-made "sour" silage may be kept sound for six or nine months, and even longer, when freely exposed to air, without turning mouldy.

At the same time "sour" silage even does not always keep well. So far as a conclusion could be drawn from the experiments he had made, Dr. Voelcker was of opinion that it is likely that the whole difference in the keeping qualities of sour silage depends upon whether the silage had passed through the lactic acid fermentation (which takes place on the more or less complete exclusion of air) or through the alcoholic and subsequent acetic acid fermentation (which proceed with facility only if air has free access). In most cases he found that acetic acid fermentation preceded mouldiness. At the same time our knowledge of the chemical changes which silage undergoes is too imperfect to enable us to pronounce an opinion on the point; and, in another part of the paper, Dr. Voelcker says that he was not prepared "to assign any greater or more marked influence on the keeping qualities of silage to the volatile (butyric or acetic) acids than to the non-volatile (lactic) organic acids." "The proportion of the organic acids in silage varies a good deal in different samples of even the same green fodder, and the nature of the organic acids which are generated in the process of ensilage also varies greatly in different samples. In some cases of well-made silage of excellent keeping qualities, the prevailing acid is non-volatile lactic acid; in other samples which have kept equally well, volatile and aromatic smelling acids, such as butyric and acetic acids, were present in proportions preponderating over the amount of non-volatile lactic acid." "In most cases the greater part of the sugar in green fodder is converted in the silo into various kinds of organic acids, some of which possess strongly-marked preservative properties. * * * Much of the success in preserving green fodder in silos," Dr. Voelcker was convinced, "depends upon its proper state of maturity. Green rye, maize, clover, meadow grass, and, in fact, all kinds of succulent vegetable produce, should be cut down neither too immature nor over-ripe, but just a little before it arrives at full maturity, and when it is sweet to the taste and rich in sugar. Fairly matured green fodder," Dr. Voelcker found, "makes more nutritious silage, and keeps better when removed from the silo and exposed to the air, than silage made from immature green fodder or such food in over-ripe condition."

"The addition of *salt*, it would appear, is unnecessary, if not somewhat injurious, to the keeping qualities of silage.

III.—Influences which determine the general quality of silage.

"That there are great differences in the quality of the silage made from different kinds of green food, or even from the same food made on different farms, or on the same farm in different seasons, admits of no doubt. These differences are attributable in a great measure to the quality of the original green food, as regulated by its composition, and more especially by its state of maturity; but they are also, no doubt, influenced by the conditions under which the silage is made, because the variable conditions must result in corresponding modifications of the process of fermentation." Dr. Voelcker, however, had no doubt that silage of a uniform and desired quality would be produced with certainty, when the influence of these differences in the original composition of the green food, and of the varying conditions of filling the silo and applying pressure to the green food, has been more thoroughly understood than it is at present.

Regarding the state of maturity, however, at which green fodder should be silaged, there is little room for question. We have already seen how this affects the keeping qualities of the silage after exposure to the air on taking it out of the silo; but it has also an important bearing on its nutritiousness. "Generally speaking, well-rippened nutritious grass or clover, when under conditions favorable to the production of either sweet or sour silage, makes a better, more nutritious, and wholesome food than immature or over-ripe green food, which originally is either so immature as to contain hardly any sugar, or else so over-ripe as to have become insipid and woody." "Immature green food, as a rule, does not keep well when put into silos:" the sugar in it is not fully formed, which in the silo becomes converted into various kinds of organic acids, some of them possessing marked preservative properties. Over-ripe stringy green food abounding in cellular fibre, on the other hand, often keeps extremely well in the silo, as the bulk of it consists of such matters as cellular and woody fibre which do not perish rapidly; but it never makes really good nutritious silage, because the constituents upon which the nutritive qualities of the food mainly depend, and which are most liable to suffer changes by fermentation, are present only in small proportion. "Good, well-matured green food will make first-class silage if the process of ensilage is properly carried out, whilst innutritious, immature or over-ripe woody grass or clover, or similar green food, by no kind of fermentation nor modification of the process of ensilage, can be possibly converted into a really good food. Ensilage may render such food more palatable and improve its physical condition, in consequence of which it may become more digestible; but it can never change it into really good and nutritious provender.

"Well-made silage, in conjunction with decorticated cotton cake, produces abundance of good and rich milk."

IV.—Alleged loss of albuminoid nitrogen during ensilage.

It is true that, as a rule, the nitrogen in silage occurs not only in the form of *albuminoids*, but also in very variable proportions as *amides* (non-albuminoid); but as green food, especially when rather immature, also contains amides in considerable proportions, the question of the alleged reduction of albuminous nutritive compounds into innutritious amides can be settled only by a series of careful *quantitative* analysis of the fresh green food, and of the silage produced from it. This has not yet been systematically undertaken. The analysis of silage which have been made disclose very great variations in the relative proportions of albuminoid and non-albuminoid nitrogen*; but without analysis also of the green food from which the silage was made, we cannot determine whether a reduction of albuminoids took place.

* From 5 to 49·2 per cent. of non-albuminoids.

V.—Loss sustained by green fodder during ensilage.

No quantitative experiments to determine the loss which green fodder undoubtedly sustains during the process of ensilage have been made in England; but a number have been made in Germany by Weiske, Schulze, Moser, Maercker, Mayer, and Brockema, and all disclose a considerable loss of food-constituents. The loss is not confined merely to the sugar and carbo-hydrates (which, during fermentation, are broken up, their elements being re-united into new combinations, which, being partly gaseous, pass away altogether), but extends also to the albuminous compounds, and even to the woody fibre. That the loss is greater in making sour than sweet silage can hardly be doubted. In the preparation of sweet silage, active fermentation does not take place, and in consequence the sugar and carbo-hydrates are not subjected to the action of the prolonged series of fermentative processes that results in the production of sour silage.

It may be observed here that "the drainage liquids from silage made from succulent green food, when too great a weight is placed on the top, is rich in albuminous and soluble non-nitrogenous food-constituents, and therefore ought not to be allowed to run to waste."

VI.—The presence of alcohol in silage.

Dr. Voelcker did not detect even traces of alcohol in any of the samples of silage he analysed; but he accounts for this by the circumstance that they were all, when received by him, in a comparatively advanced stage of preparation, in which most were strongly acid: and he believes that all the samples in which he found from ½ to 1 per cent. of acetic acid (that is, samples of sour silage, for sweet silage is nearly free from acid) had passed through alcoholic fermentation. When sweet vegetable juices enter into alcoholic fermentation, their sugar is converted more or less completely into alcohol and a number of by-products; the alcohol in its turn yields aldehyde by the abstraction of a definite proportion of its hydrogen; and, by the oxidation of the aldehyde, acetic acid is then formed. At a certain stage of the process of ensilage, the silage often smells strongly of aldehyde.

(Signed) DUNCAN J. MACPHERSON.

DEHRI,
1st April 1885.

Abstract of a paper to Clifford Richardson, Assistant Chemist, U. S. Department of Agriculture, in the "Journal of the Chemical Society" for January 1885 entitled Notes on the Chemical Alterations in Green Fodder during its Conversion into Ensilage.

Experiments with "grass, mangles, and maize show that in the conditions existing in silos a large portion of the albuminoids are converted into non-albuminoid nitrogenous substances, whilst in the ordinary drying of fodder no such change seems to take place.

"In the samples of silage which the writer examined there was a comparatively large amount of ammonia combined with the acids produced by fermentation, acetic and lactic, which of course is lost in drying the specimens for analyses. In the results, this produces an apparent loss of nitrogen in the ensilage itself: it is at any rate a loss of nitrogen of nutritive value." This loss is relatively compensated for by the large loss of carbo-hydrates, so that in the figures showing the results of analysis neither loss is prominent, and they are at first glance deceptive.

Alcohol, though never absent from any of the samples analysed, was present in such small quantities as to be distinguished only by the iodoform test.

Lactic acid has always been detected, but never in large quantity. Acetic acid is the chief acid in silage.

In examining analytical results, it is to be remembered that a primary cause of differences in the composition of silage is the great variation which is observable in the composition of the green fodder itself. In the case of green maize, this variation is very great; and although it is largely due to the period of growth at which the stalks are cut, yet there are often marked differences in composition in those of the same stage of development, even in the same field.

As to the nature of the fermentation, the writer made some observations. "In but one sample out of many examined has any trace of *saccharomyces* been found. As a rule, the juice expressed from the fresh ensilage is swarming with *baculus subtilis*, together with some species of *bacterium* and *micrococeous*. No signs of the ordinary lactic or viscous ferment have been observed. The fermentation does not appear, therefore, to be of an alcoholic nature, or similar to any with which we are well acquainted. Analysis show the presence of an insufficient amount of alcohol, gum, or free acid for any of the usual forms of fermentation."

Most of the paper is taken up with the actual figures of the several analysis.

DEHRI,
1*st April* 1885.

(Signed) D. J. MACPHERSON,
Bengal Civil Service.

NOTE.

The lesson to be learnt from this paper is not to fill the silo rapidly; if an opinion may be hazarded regarding a subject on which we are so much in the dark, it is suggested that filling a silo to contain 600 maunds should extend over eight days.

It may be mentioned that 84 silos in the Allahabad cantonments, containing between 40,000 and 50,000 maunds, have been entirely successful, and Government cattle are now consuming 500 maunds daily of this silage, never leaving a blade.

From the information given in this paper, and the little experience gained, it would seem that not more than two crops should be siloed. The first between the 15th August and 15th September, the second between the 15th September and end of December.

Some grass cut and siloed in December at Allahabad has turned out excellent fodder.

The best economy seems to be to dig the silo in the middle of every four to six acres.

ALLAHABAD,
10*th April* 1885.

(Signed) H. MACPHERSON, Major-General,
Commanding Allahabad Division.

No. 28.

CIRCULAR MEMORANDUM
Addressed to General Officer Commanding Divisions and Districts.

Forwarded for information and guidance of Officer Commanding Cantonments in connection with the management of grass operations.

(By Order.)

(Signed) C. M. MACGREGOR, Major-General,
Quartermaster-General in India.

Sir Herbert Macpherson's Silo in the Allahabad Fort.

A subterranean chamber, which, 300 years ago in the time of the renowned Akbar, probably served for the imprisonment of State prisoners, was selected for the purpose, in August last. Sunk in solid masonry foundations, it was only necessary to build up two or three openings, which in more recent times had been made for purposes of light and access, to convert it into a most useful silo, at once thoroughly water and air-tight. Every facility for accomplishing this was afforded by Major Swinton, Commanding at the Fort, and the cost came to Rs. 32.

