FOOD FOR PLANTS

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Fifteenth Edition

CHILEAN NITRATE OF SODA EDUCATIONAL BUREAU
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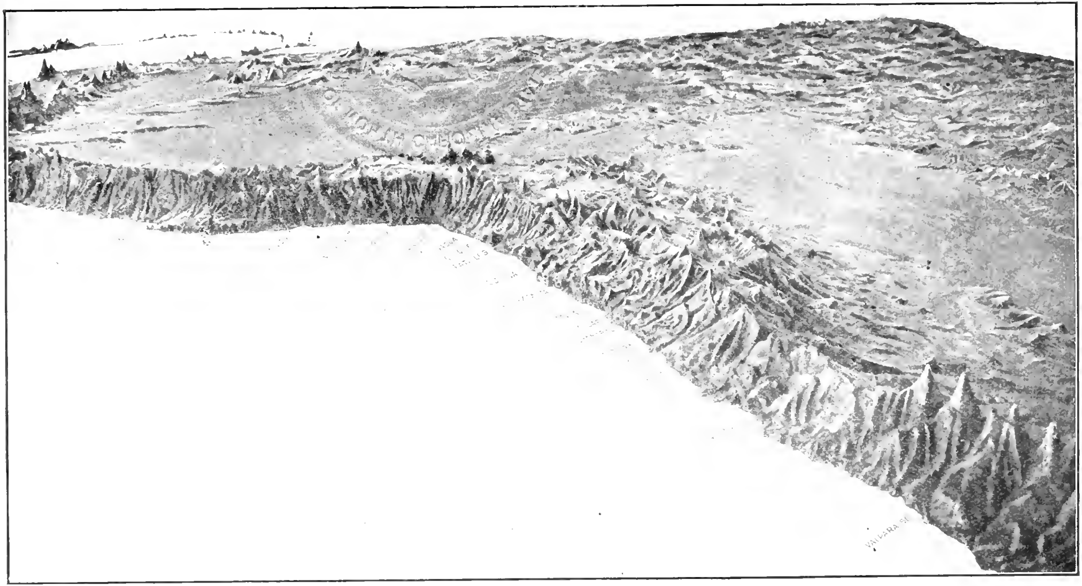


Section of Relief Map of South America.—Chile in right foreground.

PREFACE

This is the fifteenth edition of "Food for Plants." The work has come to have a standard place in American Farm literature. It includes results of experiments on Highlands Experimental Farms, under the personal direction of the late Professor E. B. Voorhees, of the New Jersey Experimental Station.

Crop utilization and relative agricultural efficiency of nitrogen in various commercial materials were outstanding points of his New Jersey work. The record of the first twenty years' work on the availability of nitrogen in Nitrate of Soda is reproduced in this volume. It includes the work of Professor Voorhees up to the time of his death. It is regarded as one of the most important contributions to Soil Science which has been made in this country.

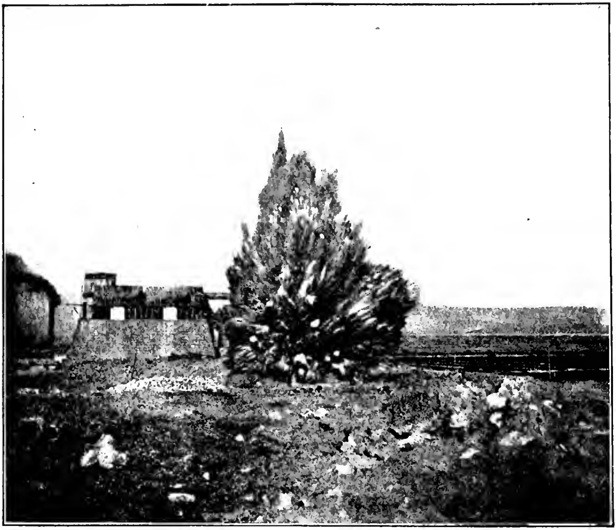
Results of experiments also set forth field work intended as demonstrations in farm practice of what may be accomplished by the rational use of Nitrate of Soda under average farm conditions in a typical hay and dairy section of New York State.

The results were also published in "Grass Growing for Profit" and "Growing Timothy Hay for Market." These practical contributions were based on actual scientific data. Results of studies of methods of crop growing, from the preparation of the land to handling and marketing, also appeared in these bulletins.

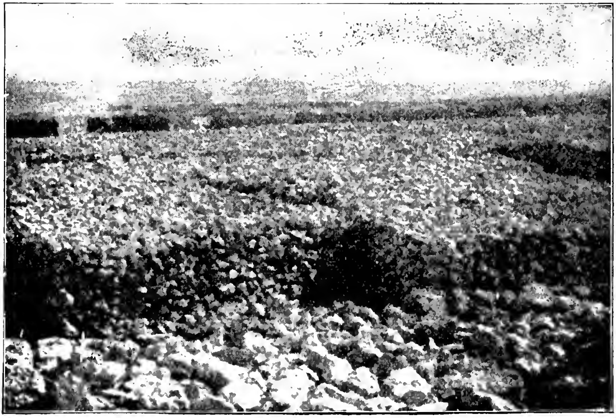
The Corn for Ensilage Experiments recorded are regarded as of first value. The United States Government made studies of the ensilage grown with Nitrate which was regarded as of high feeding quality.

Apple growing, which is at present our most important money crop in the northern states, is treated in an up-to-date manner in a chapter by itself.

The use of Nitrate on Sugar Cane is set forth briefly.



Blasting a Test Hole.



Caliche Ready for Transport to Oficina.

FOOD FOR PLANTS

The Food of Plants consists of a number of elements, including Nitrate, phosphate, lime and potash. Nearly always two of these are lacking in adequate quantities to produce crops, especially is Nitrate wanting in the vast majority of instances. In this case the normal growth and yield of the crop will be limited only by the quantity of ***Nitrate*** it can properly assimilate. There might be an abundant supply of all the other elements, but plants can never use other kinds of food without Nitrate.

Nitrate Nitrogen is the food that is nearly always deficient. The question that presents itself to the farmer, gardener and fruit grower is, How can I supply my plants with Nitrogen, phosphoric acid and potash, in the best forms and at the least expense? We will try to throw some light upon this question in the following pages. We will take first, phosphoric acid.

There are several sources of phosphoric acid, the principal being bones and rock phosphate. Of these, the rock phosphate is the cheapest source. A prevailing impression exists that super-phosphate made from rock phosphate is not as good as that made from bones. It has been shown by many experiments that this idea is entirely without foundation. What the plants want is available phosphoric acid, and it makes little or no difference from what source it is derived.

The largest deposits of rock phosphates exist in South Carolina, Florida and Tennessee. These beds of phosphate are supposed to be composed of the petrified bones and excrements of extinct animals. When this substance is ground and mixed with a sufficient quantity of sulphuric acid, the larger part of the phosphoric acid which it contains becomes available as plant food. This fact was one of the greatest agricultural discoveries of the age.

When the rock phosphate is thus treated with sulphuric acid, it becomes what is commercially known as superphosphate, or acid phosphate. The same is true if ground bone is treated in the same way. Good superphosphate, or acid phosphate, contains about 14 per cent. of soluble phosphoric acid.

The best sources of potash are sulphate of potash and unleached wood ashes, which latter contain from 3 to 5 per cent. of potash in the form of carbonate. They also contain from 1 to 2½ per cent. of phosphoric acid. They are valuable as plant food for the potash as well as for the valuable lime they contain.

Nitrate is the most important and effective element of plant food, and at the same time, as stated, is the one that is generally deficient in the soil.

Crops must have meals, that is, food cooked for them in advance. The sun will help do this cooking, as its heat and light promote nitration which is really a process of cooking and also pre-digestion. When the nitrogenous plant food is cooked and prepared for use it is Nitrate, hence Nitrate of Soda is in a class by itself, different from all other plant foods.

There are a great many ***sources of Nitrogen,*** such as dried fish, cotton-seed meal, dried blood, and tankage. But none of these furnish Nitrogen in the Nitrate form. This can only be furnished to plants in the form of Nitrate of Soda.

Nitrate of Soda contains the Nitrogen that is necessary for the growth of plants, and is the best form in which to furnish it to them. When we say the ***best*** form we mean as well the best ***practical*** form. Nitrate of Soda not only furnishes Nitrogen in its most available form, but it furnishes it cheaper than any other source, because 100 per cent. of it or all is available.

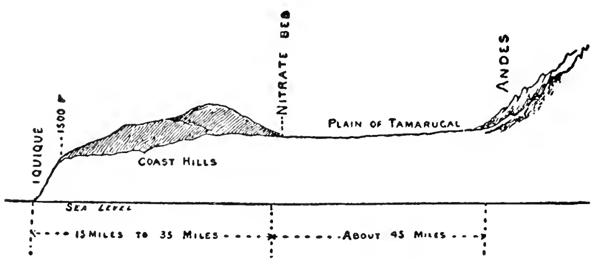
No other form containing so much available plant food is also capable of unlocking the latent potash in the soil.

Nitrate of Soda or Chile Saltpetre.

Nitrate of Soda or Chile Saltpetre occurs in vast deposits in the rainless districts of the west coast of South America, chiefly in Chile, from whence it is imported to this country for use in chemical manufacture and in agriculture. As imported into the United States, Nitrate of Soda usually contains about 15 per cent. of Nitrogen. Nitrate of Soda resembles common salt, with which and sodium sulphate it is often adulterated. This salt is at once available as a direct fertilizer. Whenever practicable, it should be applied as a top-dressing to growing crops, and if possible the dressings should be given in two or three successive rations.

Nitrate of Soda is usually applied at the rate of from 100 to 200 pounds per acre on land previously dressed with farm-yard manure. To secure an even distribution, the Nitrate should be well mixed with from three to five parts of fine loam or sand.

Much has been said and written about Nitrate of Soda exhausting the soil. This is all a mistake and is the outcome of incorrect reasoning. Nitrate of Soda does not exhaust soils. It promotes the development of the leafy parts of plants, and its effects are at once noticeable in the deep, rich green, and vigorous growth of crops. The growth of plants is greatly energized by its use, for the Nitrate in supplying an abundance of nitrogenous food to plants,

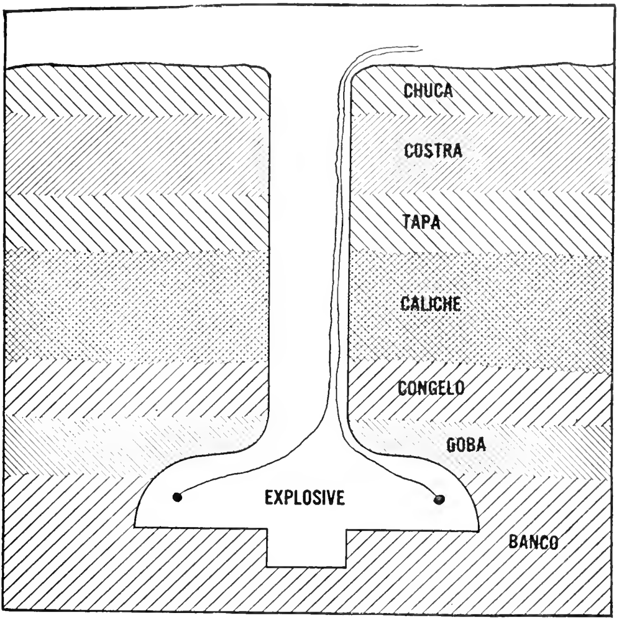


General East and West Section of the Nitrate District of Chile. Vertical Scale Exaggerated.

imparts to them a thrift and vigor which enables their roots to gather in the shortest time the largest amount of other needed foods from a greater surface of surrounding soil. The increased consumption of phosphoric acid and potash is due to the increase in the weight of the crop. The office of the Nitrate is to convert the raw materials of the soil into a crop; for we obtain by its use, as Dr. Griffiths has tersely said, "the fullest crop with the greatest amount of profit, with the least damage to the land."

