

worked out an infallible device for killing rats by wholesale, but the methods for their destruction given in the bulletin are those which careful experimenters have shown to be the best, and the formulas for poisoning and trapping are the most approved ones. Particular emphasis is placed on the rat-proof construction of

side, while a current of cold water moves in the opposite direction inside of the thin wall. The cylindrical cooler, shown in Fig. 1, has a spirally corrugated surface of tinned copper and the water flows between this and an inner smooth cylinder of sheet iron.

As the milk leaves the cooler it is caught in vessels

laid in a row on a draining table and covered with a board on which large iron weights are placed in order to press out the whey (Fig. 3). This draining process usually occupies fifteen hours. The cloths, or bags, are then laid on a table and opened and the curd is removed with small wooden scrapers.

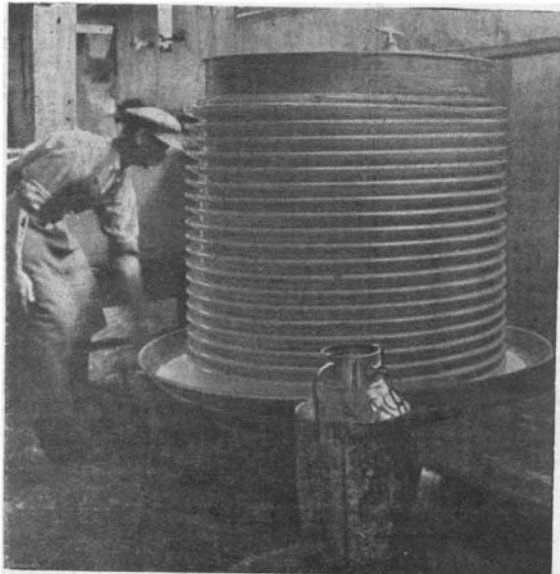


FIG. 1.—CYLINDRICAL COOLER.

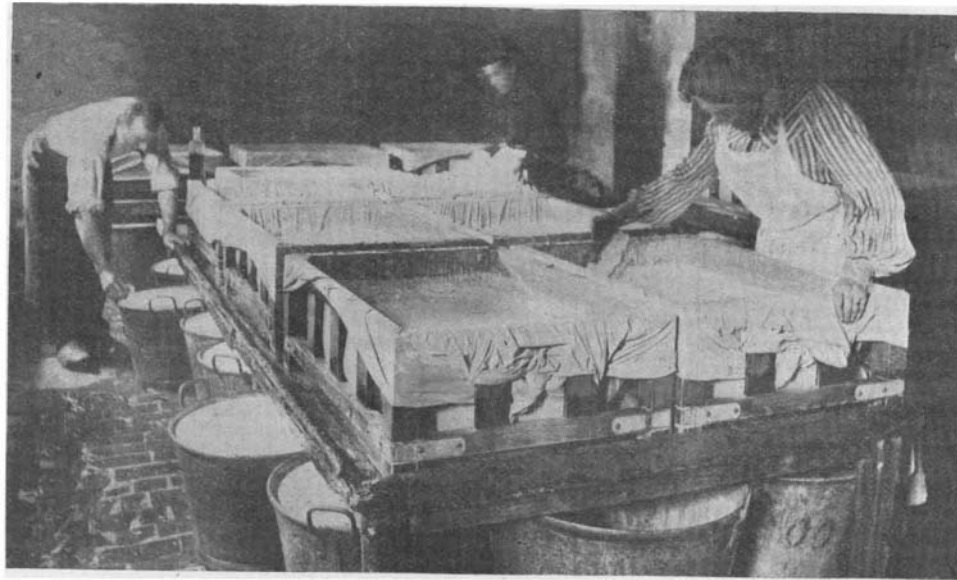


FIG. 2.—COAGULATION OF THE MILK.

buildings and on organized co-operative efforts to destroy the animals.

HOW SOFT FRENCH CHEESES ARE MADE.*

By JACQUES BOYER.

PROBABLY as much cheese is made in France as in any other country, and French cheese makers have succeeded in producing many varieties of this article of diet, as a result of competition and the endeavor to meet the varying tastes of their fastidious customers,

which are emptied into a great mixing vat in order to secure uniformity of the raw material.