The grass, selected for the experiment, grew handy inside the fort, on the slope of the ramparts, and throughout the main ditch. It was the first crop grown entirely by the monsoon rain, and in particular that from the ditch was of such forced growth that it might almost be described as rank grass. Two varieties predominate, "janewar" (*andropogen bladii*) and "unjun" (*pennisitum cenchroides*). Of dhoob (*cynoden dacty lon*), very little is to be found within the fort, and what there is has evidently been introduced, the constant tendency being for the varieties "janewar" and "unjun" to overgrow and extinguish it. Both "janewar" and "unjun" are first-rate fodder grasses, the latter being reputed "one of the best of all the wild grasses for forage, both for cows and horses." (Steuart). The grass was cut during the 19th, 20th, and 21st of August, and cast into the silo daily as cut through an aperture knocked in the upper part of the outer wall near the roof of the chamber. Cutting took place with the *hussia* and *dharanti*, and not with either the *khurpa* or *jhabhao*. The labor was paid for by the day, as the operation being experimental, it was thought desirable not to prolong the filling in beyond a few days. This made the cutting more expensive than would have been the case had the quantity cut been paid for by weight, at the usual rate of 3 pice per maund. A few coolies were inside the silo to spread the grass evenly as it was thrown in, but beyond this there was no compressing of the grass at the time of filling in. Considerable stress is laid by Professor Thorold Rogers and other writers on ensilage, on the necessity of chaffing the fodder to be stored, and of adding salt to it, and this is probably the first experiment tried in India, where grass has been ensilaged without these precautions. Much of the grass was two and three feet long, and of strong luxuriant growth, and that taken from the fort ditch was moist and even dripping wet when put into the silo. Other grass again taken from the raised interior of the fort was of a light, fine description, and semi-dried by a hot sun, ere it could be cast into the pit. When filled, the silo measured 17½ feet long, 14½ feet wide, and 11 feet deep. On the top of the grass two or three maunds of bhoosa (white) was spread, giving a dressing of about an inch in depth, and over the bhoosa 75 old wooden sleepers were laid horizontally, as close as they could be, but owing to the irregularity of many of the sleepers, numerous interstices occurred between them. Care was taken not to lay them too close to the sites of the silo, so that they could not bind against the walls as the contents settled. Upon the sleepers were placed 28 tons of round shot (cannon ball). Including the weight of the sleepers, the average weight was 280 lb. to the superficial foot. Opinions vary greatly as to what amount of weight should be used, but it may probably be accepted that for unchaffed strong Indian grasses, it should not be below 200 lb. to the square foot, and may advantageously be as much as 300 lb. The object of the weight is to compress the forage, to expel the air, and prevent its further access, and it is therefore manifest that in the case of unchaffed or unshredded fodder a great weight will best obtain these results.

The silo was left for a period of 23 weeks, or nearly six months. It was opened on the 29th of January of this year, in the presence of Colonel Badcock, C.B., Deputy Commissary-General. An attempt to open it at the top, by removing some of the sleepers, proved unsuccessful: the grass had solidified so compactly that it was found impossible to extract it, and even an iron pointed crowbar could not be driven into it. This corresponds with experiments made in America, of which it is recorded the fodder had to be dragged out by hooks harnessed to horses. One of the bilt-up openings in the wall was therefore broken down, and the ensilage cut into with an American hay knife. The whole of the sleepers and shots were subsequently removed, when no further difficulty was experienced in issuing out the ensilage, which came away in sheets. The uppermost layers were of a darker hue and drier than what was found below. The color of the grass would be correctly described as a rusty brown, although portions of it were of a yellowish green shade. This latter color was met with in the interior of the silo, where also the grass was much the most moist, so much so that it would be correctly described as reeking with its own juices.

The grass had a strong, acid and vinous smell, which it retained for fully 48 hours after removal from the silo. It was distinctly noticeable passing carts carrying the ensilage to the cattle lines, and anywhere within 50 yards of the opened silo; it more resembled the smell of an empty beer hogshead than anything else. Considerable fermentation had evidently taken place, and a thermometer thrust down into the grass itself registered 110° Fahr. When opening the silo the precaution was taken of letting down a lighted candle to the surface before any one was permitted to descend, but no effect on the light was visible, and no inconvenience whatever was experienced either by Europeans or natives who remained for hours in the pit.

The following explanation, why fodder ensilaged keeps and why it becomes acid, is offered by Mr. Barras, Secretary to the Central Agricultural Society of France. He writes:—"Fermentation, decay, rot, and fire, are all identical. The only difference is in the degree of speed with which the combustion goes on. They, all alike, depend on the presence of oxygen, and cease when this active agent is removed. The process of combustion, whether slow or rapid, consumes oxygen and gives out carbonic acid gas. The fermentation consumes the small amount of oxygen which is contained in the mass of ensilage, and liberates an amount of carbonic acid gas which takes the place of the oxygen. The fermentation in its incipient stage is arrested for want of oxygen; none can get at it from the top, for the compression which is constantly going on is all the time forcing the gases out, and when there is ever so slight a flow out none can possibly flow in. Then as carbonic acid gas is heavier than the atmosphere, the sides and bottom of the silo being tight, and as the carbonic acid cannot leak out, the air cannot get down into the space occupied by the carbonic acid any more than air can get into a jug filled with water, or any other heavy liquid, until the water or other liquid is poured or leaks out. The ensilage is thus immersed in a bath of carbonic acid gas. Further fermentation under such circumstances is an impossibility."

The silo, when originally filled in, measured 11 feet in depth, so that in six months it had sunk nearly half. In American experiments chaffed fodder subsided usually one-fourth; but where coarse rank grasses are cast in as they come, and no attempt made to lay them out regularly and evenly, or to tread them down with men or bullocks (which, however, might easily be done), no doubt the subsidence will always be found to be nearer one half than one-fourth.

The first issue of the ensilage to the Government siege train bullocks at Allahabad was made on the 30th January, and continued for a week. In all 361½ maunds were issued, at the rate of 20 lb. per bullock per diem. These bullocks are bred on the Government Farm at Hissar, and such a thing as "ensilage" has never been placed before them. They ate it readily. The most of it was put through the chaff-cutter, and given as a feed morning and evening with the ration of gram, but the bullocks as readily devoured it when given in the state in which it came out of the silo. Mules took to it less readily, whilst horses required a considerable degree of coaxing to be got to eat it at all. Milk cows and calves went at it greedily the instant it was thrown down before them: goats would not look at it. Through the cordial co-operation of Major Elliott, the Deputy Assistant Commissary-General of Transport, the experiments in feeding were fully and satisfactorily carried out, and it has now been practically demonstrated that common grasses ensilaged form an agreeable and valuable change of diet to the Government cattle during the months when only dry fodder is procurable, which at Allahabad is for a period of about eight months in the year.

The total outturn of the silo was about 365 maunds, which gives a little over 18 lb. to the cubic foot, an average far below the 45 to 50 lb. to the cubic foot, which, it is reported, was the density of silos in America, in which however the fodder had been finely chaffed as well as trodden in. This would perhaps account for the disparity.

This experiment is of great value, because by it is demonstrated, for the first time in India, the entire feasibility of preserving the rank vegetation, which arises over all lands with the first burst of the monsoon, for future use many months afterwards, when the rains are over, and a tropical sun has once more burnt up the land. In order to compare the methods of preserving grass during the monsoon season by ensilage and by converting it into hay, at the same time as the silo was filled a large quantity of the same grass was cut in the fort for hay. Great difficulties were experienced in getting it sufficiently dried for stacking. A large quantity was destroyed by rain, and of that stacked (about 430 maunds) from ¾ths to ⅘ths of the weight of the green grass had evaporated in the process. At this season the grasses contain an enormous percentage of water which is not lost by the process of ensilage, but which, of course in the process of conversion into hay, wholly disappears. This stack of hay was cut into and issued during December; much of it was black and mouldy; and the whole of it was very inferior quality hay, and was scarcely eatable until mixed with sweet new hay, made of grasses fully matured, and reaped in the months of October and November. The experiment of making hay during the monsoon was also tried at Allahabad in 1882, and was not successful viewed as to expense and quality. Probably, throughout the North-West, two crops of grass can be got off most lands watered only by the monsoon rains, provided the first crop can be preserved, and this the system of ensilage secures. By simply casting into a silo, thousands of maunds of succulents grasses may be annually secured throughout these provinces as provision for the times of terrible fodder scarcity, which overtake the village cattle with each recurring hot weather. Before the result of the experiment became known, every native with whom I spoke on the subject was confident that the rank immatured jungle grasses sprung up by the first rains would never keep good for six months. Unquestionably great difficulty and expense and loss of weight is experienced in making hay of such, but in casting it in and pressing it in a silo everything is simple and inexpensive, and the result highly gratifying.

The need for securing grass, when it is abundant, may be estimated by the fact that at the present time, at Allahabad, a half-maund bundle of chiefly roots of grasses grubbed up with

the "khurpa," in the "kachar" land of the Ganges, or from neighbouring "jheels" (and therefore unwholesome and likely to cause colic, anthrax, &c.) fetches four annas, whilst good hay commands Re. 1 a maund. Allowing fairly for all expenses, any quantity of green grass could be "ensilaged" at Allahabad during the monsoon season at a cost of from 2 to 3 annas a maund. The nutritive value of ensilage lying midway between that of green grass and hay, its present market-rate would be 12 annas a maund.

In a future paper we hope to give an account of a silo that has been constructed in an open field, merely by digging a pit, and which, at the time of writing, has been shut up for upwards of half a year.

ALLAHABAD,
18*th February* 1884.

(Signed) G. WINGATE, Captain,
On Special Duty.

Memorandum by His Excellency the Commander-in-Chief of the Madras Army.

Silo is the Spanish for a pit. The Royal Agricultural Society have ruled that the contents be called "Silage."

Where the fodder is fairly luxuriant, a silo should be dug in every 5 or 6 acres of the following dimensions:—

30′ × 12′ × 6′ = 2,160 cubic feet to contain about 5,000 maunds = 40,000 lb.

2. The silo once dug is good for all time, the earth excavated gives the pressure that is wanted. A cubic foot of earth weighs 60 pounds, so that allowing an average of 4 cubic feet over the pit, there will be a pressure of 240 lb. on each square foot.

3. At Allahabad where eighty-four silos were filled in 1884, it was not found necessary to line the pits with mortar or to dry them artificially, nor is it necessary to slope the sides.

4. When the rainfall is from 35 to 40 inches and there is a reasonable hope of one quarter of that quantity in September and October, the fodder, *i.e.*, grass should be cut in August. If this is done as a rule, there will be an increased crop in October; the koorpa* is a more useful implement than the sickle or hook. The koorpa acts as a cultivator by loosening the earth about the roots of the grass.

* Hand hoe, in tamil "Pulvettie."

5. Experience has not yet determined whether the silos should be filled and covered over at once, or whether the operation should be prolonged for, say, five or six days. The smell of silage that was packed rapidly, when wet, was very disagreeable, but cattle do not seem to mind the smell and devour the stuff greedily.