NITRATE: WHAT IT IS IN AGRICULTURE.

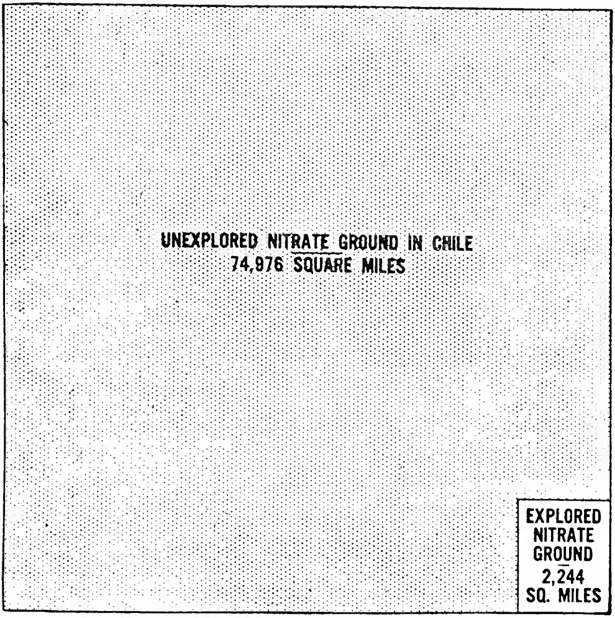
Nitrate of Soda, from the standpoint of the agricultural chemist, is a substance formed by the union of nitric oxide and soda. In appearance it resembles



coarse salt. In agriculture, it is valuable chiefly for its active Nitrogen, although it is also a soil sweetener and is frequently capable of rendering soil potash available.

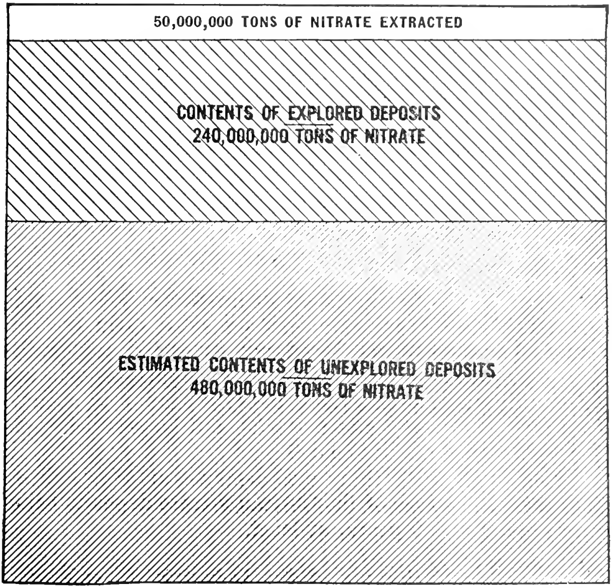
Commercially pure Nitrate contains about 15 per cent. of Nitrogen, equivalent to 18.25 per cent. of ammonia, or 300 pounds of Nitrogen to the ton.

Nitrate of Soda is found in vast quantities in Chile. The beds of Nitrate, or "Caliche," as it is called in Chile before it is refined, are several thousand feet



above the sea, on a desert plain extending for seventy-five miles north and south, and about twenty miles wide, in a rainless region. The surface of the desert is covered with earth or rock, called "costra," which varies from three to ten or more feet in thickness. Under this is found the "Caliche," or crude Nitrate.

The layer of "Caliche" is sometimes eight or ten feet thick, but averages about three feet. This "Caliche" contains on an average from 15 to 50 per cent. of pure Nitrate of Soda.



It is calculated there is ample Nitrate now in sight to last upwards of three hundred years.

The "Caliche" is refined by boiling in water to dissolve the Nitrate. This hot water is then run off and allowed to cool in tanks, when the Nitrate forms in crystals like common salt. The Nitrate is then placed in bags of about 176 pounds (or nearly two bushels) each and shipped to all parts of the world. The process of refining is an expensive one.

How these beds of Nitrate were formed has been the subject of much speculation. The generally accepted theory is, that they were formed by the gradual decomposition and natural manurial fermentation of marine animal and vegetable matter, which contains a considerable amount of Nitrogen.

The same wise Providence that stored up the coal in the mountains of Pennsylvania to furnish fuel for people when their supply of wood had become exhausted, preserved this vast quantity of Nitrate of Soda in the rainless region of Chile, to be used to furnish crops with the necessary Nitrate when the natural supply in the soil had become deficient.

The enormous explosive industry of this country could not be conducted without Nitrate of Soda, and glass works are dependent upon it. In fact, glass works and powder works usually have Nitrate on hand.

Nitrate of Soda has a special bearing on the process of modern agriculture, being the most nutritious form of Nitrogenous or ammoniate plant food. While the action of micro-organisms with certain crops (legumes) combines and makes effective use of the inert Nitrogen of the atmosphere, such action is far too slow and uncertain for all the requirements of modern agriculture, for it is not available for use for a whole year or even longer. The rapid exhaustion of combined Nitrogen has several times been noticed by eminent scientific men, with reference to food famine, because of a lack of the needful Nitrogenous plant food. It has been estimated under the present methods of cropping the rich lands of our western states, that for every pound of Nitrogen actually used to make a wheat crop, four to five pounds are utterly wasted. In other words, our pioneer agriculture has proceeded as though fertility capital could be drawn upon forever.

This injudicious waste is already reducing the yield of many of the best lands, rendering the use of at least a small application per acre of Nitrate both profitable and necessary. The agricultural value of Nitrate of Soda has had the attention of the foremost agricultural and scientific specialists of the world, including such men as Lawes and Gilbert, Sir William Crookes, Dr. Dyer, Dr. Hall and Dr. Voelcker, in England; Professors Grandeau, Cassarini, Migneaux, and Cadoret, in France; Professors Bernardo and Alino, in Spain; Dr. Wagner and Professor Maercker, of Germany; and Drs. Voorhees, J. G. Lipman, Brooks, Duggar, Ross, Patterson, Hilgard and Garcia in America. The results obtained by these officials may be summarized as follows:

1. Nitrate of Soda acts very beneficially and with great certainty upon all straw-growing plants.

2. It is of special value for forcing the rapid development and early maturity of most garden crops.

3. It is of great importance in the production of sugar beets, potatoes, hops, fodder crops, fiber plants, and tobacco.

4. It is exceedingly valuable in developing and maintaining meadow grass and pasture lands.

5. In the early stages of development it produces favorable results upon peas, vetches, lupines, clover, and alfalfa.

6. It has been applied with much advantage to various kinds of berries, bush fruits, vineyards, orchards and nursery stock, and small fruits generally.

7. It provides the means in the hands of the farmer, for energizing his crops so that they may better withstand the ravages of drought, or the onslaughts of plant diseases or insect pests, such as boll weevil, and others.

8. It may be used as a surface application to the soil, from time to time, should the plants indicate a need of it by their lack of color and growth.

9. It is immediately available, and under favorable conditions its effect upon many crops may be noticed within a few days after its application.

10. It may be used either as a special fertilizer, or as a supplemental fertilizer.

11. The best results are obtained from its application when the soil contains ample supplies of available phosphoric acid and potash. It should be remembered that it furnishes the one most expensive and necessary element of plant food, namely, Nitrogen, and of the various commercial forms of Nitrogen, Nitrate is the cheapest.

12. Its uniform action seems to be to energize the capacity of the plant for developing growth. Its action is characterized by imparting to the plant a deep green, healthy appearance, and by also causing it to grow rapidly and to put out numbers of new shoots.

13. The immediate effect of an application of Nitrate of Soda, therefore, is to develop a much larger plant growth and its skillful application must

be relied upon to secure the largest yields of fruits and grain.

14. Under favorable conditions of moisture and cultivation, these effects may be confidently anticipated upon all kinds of soils.

15. All of the plant food contained in Nitrate of Soda is available and existing in a soluble form. The farmer should understand that it is not economical to apply more of it than can be utilized by the crop; one of the most valuable qualities of this fertilizer being that it need not lie dormant in the soil from one season to the next.

16. The best results are secured when it is applied during the early growing period of the plant. If applied too late in the development of the plant, it generally has a tendency to protract its growing period and to delay the ripening of the fruit, as after a liberal application of Nitrate of Soda, the energies of the plant are immediately concentrated upon developing its growth. This is true with a few exceptions.

17. The farmer must not expect it to excuse him from applying proper principles of land drainage, or cultivation of the soil, nor should Nitrate of Soda be used in excessive quantities too close to the plants that are fertilized with it. For most seeded crops, an application of one hundred pounds to the acre is sufficient when it is used alone.

18. It may be applied in a dry state to either agricultural or garden lands by sowing it broadcast, or by means of any fertilizer-distributing machine. It can be applied to the surface, or it may be cultivated into the soil by some light agricultural implement,

such as a harrow, weeder, cultivator or horse hoe. The capillary movement of the soil waters will distribute it in the soil, and osmosis of soil solutions and the capillary attraction of the soil particles when in good tilth will retain it safely until the plant uses it.

Accepting the conclusions of these scientific men, the use of Nitrate of Soda in agriculture ought to increase proportionately to the dissemination of the knowledge of its usefulness among our farmers. An increase in the consumption of Nitrate among growers of tobacco, fiber plants, sugar beets, the hop, grape, grass and small fruits, has been most notable of late. The element of plant food first exhausted in soils is Nitrogen, and in many cases a marked increase in crop is obtained through the use of Nitrate alone. "Complete" fertilizers are generally rather low in Nitrogen, and Nitrate may be wisely used to supplement them, as it is practically the cheapest form of plant food Nitrogen.

By "complete fertilizers," is meant fertilizers containing Nitrogen, phosphoric acid and potash. These fertilizers are often called "phosphates," and people have fallen into the habit of calling any commercial fertilizer a "phosphate," whether it contains phosphate or not. Many so-called "complete fertilizers" are merely acid phosphates with insignificant amounts of other essential plant foods. They are frequently ill-balanced rations for all crops.

The value of these "phosphates," no matter how high sounding their names, consists in their phosphoric acid and potash in many cases.

The Nitrogen contained in these "complete fertilizers" is often in a form that is neither available nor useful to the plants.

Statistics gathered by the Experiment Stations show that in the United States many millions of dollars are spent annually for "complete fertilizers."