If the so-called "Swiss" or double cream cheese is to be made, cream is added to the milk in proportions varying from one-sixth to one-third of the total volume. The milk and cream having been thoroughly mixed in a tinned iron vessel the curd is formed at a temperature of 59 or 61 deg. F., by the addition of rennet, a substance obtained from the fourth stomach of young calves (Fig. 2). For double cream cheese the rennet is diluted with water and the formation of the curd

To give the paste the desired consistence, it is next kneaded, either with the hands, or (with the addition of a little cream) in machines with smooth rollers, one of which is shown in operation in Fig. 4. The kneaded mass is collected in vessels lined with cloth and paraffined paper, allowed to dry for a time and then molded into the desired form. The mold (Fig. 5) is composed of a number of small cylinders of tin, open at both ends, and soldered to a tin plate. The mold being set in a perforated board, the molder lines the cylinders with strips of paper, presses the mass into their open mouths and then lifts the mold, leaving the little cheeses, wrapped in paper, on the board. After they have been drained sufficiently they are packed and shipped. "Swiss" cheeses made in this particular manner are called "Gervais" cheeses from the name of the manufacturer who first made them at Ferrières-Gournay in the department of the lower Seine.

"Bondons," "Malakoffs," and "Petits-Carrés" (little squares) are other varieties of "Swiss" cheese, produced by a similar process, but of harder texture due to the greater pressure to which the curd is subjected.

But these double cream cheeses, which are sold chiefly in summer and contain a large proportion of fatty matter, soon become rancid. They may be preserved by applying two per cent of salt, with the hand or salt shaker. There are also "half salt" cheeses (Fig. 10), which keep and ship well. Whatever the quantity, the salt should be perfectly dry in order that it may be distributed as uniformly as possible.

A great deal of attention is now given in French commercial dairies to the manufacture of "ripened" cheeses with superficial molds. The most popular sort is "Brie," which has long been in high favor with all classes of consumers.



FIG. 4.—KNEADING THE MASS WITH A ROLLER-KNEADING MACHINE.

who hold, with Brillat-Savarin, that "a dinner without cheese is like a beautiful woman with only one eye." In this article we shall confine our attention to the principal soft cheeses which are marketed either in the fresh state or after undergoing the process of fermentation which is known as "ripening."

In order to obtain so many sorts of cheese from the same raw material—whole or partly skimmed milk—it is necessary to subject the milk to various treatments, differing in the temperature at which the curd is formed and the methods of shaping and ripening. Suppose, then, that we visit an up-to-date cheese factory and see what is done there.

Usually the factory collects milk from the surrounding country, either sending for it to the farms two or three times a day or receiving it from the dairymen, who bring it to the factory in tin cans containing about twenty quarts each. In summer, the milk is cooled immediately after its arrival at the factory, as the microbes which spoil milk do not thrive at low temperatures. The simplest method of cooling consists in setting the cans in a tank of cold water, but special refrigerating devices are employed in large factories. These coolers, which are of various forms, are so arranged that the milk flows downward over the out-

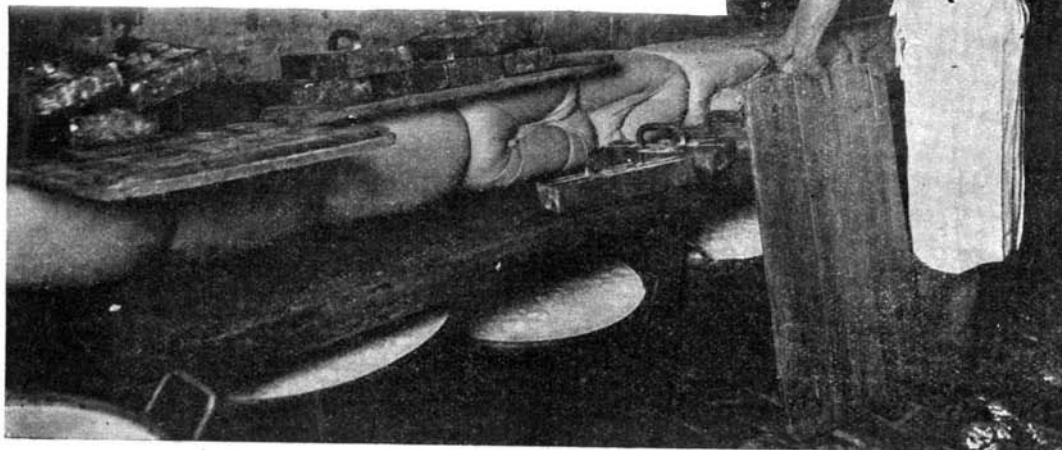


FIG. 3.—REMOVING THE WHEY FROM THE CURD BY PRESSURE.