6. It is believed that many people have given up silage as bad, merely because the smell was very unpleasant.

7. At Allahabad when failure was almost courted, thirteen hundred ponies and some two thousand Government bullocks were fed for some four months on silage and never left a blade.

8. A good book on silage is published by the Field Newspaper compiled by the Sub-Editor Mr. Cox—price, 4 shillings.

9. The silage consumed at Allahabad represented a clear profit to the State of Rs. 17,000.

10. The Americans, who have gone beyond the stage of experiment, are convinced that five head of cattle can be kept with the assistance of silage where it was difficult to maintain one head on the old system of grazing and storing of hay.

11. If the consumption is not sufficient to empty one silo at once, the silage can be cut daily as is done with a hay-stack in England.

12. In upwards of 500 reports, in the United Kingdom, almost unanimous testimony is afforded as to the favorable effects of silage upon the health of stock, while in many instances unstinted praise of its value is recorded.

13. I shall be glad to answer any number of questions on this very important and interesting subject.

OOTACAMUND,
30*th June* 1886.

(Signed) H. MACPHERSON.

ORDER—dated 9th July 1886, No. 573, Revenue.

Miscellaneous.

His Excellency the Governor in Council having had under consideration the very important question of the means of providing, in an economical manner, during the hot season, fodder for the cattle and sheep of the agricultural population, deems it desirable that careful experiment should be made, by selected officers, in view to determining whether this end cannot be successfully attained by means of ensilage; the merits and cheapness of which have now been definitely shown by extensive trial and inquiry in both Europe and America and, to a minor degree, in Northern India. He, therefore, resolves to publish the papers read above and to direct that the officers marginally noted be supplied with copies of them, and that the Director of Revenue Settlement and Agriculture, who will debit the charges so incurred to the head of "Improvement of Trade and Agriculture," shall place at the disposal of each the sum of Rs. 50.

W. H. Glenny.	W. J. Tate.
Hon. H. St. A. Goodrich.	T. M. Horsfall.
G. McWatters.	J. W. F. Dumergue.
L. R. Burrows.	J. Andrew.
E. C. Johnson.	H. G. Turner.
H. R. Farmer.	A. W. B. Higgens.
M. R. Weld.	H. W. Foster.
F. A. Nicholson.	J. W. Johnstone.

2. Each officer entrusted with silage experiments, will, in carrying them out, be careful to attend to the instructions given in the "Memorandum on silos and Silage," and he will keep a record in the forms A and B, which should be transmitted to the Director of Revenue Settlement and Agriculture, to whom the general supervision of the experiments made will be entrusted, and who will, at their conclusion, collate and submit to Government the results obtained, with such remarks as may appear to him necessary.

3. A portion of the grants made can, where ryots will not lend their cattle and sheep for experiment, be devoted to the purchase, or hire, of animals upon which to make trial of the merits of feeding upon silage. Where weights, at different periods of feeding, can be definitely ascertained, they should be carefully recorded in form B, but where this cannot be done, it will be easy for the officers conducting the experiments to note whether the animals increase in condition or not, and whether the quantity and quality of the milk of cows improves. It is desirable that trial should be made with ponies as well as cattle and sheep.

4. His Excellency the Governor in Council desires that the utmost publicity should be given to the experiments made; that the people, generally, should be afforded every opportunity of watching operations, in every stage; and that any who may wish to try silos themselves, should be given help and advice.

5. In addition to the experiments now ordered, His Excellency in Council considers that it would be of benefit if the Forest Department constructed a few silos in the reserves to which the people resort, or are likely to resort, for grass, and that, where any disposition to take the silage for use is shown, it should be given gratis until the ryots have learned to appreciate its value. In no case should silage be sold by any officer conducting experiments, without the previous sanction of Government.

Form A.

Silos dug out in .

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.

Form B.

Statement showing the results of feeding with ensilage.

District.	Officer conducting experiment.	Description of Animals.			Period during which fed.		Quantity in lb. per diem given to each animal.	Whether with other food or not. If with other food, nature and quantity to be stated.	Results and remarks.
		Cattle.	Horses or Ponies.	Sheep or Goats.	From.	To.			

Note.—Where possible, the weight of animals at the time of commencing the experiment and at its conclusion should be noted in the remark column.

(True Extract.)

(Signed) J. F. PRICE,
Ag. Secretary to Government.

To the Board of Revenue.
„ the Director of Revenue Settlement and Agriculture.
„ the Public Department.
„ the Educational Department.
„ the Military Department.
„ the Public Works Department.
„ the Government Botanist.
„ the Accountant-General.
„ the Editors' Table.

Exd. W. J. Lewis.

200 Copies.

1996 W of 10th August 1886

Communicated to Superintending Engineers for information.

/Sd/ J. S. S.

To

The Supdg. Engineers & Chief Engr. for Irrigation

Govt. of {1886} Madras.

REVENUE.

Issued

Recd. *Encl.*

G.O., 9th July 1886, No. 573.

JULY.

Ensilage.

Orders passed on papers regarding experiments to be made with —.

Withdrawn

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

READ—the following paper :—

MEMORANDUM* ON SILOS AND SILAGE.

A silo is a pit, made either above or below ground, or partly in and partly out of the ground, which is, as far as possible, watertight and airtight. It is intended for the storage and preservation of green forage. If it be properly constructed it allows of the least possible change in substance of that which is packed in it. The object with which silos are constructed is to supply the owners of cattle and other animals with the most abundant, cheap and nutritious kind of food for their stock, of making the storage of the article independent of the risks of weather, whether of wet or cold or heat, and of putting the material so stored in such a position as to admit of access to the store in the most convenient manner.

2. The process of storing green forage in silos is called ensilage.

3. Material which has been subjected to the process of ensilage is called silage.

4. All kinds of succulent vegetable produce may be converted into silage. Maize, millet, peas, beans, grasses (even of the coarsest descriptions), green leaves, young bamboo shoots, clover, rye, oats, prickly-pear, rice stalks can all with advantage be preserved by the process of ensilage. There is no objection to mixing various kinds of produce in one silo.

5. The best time for cutting a crop for ensilage is before it arrives at maturity, when it is sweet to the taste and rich in saccharine matter. Immature or overripe produce should not be used for this purpose. Where the rainfall is moderate and does not exceed about 40 inches in the year and where there is a reasonable hope of one-quarter of such rainfall falling in September and October, the material for ensilage is best cut in August. The cutting can, however, be counted on for success, if done even as late as in December. Grass cut and placed in a silo during that month has turned out excellent fodder. The material may be cut with the implement ordinarily used in the locality. In respect of grass which is being cut for a silo, the koorpa (hand hoe) is useful, because it acts as a cultivator by loosening the earth about the roots of the grass.

6. The green crop should be cut whilst wet with dew or rain, and should be thrown into the silo whilst quite fresh. Quick filling of the silo (within 24 hours if possible) seems preferable to slow filling. In many successful experiments, however, the filling has extended over five and six days.

7. Any space above ground, which is enclosed by walls, as for example a room, a hut, a godown, can be used as a silo, provided that the sides are smooth and perpendicular and that air, rain and damp are excluded. Below ground, trenches, pits and holes are equally effective. In Coorg and Mysore silos excavated in the ground will probably be found to be most practicable and economical. It is believed that there is no necessity to line excavated silos with mortar, or to dry them artificially, or to slope their sides, though these practices find favor with some persons of experience. It is best to round off corners slightly.

* This memorandum, which has been drawn up solely in the hope of benefiting planters and other owners of stock in Mysore and Coorg, is based on Mr. Thorold Rogers' "Ensilage in America," on papers received from Sir Herbert Macpherson and from the Revenue and Agricultural Department, and on a note with which Mr. Norman Tod of Alicutty in Coorg has favored me.—C.G.

8. The size of a silo must depend on the amount of available produce near at hand. Where green fodder is fairly abundant a silo of

30 feet long,
12 feet broad,
6 feet deep,

can with advantage be used for every 5 or 6 acres of land. The above dimensions give 2,160 cubic feet, which will store about 500 maunds of 80 lb. each (= 40,000 lb.). For smaller silos the length and breadth, but not the depth, should be reduced. According to some persons a greater depth than 6 feet is desirable in a damp climate.

9. An excavated silo is good not for one year only, but for many.

10. A silo must be completely filled. The filling can be done in rain without risk of injury. The green fodder may be put into the silo either shredded or not shredded, as may be preferred. If unshredded, it will need a greater subsequent pressure, so as to ensure that it lies close and that air is excluded. In the case of an excavated silo, the excavated earth should be used as a covering, and will suffice for the necessary pressure. It is important that the weight of earth so put on should be equally distributed. The height of the earth above the contents of the silo should, if possible, be not less than 4 feet, and the pressure not less than 240 lb. to the square foot. A pressure up to 300 lb. per square foot is the maximum that is desirable. In connection with this it may be mentioned that one cubic foot of moist earth averages about 100 lb. in weight. The object of the weight is to compress the forage, to expel the air, and to prevent later access of air. In a room or other building, the requisite pressure can be effected by means of wooden-sleepers and stones over them. There is no need to place mats or any other material between the contents of the silo and the earth or other substance which supplies the pressure. The edges of earth used as a covering for a silo should be carefully looked at and hammered down, as occasion may require, after the silo has been covered in. Any cracks or crevices which appear should be instantly filled in, so as to keep out air from the silo.

11. Silage is not fit for use in a less period than three months from the date of covering up the silo, and it is better if possible to extend the period up to six months. When a silo is being opened, as little of the weight should be removed from the top and sides as possible. If the consumption is not enough to allow of the silo being emptied at once, the silage should be cut daily, as a hay stack is in England, in such a way as to exclude the air to the utmost from the remainder. Silage is best cut out with a big knife. Sometimes the cutting out involves a considerable amount of force owing to the compressed state of the material.

12. The smell of silage, which is acid and not unlike the smell of a tanyard in character, is never pleasant. Sometimes it is very disagreeable. Many persons have rejected silage as bad merely because of its unpleasant smell. But, notwithstanding the smell, sheep, pigs, horses and cattle have been found to eat it with avidity and to prefer it to other kinds of fodder. Before presenting it to animals, it is generally advisable to shake silage out in the air or sun for a few minutes.

13. Half a cubic foot of silage is a full ration for an ordinarily sized country cow or bullock. One cubic foot is a full ration for a large English cow. The Americans, who practice ensilage extensively, hold that five head of cattle can, under the system of silage, be kept from the same amount of ground as with difficulty sufficed for one head under the old system of grazing and storing of hay. Repeated experiments have proved that silage is more fattening and more nourishing than green or sundried grass. In Northern India the result financially has been to establish that a country cow can be fed on silage at a cost of about Rs. 11 a-year, instead of Rs. 45, which was the cheapest cost under previous management. The experiments in Northern India have been on a very large scale and in many places, and have ended in effecting a great economy in the keep of cattle and ponies belonging to the Commissariat and Transport departments of Government.