Would you not think a man very unwise who should buy somebody's "Complete Prepared Food," at a high price, when he wanted feed for his horses, instead of going into the market and buying corn, oats and hay, at market prices?

The "Complete Prepared Food" would probably be composed of corn, oats and hay mixed together, and the price would be, perhaps, twice as much as the corn, oats and hay would cost separately. It is frequently more economical to buy the different fertilizing materials and mix them at home than to purchase "complete" fertilizers as they are often called. Some do not wish to take pains to get good materials and mix them, and prefer to purchase the "complete" fertilizers. If this be done, special attention should be given to ascertaining in what form the Nitrogen exists. Many of the manufacturers do not tell this, but some of the experiment stations analyze all the fertilizers sold in their respective states and publish the results in bulletins, which are sent free to anyone asking for them. These analyses should show in what form the Nitrogen is. The "complete fertilizers" that contain the most Nitrogen in the form of Nitrate are the ones to use, and the ones which do not contain Nitrate or which do not give information on this vital point should be avoided. If you have on hand a "complete fertilizer" containing a small percentage of Nitrogen, and only in organic form, such as cotton-seed or "tankage," it will be of great advantage to use one hundred pounds per acre of Nitrate of Soda in addition to it. No fertilizer is really complete without Nitrate of Soda.

It is now known that the Nitrogen in organic matter of soil or manure is slowly converted into the available form by a minute organism. This cannot work if the soil is too cold, or too wet, or too dry, or in a sour soil. As a general rule, soils must be kept sweet and the other conditions necessary for the conversion of the Nitrogen into the form are warm weather and a moist soil in good physical condition.

In the early spring the soil is too wet and too cold for the change to take place. We must wait for warm weather. But the gardener does not want to wait. He makes his profits largely on his early crops. Guided only by experience and tradition, he fills his land with manure, and even then he gets only a moderate crop the first year. He puts on seventy-five tons more manure the next year, and gets a better crop. And he may continue putting on manure till the soil is as rich in Nitrogen as the manure itself, and even then he must keep on manuring or he fails to get a good early crop. Why? The Nitrogen of the soil, or of roots of plants, or manure, is retained in the soil in a comparatively inert condition. There is little or no loss. But when it is slowly converted into Nitrate during warm weather, the plants take it up and grow rapidly.

How, then, is the market gardener to get the Nitrate absolutely necessary for the growth of his early plants? He may get it, as before stated, from an excessive and continuous use of stable manure, but even then he fails to get it in sufficient quantity.

One thousand pounds of Nitrate of Soda will furnish more Nitrogen to the plants early in the spring than the gardener can get from 100 tons of well-rotted stable manure. The stable manure may help furnish Nitrate for his later crops, but for his early crops the gardener who fails to use Nitrate of Soda is blind to his own interests.

A given quantity of Nitrate will produce a given amount of plant substance. A ton of wheat, straw and grain together, contain about 1,500 pounds of dry matter, of which 25 pounds is Nitrogen. To produce a ton of wheat and straw together would require, therefore, 170 pounds of Nitrate of Soda, in which quantity there is 25 pounds of Nitrogen.

A ton of cabbage, on the other hand, contains about 4½ pounds of Nitrogen. To produce a ton of cabbage, therefore, would require 30 pounds of Nitrate of Soda.

There are no crops on which it is more profitable to use fertilizers than on vegetables and small fruits, provided they are used rightly. Failures with chemical fertilizers are caused usually by lack of knowledge. There is no doubt but that stable manure is available as a fertilizer, and in some cases may be indispensable, but at the same time the ***quantities*** necessary to produce good results could be greatly reduced by using chemical fertilizers to supply plant ***food*** and only enough manure to give lightness and add humus to the soil.

For crops like cabbage and beets, that it is desirable to force to rapid maturity, the kind of plant food, especially of Nitrogen, is of the greatest importance. Many fertilizers sold for this purpose have all the Nitrogen they contain in insoluble and unavailable form, so that it requires a considerable time for the plants to get it. Another fault is that they do not contain nearly enough Nitrogen. Stable manure contains on the average in one ton 10 pounds Nitrogen, 10 pounds potash, and only 5 pounds phosphoric acid, while the average "complete" fertilizer contains more than ***twice*** as much phosphoric acid as Nitrogen, a most unnatural and unprofitable ration. A ration of 2 Nitrogen, 2 potash, and 8 of phosphoric acid, is frequent in many of the so-called "complete fertilizers," which are really incomplete and unbalanced as well. A fertilizer for quick-growing vegetables should contain as much Nitrogen as phosphoric acid, and at least half this Nitrogen should be in the form of Nitrate of Soda, which is the only immediately available nitrogenous plant food.

Comparative Availability of Nitrogen in Various Forms.

Some interesting and valuable experiments were made at the Connecticut Experiment Station, to ascertain how much of the Nitrogen contained in such materials as dried blood, tankage, dry fish, and cotton-seed meal, is available for plants.

The experiments were made with corn, and it was found that when the same quantity of Nitrogen was applied in the various forms the crop increased over that where no Nitrogen was applied, as shown in the following table:

Increase of Crop from Same Quantity of Nitrogen from Different Sources.

Sources of Nitrogen	Relative Crop Increase
Nitrate of Soda	100
Dried Blood	73
Cotton-seed Meal	72
Dry Fish	70
Tankage	62
Linseed Meal	78

This table shows some interesting facts. It is evident that only about three-fourths as much of the Nitrogen in dried blood or cotton-seed meal as in Nitrate of Soda is available the first season. The Nitrogen in tankage is even less available, only a little over half being used by the crop.

These experiments were made with corn, which grows for a long period when the ground is warm and the conditions most favorable to render the Nitrogen in organic substances available, and yet only part of it could be used by the crop.

When it is considered that Nitrogen in the form of Nitrate of Soda can be bought for as little or less per pound than in almost any other form, the advantage and economy of purchasing and using this form is very apparent.

Nitration as studied by means of the drainage water of 6 plots of land, each 300 square yards in area, during 4 years, shows that the loss of Nitrogen in the drainage water was practically negligible.

Even when Nitrogen was applied in the spring the losses were not large unless heavy rains occurred at the time. The Nitrogen is apparently rapidly taken up by the young growing plants at this season of the year and only a small portion is free to pass into the drainage. The greatest losses occur in the fall, when the soil is bare and heavy rains occur, the Nitrates having accumulated in large quantities during the warmer period of the year. Large losses at this season are, however, prevented by the growing of cover crops.

In applying fertilizers it should be remembered that any form of phosphoric acid, such as acid phosphate, dissolved bone-black or bone meal is only partially soluble, and will not circulate freely in the soil. These fertilizers should, therefore, be evenly distributed over the soil and well mixed with it. This is usually best done by applying broadcast before sowing the seed and before the ground is thoroughly prepared.

Nitrate of Soda, on the other hand, will diffuse itself thoroughly throughout the soil if there is enough moisture to dissolve it. It can, therefore, be applied by scattering on the surface of the ground.

Since Nitrate of Soda and salts of potash are brought to this country by sea, and phosphate is usually transported from the mines in vessels, all these materials, as a rule, can be purchased at the seaports cheaper than in the interior. New York is the largest market for these materials, but Philadelphia, Baltimore, Charleston, Savannah, Mobile, New Orleans, Galveston, San Francisco, Portland and Seattle, are also ports of entry.

Lower prices can be obtained by buying fertilizing materials in carload lots. If you cannot use a carload yourself, get your neighbors to join with you. Much money has often been saved in this way.

In buying, always consider the percentage of availability.

This may be illustrated by comparing gold ores of the same percentages derived from different sources, —one gold ore containing ten ounces to the ton might be worth a great deal of money per ton,—that is to say, if the gold were extractable with ease and without undue expense,—whereas another ten-ounce ore might contain its gold in such form as to be extracted only with great difficulty and at great expense.

HOW TO USE CHEMICAL FERTILIZERS TO ADVANTAGE.

The form of Nitrogen most active as plant food is the nitrated form, namely, Nitrate of Soda. Sir John Lawes wisely remarks: "When we consider that the application of a few pounds of Nitrogen in Nitrate of Soda to a soil which contains several thousand pounds of Nitrogen in its organic form, is capable of increasing the crop from 14 to 40 or even 50 bushels of wheat per acre, I think it must be apparent to all that we have very convincing evidence of the value of Nitrate." The Nitrogen of Nitrate of Soda is immediately available as plant food, and it should, therefore, be applied only when plants are ready to use it. By such a ready supply of available plant food, young plants are able to establish such a vigor of growth that they can much better resist disease, and the attacks of insects and parasites. The famous experiments of Lawes and Gilbert at Rothamsted have demonstrated that cereals utilize more than three times as much of the Nitrogen in Nitrate of Soda as of the Nitrogen contained in farmyard manure; in practice, four and one-half tons of farmyard manure supply only as much available plant food as 100 pounds of Nitrate of Soda.

Catch-crops are recommended to prevent losses of available plant food after crops are removed. Rape

Italian rye grass, rye, thousand-headed kale and clovers are suitable. All these should be top-dressed with from 100 to 200 pounds per acre of Nitrate of Soda, depending upon the exhaustion of the soil. In our remarks on the use of Nitrate, we have taken it for granted that our readers fully understand that in all cases where Nitrate has been recommended in large amounts, potash and phosphates should be used also unless the soil already contains ample supplies of both.

The most important material used to supply Nitrogen in the composition of commercial fertilizers is Nitrate of Soda. Nitrate of Soda is particularly adapted for top-dressing during the growing season, and is the quickest acting of all the nitrogenous fertilizers.

Dried blood, tankage, azotine, fish scrap, castor pomace, and cotton-seed meal represent fertilizers where the Nitrogen is only slowly available, and they must be applied in the fall so as to be decomposed and available for the following season. Nitrogen in the form of Nitrate of Soda is available during the growing and fruiting season, possessing, therefore, a decided advantage over all other Nitrogen plant foods.

Chemical Composition of Soils.

Sandy soils may be described as soils containing seventy-six (76) per cent. or more of sand.

Sandy loam is a soil containing from sixty (60) to seventy-five (75) per cent. of sand, and a loam is said to be a soil containing forty (40) to fifty-nine (59) per cent. of sand.

Clay loam runs between twenty-nine (29) to thirty-nine (39) per cent. of sand, and a clay soil would be described as a soil containing about sixty-one (61) per cent. or more of clay.

A very rich soil may be described as a soil containing 2 per cent. of lime and 1.80 per cent. of potash and from .02 to .10 per cent. of sulphuric acid, in the form of sulphate, and from .10 to .30 per cent. of phosphoric acid, in the form of phosphates, with humus running from 1.20 per cent. to 2.20 per cent. and Nitrogen from .20 to 1 per cent.

According to French authorities a good soil would contain .20 per cent. of Nitrogen and .20 per cent. of phosphoric acid, in the form of phosphates, and .30 per cent. of potash. Anything above these figures would be called very rich.

Very poor soil would average about .08 per cent. of Nitrogen and .08 per cent. of potash and .08 per cent. of phosphoric acid with humus of .30 per cent. Anything less than these figures would be very poor indeed.