HOW SOFT FRENCH CHEESES ARE MADE.

occupies about twenty hours. In consequence of the slowness of coagulation the curd is very rich and creamy. Very little rennet is required—about one part to 10,000 parts of milk.

When the coagulation is complete men lift the curd with large tin ladles and lay it on cloths, which are then folded so that they resemble oddly shaped pillows,

As long ago as 1407, Charles d'Orleans used to present his friends with Brie cheeses, and at the end of the sixteenth century, according to the chroniclers, Henri IV. relieved the tedium of the siege of Paris with this "royal cheese," of which he was especially fond.

The manufacture of Brie cheese comprises six oper-

*From *American Homes and Gardens*. Published by Munn & Co.

ations: renneting, shaking, draining, salting, drying, and ripening.

As curd is made only once a day it is usually necessary to heat the milk in wooden or copper vats, with steam pipes, to a temperature of from 91 to 106 deg. F. The milk is then siphoned into tinned iron troughs

zinc, perforated to permit the escape of the remaining whey. One of these is placed around each mold and its ends are fastened together by means of a button on one end and one of a number of slits in the other. When the mold is lifted the cheese remains securely clasped by the zinc band. On this a dry mat is now

moule," 12 inches and 4 pounds, and the "petit moule," or Coulonnier, the diameter of which varies from 5 to 10 inches according to locality.

To the same class of products belongs the cheese first made at Camembert, in the department of the Orne, which differs from Brie only in being smaller.



FIG. 5.—COMPOUND MOLDS USED IN MAKING "SWISS" CHEESE.

for curdling; sometimes the farmers add 10 per cent of skimmed milk from the preceding milking. This addition facilitates draining and consequently increases the hardness of the curd, and it also favors the growth of the superficial mold. Three teaspoonfuls of rennet suffice to coagulate five hundred quarts of milk in two hours.



FIG. 7.—A BRIE RIPENING CELLAR. THE WORKMAN IS SHOWN TURNING A LARGE CHEESE AND TRANSFERRING IT TO A FRESH MAT.

The making of the curd is a delicate operation and one which greatly influences the quality of the finished product. If the coagulation is too slow the cream rises to the surface, and if it is too rapid the result is a dry cheese.

The morning's milk, which was frothing in the pails a few hours ago, is now transformed into a white gelatinous mass of curd, mixed with whey. The next operation, technically called "dressage," is the shaping of the cheeses in tinned iron molds (Fig. 6). With a

laid and covered with a plank. The cheese, with its band and both planks and mats, is then inverted and the wet mat and plank, which are now on top, are removed. Ten hours later the cheese is turned again in the same manner and is salted by removing the band and sprinkling salt over the top and side. Ten or twelve hours after the first salting the cheese is turned once more and when the whey has ceased to exude the band is finally removed and the second face is salted. The cheeses are then laid on shelves, on dry straw mats, and are turned night and morning for two days, after which they go to the drying room, a large and well-ventilated cellar kept at the temperature of 53.6 deg. F., and furnished with wooden shelves on which the cheeses are laid.

Here the ripening process commences. In a short time a downy white mold, *Penicillium candidum*, appears on the surface of the cheese. This fungus destroys the lactic acid and prepares the way for other organisms which complete the ripening process in the ripening cellars to which the cheeses are transferred two weeks later (Fig. 7). Here the cheeses soften under the influence of *Bacillus firmatatis*, which has been studied by M. G. Roger. The colonies of this highly-colored bacillus appear first as yellow, later as red spots, and its secretions check the development of the white *Penicillium*, which ceases to grow while the red colonies become diffused through the entire substance of the cheese, which they convert into an elastic paste of deep cream color. Finally, a third marauder, the *Micrococcus mieldensis*, discovered by M. G. Roger, comes upon the scene and stops the work of the *Bacillus firmatatis*, which, but for this intervention, would soften the creamy cheese too greatly and would ultimately cause "running," that nightmare of cheese makers. The work of these infinitesimal organisms, therefore, is divided into three stages. The first germ destroys the lactic acid; the second, more vigorous, drives out the first; and the third, in consequence of its production of diastases, plays the part of moderator and preserves the cohesion of the mass. But these industrious micro-organisms have an enemy, the *Penicillium glaucum*, or common green mold, which sometimes disturbs their mysterious operations (Fig. 8). The green or black spores of this fungus give the crust of the cheese a tint which lowers its market value. Brie which is affected with this malady, which the manufacturers call "the blues," also acquires a bitter taste. To resist the invasion of this dangerous cryptogam it is necessary to disinfect thoroughly the ripening cellar and all the utensils employed. Tubs, molds, zinc bands, and skimmers are washed with boiling soda

The curd is made and shaped and the cheese salted and ripened almost exactly as described above (Fig. 9).