14. For those who wish to study the subject of ensilage more fully, the works of Mr. Thorold Rogers (published by W. Swan Sonnenschein and Co., Paternoster Row, London) and Mr. Cox (published at the Field Office, Strand, London) are recommended for perusal.

BANGALORE,
15th April 1886.

(Signed) C. E. R. GIRDLESTONE,
Offg. Resident and Chief Commissioner.

Extract from Brigadier-General Wilkinson's report which might be added :—

"Silage can be made with very little preparation by almost every ryot in India.

"He can take the wild grass near his village at the time when it is most valuable as forage ; just as the seed is beginning to harden another crop will grow long before the rains are over, so that all he cuts and packs into his silo is clear gain to him."

ENCLOSURES.

Letter from Captain S. C. F. PEILE, Assistant Commissary-General, to Major-General Sir H. Macpherson, V.C., K.C.B., K.C.S.I., Commanding Allahabad Division.

As the experiments in ensilage, conducted during 1884-85 at Allahabad in connection with the preservation of grass, were perhaps larger and more comprehensive than any experiments which ever took place at any other one place, I propose submitting a report showing generally the process of this method of the underground preservation of grass, and in detail the contents and outturn of the several silos dug in Allahabad cantonments.

2. Eighty-four silos in all were dug and filled with grass, &c., between 23rd July and 29th October 1884. The dimensions of the majority of these were 30 feet × 12 feet × 6 feet, while the rest were of various sizes.

3. The silos were so situated as to be in the centre of the plot from which it was intended the grass should be cut. This was done to avoid the necessity of engaging carriage to take the grass to the pits, and by these means the only expense incurred in filling the silos was the contract rate of cutting the grass, viz., about 9 pies per maund.

4. It was found by experiment that a field or plot of about five acres of ordinary grass land will fill a silo 30 feet × 12 feet × 6 feet dug in the centre of it. The coolies who cut the grass will carry it and throw it into the pit.

5. The cost of three silos of the above size was Rs. 11, or at the rate of Rs. 1-11-2 per 1,000 cubic feet. In addition to Rs. 3-10-8 for excavating the silo, there is the charge for covering and uncovering it with 4½ feet of earth, which is about Rs. 1-5-4, and hence the total expense connected with a silo 30 feet × 12 feet × 6 feet containing 600 maunds of grass should be about Rs. 5.

6. The principle on which these experiments were carried out, was to find out the very cheapest method of preserving grass, karbi, mothi, &c., so as to bring it within the power of the poorest villager to store food for his cattle. It was with this object that only earth silos were dug, no elaborate means of draining or pressing were attempted, the experiments were conducted in the simplest and cheapest form, and though a small percentage of the silos was not good, yet on the whole the experiment may be deemed to have been highly successful, and, considering that the operations were nothing more than digging a hole in the ground and filling it with grass, it is highly satisfactory that over 40,000 maunds of food so stored should have been eaten and eaten with relish by the cattle (numbering 2,000) and upwards of 1,200 ponies.

7. To examine the financial results of the above operations it will be seen that, roughly speaking, the silos containing these 40,000 maunds of fodder cost Rs. 350 and the cost of cutting the grass was Rs. 1,875, and thus giving even the liberal allowance of 40 lb. per head per bullock per day, it would be possible to feed 80,000 cattle for Rs. 2,225, or, in other words, to forage over 200 bullocks daily for a whole year at a total cost of Rs. 2,225, or at the rate of Rs. 11 per bullock per annum.

8. Now, at the most moderate computation, and giving only 20 lb. per diem, it would cost to feed a bullock on bhoosa Rs. 45 per annum, or more than four times as much as the ensilage. This is taking the rate of bhoosa at eight annas per maund.

9. The only precautions necessary in filling an earth silo are to heap the grass as high above the surface of the silo as the depth of the silo, and then to cover the grass so heaped up with the whole of the earth which has been previously excavated, care being taken to cover a margin of two feet all round the sides of the pit to keep out air and water. With a few exceptions nearly all the Allahabad silos were filled while it was raining hard.

10. When a silo has been covered up, great care must be taken in filling up any cracks or crevices the moment they happen to appear.

11. For the first twenty-five silos that were made an elephant was employed to press the grass, but subsequently the services of the elephant were dispensed with and no pressure, other than the weight of the excavated earth, was used. The latter appears to be quite sufficient and is the least expensive form of pressure that can be applied. It is of course highly important that the weight of the earth so put on should be equally distributed.

12. Another form of pressure that was tried was wooden sleepers; but unless great care is taken in placing the grass evenly, it is very difficult to obtain an equal pressure, as the sleepers, being flat, will naturally press only on the highest points of the grass. Our experience seems to show that the earth pressure is all that is necessary if carefully applied.

13. A most important result was obtained from 12 silos, which were made along the line of rail between Allahabad and Manauri, for though they were filled almost entirely with the coarsest description of grass, viz., kusa, kasa, and ganhra grasses, which make poor hay, yet the ensilage turned out excellent. The coarse grasses came out of the silo soft and succulent, and that they were nutritious and palatable was proved by the condition of the bullocks during the issue of this ensilage, and by the greedy manner in which the animals devoured this fodder.

14. I think also that results proved that, for the purpose of being siloed, grass should be cut either with the "jábao" (small circular scythe) or with the "hassa" (sickle) and not with the "kurpa," for with the latter it is almost impossible to avoid scraping up dirt and roots, which not only make the ensilage gritty and unpalatable, but also tend to cause it to have an obnoxious smell.

15. After opening the silos on the railway, we opened eleven that had been dug on the Fort esplanade. These were formed from the following good grasses; viz., bandari, jenewah, mussel and dhub, and turned out excellent. These grasses had been in the pits about six months, and came out as green as when put in.

16. I then had to open out the silos in new cantonments. These did not turn out so well as those on the railway and fort, and three or four were so bad that they had to be closed again. The smell of this ensilage while in the pit was malty, but when removed and exposed to the air, it became unpleasant, resembling a tanyard in smell. Most of it, however, was greedily devoured by the cattle, though some three or four silos could not be used.

17. The reason the silos in new cantonments were not so good as the others can fairly be attributed to the fact that the grass put into them was immature and young, and from this the following deduction can be made:—Ensilage to be good should be made from grass cut just before it flowers, and this will allow a good second crop to spring up for hay.

18. The transport lines in Allahabad are in every way inconveniently situated, being in what are called the Chatham lines, three or four miles away from the barracks, Commissariat godown and other places in which the bullocks are called upon to work. This necessitates most of the bullocks for duty having to walk four miles before their work is begun, and again to perform a return journey of four miles when their work is finished.

19. Carrying the ensilage to the Chatham lines was fraught with a great deal of inconvenience, for to get there from new cantonments necessitates passing through the greater part of the civil station, the inhabitants of which naturally complained of the smell of the ensilage. As soon as it was found that annoyance was being caused, the issue of ensilage to the animals in the Chatham lines was stopped.

20. Ensilage has a curious smell, very like that of a tanyard, which is unpleasant to anyone unaccustomed to it, but which ceases to be unpleasant after one is used to it. There is nothing to show that the smell is at all unhealthy; on the contrary, the coolies who were employed daily on the silos kept in excellent health, and the siege train bullocks who were fed almost entirely on it, kept well and in very good condition. There was only one death amongst these animals, and that was caused by rinderpest. This epizootic disease spread considerably amongst the new bullocks bought for the proposed expedition to Quetta and caused many deaths. The Commissariat slaughter cattle were fed almost entirely on ensilage, and nothing else, with the most favorable results. I mention this as an idea seemed to have gained ground that the deaths amongst the new purchases were due in some way to the ensilage. This can hardly be maintained in the face of the following facts:—

(*a*) Siege train bullocks fed on ensilage from the time of the first silo being opened to the last being closed, kept well and in good condition.
(*b*) Slaughter cattle same result.
(*c*) Slaughter sheep fed partially on ensilage with good results.
(*d*) Ponies fed on ensilage.

I think it has since been incontestably proved that the deaths among the new bullocks were due to rinderpest, and that this disease was raging in the villages round about Allahabad is well known, and was witnessed by the Major-General and Deputy Assistant Quarter-master-General of the division, who, when out in the district, saw the corpses of many hundreds of bullocks that had been carried off by this disease.

21. I made an experimental silo with wonderfully good results. It was filled in the following manner:—At the bottom was placed about 2 feet of green "mothi," next some rather dry munj, on this came some 2 feet of chaffed sorghum, then a layer of dry karbi, pressed down by about 6 inches of green mothi, and on the top of all a layer of sorghum. This pit was opened on 13th May 1885, after having been covered for six and-a-half months. Two inches of sorghum at the top had to be discarded. The remaining articles came out most excellent, the dry karbi* appearing as juicy and fresh as the green. The animals devoured this ensilage in the greediest manner.

* Cholum stalks.

22. I attach a statement showing the result of each silo in detail, and in conclusion I submit the following summary of what would appear to be the facts ascertained in connection with this most interesting experiment, which was conducted on so large a scale at Allahabad this year:—

(1) It does not appear necessary to go to the expense of building masonry silos, or to take any particular precautions in draining and pressing, as an earth silo seems to fulfil all the necessary conditions, and apparently drains itself if kept air and water tight.
(2) The only pressure that seems to be necessary is that caused by the excavated earth being piled on the grass.
(3) The best time to cut the grass is when it is mature, between 15th August and 1st November; this will give a second crop for hay.
(4) The fact of its raining while a silo is being filled does not appear to do any harm.
(5) The ensilage should be issued green, *i.e.*, as it is taken out of the pit.
(6) Thirty-five lb. of ensilage would appear to be equal to 20 lb. of bhoosa, the ration of a siege train bullock.
(7) Ensilaged karbi forms good food for elephants.
(8) The fact of cutting the grass for ensilage gives a finer and better second crop for hay-making.

* * * * *

I trust that the experiments at Allahabad may in the course of time show the villagers and country people that they have now a sure and safe means at hand for preserving fodder for their cattle, and a cheaper method by far of procuring good fodder than any now in existence; and in conclusion I would point out that the success of these experiments is mainly due to the intelligence and hard work of Sergeant Meagher, of the Commissariat Department, who has not only been out in all weathers, but has taken an intelligent interest in the operations, which has gone far to make them so successful.

Silos dug in new cantonment.