The pounds of available fertility are reckoned to be contained within eight (8) inches of the surface. The weight of an acre generally would run about two thousand (2,000) tons.

HOW MONEY CROPS FEED.

The substance of plants is largely water and variations of woody fiber, yet these comprise no part of what is commonly understood as plant food. More or less by accident was discovered the value of farmyard manures and general farm refuse and roughage as a means of increasing the growth of plants. In the course of time, the supply of these manures failed to equal the need, and it became necessary to search for other means of feeding plants. The steps in the search were many, covering years of careful investigation, and as a result, we have the established fact that the food of plants consists of three different substances, Nitrogen, potash, and phosphates.

These words are now popular names, and are used for the convenience of the general public. Nitrate of Soda contains an amount equivalent to about 15 per cent. of Nitrogen, 300 pounds to the ton, and cotton-seed meal, for example, about 6 per cent. More than three pounds of cotton-seed meal are necessary to furnish as much available Nitrogen as one pound of Nitrate of Soda. We value the plant food on the amount of Nitrate Nitrogen it contains, and on this account Nitrate has become a standard name for this element of plant food. In like manner, phosphoric acid and potash are standards, hence the importance of farmers and planters familiarizing themselves with these expressions. We always should think of fertilizers and manures as just so much Nitrate, phosphoric acid and potash, as we can then at once compare the usefulness of all fertilizer materials. No doubt, other substances are necessary for the proper development of crops, but soils so generally supply these in ample quantities that they may safely be neglected in a consideration of soil needs and plant foods. The food of plants may therefore be understood to mean simply ***Nitrate, Phosphoric Acid and Potash.***

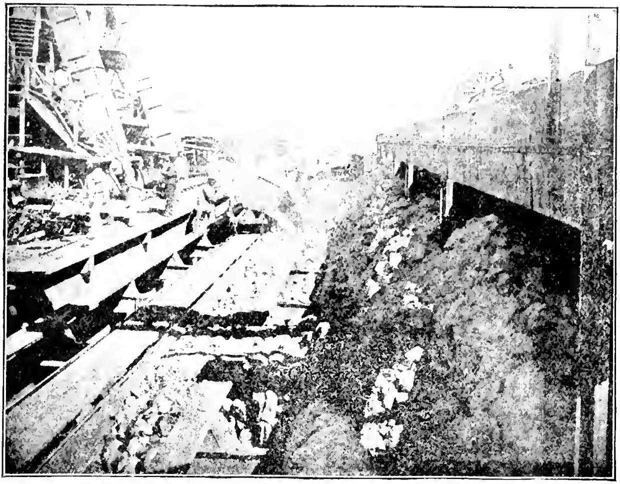
Farmyard manure acts in promoting plant growth almost wholly because it contains these three substances; green manuring is valuable for the same reason and largely for that only. Various refuse substances, such as bone, wood ashes, etc., contain one or more of these plant food elements, and are valuable to the farmer and planter on that account.

The Quality of Manures and Fertilizers.

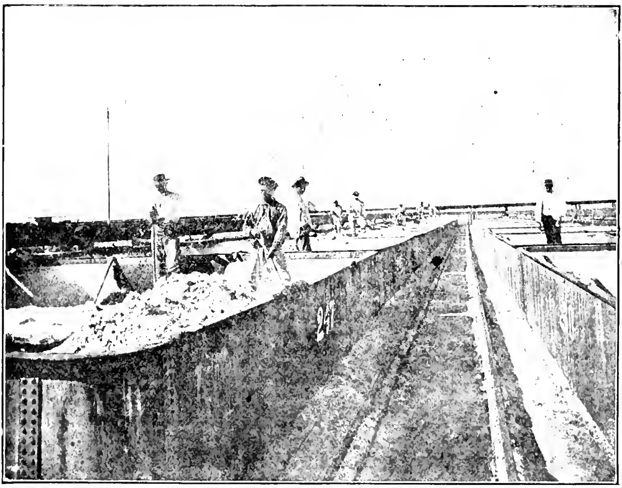
While plant food is always plant food, like all other things it possesses the limitation of quality. Quality in plant food means the readiness with which plants can make use of it. In a large sense, this is dependent upon the solubility of the material containing the plant food—not merely solubility in water, but solubility in soil waters as well. Fertilizer substances freely soluble in water are generally of the highest quality, yet there are differences even in this. For example, Nitrate of Soda is freely soluble in soil liquids and water, and is the highest grade of plant food Nitrogen; sulphate of ammonia is also soluble in water, but of distinctly lower quality because plants in general find it less available than in the Nitrate form. This change is effected in the soil by the action of certain organisms, under favorable conditions. The weather must be suitable, the soil in a certain condition; and besides there are considerable losses of valuable substance in the natural soil process of nitrating such Nitrogen. By unfavorable weather conditions, or very wet or acid soils, nitration may be prevented until the season is too far advanced, hence there may be loss of time, crop and money. The quality of nitrogens, such as cotton-seed meal, dried fish, dried blood, and tankage, is limited by conditions similar to those which limit sulphate of ammonia. Perfectly authentic experiments, and made under official supervision, have shown that 100 pounds of Nitrogen in these organic forms have only from one-half to three-fourths the manurial value of 100 pounds of Nitrate of Soda.

Special Functions of Plant Food.

As stated before, plants must have all three of the plant food elements—Nitrate, Phosphates and Potash —but notwithstanding this imperative need, each of the three elements has its special use. There are many cases in which considerations of the special functions of plant food elements become important. For example, a soil may be rich in organic ammonia from vegetable matter turned under as green manure, and through a late wet spring fail to supply the available Nitrate in time to get the crop well started before the hot, dry, summer season sets in. In this



Top of Caliche Hopper; Carts Tipping Caliche.



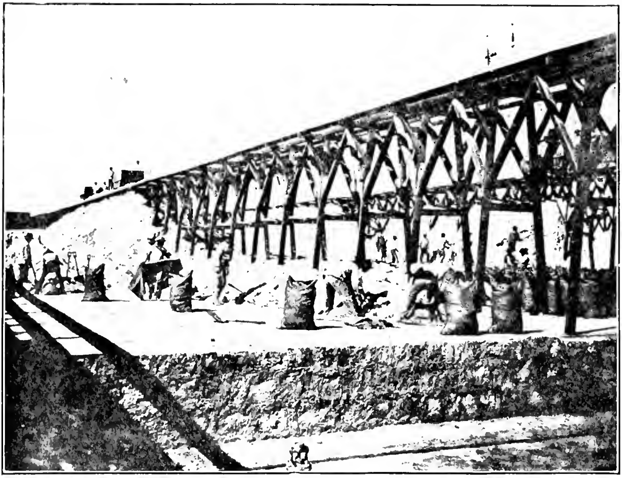
Crystallizing Pans After Running Off Mother-liquor, showing Deposit of Nitrate Crystals.

case the use of Nitrate of Soda alone will force growth to the extent of fully establishing the crop against heat and moderate drouth.

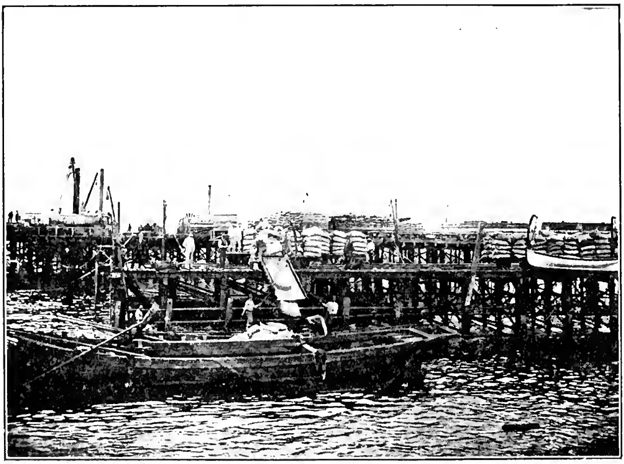
Nitrate as plant food seems to influence more especially the development of stems, leaves, and roots, which are the framework of the plant, while the formation of fruit buds is held in reserve. This action is, of course, a necessary preliminary to the maturity of the plant, and the broader the framework, the greater the yield at maturity. The color of the foliage is deepened, indicating health and activity in the forces at work on the structure of the plant. Nitrates also show markedly in the economic value of the crop; the more freely Nitrates are given to plants the greater the relative proportion in the composition of the plant itself, and the most valuable part of all vegetable substances, for food purposes, is that produced by Nitrate of Soda. Nitrate is seldom used in sufficient quantities in the manufacture of "complete fertilizers."

Potash as plant food seems to influence more particularly the development of the woody parts of stems and the pulp of fruits. In fact, this element of plant food seems to supplement the action of Nitrate by filling out the framework established by the latter.

Phosphoric acid as a plant food seems to influence more particularly the maturity of plants and the production of seed or grain. Its special use in practical agriculture is to help hasten the maturity of crops likely to be caught by an early fall, and to supplement green manuring where grain is to be grown.



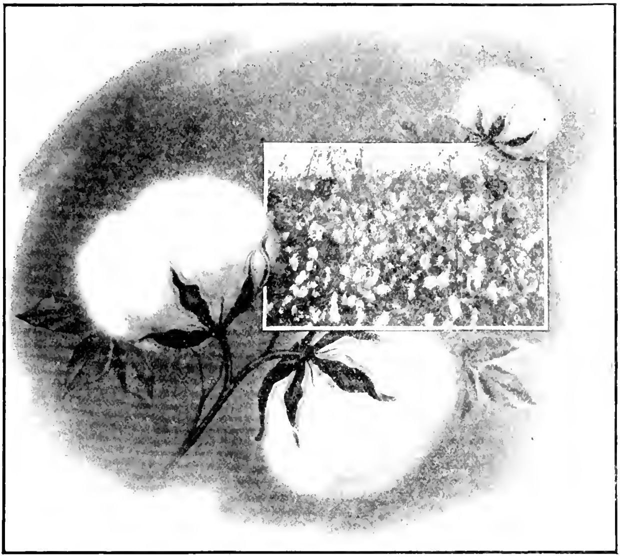
Packing Nitrate into Bags.



Loading Lighters.

It is frequently used in altogether unnecessary excess in "complete" fertilizers.

The natural plant food of the soil comes from many sources, but chiefly from decaying vegetable matter and the weathering of the mineral matter of the soil. Both these processes supply potash and phosphoric acid, ***but only the former supplies Nitrate.*** Whether the soil has been fertilized or not, there are certain signs which indicate the need of plant food more or less early in the growth of the crop. If a crop appears to make a slow growth, or seems sickly in color, it does not greatly matter whether the soil is deficient in Nitrate or simply that the Nitrogen present has not been nitrated and so is not available; the remedy lies in the use of the immediately available form of Nitrate of Soda.



COTTON AND FIBER PLANTS

Cotton is profitably grown in nearly all kinds of soil, but does best perhaps on a strong, sandy loam. On light uplands the yield is light, but with a fair proportion of lint; on heavy bottom lands the growth may be heavy, but the proportion of lint to the whole plant is much reduced.

The preparation of the soil must be even and thorough. About one bushel of seed per acre is the usual allowance.