Finally, mention should be made of washed cheeses, which differ from the foregoing varieties by being ripened without the aid of fungous growth. The principal types are Géromé, Pont l'Evêque, and Livàrot.

In the manufacture of Géromé the milk is curdled at a temperature of from 81 to 90 deg. F., so that coagulation is completed in two hours. The curd is then cut into pieces measuring three-quarters of an inch every way and allowed to stand for half an hour, after

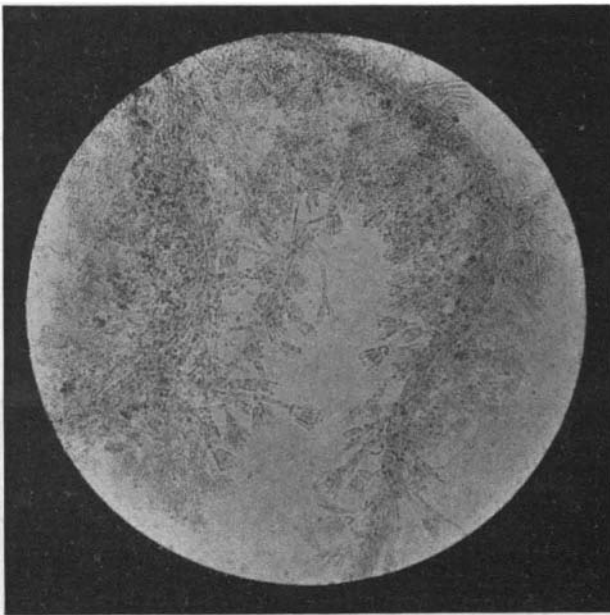


FIG. 8.—PENICILLIUM GLAUCUM, ENLARGED ONE HUNDRED AND EIGHTY TIMES. THIS FUNGUS CAUSES "BLUES" IN BRIE CHEESE.

which the whey is removed by means of a colander with small holes. The curd is then put into tinned iron molds which rest on wooden gratings supported by planks. When the curd has settled well down in the mold five or six hours after filling, the mold is inverted on a dry mat. In the evening this operation is repeated and on the following day the cheeses are transferred to forms of less height. At night they are turned again and on the third day salt is applied to the rim and one face, and, twelve hours afterward, to



FIG. 9.—SALTING CAMEMBERT.



FIG. 10.—SHAPING "HALF SALT" CHEESE BY HAND.

HOW SOFT FRENCH CHEESES ARE MADE.

skimmer the workman cuts horizontal slices, thin and uniform, from the curd and deposits them unbroken in the molds. The latter are placed on rush mats which rest on wooden planks.

Twelve hours later the cheeses, now considerably diminished in thickness, are transferred from the molds to "éclisses." These are wide bands of sheet

lye; the cellars and drying rooms are whitewashed and fumigated with sulphur.

The principal wholesale market for Brie cheeses is at Meaux (Seine et Marne), where sales take place weekly, on Saturdays. Brie cheeses are of various sizes; the "grand moule" (Fig. 7), averaging 16 inches in diameter and weighing 6½ pounds; the "moyen

the other face. The Géromé cheeses are then sent to the drying room, where they remain two or three days, after which they are turned once more and taken to a cellar kept at a temperature of 54 or 55 deg. F. Here they are turned and wiped with a cloth wet with warm brine every other day. They gradually acquire a reddish tinge and at the end of two months the

ripening is complete. According to M. Charles Martin's excellent work on the dairy (1904) the size of G rom  cheeses has been reduced in recent years. Originally they weighed from 4 1/2 to 11 pounds each.