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	HOURS.						
23rd July 1884 ...	3	Top 10′ 6″ × 5′ 9″ ... Bottom base 9′ 6″ × 4′ 3″ Depth 4′ 3″	Raining hard.	116 maunds of immature grass.	3 feet of earth.	November 1884.	Ensilage brownish, smell unpleasant issued after being dried.
	DAYS.						
29th ,, ,, ...	4	Top 30′ × 12′ ... ... Bottom 28′ 6″ × 12′ ... Depth 6′...	Do. ...	750 do. do.	Elephant pressure and 5 feet of earth.	11th Nov. ,,	Ensilage green and very wet. A little at top and sides was bad, remainder issued green.
8th Aug. ,, ...	2	30′ × 12′ × 6′... ...	Fair ...	650 do. do.	Do. ...	21st April 1885.	Ensilage green and wet, smell unpleasant, but issued and eaten in one day. Top and sides not issued, being bad.
10th ,, ,, ...	3	28′ × 12′ × 6′... ...	Very rainy.	525 do. do.	Do. ...	22nd ,, ,,	Do. do. do.
12th ,, ,, ...	4	Top 28′ × 10′ ... Bottom 27′ × 8′ ... Depth 6′ ...	Raining ...	415 do. do.	Do. and 4 feet of earth	23rd ,, ,,	Ensilage good, green, and wet; scarcely any heat in silo.
8th ,, ,, ...	3	30′ × 12′ × 6′ ..	Raining night and day.	800 do. do.	Do. and 5 feet of earth.	Not yet opened.	
10th ,, ,, ...	2	30′ × 12′ × 6′ ...	Raining ...	850 do. do.	Do. ...	Do.	
12th ,, ,, ...	2	Top 30′ × 12′ Bottom 28′ 6″ × 10′ 6″. × 6′.	Very rainy...	750 do. do.	Do. do. and sleepers laid across.	April 1885 ...	Ensilage on top for 3 feet, bad, wet and jammed up into cakes; color black, smell offensive, heat 105°, not issued.
12th ,, ,, ...	2	30′ × 12′ / 29′ × 11′ × 6′ ...	Raining ...	750 do. do.	Do. do. no sleepers.	1st February ...	Green, wet, and good; no heat in silo.

Silos dug in New Cantonments—(*Continued*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
12th Aug. 1884 ...	2	Top 29′ 6″ × 12′ / Bottom 28′ × 10′ × 5′ 6″	Very rainy.	650 maunds of rather ripe grass.	Elephant and 5 feet of earth.	May 1885 ...	Ensilage excellent, issued in one day, color green, heat 90°.
13th ,, ,, ...	2	Top 30′ × 12′ / Bottom 27′ × 8′ × 6′	Fair ..	670 maunds of immature grass.	Do. do.	Not opened.	.....
14th ,, ,, ...	3	24′ × 10′ × 6′ ...	Raining ...	650 maunds do.	Do. do.	.....	Ensilage excellent, issued in one day.
15th ,, ,, ...	4	30′ × 12′ × 6′ ...	Very rainy.	640 maunds do.	Do do.	April 1885 ...	Left open two days after being filled. Little on top of sides bad, otherwise good.
19th ,, ,, ...	2	32′ × 12′ × 6′ ...	Fair ...	650 maunds do.	Do. do.	May 1885 ...	Very good, no heat.
20th ,, ,, ...	3	30′ × 12′ × 5′ 9″ ...	Do. ...	700 maunds do.	Do. do.	Do. ...	Very good, 103° Fahr.
21st ,, ,, ...	4	30′ × 12′ / 29′ × 12′ × 5′ 8″ ...	Do. ...	800 maunds do.	Do. do.	April 1885 ...	Color black, ensilage bad and jammed into cakes. Water must have got into this silo.
21st ,, ,, ...	2	30′ × 12′ / 26′ × 8′ × 6′ ...	Do. ...	400 maunds do.	Do. do.	May 1885 ...	Good, 105° Fahr.
28th ,, ,, ...	2	30′ × 12′ / 29′ × 11′ × 6′ ...	Do. ...	700 maunds do.	Do. do.	April 1885 ...	Ensilage good, smell pleasant and sweet, scarcely any heat.
28th ,, ,, ...	2	32′ × 12′ / 30′ × 8′ × 5′ ...	Do. ...	752 maunds do.	5 feet of earth only.	Do. ...	Green and wet, fair ensilage, 90° Fahr.
30th ,, ,, ...	3	43′ × 16′ × 6′ ...	Do. ...	1,400 maunds do.	7 feet of earth only.	March 1885 ...	Filled with long coarse grasses. Ensilage excellent, smell sweet, 110° Fahr.
30th ,, ,, ...	2	30′ × 11′ × 6′ ...	Do. ...	720 maunds do.	5 feet of earth only.	Do. ...	Do. do. do.
3rd Sept. ,, ...	5	30′ × 12′ × 6′ ...	Very rainy.	652 maunds do.	Elephant and 5 feet of earth only.	April 1885 ...	Smell unpleasant, heat 85° Fahr. Ensilage fair.

Silos dug in New Cantonments—(*Continued*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
3rd Sept. 1884 ...	4	30′ × 12′ × 6′ ...	Very rainy.	732 maunds of immature grass.	Elephant and 5 feet of earth only.	April 1885 ...	Smell unpleasant, heat 85° Fahr. Ensilage fair.
31st Aug. „ ...	2	30′ × 12′ × 6′ ...	Rainy ...	700 maunds do.	5 feet of earth only.	Do. ...	Do. do. do.
2nd Sept. „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds of nearly ripe grass.	Do. do. ...	May 1885 ...	Ensilage excellent, smell vinous, 95° Fahr.
3rd „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	820 maunds do.	Do. do. ...	21st April 1885.	Ensilage excellent, smell vinous, temperature cool.
5th „ „ ...	1½	30′ × 12′ × 6′ ...	Fair ...	761 maunds do.	Do. do. ...	April 1885 ...	Do. do. do.
5th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	765 maunds do.	Elephant and 5 feet of earth only.	Do. ...	Ensilage inferior, color black and jammed into cakes. Water must have got in or possibly too much pressure.
6th „ „ ...	1½	18′ × 18′ × 9′ ...	Do. ...	1,100 maunds of almost ripe grass.	Earth on top.	3rd April 1885...	Ensilage excellent, pit cylindrical in shape, color green. No heat. The best silo opened.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	707 maunds do.	5 feet of earth on top.	April 1885 ...	Ensilage good, green, and wet. Temperature. 90°.
8th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds do.	Do. do. ...	Do. ...	Do. do. do.
9th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	750 maunds do.	Do. do. ...	Do. ...	Do. do. do.
9th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	800 maunds do.	Do. do. ...	Do. ...	Do. do. do.
21st „ „ ...	7	30′ × 12′ × 6′ ...	Rainy ...	693 maunds do.	Do. do. ...	May 1885 ...	Good, color brown, smell sweet, 108° Fahr.
28th „ „ ...	3	30′ × 12′ × 6′ ...	Fair ...	527 maunds do.	Do. do. ...	Do. ...	Very good, quite different smell, 805° Fahr.
28th „ „ ...	4	30′ × 12′ × 6′ ...	Rainy ...	688 maunds do.	Do. do. ...	27th March 1885.	Made of course grasses, smell very vinous. Heat about 110° Fahr.

Silos dug in New Cantonments—(*Concluded*).

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
4th Oct. 1884 ...	2	30′ × 12′ × 6′ ...	Fair ...	733 maunds of almost ripe grass.	5 feet of earth on top.	30th March 1885.	Same as above, ensilage drier.
8th „ „ ...	2	30′ × 12′ × 6′ ...	Do. ...	476 maunds do....	Do. do. ...	April 1885 ...	Do. do.
4th „ „ ...	2	30′ × 12′ × 6′ ..	Do. ...	611 maunds do....	Do. do. ...	29th March 1885.	Do. do.
6th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	633 maunds do....	Do. do. ...	March 1885 ...	Do. do.
4th „ „ ...	5	30′ × 12′ × 6′ ...	Rainy ...	700 maunds do....	Do. do. ...	April 1885 ...	Color brown, ensilage dry and good, smell sweet, heat 110° Fahr.
9th „ „ ...	3	30′ × 12′ × 6′ ...	Fair ...	750 maunds do....	Do. do. ..	Do. ...	Do. heat 130° Fahr.
12th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	800 maunds do....	Do. do. ...	Do. ...	Do. do.
13th „ „ ...	3	30′ × 12′ × 6′ ...	Do. ...	Kurbi ...	Do. do. ...	Do. ...	Kurbi, ensilage was excellent, almost the same color as when put in.
24th Sept. „ ...	5	30′ × 12′ × 6′ ...	Do. ...	Bajra, mothi munj	Do. do. ...	Not yet opened	.....
29th Oct. „ ...	4	30′ × 12′ × 6′ ..	Fine ...	Sorgham, mothi, kurbi.	Do. do. ...	May 1885 ...	Ensilage excellent, heat 103° Fahr. The best ensilage made ; devoured greedily by animals.

Silos dug in the Chatham Lines.

16th Sept. 1884 ...	3	30′×12′×6′ ...		650 maunds immature grass.	Elephant and 5 feet earth.	April 1885 ...	Ensilage good, all alike, color green, smell vinous, heat 90° Fahr.
21st „ „ ...	4		Rainy ...	700 ripe. ...	Five feet of earth only.		
17th „ „ ...	3			756 do. ...			
22nd „ „ ...	6			550 do. ...			
20th „ „ ...	3		Fair ...	750 do. ...			
24th „ „ ...	2		Rainy ...	706 do. ...			

Silos dug on the Fort Esplanade.

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.
	DAYS.						
Silos dug on the Fort Esplanade.							
11th Sept. 1884 ...	2	30′ × 12′ × 6′	Fair ...	787 maunds of mature grass.	Five feet of earth only.	In Feb. and March 1885.	The whole of the ensilage, though composed of coarse grasses, was excellent, light green in color, sweet in smell and greedily devoured by the cattle. Heat 90° Fahr.
13th ,, ...	2			750 maunds do.			
12th ,, ...	2			745 maunds do.			
12th ,, ...	3			768 maunds do.			
13th ,, ...	1			650 maunds do.			
21st ,, ...	1			716 maunds do.			
23rd ,, ...	2		Rainy ...	649 maunds do.			
22nd ,, ...	1			504 maunds do.			
24th ,, ...	2			440 maunds do.			
17th ,, ...	2		Fair ...	618 maunds do.			
20th ,, ...	3			434 maunds do.			
Silos along the Line of Railway.							
3rd Sept. 1884 ...	4	30′ × 12′ × 6′ ...	Rainy ...	650 maunds mature grass.	Five feet of earth only.	In March and April 1885.	Ensilage excellent throughout green in color. Smell sweet, heat alike throughout about 90° Fahr.
6th ,, ...	4		Do. ...	650 maunds do.			
8th ,, ...	4		Fair ...	700 maunds do.			
12th ,, ...	4		Do. ...	600 maunds do.			
12th ,, ...	3		Do. ...	550 maunds do.			
16th ,, ...	2		Do. ...	557 maunds do.			
18th ,, ...	2		Do. ...	535 maunds do.			
21st ,, ...	2		Do. ...	591 maunds do.			
23rd ,, ...	2		Do. ...	550 maunds do.			
25th ,, ...	2		Do. ...	565 maunds do.			
30th ,, ...	6	40′ × 16′ × 6′ ...	Do. ...	900 maunds do.			