Many fertilizer formulas have been recommended, and by all kinds of authority, and green manuring is widely advised as a means of helping to get a supply of cheap Nitrogen; but, with this crop especially, cheap forms of Nitrogen are very dear.

Report on Alabama Cotton Prize Experiments with Chemical Fertilizers.

Extended experiments have been made from year to year by all the Experiment Stations in the various cotton-growing states with a view to arriving at the fertilizer requirements of the cotton plant under the varying conditions of soil and climate which are met with throughout the cotton belt, and the needs of the plant for the various essential fertilizing elements have been determined with comparative accuracy.

Many of the formulas for cotton and corn which are in use throughout the cotton-growing states supply proportions of Nitrogen, and, in some cases, of potash, which are far below the fertilizer requirements of the crop, while as before stated little attention is given to the matter of supplying these elements in forms most available for the needs of the plant.

Analyses of the cotton plant, made at the South Carolina, Mississippi and Alabama Experiment Stations, show the needs of the plant for liberal supplies of Nitrogen and of potash, particularly of the former element, since our average cotton soils are, as a rule, so poorly supplied with it.

At the Alabama Experiment Station in 1899 (Bulletin 107), analyses were made of all portions of the cotton plant at various stages of growth, including the plant at full maturity. The weight of the various fertilizing constituents contained in the whole plant grown on one acre, and producing a crop equivalent to 300 pounds dry lint cotton per acre, was also carefully ascertained by analyses and calculation, the figures being presented in the following table.

The weight of Nitrogen, phosphoric acid, potash, and lime contained in a crop producing 300 pounds of lint is given, and the relative distribution of these constituents through different parts of the plant is also presented. The weights of the different parts of the plant in a thoroughly dried condition are also given, and it will be noted that the ***total dry weight of the crop required to yield 300 pounds of lint is, 2,470.8 pounds.***

Amounts of Fertilizer Constituents in Pounds Required to Produce a Crop of 300 Pounds of Lint.

		Nitrogen	Phosphoric Acid	Potash	Lime
Lint	300.0 lbs......	0.54	0.27	1.77	0.21
Seed	507.1 lbs......	17.95	7.10	5.73	1.52
Burrs	363.1 lbs......	2.99	1.74	11.22	4.14
Leaves	566.2 lbs......	12.64	2.70	6.13	29.90
Roots	130.2 lbs......	0.62	0.34	1.17	0.59
Stems	604.2 lbs......	3.87	1.27	5.14	4.71
Total	2,470.8 lbs......	38.61	13.42	31.16	41.07

It appears from this table that to produce 300 pounds of dry lint there are required 38.61 pounds of Nitrogen, 13.42 pounds of phosphoric acid, 31.16 pounds of potash and 41.07 pounds of lime.

The need of the cotton plant for liberal amounts of Nitrogen being thus indicated by laboratory tests, the writer has during the past two seasons supervised and directed a series of experiments upon the farm of Mr. J. C. Moore, near Auburn, Alabama, who was desirous of securing a formula adapted to the growing of cotton upon the sandy soil of his farm and of the immediate section in which he resided.

This soil is designated by the U. S. Soil Survey of this region as the "Norfolk Sandy Loam." It is described in the official report of the soil survey of Lee county as follows: "The Norfolk Sandy Loam is an easily tilled soil and the best for general farming of any of the Norfolk types in this country. It is well adapted to cotton and when fertilized produces fair yields of corn and oats. The lightest phase is well adapted to the production of potatoes, berries and truck crops. The soil needs organic matter which may be supplied by green or stable manure."

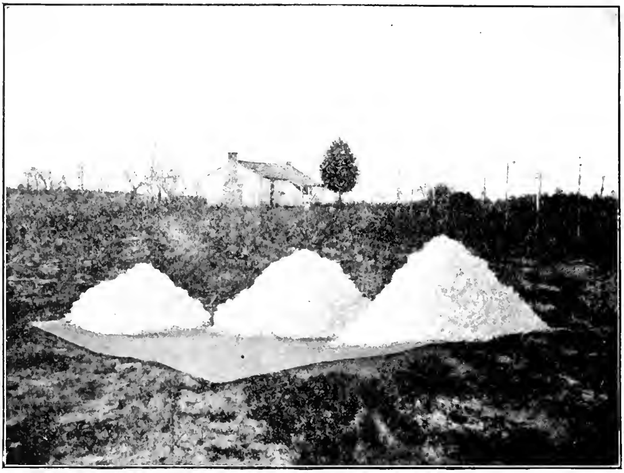
The cotton experiments conducted upon the farm of Mr. Moore were carried out upon several plots aggregating in area two-thirds of an acre.

The land, after proper preparation, was laid off in rows seventy yards in length, while the distance between the rows was so adjusted that ten rows would constitute a plot of one-sixth of an acre. ***Two blank rows were left between the individual plots*** so that the fertilizers applied to one plot would not have any undue effect upon the adjacent plots.

Plot No. 1 was fertilized by the application of an acid phosphate containing 14 per cent. available phosphoric acid and 4 per cent. potash, this fertilizer being applied at the rate of 300 pounds per acre.

The remaining three experimental plots of ten rows each (covering an area of one-sixth acre each) were also fertilized by the application of the same

Products of Auburn Cotton Plots, Group 1, 1905.



Yields of Seed Cotton.

Plot 1.	Plot 3.	Plot 4
750 lbs.	1,272 lbs.	1,440 lbs.

Fertilizers

Acid Phosphate and Potash Carried in 300 lbs. of a 14-4-0 Mixture and Without Nitrate	84 lbs. Nitrate of Soda, Acid Phosphate and Potash Carried in 300 lbs. of a 14-4-0 Mixture	126 lbs. Nitrate of Soda, Acid Phosphate and Potash Carried in 300 lbs. of a 14-4-0 Mixture

quantity of the above mentioned acid phosphate containing potash, and, in addition, Nitrate of Soda was applied to plots 2, 3 and 4 in the proportions of 42, 84 and 126 pounds per acre, respectively, while no Nitrate or other form of Nitrogen was applied to plot No. 1.

Data on Yields of Cotton Experiments in Lee County, Alabama, on Norfolk Sandy Loam, 1905-1906.

Four plots were employed on one-sixth of an acre each and the yields per acre are reported in terms of seed cotton. In tabular form the results are presented as follows:

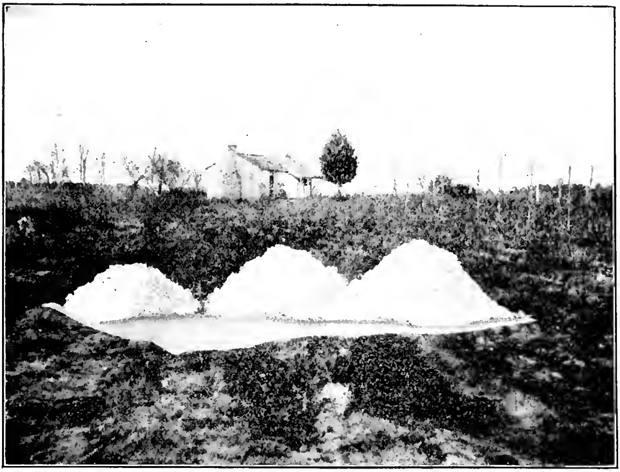
	Rates Application of Nitrate of Soda Each Year	1905 Rate of Yield Per Acre	1906 Rate of Yield Per Acre
Plot 1—The general fertilizer on all four plots was a mixture carrying 14% phosphoric acid and 4% potash. It was used at the rate of 300 lbs. per acre, without Nitrate..	No Nitrate	750 lbs.	930 lbs.
Plot 2—Above mixture of phosphoric acid and potash and an application at the rate of 42 lbs. of Nitrate of Soda per acre....................	42 lbs.	1116 "	900 "
Plot 3—Above mixture of phosphoric acid and potash and an application at the rate of 84 lbs. of Nitrate of Soda per acre...........	84 "	1272 "	1284 "
Plot 4—Above mixture of phosphoric acid and potash and an application at the rate of 126 lbs. of Nitrate of Soda per acre....................	126 "	1440 "	1776 "

In 1905, the fertilizers were applied ***at the time of planting,*** the date being April 27th. In 1906, the date of application of fertilizers was April 21st.

Nitrate was applied in the furrow along with the other fertilizer materials all at the time of planting.

As above stated, all of these plots were fertilized

Products of Auburn Cotton Plots, Group 2, 1906.



Yields of Seed Cotton.

Plot 1.	Plot 3.	Plot 4.
930 lbs.	1,284 lbs.	1,776 lbs.

Fertilizers

Acid Phosphate and Potash Carried in 300 lbs. of a 14-4-0 Mixture and Without Nitrate	84 lbs. Nitrate of Soda, Acid Phosphate and Potash Carried in 300 lbs. of a 14-4-0 Mixture	126 lbs. Nitrate of Soda, Acid Phosphate and Potash Carried in 300 lbs. of a 14-4-0 Mixture

equally as regards the amount of phosphoric acid and potash, so that the effects of supplying or withholding Nitrate of Soda could be easily noted.

It will be noted that the increased yields are particularly striking in the case of the application of 84 and 126 pounds of Nitrate. On plot 2, in 1906, the yield was practically the same as that on plot 1, but this was due to the fact that a few rows in plot 2, owing to the stand on a part of the plot being not so good and possibly on account of some other condition, brought down the average yield per row of that plot. A majority of the rows of that plot, however, undoubtedly gave a better yield than plot No. 1, and it was apparent to the eye that most of this plot was superior to plot No. 1.

In 1905 it was noted that the cotton grown upon the "No Nitrate" plot rusted quite badly, while plots 3 and 4, upon which an abundance of Nitrate had been applied, were almost immune from rust.

Experimental tests upon small lots of the seed cotton produced in 1906, showed that the yield of lint was about 34.4 per cent. of the weight of the seed cotton, but no data were secured with regard to the proportionate yield of lint in 1905. Applying these figures to the excess yield of seed cotton by reason of the application of 126 pounds of Nitrate, it will be found that there was an increase of about 238 pounds of lint cotton (690 pounds seed cotton) over the yield on the "No Nitrate" plot in 1905 and an increase of 291 pounds lint cotton (846 seed cotton) in 1906. At 10 cents per pound, the increased value of the lint cotton yield by applying 126 pounds of Nitrate would be $23.80 for 1905 and $29.10 for 1906, to say nothing of the value of the increased yield of seed which was worth from $3 to $4 more.

The views given, herewith, will afford an idea of the comparative yields from plots 1, 3 and 4 in 1905 and 1906. The quantities of seed cotton represented therein are equal to the yields of one-twelfth of an acre.

In this connection it should be stated that Mr. Moore gave a large amount of care and attention to these experiments. By his close personal supervision of the work, the details of the experiments have been secured and most accurately recorded.

Purebred Seed for Cotton and Nitrate Fertilization.

There is always a big demand for the best grades of cotton.

After having selected the right variety for your locality, the best specimens of the plants should be saved for seed.

Grow the best lint from purebred seed and fertilize your plants properly with Nitrate of Soda.