The best Pont l' v que cheeses are made in the valley of Ange. Coagulation is effected in twenty minutes at from 85 to 104 deg. F. The whey which covers the curd is then removed and the curd is cut with a wooden knife and placed to drain on reed mats called "glottes." The curd is covered with cloth to keep it warm. It is then put into square molds, which are turned ten times during the first half hour, after which they are placed on fresh and thoroughly dry mats and turned five or six times more in the course of the day. At the end of forty-eight hours, the cheeses are taken from the molds, salted, and placed on gratings covered with straw in the drying room, where they remain four days, and are turned daily. Then they go to the ripening cellars, where they are placed on edge, in contact with each other, in order to prevent the development of fungous growths. They are turned every second day and become ready for market in three weeks.

Liv rot cheese is made from partly-skimmed milk, coagulated in an hour and a half at from 85 to 104 deg. F. The curd is cut with a wooden knife and placed either on cloths or on reed mats, where it is allowed to drain for a quarter of an hour. During this time the curd is broken up with the fingers into particles of the size of a grain of wheat. It is then put into tinned iron molds, six inches in height and diameter, which are turned at intervals until the cheese has become solid. The cheese is then salted and is allowed to drain for five days longer. After a sojourn of a fortnight in the drying room it goes to the cellar, where it is turned three times a week and wiped, each time, with a cloth saturated with brine. Finally, it is wrapped with sedge leaves to keep it in shape. The ripening process occupies from three to five months, according to the size of the cheese. Before being shipped, Liv rot cheeses are colored superficially.

[Continued from SUPPLEMENT No. 1641, page 26295.]
ARTIFICIAL FERTILIZERS: THEIR NATURE AND FUNCTION.—III.*

By A. D. HALL, M.A., Director of the Rothamsted Experimental Station, Lawes Agricultural Trust.

THE NITROGENOUS MANURES.

WE can begin by dividing the nitrogenous manures into two classes, the quick and the slow acting, in the first of which we have practically only nitrate of soda, sulphate of ammonia, cyanamide, and nitrate of lime. Our acquaintance with the latter two is too limited as yet to enable us to do more than predict that they will fall into line with sulphate of ammonia and nitrate of soda respectively. Nitrate of soda has now been in use in this country for something like seventy years, the Chilean deposits having been first discovered about the time of Darwin's voyage around the world in the "Beagle." As niter had long been known to possess great manurial value, the exportation of nitrate of soda to Europe was at once suggested, and in 1830 it appears that a trial shipment was made of 18,700 quintals of about 100 pounds each. By 1838, the date of the first volume of the Journal of the Royal Agricultural Society, it was being tried experimentally by a good many landlords and farmers in this country. The production grew rapidly, and reached its maximum in 1899 when 1,344,550 tons were consumed; since then the output has declined a little owing to combination between the producers. At the present time the United Kingdom takes about one-twelfth of the total production, Belgium an equal share, France and the United States about one-sixth each, and Germany rather more than one-third of the whole. Opinions differ greatly as to the approaching exhaustion of the Chilean deposits; various estimates set their probable life at from twenty to forty years, but doubtless long before exhaustion sets in, the poorer grounds, now being neglected as containing less than the paying amount of nitrate, will be exploited, provided always that the artificial nitrate of lime does not render the whole industry unprofitable.

As to the origin of the nitrate of soda deposits there are two theories, to understand which some description of their mode of occurrence is necessary. The chief deposit lies in the province of Tarapaca, in Chile, on an elevated plain known as the Pampa of Tamarugal, about 3,000 feet above sea level, stretching for a breadth of some thirty or forty miles from the Cordilleras on the eastward to a low range of foothills separating it from the sea. The climate is intensely dry, rain falling only every two or three years, and then only in quantities which rapidly evaporate. The special nitrate-bearing deposit or *caliche* occurs a few feet below the surface, and is associated with earthy matters, gypsum, common salt, and sulphates of sodium and potassium. The generally accepted theory regards the plain as an ancient sea bed elevated by one of the volcanic movements common on that coast, and then desiccated. The nitrate of soda is set down to the oxidation of immense masses of seaweed present in the original sea, the salt of which has provided the necessary sodium base. The chief argument in support is the presence of a small amount of sodium iodate in the crude *caliche*, seaweed being known to contain iodine. But such a theory is as impossible on chemical grounds as it is untenable geologically. It involves in the first place an extravagant amount of seaweed, and our knowledge of the nitrification process is quite

* From the Journal of the Society of Arts.

opposed to the idea that it would take place in a rapidly concentrating medium containing common salt. Nor have we any reason to suppose that salt would supply a base for nitrification, even if its hydrochloric acid could be turned out, the liberated acid would at once suspend the process. And again if the iodates are to be taken as indicating seaweed, why are not bromates also present in the *caliche*, since both bromine and iodine are associated in seaweed?