About 10 silos still remain unopened, as an experiment, to see what they will be like next year. Not included in this statement.

OFFICE OF QUARTERMASTER-GENERAL IN INDIA,

ARMY HEAD QUARTERS,

Simla, 1st July 1885.

Copy of a letter from Major-General Sir H. Macpherson, K.C.B., K.C.S.I., V.C.—*No.* 1—*S, dated Allahabad, 20th April,* 1885.

In the hope that they may be considered worth distributing to Executive officers, I have the honor to forward copies of a compilation of some interesting notes on storing fodder in silos, by Mr. D. J. Macpherson, B.C.S., with a brief notice of some experience at Allahabad.

2. To this should have been added that silos 30′ × 12′ × 6′ cost Rs. 3-10-8 each, that no lining of masonry seems necessary, and that the earth excavated gives all the pressure that is required.

3. The items are—

	RS.	A.	P.
Cutting grass and throwing it into the silo, per maund ...	0	0	9
Proportion of cost of silo covering and opening, per maund ...	0	0	3
Price per maund ...	0	1	0

4. The smell from the silos, opened early in the season, was very disagreeable; the cattle nevertheless eat the contents.

5. The silage now being consumed is far less objectionable, and it is hoped that in the coming crop, when the sweet fermentation has been produced, the fragrance of the grass may be preserved.

Abstract of a Paper by Dr. Augustus Voelcker, F. R. S., in the "Journal of the Royal Agricultural Society of England" for October 1884 (*Vol. XX, Part* 2), *on the Chemistry of Ensilage.*

The paper consists mainly of an account of the chemical composition of 25 illustrative specimens of silage, which had been sent to the Agricultural Society's Laboratory for analysis by Dr. Voelcker; but it contains several observations of a general character on the chemistry of ensilage.

Dr. Voelcker is of opinion that we do not yet possess a sufficient number of data upon which to base a sound theory of the chemistry of ensilage or which would guide the farmer in producing at will either "sweet" or "sour" silage of good keeping quality. Indeed, the operation of ensilage is at present, in a large measure, conducted in a haphazard way, owing to our scanty knowledge of the complicated processes of fermentation, and of similar chemical and physical changes, to which succulent green food is liable under various conditions of temperature, the total or partial exclusion of atmospheric air, or its free admission.

Dr. Voelcker's remarks on special points of importance are, in many cases, found in a disconnected manner among his comments on the analysis of different samples; but in this abstract they are grouped under different heads according to the subject to which they relate.

I.—Regulation of the temperature in silos, with relation to the theory of fermentation.

"In filling silos, most writers on ensilage give directions which are based on Liebig's chemical theory of fermentation; they recommended the thorough consolidation of the green fodder as it is put in, the rapid filling of the silo, and the covering up and weighting of it at once, in order to prevent, as far as possible, the exposure of the fodder to the oxygen of the atmosphere, which is assumed to be the exciting cause of fermentation. Pasteur's recent investigations, however, have greatly enlarged our knowledge of the conditions which favor fermentation. He has shown that oxygen itself is not directly concerned in the process, but that certain living ferments and germs, generating various kinds of bacteria of fermentation, greatly modify the character of the silage produced.

"It would appear that a temperature of about 125° is sufficiently high to kill the bacteria which produce acid fermentation, and if the bacteria are killed, and the silo is covered and weighted, the enclosed mass of green fodder will remain sweet, and be practically preserved under the same conditions as fruits, vegetables, or meats are preserved when canned. If this be the case, it will be at once intelligible that by less packing of the fodder when put into the silo, and extending the time of filling until the temperature rises to a point which is fatal to the bacteria, the resulting silage will be sweet and free from acidity; while sour silage is produced by at once consolidating, covering up, and weighting the green fodder, so as to prevent the temperature rising to the point fatal to the bacteria."

Mr. George Fry of Chobham is the first man who has made accurate observations pointing out the influence of temperature on the production of the aromatic or fruity smell which grass, clover, and similar green produce acquire when put into a silo without any pressure beyond that exercised by the mass of ensilaged green food upon the lower layers. He insisted on the importance of allowing green food, when first placed in the silo, to attain a temperature not lower than 125° and, if possible, as high as 150° Fahrenheit, before applying considerable pressure by means of weights or a layer of sand. By this rise of temperature it passes through a process which he terms "sweet" or "hay" fermentation. This he accomplishes by filling his silos without close packing, and by deferring weighting the mass for two or three days, until the temperature of the silage at a depth of about four feet from the bottom of the silo has risen rather higher than 125° Fahrenheit. He then covers the silage with close-fitting boards, upon which he places weights or sand to a depth of about nine inches whereby the air is excluded and a steady uniform pressure is applied. From his observations it would appear that the too rapid exclusion of air by weighting the silage, as soon as it is put into the silo, prevents the green food from attaining a temperature of 125°, below which he holds that sweet or hay fermentation does not take place, but instead either lactic or acetic fermentation, which results in the production of more or less sour silage. Certainly, by following his directions, silage can be produced which shows not more than a trace of acidity, and as sweet and almost as aromatic as well-made hay. [All this was confirmed by experiments which the late Dr. Voelcker was carrying out at the time he wrote this paper.]

II.—Keeping quality of silage after it is taken out of the silo.

"Sweet" silage, however, keeps only a short time on exposure to the air after being taken out of the silo; whereas well-made "sour" silage may be kept sound for six or nine months, and even longer, when freely exposed to air, without turning mouldy.

At the same time "sour" silage even does not always keep well. So far as a conclusion could be drawn from the experiments he had made, Dr. Voelcker was of opinion that it is likely that the whole difference in the keeping qualities of sour silage depends upon whether the silage had passed through the lactic acid fermentation (which takes place on the more or less complete exclusion of air) or through the alcoholic and subsequent acetic acid fermentation (which proceed with facility only if air has free access). In most cases he found that acetic acid fermentation preceded mouldiness. At the same time our knowledge of the chemical changes which silage undergoes is too imperfect to enable us to pronounce an opinion on the point; and, in another part of the paper, Dr. Voelcker says that he was not prepared "to assign any greater or more marked influence on the keeping qualities of silage to the volatile (butyric or acetic) acids than to the non-volatile (lactic) organic acids." "The proportion of the organic acids in silage varies a good deal in different samples of even the same green fodder, and the nature of the organic acids which are generated in the process of ensilage also varies greatly in different samples. In some cases of well-made silage of excellent keeping qualities, the prevailing acid is non-volatile lactic acid; in other samples which have kept equally well, volatile and aromatic smelling acids, such as butyric and acetic acids, were present in proportions preponderating over the amount of non-volatile lactic acid." "In most cases the greater part of the sugar in green fodder is converted in the silo into various kinds of organic acids, some of which possess strongly-marked preservative properties. * * * Much of the success in preserving green fodder in silos," Dr. Voelcker was convinced, "depends upon its proper state of maturity. Green rye, maize, clover, meadow grass, and, in fact, all kinds of succulent vegetable produce, should be cut down neither too immature nor over-ripe, but just a little before it arrives at full maturity, and when it is sweet to the taste and rich in sugar. Fairly matured green fodder," Dr. Voelcker found, "makes more nutritious silage, and keeps better when removed from the silo and exposed to the air, than silage made from immature green fodder or such food in over-ripe condition."

"The addition of *salt*, it would appear, is unnecessary, if not somewhat injurious, to the keeping qualities of silage.

III.—Influences which determine the general quality of silage.

"That there are great differences in the quality of the silage made from different kinds of green food, or even from the same food made on different farms, or on the same farm in different seasons, admits of no doubt. These differences are attributable in a great measure to the quality of the original green food, as regulated by its composition, and more especially by its state of maturity; but they are also, no doubt, influenced by the conditions under which the silage is made, because the variable conditions must result in corresponding modifications of the process of fermentation." Dr. Voelcker, however, had no doubt that silage of a uniform and desired quality would be produced with certainty, when the influence of these differences in the original composition of the green food, and of the varying conditions of filling the silo and applying pressure to the green food, has been more thoroughly understood than it is at present.

Regarding the state of maturity, however, at which green fodder should be silaged, there is little room for question. We have already seen how this affects the keeping qualities of the silage after exposure to the air on taking it out of the silo; but it has also an important bearing on its nutritiousness. "Generally speaking, well-rippened nutritious grass or clover, when under conditions favorable to the production of either sweet or sour silage, makes a better, more nutritious, and wholesome food than immature or over-ripe green food, which originally is either so immature as to contain hardly any sugar, or else so over-ripe as to have become insipid and woody." "Immature green food, as a rule, does not keep well when put into silos:" the sugar in it is not fully formed, which in the silo becomes converted into various kinds of organic acids, some of them possessing marked preservative properties. Over-ripe stringy green food abounding in cellular fibre, on the other hand, often keeps extremely well in the silo, as the bulk of it consists of such matters as cellular and woody fibre which do not perish rapidly; but it never makes really good nutritious silage, because the constituents upon which the nutritive qualities of the food mainly depend, and which are most liable to suffer changes by fermentation, are present only in small proportion. "Good, well-matured green food will make first class silage if the process of ensilage is properly carried out, whilst innutritious, immature or over-ripe woody grass or clover, or similar green food, by no kind of fermentation nor modification of the process of ensilage, can be possibly converted into a really good food. Ensilage may render such food more palatable and improve its physical condition, in consequence of which it may become more digestible; but it can never change it into really good and nutritious provender.

"Well-made silage, in conjunction with decorticated cotton cake, produces abundance of good and rich milk."

IV.—Alleged loss of albuminoid nitrogen during ensilage.

It is true that, as a rule, the nitrogen in silage occurs not only in the form of *albuminoids*, but also in very variable proportions as *amides* (non-albuminoid); but as green food, especially when rather immature, also contains amides in considerable proportions, the question of the alleged reduction of albuminous nutritive compounds into innutritious amides can be settled only by a series of careful *quantitative* analysis of the fresh green food, and of the silage produced from it. This has not yet been systematically undertaken. The analysis of silage which have been made disclose very great variations in the relative proportions of albuminoid and non-albuminoid nitrogen*; but without analysis also of the green food from which the silage was made, we cannot determine whether a reduction of albuminoids took place.

* From 5 to 49·2 per cent. of non-albuminoids.

V.—Loss sustained by green fodder during ensilage.