It is just as easy and twice as profitable to feed a purebred cotton plant as it is to feed a low grade lint producer.

The use of Nitrate of Soda does not take the place of thorough cultivation.

The need of the South, and the whole United States, in fact, is for a more rational method of fertilization than has ever been our practice.

The yields of our staple crops in this country do not compare with the yields of the same crops in Europe, because in Europe they use two or three times as much nitrogen plant food per acre, and proportionately a vastly better balanced plant food ration.

In parts of this country, even where the most fertilizers are used, and the best yields are obtained, such yields do not compare with the average yields of Europe, for the reason that we do not use as much available nitrogenous fertilizer per acre. ***We use proportionately too much of other ingredients*** which do not compare with Nitrate of Soda as profit producers.

Every cotton planter ought to grow more cotton per acre of the best quality. It is not at all necessary to diminish the acres of cotton you are growing; but it is highly desirable for you to grow higher grades for which there is always a splendid market. Nitrate of Soda is the most effective of all the fertilizers for this purpose, and a few hundred pounds of it will do much more work and is far more profitable than the low grade mixtures containing second grade ammoniates, which are not available until a year or two after they are applied. With proper cultivation and with reasonable rational fertilization, which requires much Nitrogen, and which necessitates a larger proportion of Nitrogen than has ever been used in our Cotton Belt, a handsome revenue return to cotton planters is possible.

Some critics of Nitrate have claimed that it made such a bushy growth of the cotton plant, that it had shaded the bottom part of the plant where most of the cotton is produced under weevil conditions. This will not happen if you put your Nitrate on early at planting time.

Where any Nitrogenous fertilizer is used to excess, too leafy a growth is apt to result, and excessive quantities of Nitrate, or indeed of any fertilizers, are not recommended.

Quinine is a wonderful remedy, but no one would advise the use of forty grains of it when four grains would be sufficient and satisfactory in every way.

Practice early and thorough preparation of the soil so as to get a good seed bed for quick germination and vigorous early growth of the cotton.

Cotton should be forced as rapidly as possible in its early growth, to get ahead of the boll weevil. Early applications of Nitrate are very helpful in accomplishing this result.

How Fertilizers Beat the Weevil.
(*Progressive Farmer.*)

The fertilization of cotton deserves to be given more serious thought since the boll weevil has practically covered the cotton area of the South. Everyone who has given serious thought to cotton production knows that success in fighting the weevil comes very largely from means and methods leading to early setting of bolls and early maturity of the crop. Early and thorough preparation of the soil, early planting of the best varieties, thick spacing, and delayed and limited chopping, together with frequent and shallow cultivation, are all useful. They aid in inducing the crop to get ahead of the weevil by setting and maturing fruit before the weevils have multiplied in numbers so great as to practically destroy the squares. Another effective but indirect means of fighting the weevil is found in the use of a fertilizer that develops and matures the crop quickly.

Experiments conducted by the North Carolina Experiment Station throw valuable light on the efficiency of fertilizer in cotton production and especially upon the common carriers of Nitrogen used with phosphoric acid and potash. These tests show that Nitrate of Soda was the most efficient of the six sources of Nitrogen used in the experiment. It produced the most lint, as is shown in the following comparison of yields:

	Yield of Seed Cotton per Acre	Relative Efficiency
Nitrate of Soda	699 lbs.	91.1
Sulphate of Ammonia	637 lbs.	85.4
Nitrate of Lime	597 lbs.	85.4
Cottonseed Meal	569 lbs.	81.4
Dried Blood	550 lbs.	78.7
Tankage	488 lbs.	69.8

From these results it is shown that the Nitrogen furnished by Nitrate of Soda has given a larger yield of seed cotton than Nitrogen derived from any other source tried. Under boll weevil conditions the late or top crop is destroyed. Consequently, all that can be done to induce the setting and maturing of the earliest possible crop is of first consideration. Phosphoric acid is the element in fertilizer that induces fruitfulness and early ripening, while Nitrogen makes the body or frame of the plant for carrying the fruit. Acid phosphate is the best source of phosphoric acid and Nitrate of Soda is the quickest and most efficient source of Nitrogen. This is not only shown by the North Carolina experiment just mentioned but by many others the world over.

Early Versus Late Applications of Nitrate of Soda to Cotton.

The following figures of averages prove positively that early applications of Nitrate of Soda to cotton give the best results.

1919–1920–1921–1922

Average increase of 23 early applications, 1919..	90.22%
Average increase of 15 late applications, 1919...	42.02%
Average increase of 8 early applications, 1920..	197.35%
Average increase of 4 late applications, 1920...	35.50%
Average increase of 7 early applications, 1921..	61.44%
Average increase of 2 late applications, 1921...	16.30%
Average increase of 38 early applications, 1919–1921	115.21%
Average increase of 21 late applications, 1919–1921	31.27%

April 1–May 11, inclusive, are "Early" applications.
May 12–June 26, inclusive, are "Late" applications.

Average increase of 165 early applications, 1922..	61.37%
Average increase of 80 late applications, 1922...	49.0 %

Date of Division: Early — Planting Time.
Late — Two weeks after planting, and later.

What Nitrate Has Done in the Planters' Own Hands.

H. F. Lyle, Somerville, Alabama:

"Plot with Nitrate produced 207 lbs. Cotton. Plot without Nitrate produced 87 lbs. Cotton.

"Nitrate plot did not shed off fruit in dry weather like the other plot,— in fact, did not shed any. One-third larger stalk. Did not have more than half stand on plots."

B. F. White, Olive Branch, Louisiana:

"Plot with Nitrate produced 90 lbs. Cotton. Plot without Nitrate produced 36 lbs. Cotton.

"The Nitrate of Soda Cotton matured before the boll weevil affected it. I consider it the best I ever used,— ahead of any for this climate."

In Alabama the use of 126 pounds of Nitrate per acre for two successive seasons gave an average increased yield of 768 pounds of seed cotton per acre; or an increased yield of lint of 256 pounds per acre in addition to the seed yield of 512 pounds for the same area.

Directions for the Use of Nitrate of Soda.
Nitrate Gives Best Results from Early Applications.

When Nitrate of Soda is applied early in the season to cotton, as it preferably should be, early maturity results. Too late applications of any nitrogenous fertilizer will delay maturity.

If the planter has been badly advised, and in consequence applies his nitrogenous fertilizer too late, he should not blame the fertilizer for his cotton having behaved contrary to nature's intent.

What is needed most is to secure a certain measure of maturity of the cotton before the boll weevil comes out of hibernation in too great force.

It has been alleged that the use of Nitrate causes a "weedy" growth of the cotton plant without proper fruitage. This is not true when Nitrate is applied in proper amounts and at the best time, viz., under the cotton before planting. Heavy applications of Nitrate put on early will always bring early maturity and full, early fruitage. Heavy applications of Nitrate put on late delay maturity and are never advised. When it is necessary to put Nitrate on cotton later in the season, light applications not to exceed 100 pounds to the acre may be made. This necessity is not likely to arise when enough Nitrate has been put on early.

In the cases of the cultivated crops Nitrate should be well covered or thoroughly mixed with the soil.

Larger amounts of Nitrate of Soda may be used up to 250 pounds per acre, or even more.

Cotton is not an exhaustive crop when grown in rotation and when properly fertilized.

Formula for Cotton.

Nitrate alone	150 lbs. per acre
or preferably	
Nitrate	200 lbs. per acre
Acid Phosphate	200 lbs. per acre

The use of sulphate or muriate of potash is advised every other year at planting time at the rate of fifty pounds to the acre. In case neither salt can be secured an equivalent amount of other forms of potash salts may be used.

TOBACCO.

The value of tobacco depends so much upon its grade, and the grade so much upon the soil and climate, as well as fertilization, that general rules for tobacco culture should not be mathematically laid down. Leaving out special kinds, such as Perique, the simplest classification of tobacco is as follows: ***Cigar.***—Tobacco for cigar manufacture, grown chiefly in Connecticut and Wisconsin. ***Manufacturing.***—Tobacco manufactured into plug, or the various forms for pipe smoking and cigarettes. All kinds of tobacco have the same general habits of growth, but the two classes mentioned have very different plant food requirements.

Cigar tobaccos generally require a rather light soil; the manufacturing kinds prefer heavy, fertile soils. In either case, the soil must be clean, deeply broken, and thoroughly pulverized. Fall plowing is always practiced on heavy lands, or lands new to tobacco culture. Tobacco may be safely grown on the same land year after year. The plant must be richly fertilized; it has thick, fleshy roots, and comparatively little foraging power—that is, ability to send out roots over an extensive tract of soil in search of plant food.

Fertilizer for tobacco is used in quantities per acre as low as 400 pounds of high grade and as much as 3,000 pounds of low grade. While the production of leaf may be greatly increased by the use of Nitrate, the other plant food elements should also be used to secure a well matured crop. In the case of cigar tobaccos, Nitrate may be used exclusively as the source of Nitrogen as it is difficult to secure a thoroughly matured leaf unless the supply of digest-

Virginia Experiments.

No Nitrate. 100 lbs. Nitrate of Soda per Acre.

ible Nitrogen is more or less under control, a condition not practicable with ordinary fertilizers.

Tobacco growing is special farming, and should be carefully studied before starting in as a planter. For small plantations, the plants are best bought of a regular seedsman. The cultivation is always clean, and an earth mulch two or three inches in depth should be maintained—that is, the surface soil to that depth kept thoroughly pulverized.

At the Kentucky Experiment Station, experiments were made with fertilizers on Burley Tobacco. The land was "deficient in natural drainage," so that the fertilizers could hardly be expected to have their full effect. Yet, as will be seen by the following table, the profits from the use of the fertilizers were enormous:

Experiments on Tobacco at the Kentucky Experiment Station.

Fertilizer per Acre	Yield of Tobacco — Pounds					Total	Value of Tobacco per Acre
	Bright	Red	Lugs	Tips	Trash		
1. No manure........	...	200	360	60	540	1,160	$67.20
2. 160 lbs. Nitrate of Soda	230	450	310	90	530	1,610	138.40
3. 160 lbs sulp. of potash; 160 lbs. Nitrate of Soda.....	190	755	605	120	140	1,810	190.45
4. 320 lbs. superphosphate; 160 lbs. sulp. of potash; 160 lbs. Nitrate of Soda	310	810	420	10	360	2,000	201.20

"The tobacco was assorted by an expert and the prices given as follows: bright and red, fifteen cents per pound; lugs, six cents per pound; tips, eight cents per pound; trash, two cents per pound."

One hundred and sixty pounds Nitrate of Soda, costing about $3.75, increased the value of the crop $71.20 per acre!

Instructions for Using Nitrate of Soda on Tobacco.

Just before setting out plants, apply the Nitrate of Soda by broadcasting it evenly, by machine, or by hand, over the entire surface of the tobacco field you are fertilizing, at the rate of 150 pounds per acre. One hundred and fifty pounds of Nitrate is equal in bulk to about one and one-half bushels.

Formula for Tobacco.

Nitrate alone	150 lbs. per acre
or preferably	
Nitrate	200 lbs. per acre
Acid Phosphate	200 lbs. per acre

When potash salts can conveniently be obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

FERTILIZERS FOR CORN.