A much more probable theory is that the deposit represents the desiccated residues of fresh water streams flowing off the Cordilleras, containing nitrates and other salts derived from old rich soils or rocks on the heights. The evaporation of such waters for a long period of progressive desiccation would result in the accumulation of the dissolved salts in the dry region over which the waters formerly spread when the rainfall was greater. The occurrence of iodine cannot be explained until more is known as to the amount of this element present in the water and soils of the Cordilleras.

The only other deposits of nitrate of soda which assume any economic importance are those which occur in Upper Egypt, where certain shale beds of Eocene age, outcropping on both sides of the Nile between Qen  and Assouan, contain enough sodium nitrate to make the clay worth carriage as a manure, known locally as "taffa." Analyses of a series of these shales by Mr. F. Hughes shows an average of 6.7 per cent of nitrate of soda associated with 10.1 per cent of sodium chloride, and 5.4 per cent of sodium sulphate. The material is disseminated throughout the whole bulk of the clay, and as this is not permeable to any extent by water the nitrate can hardly be due to infiltration, but must have been formed *in situ*; a conclusion which is much strengthened by the fact brought out by Mr. Hughes's analysis that small quantities of nitrogenous organic matter, ammonia, and nitrites, are also present in the extract from the clay.

In all probability the nitrates in these shales represent the results of nitrification of a mass of organic matter originally contained in the deposit, but until further data have been accumulated as to the depth to which the nitrates extend, and their replacement or not by unoxidized organic nitrogen compounds at depths beyond the access of atmospheric oxygen, it is impossible to say whether we are dealing with recent or what might be termed fossil nitrification, or again whether there has been any concentration of the salts in the surface layer analyzed.

In any case these Egyptian deposits give a clue to the possible origin of the Chile beds by the washing out of similar strata (and the Cordilleras consist of rocks of recent age) into a rainless area where the salts are accumulated by evaporation.

The two deposits present this common difficulty, that the deposit is nitrate of soda instead of nitrate of lime, the usual result of nitrification in soil; again, both are associated with a preponderance of sulphates over chlorides, a fact which seems to put any marine origin out of the question. We are, however, dealing with typically arid conditions, and in all parts of the world sodium salts are characteristically abundant in the soils and rocks of areas of small rainfall; indeed, sodium carbonate is always found in such cases, and this would form the base for nitrification. At the same time, similar oxidizing processes to those which give rise to nitrates would convert the sulphur of the organic matter to sulphates. But really to settle the problem of the origin of the Chile deposits of nitrate of soda, an examination is required of the salts in the rocks of the Cordilleras, the drainage from which would find its way into the plain of Tamarugal.

As a manure, nitrate of soda is of course treated as a source of nitrogen. It is not sufficiently realized how valuable the soda base may be. This is not because soda is in any way necessary to the nutrition of the plant, but because of the action of any soluble salt upon the insoluble potash compounds in the soil. The potash of the soil is due to the partial weathering of double silicates like feldspar, into clay, which is not to be regarded as pure kaolinite, $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$, but as containing a certain proportion of zeolitic bodies intermediate between feldspar and kaolinite—hydrated double silicates containing potash, soda, magnesia, and lime combined with alumina and silica. Any soluble salt, and particularly a soluble soda salt, will react with these zeolites and exchange bases to an extent depending upon the relative masses of the two bodies, hence nitrate of soda acts on the clay in the soil and brings a little potash into solution. To such an extent does this action take place, that in practice a dressing of nitrate of soda on any but the lightest soils will dispense with the necessity of any specific potash manuring even for potash-loving crops.

This is well illustrated in the Rothamsted experiments (see Table XI.) upon mangels, if we compare

TABLE XI.

Plot.		With Nitrate of Soda.	With Sulphate of Ammonia.	With Rape-cake.
		Tons.	Tons.	Tons.
6	Superphosphate and potash	29.6	28.2	29.4
5	Superphosphate only	28.3	12.0	14.9

the yields on the plots receiving equivalent amounts of nitrogen as nitrate of soda, sulphate of ammonia,

and rape cake, both with and without potash. The table refers to the season of 1900, the twenty-fifth year of that series of experiments, when it might be supposed the potash in the soils of the plots receiving no potash in the manure must have become thoroughly exhausted.