No quantitative experiments to determine the loss which green fodder undoubtedly sustains during the process of ensilage have been made in England; but a number have been made in Germany by Weiske, Schulze, Moser, Maercker, Mayer, and Brockema, and all disclose a considerable loss of food-constituents. The loss is not confined merely to the sugar and carbo-hydrates (which, during fermentation, are broken up, their elements being re-united into new combinations, which, being partly gaseous, pass away altogether), but extends also to the albuminous compounds, and even to the woody fibre. That the loss is greater in making sour than sweet silage can hardly be doubted. In the preparation of sweet silage, active fermentation does not take place, and in consequence the sugar and carbo-hydrates are not subjected to the action of the prolonged series of fermentative processes that results in the production of sour silage.

It may be observed here that "the drainage liquids from silage made from succulent green food, when too great a weight is placed on the top, is rich in albuminous and soluble non-nitrogenous food-constituents, and therefore ought not to be allowed to run to waste."

VI.—The presence of alcohol in silage.

Dr. Voelcker did not detect even traces of alcohol in any of the samples of silage he analysed; but he accounts for this by the circumstance that they were all, when received by him, in a comparatively advanced stage of preparation, in which most were strongly acid: and he believes that all the samples in which he found from ½ to 1 per cent. of acetic acid (that is, samples of sour silage, for sweet silage is nearly free from acid) had passed through alcoholic fermentation. When sweet vegetable juices enter into alcoholic fermentation, their sugar is converted more or less completely into alcohol and a number of by-products; the alcohol in its turn yields aldehyde by the abstraction of a definite proportion of its hydrogen; and, by the oxidation of the aldehyde, acetic acid is then formed. At a certain stage of the process of ensilage, the silage often smells strongly of aldehyde.

(Signed) DUNCAN J. MACPHERSON.

Dehri,
1st April 1885.

Abstract of a paper to Clifford Richardson, Assistant Chemist, U. S. Department of Agriculture, in the "Journal of the Chemical Society" for January 1885 entitled Notes on the Chemical Alterations in Green Fodder during its Conversion into Ensilage.

Experiments with "grass, mangles, and maize show that in the conditions existing in silos a large portion of the albuminoids are converted into non-albuminoid nitrogenous substances, whilst in the ordinary drying of fodder no such change seems to take place.

"In the samples of silage which the writer examined there was a comparatively large amount of ammonia combined with the acids produced by fermentation, acetic and lactic, which of course is lost in drying the specimens for analyses. In the results, this produces an apparent loss of nitrogen in the ensilage itself: it is at any rate a loss of nitrogen of nutritive value." This loss is relatively compensated for by the large loss of carbo-hydrates, so that in the figures showing the results of analysis neither loss is prominent, and they are at first glance deceptive.

Alcohol, though never absent from any of the samples analysed, was present in such small quantities as to be distinguished only by the iodoform test.

Lactic acid has always been detected, but never in large quantity. Acetic acid is the chief acid in silage.

In examining analytical results, it is to be remembered that a primary cause of differences in the composition of silage is the great variation which is observable in the composition of the green fodder itself. In the case of green maize, this variation is very great; and although it is largely due to the period of growth at which the stalks are cut, yet there are often marked differences in composition in those of the same stage of development, even in the same field.

As to the nature of the fermentation, the writer made some observations. "In but one sample out of many examined has any trace of *saccharomyces* been found. As a rule, the juice expressed from the fresh ensilage is swarming with *baculus subtilis*, together with some species of *bacterium* and *micrococeous*. No signs of the ordinary lactic or viscous ferment have been observed. The fermentation does not appear, therefore, to be of an alcoholic nature, or similar to any with which we are well acquainted. Analysis show the presence of an insufficient amount of alcohol, gum, or free acid for any of the usual forms of fermentation."

Most of the paper is taken up with the actual figures of the several analysis.

DEHRI,
1*st April* 1885.

(Signed) D. J. MACPHERSON,
Bengal Civil Service.

NOTE.

The lesson to be learnt from this paper is not to fill the silo rapidly; if an opinion may be hazarded regarding a subject on which we are so much in the dark, it is suggested that filling a silo to contain 600 maunds should extend over eight days.

It may be mentioned that 84 silos in the Allahabad cantonments, containing between 40,000 and 50,000 maunds, have been entirely successful, and Government cattle are now consuming 500 maunds daily of this silage, never leaving a blade.

From the information given in this paper, and the little experience gained, it would seem that not more than two crops should be siloed. The first between the 15th August and 15th September, the second between the 15th September and end of December.

Some grass cut and siloed in December at Allahabad has turned out excellent fodder.

The best economy seems to be to dig the silo in the middle of every four to six acres.

ALLAHABAD,
10*th April* 1885.

(Signed) H. MACPHERSON, Major-General,
Commanding Allahabad Division.

No. 28.

CIRCULAR MEMORANDUM
Addressed to General Officer Commanding Divisions and Districts.

Forwarded for information and guidance of Officer Commanding Cantonments in connection with the management of grass operations.

(By Order.)

(Signed) C. M. MACGREGOR, Major-General,
Quartermaster-General in India.

Sir Herbert Macpherson's Silo in the Allahabad Fort.

A subterranean chamber, which, 300 years ago in the time of the renowned Akbar, probably served for the imprisonment of State prisoners, was selected for the purpose, in August last. Sunk in solid masonry foundations, it was only necessary to build up two or three openings, which in more recent times had been made for purposes of light and access, to convert it into a most useful silo, at once thoroughly water and air-tight. Every facility for accomplishing this was afforded by Major Swinton, Commanding at the Fort, and the cost came to Rs. 32.

The grass, selected for the experiment, grew handy inside the fort, on the slope of the ramparts, and throughout the main ditch. It was the first crop grown entirely by the monsoon rain, and in particular that from the ditch was of such forced growth that it might almost be described as rank grass. Two varieties predominate, "janewar" (*andropogen bladii*) and "unjun" (*pennisitum cenchroides*). Of dhoob (*cynoden dacty lon*), very little is to be found within the fort, and what there is has evidently been introduced, the constant tendency being for the varieties "janewar" and "unjun" to overgrow and extinguish it. Both "janewar" and "unjun" are first-rate fodder grasses, the latter being reputed "one of the best of all the wild grasses for forage, both for cows and horses." (Steuart). The grass was cut during the 19th, 20th, and 21st of August, and cast into the silo daily as cut through an aperture knocked in the upper part of the outer wall near the roof of the chamber. Cutting took place with the *hussia* and *dharanti*, and not with either the *khurpa* or *jhabhao*. The labor was paid for by the day, as the operation being experimental, it was thought desirable not to prolong the filling in beyond a few days. This made the cutting more expensive than would have been the case had the quantity cut been paid for by weight, at the usual rate of 3 pice per maund. A few coolies were inside the silo to spread the grass evenly as it was thrown in, but beyond this there was no compressing of the grass at the time of filling in. Considerable stress is laid by Professor Thorold Rogers and other writers on ensilage, on the necessity of chaffing the fodder to be stored, and of adding salt to it, and this is probably the first experiment tried in India, where grass has been ensilaged without these precautions. Much of the grass was two and three feet long, and of strong luxuriant growth, and that taken from the fort ditch was moist and even dripping wet when put into the silo. Other grass again taken from the raised interior of the fort was of a light, fine description, and semi-dried by a hot sun, ere it could be cast into the pit. When filled, the silo measured 17½ feet long, 14½ feet wide, and 11 feet deep. On the top of the grass two or three maunds of bhoosa (white) was spread, giving a dressing of about an inch in depth, and over the bhoosa 75 old wooden sleepers were laid horizontally, as close as they could be, but owing to the irregularity of many of the sleepers, numerous interstices occurred between them. Care was taken not to lay them too close to the sites of the silo, so that they could not bind against the walls as the contents settled. Upon the sleepers were placed 28 tons of round shot (cannon ball). Including the weight of the sleepers, the average weight was 280 lb. to the superficial foot. Opinions vary greatly as to what amount of weight should be used, but it may probably be accepted that for unchaffed strong Indian grasses, it should not be below 200 lb. to the square foot, and may advantageously be as much as 300 lb. The object of the weight is to compress the forage, to expel the air, and prevent its further access, and it is therefore manifest that in the case of unchaffed or unshredded fodder a great weight will best obtain these results.

The silo was left for a period of 23 weeks, or nearly six months. It was opened on the 29th of January of this year, in the presence of Colonel Badcock, C.B., Deputy Commissary-General. An attempt to open it at the top, by removing some of the sleepers, proved unsuccessful: the grass had solidified so compactly that it was found impossible to extract it, and even an iron pointed crowbar could not be driven into it. This corresponds with experiments made in America, of which it is recorded the fodder had to be dragged out by hooks harnessed to horses. One of the bilt-up openings in the wall was therefore broken down, and the ensilage cut into with an American hay knife. The whole of the sleepers and shots were subsequently removed, when no further difficulty was experienced in issuing out the ensilage, which came away in sheets. The uppermost layers were of a darker hue and drier than what was found below. The color of the grass would be correctly described as a rusty brown, although portions of it were of a yellowish green shade. This latter color was met with in the interior of the silo, where also the grass was much the most moist, so much so that it would be correctly described as reeking with its own juices.

The grass had a strong, acid and vinous smell, which it retained for fully 48 hours after removal from the silo. It was distinctly noticeable passing carts carrying the ensilage to the cattle lines, and anywhere within 50 yards of the opened silo; it more resembled the smell of an empty beer hogshead than anything else. Considerable fermentation had evidently taken place, and a thermometer thrust down into the grass itself registered 110° Fahr. When opening the silo the precaution was taken of letting down a lighted candle to the surface before any one was permitted to descend, but no effect on the light was visible, and no inconvenience whatever was experienced either by Europeans or natives who remained for hours in the pit.

The following explanation, why fodder ensilaged keeps and why it becomes acid, is offered by Mr. Barras, Secretary to the Central Agricultural Society of France. He writes:—"Fermentation, decay, rot, and fire, are all identical. The only difference is in the degree of speed with which the combustion goes on. They, all alike, depend on the presence of oxygen, and cease when this active agent is removed. The process of combustion, whether slow or rapid, consumes oxygen and gives out carbonic acid gas. The fermentation consumes the small amount of oxygen which is contained in the mass of ensilage, and liberates an amount of carbonic acid gas which takes the place of the oxygen. The fermentation in its incipient stage is arrested for want of oxygen; none can get at it from the top, for the compression which is constantly going on is all the time forcing the gases out, and when there is ever so slight a flow out none can possibly flow in. Then as carbonic acid gas is heavier than the atmosphere, the sides and bottom of the silo being tight, and as the carbonic acid cannot leak out, the air cannot get down into the space occupied by the carbonic acid any more than air can get into a jug filled with water, or any other heavy liquid, until the water or other liquid is poured or leaks out. The ensilage is thus immersed in a bath of carbonic acid gas. Further fermentation under such circumstances is an impossibility."