Corn varies in yield of grain per acre, according to the character of the soil upon which it is grown,

Fertilizer, 300 pounds per acre minerals and 150 pounds per acre Nitrate of Soda.
Rate of yield, 100 bushels ears per acre, excellent quality.

Fertilizer, 300 pounds per acre minerals only.
Rate of yield, 80 bushels ears per acre, poor quality.

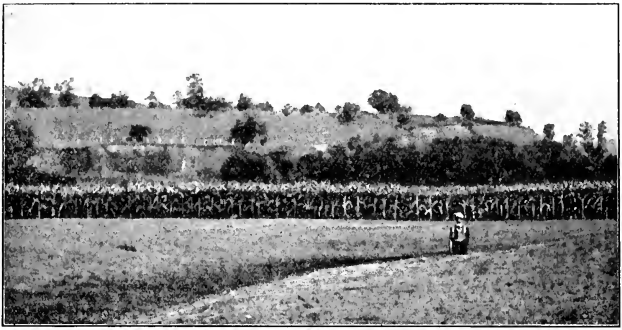
the location of its growth and the variety used. Soils best suited for corn culture are rich, deep loams, naturally well drained and located in those regions where the average temperatures during the growing months of May to September, inclusive, reach from 75 degrees to 80 degrees Fahr. That is, the best climatic conditions do not depend upon average annual temperature, but upon the high temperature maintained during these growing months. The growing season will, however, vary also in different sections of the country, ranging from 90 to 160 days, and varieties exist which are adapted to these different growing periods. The yield is also, of course, influenced by moisture, depending again not altogether upon the total rainfall, but upon the requisite amounts that may be depended upon from May to September, the growing months. The plants need high temperatures and maximum rainfalls throughout July and August, with clear, sunshiny weather between rains.

The variety also has a direct influence upon the yield of the crop, and work done recently in the matter of corn breeding and selection has very considerably broadened the area of profitable culture. The Flint varieties are more suitable for the northern sections, and the Dent varieties for the central and southern sections of the United States.

The Object of Growth — Grain.

Corn is grown mainly for its grain, and for this reason the greatest attention has been given to the development of varieties that will yield the largest proportion of grain to stalk; because, however, of the increasing use of corn as a forage plant, much attention has recently been given to the varieties adapted for soiling and for silage.

In growing corn for these different purposes different methods are adopted. When the main object is to secure grain, varieties are selected which



One Hundred Bushels of Ears of Corn per Acre, Before Harvesting.

produce large, uniform ears, with deep grains. In order to insure its proper development and ripening, it is planted preferably in hills, at such distances as will permit a maximum amount of sunshine to reach all parts of the plant, and so cultivated as to encourage the largest use of food from soil sources. In other words, every precaution is taken to insure the largest proportion of ripened grain; the stalks often being regarded as a by-product of little value. In fact, in many parts of the country the stalks are not utilized as they should be, although when well cured they are equivalent in food value, on the dry matter basis, to good timothy hay.

In planting Indian corn for grain we doubtless often plant the seed too thick.

Silage.

When grown for silage, the object is to secure the largest amount of digestible matter per acre. Hence, varieties with larger stalk and leaf are generally used and the corn planted much closer together and thicker in the rows, but not so thick as to prevent many of the stalks from producing ears. When cut when the ears are beginning to glaze, good crops will oftentimes yield as much as 5,000 to 6,000 pounds of dry matter per acre. Larger amounts of plant food than for grain are required, as a rule, in order that the vegetative functions may be increased, hence on most soils, even in a good state of fertility, applications of fertilizers are necessary, more particularly those containing Nitrogen.

Soiling.

In growing corn for soiling, the object is to obtain the largest amount of succulent food per acre, which may be completely eaten by the animal. Hence, for soiling, quick-growing varieties, with a large proportion of leaf and small stalks, are grown and planted thicker than for silage, and still greater care in the use of manures and fertilizers is required in order to enable the plant to absorb food throughout its entire growth.

Sweet Corn.

When sweet varieties are grown, the object is to obtain a large number of ears suitable for the table. The sweet varieties are less hardy and vigorous than

Corn and Oats, New York Experimental Fields.

the ordinary field varieties, and are better adapted for light soils, hence the treatment is still different from that used when grown for the purposes already mentioned. The grain is not planted ordinarily until the soil is thoroughly warm, and the temperature is likely to continue high and, because better suited for light soils, special fertilization is necessary.

Indian Corn (Maize) Experiments.

New York State, Seasons of 1918 and of 1919.

Experiments in New York State carried on with maize ensilage, or Indian corn, show that whilst the return in value of the increased crop is not excessive owing, no doubt, to the lateness of the fertilizer application, notable crop increases were obtained.

The late fertilizer application was used in this case advisedly to check up this practice which is followed by many farmers, and which is rather against our general advice as to very late dressings of Nitrate. Earlier applications on corn, we are confident, will prove to be more profitable.

Among interesting items secured are the yields of protein per acre as tabulated in the following tables. It is notable that the total ash mineral residue per acre removed from the plot on which Nitrate alone was used is less than on the check plot, and that the exhaustion of phosphoric acid, potash and lime was at a lower rate per acre on the Nitrate plot than on the check plot. Notable also is the fact that the rate of yield of protein was lower on the check plot and also on the acid phosphate alone plot than on the Nitrate plot. Protein is, of course, a factor of very high food value for dairy stock.

The results speak well for Nitrate ***not*** exhausting soil fertility as to its mineral essentials. It confirms the idea that soil exhaustion proceeds more rapidly when no fertilizers are used as compared with their rational use.

Reports on Experimental Work on Maize Ensilage.

1918.

Crop — Maize Ensilage.
Variety — Half State Corn; Half Gold Nugget.
Location — Chenango County, New York.
Soil — Bottom land.
Cultivations — Three.
Climate — Short season; high altitude, 1,000 feet.
Weather — Cool; latter part of summer, drought.
Date of Application of Fertilizer — July 5, 1918.
Date of Harvesting — September 16, 1918.
Size of Plots — ¼ acre.
Rate of Application per Acre — 250 lbs. Nitrate of Soda; 400 lbs. Acid Phosphate.
Fertilizers Used — Nitrate of Soda and Acid Phosphate.
Cost of Fertilizer per Acre — Plot 1, $12; plot 2, $8; plot 3, $4.

Crop in Pounds per Acre.

TABLE NO. I

Plot Nos.	Rate of Application per Acre	Yields per Plot	Rate of Crop Yields per Acre
1. Nitrate of Soda..........	250 lbs.	7,120 lbs.	28,480 lbs.
and			
Acid Phosphate..........	400 lbs.		
2. Nitrate alone.............	250 lbs.	6,610 lbs.	26,440 lbs.
*3. Acid Phosphate alone.....	400 lbs.	6,030 lbs.	24,120 lbs.
4. Check — nothing	...	6,290 lbs.	25,160 lbs.

Pounds per Acre of Essential Fertility Removed by Crop.

TABLE NO. II

Plot Nos.	Phosphoric Acid	Potash	Nitrogen
1. Nitrate of Soda and Acid Phosphate	38.45 lbs.	91.99 lbs.	46.28 lbs.
2. Nitrate alone.............	34.64 lbs.	82.76 lbs.	42.97 lbs.
3. Acid Phosphate alone.....	33.29 lbs.	81.53 lbs.	39.20 lbs.
4. Check — nothing	37.24 lbs.	94.35 lbs.	40.89 lbs.

* Acid Phosphate alone appears to have diminished the crop here as it did in the case of our sugar cane in Porto Rico.

Pounds per Acre of Protein and Ash (Minerals) and Lime Removed by Crop.

TABLE NO. III

Plot Nos.	Protein	Ash	Lime
1. Nitrate of Soda and Acid Phosphate	506.9 lbs.	336.1 lbs.	17.94 lbs.
2. Nitrate alone.............	499.7 lbs.	290.8 lbs.	14.81 lbs.
3. Acid Phosphate alone.....	465.5 lbs.	282.2 lbs.	18.09 lbs.
4. Check — nothing	462.9 lbs.	299.4 lbs.	19.88 lbs.

1919.

Crop — Maize Ensilage.

Variety — Golden Nugget.

Location — Chenango County, New York.

Soil — Clay loam.

Cultivations — Three.

Climate — Temperate; 1,000 feet above sea.

Weather — Cloudy; wet.

Amount of Fertilizer per Plot — 20, 40 and 80 lbs.

Method of Cultivation — Horse cultivator and by hand hoeing.

Date of Application of Fertilizer — June 5, 1919, for plots 1, 2, 3 and 4; and June 5 and 24 for plots 5 and 6, when corn was 9 inches high.

Date of Harvesting — September 15, 1919.

Size of Plot — 1/10 acre, plots 1, 2, 3 and 4; 1/20 acre, plots 5 and 6.

Rate of Application per Acre — 200 lbs., 400 lbs. and 600 lbs.

Fertilizers Used — Nitrate of Soda and Acid Phosphate.

Cost of Fertilizer per Acre — $26.40.

Method of Applying — Broadcast, cultivated in immediately.

Crops in Pounds per Acre.

TABLE NO. I

Plot Nos.	Rate of Application per Acre	Crops Yield per Plot	Rate of Crop Yields per Acre
1. Nitrate of Soda and Acid Phosphate	400	4,180	41,800
2. Nitrate alone	400	4,100	41,000
3. Acid Phosphate alone	400	2,840	28,400
4. Check — nothing	...	2,820	28,200
5. $NaNO_3$ and P_2O_5	200 each June 5, 1919; 200 each June 24, 1919..	1,780	35,600
6. $NaNO_3$ and P_2O_5	200 each June 5, 1919; 400 each June 24, 1919..	2,040	40,800

Pounds per Acre of Protein and Minerals Removed by Crop.

TABLE NO. II

Plot Nos.	Phosphoric Acid	Potash	Protein	Nitrogen
1. Nitrate of Soda and Acid Phosphate	47.23	95.30	689.7	110.3
2. Nitrate alone	38.06	109.06	471.5	75.4
3. Acid Phosphate alone	56.99	77.25	289.4	46.3
4. Check — nothing	31.58	62.89	377.3	61.1
5. $NaNO_3$ and P_2O_5	47.70	75.83	585.2	93.6
6. $NaNO_3$ and P_2O_5	56.71	102.82	739.7	118.3

Pounds per Acre of Minerals Removed by Crop.

TABLE NO. III

Plot Nos.	Ash	Lime
1. Nitrate of Soda and Acid Phosphate	456.9	31.77
2. Nitrate alone	468.6	38.54
3. Acid Phosphate alone	342.2	28.12
4. Check — nothing	293.0	27.35
5. $NaNO_3$ and P_2O_5	408.0	45.57
6. $NaNO_3$ and P_2O_5	472.1	34.68

Pounds per Acre of Essential Fertilizer Ingredients Added to the Soil in the Fertilizers Used. 1919.