The plots receiving potash all give about the same yield whatever the source of nitrogen, but on plot 5 without potash the yield is only maintained on the nitrate of soda plot; on the other two the plant is neither supplied with potash by the manure, nor is the soil forced to give up its reserves as it is by the nitrate of soda alone, and the yield declines by one-half or more. In twenty-five years, then, the use of nitrate of soda alone has enabled the soil to supply a mangel crop with the large amount of potash it wanted, though the store of potash in the soil apparently soon becomes exhausted when a manure is used which cannot bring it into solution. With other crops the same results are manifest, though not so quickly as in the case of mangels. For example, we may compare the yield of barley (Table XII.) for successive ten year periods, and to eliminate seasonal influences the yield of each plot will be calculated as a percentage of that on the completely manured plot receiving nitrate of soda.

TABLE XII.
BARLEY GRAIN, HOOSFIELD, ROTHAMSTED.

Plot.		10 years, 1852-1861.	10 years, 1862-1871.	10 years, 1872-1881.	10 years, 1882-1891.	10 years, 1892-1901.
4 N	Nitrate, superphosphate and potash	100	100	100	100	100
2 N	Nitrate and superphosphate	98.0	100.2	99.5	105.7	101.4
4 A	Ammonia, superphosphate and potash	92.4	93.7	97.2	100.7	100.8
2 A	Ammonia and superphosphate	91.4	97.8	96.0	90.8	77.8

It will be seen that when the manure contains potash the ammonia salts yield practically the same crops as nitrate of soda. When the nitrogenous manure is nitrate of soda the omission of potash causes no diminution in the yield; but with ammonia salts and no potash the crop after the third decade becomes unable to satisfy its potash requirements from the soil alone and the yield declines. In other words nitrate of soda has dispensed with the necessity of a potash dressing, which is wanted when sulphate of ammonia is the nitrogenous manure.

One of the most characteristic effects of the use of nitrate of soda as a manure, either repeatedly or in any quantity, is its deleterious effect upon the texture of a heavy soil; farmers have repeatedly observed that the land remains very wet and poaches badly if it is at all disturbed before it has dried. Market gardeners in particular, who manure heavily with nitrate of soda, have found this destruction of the tilth a serious drawback to its use. The cause has usually been put down to the hygroscopic character of nitrate of soda; since the salt itself readily attracts moisture from the air and will even liquefy spontaneously, it is considered that it keeps the land moist for the same reason. But the extra amount of moisture that could be held in the soil by a few hundred-weight of nitrate of soda would be wholly imperceptible when distributed through the hundred tons or more which the top inch of soil weighs per acre, even if the application of nitrate of soda persisted near the surface and were not quickly washed down in the soil. Some of the Rothamsted plots in the Barnfield growing mangels, where very large amounts of nitrate of soda have been applied year after year for the last fifty years, show this deterioration of tilth in very marked fashion, the land being intolerably sticky after rain and drying into hard intractable clods, so much so that it is very difficult to secure a plant of roots unless the season is favorable. Determinations, however, of moisture in the surface soil do not show any sensible difference between these plots and those working more kindly, so that we must put aside the idea that there is any direct attraction of water by nitrate of soda remaining in the soil. The explanation appears to be more complex. When a plant is feeding upon a neutral salt like nitrate of soda it takes up rather more of the nitric acid than of the soda, leaving some of the soda in the soil combined with carbonic acid excreted from the root. Water cultures in which plants are grown with nitrate of soda will actually become alkaline to test paper from this cause. Now a very small quantity of a free alkali like carbonate of soda has an altogether disproportionate effect upon clay; the clay is deflocculated, i. e., the little aggregates of very fine particles which cause the clay to crumble down when dry and to allow water to drain through it, are immediately resolved into their finest state of division, and all the characteristic properties of clay are accentuated. Deflocculation is effected mechanically whenever clay is puddled or worked in a wet condition, and all the features of puddled clay, which is both retentive of water and impermeable by it, which shrinks greatly in drying and then holds together with extreme tenacity, are found in these soils when the deflocculation is brought about by a little dissolved alkali. The fact that such deflocculation has taken place may be illustrated by a very simple experiment. Here are two large jars, each containing three liters of distilled water, in which has