The silo, when originally filled in, measured 11 feet in depth, so that in six months it had sunk nearly half. In American experiments chaffed fodder subsided usually one-fourth; but where coarse rank grasses are cast in as they come, and no attempt made to lay them out regularly and evenly, or to tread them down with men or bullocks (which, however, might easily be done), no doubt the subsidence will always be found to be nearer one half than one-fourth.

The first issue of the ensilage to the Government siege train bullocks at Allahabad was made on the 30th January, and continued for a week. In all 361½ maunds were issued, at the rate of 20 lb. per bullock per diem. These bullocks are bred on the Government Farm at Hissar, and such a thing as "ensilage" has never been placed before them. They ate it readily. The most of it was put through the chaff-cutter, and given as a feed morning and evening with the ration of gram, but the bullocks as readily devoured it when given in the state in which it came out of the silo. Mules took to it less readily, whilst horses required a considerable degree of coaxing to be got to eat it at all. Milk cows and calves went at it greedily the instant it was thrown down before them: goats would not look at it. Through the cordial co-operation of Major Elliott, the Deputy Assistant Commissary-General of Transport, the experiments in feeding were fully and satisfactorily carried out, and it has now been practically demonstrated that common grasses ensilaged form an agreeable and valuable change of diet to the Government cattle during the months when only dry fodder is procurable, which at Allahabad is for a period of about eight months in the year.

The total outturn of the silo was about 365 maunds, which gives a little over 18 lb. to the cubic foot, an average far below the 45 to 50 lb. to the cubic foot, which, it is reported, was the density of silos in America, in which however the fodder had been finely chaffed as well as trodden in. This would perhaps account for the disparity.

This experiment is of great value, because by it is demonstrated, for the first time in India, the entire feasibility of preserving the rank vegetation, which arises over all lands with the first burst of the monsoon, for future use many months afterwards, when the rains are over, and a tropical sun has once more burnt up the land. In order to compare the methods of preserving grass during the monsoon season by ensilage and by converting it into hay, at the same time as the silo was filled a large quantity of the same grass was cut in the fort for hay. Great difficulties were experienced in getting it sufficiently dried for stacking. A large quantity was destroyed by rain, and of that stacked (about 430 maunds) from ¾ths to ⅘ths of the weight of the green grass had evaporated in the process. At this season the grasses contain an enormous percentage of water which is not lost by the process of ensilage, but which, of course in the process of conversion into hay, wholly disappears. This stack of hay was cut into and issued during December; much of it was black and mouldy; and the whole of it was very inferior quality hay, and was scarcely eatable until mixed with sweet new hay, made of grasses fully matured, and reaped in the months of October and November. The experiment of making hay during the monsoon was also tried at Allahabad in 1882, and was not successful viewed as to expense and quality. Probably, throughout the North-West, two crops of grass can be got off most lands watered only by the monsoon rains, provided the first crop can be preserved, and this the system of ensilage secures. By simply casting into a silo, thousands of maunds of succulents grasses may be annually secured throughout these provinces as provision for the times of terrible fodder scarcity, which overtake the village cattle with each recurring hot weather. Before the result of the experiment became known, every native with whom I spoke on the subject was confident that the rank immatured jungle grasses sprung up by the first rains would never keep good for six months. Unquestionably great difficulty and expense and loss of weight is experienced in making hay of such, but in casting it in and pressing it in a silo everything is simple and inexpensive, and the result highly gratifying.

The need for securing grass, when it is abundant, may be estimated by the fact that at the present time, at Allahabad, a half-maund bundle of chiefly roots of grasses grubbed up with the "khurpa," in the "kachar" land of the Ganges, or from neighbouring "jheels" (and therefore unwholesome and likely to cause colic, anthrax, &c.) fetches four annas, whilst good hay commands Re. 1 a maund. Allowing fairly for all expenses, any quantity of green grass could be "ensilaged" at Allahabad during the monsoon season at a cost of from 2 to 3 annas a maund. The nutritive value of ensilage lying midway between that of green grass and hay, its present market-rate would be 12 annas a maund.

In a future paper we hope to give an account of a silo that has been constructed in an open field, merely by digging a pit, and which, at the time of writing, has been shut up for upwards of half a year.

ALLAHABAD,
18*th February* 1884.

(Signed) G. WINGATE, Captain,
On Special Duty.

Memorandum by His Excellency the Commander-in-Chief of the Madras Army.

Silo is the Spanish for a pit. The Royal Agricultural Society have ruled that the contents be called "Silage."

Where the fodder is fairly luxuriant, a silo should be dug in every 5 or 6 acres of the following dimensions:—

30′ × 12′ × 6′ = 2,160 cubic feet to contain about 5,000 maunds = 40,000 lb.

2. The silo once dug is good for all time, the earth excavated gives the pressure that is wanted. A cubic foot of earth weighs 60 pounds, so that allowing an average of 4 cubic feet over the pit, there will be a pressure of 240 lb. on each square foot.

3. At Allahabad where eighty-four silos were filled in 1884, it was not found necessary to line the pits with mortar or to dry them artificially, nor is it necessary to slope the sides.

4. When the rainfall is from 35 to 40 inches and there is a reasonable hope of one quarter of that quantity in September and October, the fodder, *i.e.*, grass should be cut in August. If this is done as a rule, there will be an increased crop in October; the koorpa* is a more useful implement than the sickle or hook. The koorpa acts as a cultivator by loosening the earth about the roots of the grass.

* Hand hoe, in tamil "Pulvettie."

5. Experience has not yet determined whether the silos should be filled and covered over at once, or whether the operation should be prolonged for, say, five or six days. The smell of silage that was packed rapidly, when wet, was very disagreeable, but cattle do not seem to mind the smell and devour the stuff greedily.

6. It is believed that many people have given up silage as bad, merely because the smell was very unpleasant.

7. At Allahabad when failure was almost courted, thirteen hundred ponies and some two thousand Government bullocks were fed for some four months on silage and never left a blade.

8. A good book on silage is published by the Field Newspaper compiled by the Sub-Editor Mr. Cox—price, 4 shillings.

9. The silage consumed at Allahabad represented a clear profit to the State of Rs. 17,000.

10. The Americans, who have gone beyond the stage of experiment, are convinced that five head of cattle can be kept with the assistance of silage where it was difficult to maintain one head on the old system of grazing and storing of hay.

11. If the consumption is not sufficient to empty one silo at once, the silage can be cut daily as is done with a hay-stack in England.

12. In upwards of 500 reports, in the United Kingdom, almost unanimous testimony is afforded as to the favorable effects of silage upon the health of stock, while in many instances unstinted praise of its value is recorded.

13. I shall be glad to answer any number of questions on this very important and interesting subject.

OOTACAMUND,
30*th June* 1886.

(Signed) H. MACPHERSON.

ORDER—dated 9th July 1886, No. 573, Revenue.

Miscellaneous

His Excellency the Governor in Council having had under consideration the very important question of the means of providing, in an economical manner, during the hot season, fodder for the cattle and sheep of the agricultural population, deems it desirable that careful experiment should be made, by selected officers, in view to determining whether this end cannot be successfully attained by means of ensilage; the merits and cheapness of which have now been definitely shown by extensive trial and inquiry in both Europe and America and, to a minor degree, in Northern India. He, therefore, resolves to publish the papers read above and to direct that the officers marginally noted be supplied with copies of them, and that the Director of Revenue Settlement and Agriculture, who will debit the charges so incurred to the head of "Improvement of Trade and Agriculture," shall place at the disposal of each the sum of Rs. 50.

W. H. Glenny.	W. J. Tate.
Hon. H. St. A. Goodrich.	T. M. Horsfall.
G. McWatters.	J. W. F. Dumergue.
L. R. Burrows.	J. Andrew.
E. C. Johnson.	H. G. Turner.
H. R. Farmer.	A. W. B. Higgens.
M. R. Weld.	H. W. Foster.
F. A. Nicholson.	J. W. Johnstone.

2. Each officer entrusted with silage experiments, will, in carrying them out, be careful to attend to the instructions given in the "Memorandum on silos and Silage," and he will keep a record in the forms A and B, which should be transmitted to the Director of Revenue Settlement and Agriculture, to whom the general supervision of the experiments made will be entrusted, and who will, at their conclusion, collate and submit to Government the results obtained, with such remarks as may appear to him necessary.

3. A portion of the grants made can, where ryots will not lend their cattle and sheep for experiment, be devoted to the purchase, or hire, of animals upon which to make trial of the merits of feeding upon silage. Where weights, at different periods of feeding, can be definitely ascertained, they should be carefully recorded in form B, but where this cannot be done, it will be easy for the officers conducting the experiments to note whether the animals increase in condition or not, and whether the quantity and quality of the milk of cows improves. It is desirable that trial should be made with ponies as well as cattle and sheep.

4. His Excellency the Governor in Council desires that the utmost publicity should be given to the experiments made; that the people, generally, should be afforded every opportunity of watching operations, in every stage; and that any who may wish to try silos themselves, should be given help and advice.

5. In addition to the experiments now ordered, His Excellency in Council considers that it would be of benefit if the Forest Department constructed a few silos in the reserves to which the people resort, or are likely to resort, for grass, and that, where any disposition to take the silage for use is shown, it should be given gratis until the ryots have learned to appreciate its value. In no case should silage be sold by any officer conducting experiments, without the previous sanction of Government.

Form A.

Silos dug out in

Date when covered.	Time taken in filling.	Dimensions.	Weather when filling.	Contents.	Kind of pressure.	Date when opened.	Remarks.

Form B.

Statement showing the results of feeding with ensilage.

District.	Officer conducting experiment.	Description of Animals.			Period during which fed.		Quantity in lb. per diem given to each animal.	Whether with other food or not. If with other food, nature and quantity to be stated.	Results and remarks.
		Cattle.	Horses or Ponies.	Sheep or Goats.	From.	To.			

Note.—Where possible, the weight of animals at the time of commencing the experiment and at its conclusion should be noted in the remark column.

(True Extract.)

H. A. Cleare

for Ag. Secretary to Government.

To the Board of Revenue.
" the Director of Revenue Settlement and Agriculture.
" the Public Department.
" the Educational Department.
" the Military Department.
" the Public Works Department.
" the Government Botanist.
" the Accountant-General.
" the Editors' Table.

Exd. W. J. Lewis.

200 Copies.

24 le

C.W.C. No 6003.

1996 W of 10th August 1886

Govt. of {1886} Madras.

REVENUE.

Commd: to
Supty: Engrs:
for information.

24 5/c

Issued

Recd. 3-8-86 Encl.

G.O., 9th July 1886, No. 573.

1996 W of 10th August 1886

JULY.

Ensilage.

Orders passed on papers regarding experiments to be made with —.