TABLE NO. IV

Plot Nos.	Rate of Application per Acre	Nitrogen	Phosphoric Acid	Potash in Nitrate Used Estimated
1. Nitrate of Soda......	400	56	..	8
and Acid Phosphate	400	..	56	8
2. Nitrate alone........	400	56	..	8
3. Acid Phosphate alone.	400	...	56	..
4. Check — nothing	...	..	..	..
5. $NaNO_3$ and P_2O_5.....	400 each	56	56	8
6. $NaNO_3$ and P_2O_5.....	400 each	84	84	12

The profit per acre as between the application of 400 pounds of acid phosphate alone, and of Nitrate and acid phosphate together shows that the added investment in 400 pounds of Nitrate, which may be estimated at practically fourteen dollars ($14), gave a rate of profit of twenty dollars ($20) per acre, valuing ensilage at present at five dollars ($5) a ton.

Since the rate of yield per acre of the Nitrate and acid phosphate plot was 20.9 tons as against a rate of yield per acre of 14.1 tons for the acid phosphate alone plot, — the value in the first case is placed at one hundred four dollars and fifty cents ($104.50) per acre, and in the latter case at seventy dollars and fifty cents ($70.50) per acre. As the crop increase from the use of 400 pounds of Nitrate is valued at thirty-four dollars ($34), and the cost of the Nitrate at fourteen dollars ($14), a profit at the rate of twenty dollars ($20) per acre is the result, as above stated.

These figures are in general in close agreement with those secured in 1918, and confirm the view that rational fertilizing with Nitrate does not appear to exhaust the soil in the ***net*** result as much as does doing without fertilizers.

Instructions for Using Nitrate of Soda on Corn.

As soon as the corn is planted in the spring, apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the corn field you are fertilizing at the rate of 200 pounds per acre, which is equal in bulk to about two bushels.

Our Formula for Corn.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 lbs. per acre
Acid Phosphate	300 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of muriate of potash to the acre every other year.

SMALL FRUITS.

Under this head we treat of blackberries, currants, gooseberries and raspberries. Strawberries are treated separately. All these small fruits are commonly grown in the garden, generally under such conditions that systematic tillage is not practicable. For this reason such plant food essentials as may exist naturally in the soil become available to the uses of the plants very slowly. This is as true of the decomposition of animal or vegetable ammoniates as of phosphates and potashes. Consequently, small fruits in the garden suffer from lack of sufficient plant food. All these plants when planted in gardens are usually set in rows four feet apart, the plants about three feet apart in the rows; about 4,200 plants to an acre. In field culture, blackberries are usually set four feet apart each way.

So far as possible, small fruits should be cultivated in the early spring, and all dead canes removed. Work into the soil along the rows 300 pounds of acid phosphate and 50 pounds of sulphate of potash if obtainable; when the plants are in full leaf, broadcast along the rows 300 pounds of Nitrate of Soda, and work in with a rake. If at any time before August the vines show a tendency to drop leaves, or stop growing, apply more Nitrate. Small fruits must have a steady, even growth; in most cases unsatisfactory results can be directly traced to irregular feeding of the plants. In field culture, the crop must be tilled quite the same as for corn; in the garden in very dry weather irrigation should be used if possible. The yield per acre is very heavy, and, of course, the plants must be given plant food in proportion.

Raspberries, Currants, Gooseberries.

Sow broadcast, in the fall, a mixture of 300 pounds of acid or superphosphate and 50 pounds sulphate of potash per acre if obtainable. This can be done, if the rows are four feet apart, by sowing a large handful at every two steps ***on each side of the row.*** Raspberries and gooseberries should have a small handful, and currants a large handful to each bush. This should be cultivated in, if possible, early in the spring. Sow Nitrate of Soda in the same way. It will pay to put on as much Nitrate as you did acid or superphosphate, but if you do not want to put on so much, use smaller handfuls.

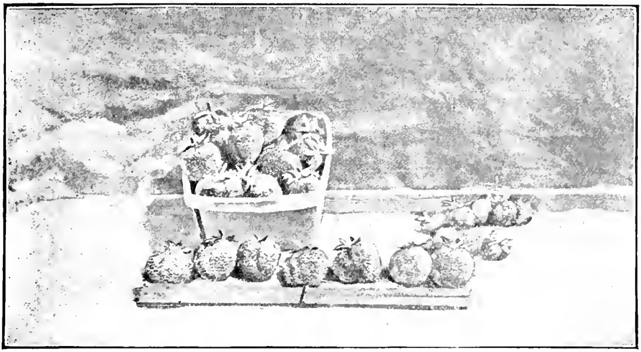
Our Formula for Raspberries and Currants.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 lbs. per acre
Acid Phosphate	300 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Strawberries.

This plant requires a moist soil, but not one waterlogged at any time of the year. A light clay loam, or a sandy loam is preferable. There are several methods of cultivation, but the matted row is generally found more profitable than the plan of growing only in hills. While some growers claim that one year's crop is all that should be harvested before ploughing down for potatoes, as a matter of fact the common practice is to keep the bed for at least two



In the basket, and lying on 12-inch rule, 200 lbs. Nitrate of Soda to the acre.

To the right back of rule, no Nitrate.

harvests. In selecting plants, care should be exercised to see that pistillate plants are not kept too much by themselves, or the blossoms will prove barren. Farmyard manure should never be used after the plants are set out, as the weed seeds contained therein will give much trouble, especially as the horse hoe is of little use in the beds. Use 200 pounds of acid phosphate, applied broadcast immediately after harvest. In the spring as soon as growth begins broadcast 150 pounds of Nitrate of Soda to the acre. In setting out a new bed, broadcast the fertilizer along the rows and cultivate in, before the plants are set out.

On old beds, sow 200 pounds of acid phosphate broadcast in the fall and 150 pounds of Nitrate per acre in the spring.

Our Formula for Strawberries.

Nitrate alone	150 lbs. per acre
or preferably	
Nitrate	200 lbs. per acre
Acid Phosphate	200 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

The experiment was with a field of Bubachs. One plot was given 200 pounds of Nitrate of Soda to the acre when growth began. Another received no Nitrate. On June 3d all the ripe fruit was picked from equal length of rows of each plot. The photograph shows the result.

Grapes.

Grape vineyards should be located and planted by an expert, and one, too, who has had experience with the locality selected for the site. The treatment of the young plants is a matter of soil and climate, for which there are no general rules. When the vines have reached bearing age, however, their fertilization becomes a very important matter. The new wood must be thoroughly matured to bear next year's fruit, and an excess of ammoniate late in the season not only defeats this object, but also lessens the number of fruit buds.

Instructions for Using Nitrate of Soda on Grapes.

Apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the vineyard you are fertilizing, at the rate of 200 pounds per acre, during the early spring months, preferably just before the vines are in bud.

Our Formula for Grapes.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 lbs. per acre
Acid Phosphate	300 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

GREENHOUSE PLANT FOOD.

For flowering plants in greenhouses, as long as possible before blooming, apply one pound of Nitrate of Soda to 200 square feet of surface. This application is equal to 200 pounds per acre. If used with acid phosphate, a larger amount, viz: One and one-half pounds of Nitrate of Soda with an equal quantity of acid phosphate may be used to each 200 square feet of surface, making 300 pounds per acre, provided excessive quantities of barnyard manure have not been used. It is important to thoroughly work these fertilizers into the soil.

The use of rotted stable manure as a source of greenhouse plant food has been the custom for many years. Manure, however, supplies its plant food very irregularly and the Nitrogen which it contains is not available, hence for forcing plants it cannot be fully relied upon. It should be supplemented by the use of commercial fertilizers such as Nitrate of Soda and acid phosphate.

For Plants in Pots.

Water once every four days, during early active growth, with a solution of one-half an ounce of Nitrate of Soda to one gallon of water — avoid wetting the foliage. This will produce dark green color in the leaves, which, when obtained, indicates that for this most important period, a sufficient amount of Nitrate of Soda has been used. Do not put dry Nitrate on wet foliage.

For young fruit trees in the nursery, from one-quarter to one pound of Nitrate of Soda per acre may be used, according to age. It is important in this case that the fertilizer should be thoroughly worked into the soil.

LAWNS AND GOLF LINKS.

Good lawns are simply a matter of care and rational treatment. If the soil is very light, top-dress liberally with clay and work into the sand. In all cases the soil must be thoroughly fined and made smooth, as the seed, being very small, requires a fine seed bed. In the South, seed to Bermuda grass or Kentucky blue grass; in the North, the latter is also a good lawn grass, but perhaps a little less desirable than Rhode Island bent grass (Agrostis canina). Avoid mixtures, as they give an irregularly colored lawn under stress of drouth, or early frosts, or maturity. For Rhode Island bent grass use 50 pounds of seed per acre, Kentucky blue grass 40 to 45 pounds, and for Bermuda grass 15 pounds. If for any reason the soil cannot be properly prepared, pulverize the fertilizer very fine indeed. The grass should be mowed regularly and the clippings removed until nearly mid-summer when they are best left on the soil as a mulch. For a good lawn, broadcast per acre in the spring 50 pounds of sulphate or muriate of potash, 200 pounds of acid phosphate and 200 pounds of Nitrate of Soda. Lawns are very different from field crops as they are not called upon to mature growth in the line of seed productions, and they may safely be given applications of Nitrate whenever the sickly green color of the grass appears, which shows that digestible or nitrated ammonia is the plant food needed. These applications of plant food must be continued each year without fail, and all bare or partly bare spots well raked down and reseeded. If absolutely bare, these spots should be deeply spaded. On very heavy clay soils, and in low situations, a drainage system must be established.

Instructions for Using Nitrate of Soda on Meadows, Lawns and Golf Links.

As soon as the frost leaves the ground in the spring, apply the Nitrate of Soda by broadcasting it evenly, by hand, or by machine, over the entire surface of the lawn, or meadow you are fertilizing, at the rate of 100 pounds per acre.

Frequent rolling is of great advantage, as well as frequent raking. Every lawn in the spring should be subjected to a searching inspection for weeds. Early spring is the time for the heavy annual top-dressing of fertilizers.

Two or three weeks after the application of fertilizers, a mixture of lawn grasses may be sown and covered with a thin layer of finely sifted soil and then rolled down. Rolling should not be continually in one direction, but should be changed.

If young grasses are growing amongst the old, it will be an advantage to keep the lawn closely cut.

By this practice roots are strengthened and the density of the turf increased. In sowing lawn seed, sow half the quantity going north and south, and half east and west.

Grass which has become brown or yellow may be watered or treated with Nitrate of Soda and the green color thus restored. Lawns may safely be given applications of Nitrate whenever the sickly green color of the grass appears, as this shows that Nitrogen is the food needed. Finely sifted soil obtained from decayed leaves is the best treatment for lawns to provide them with humus.

Our Formula for Meadows, Lawns and Golf Links.

Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	200 lbs. per acre
Acid Phosphate	200 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate or muriate of potash to the acre every other year.

FLOWERS.

Every gardener (of vegetables or flowers) should have at hand, all through the season, a bag or box of Nitrate of Soda, to be broadcast on any and every

Fertilizer Experiments with Fuchsias.

Phosphoric Acid and Potash without Nitrate of Soda. Phosphoric Acid and Potash with $2\frac{1}{4}$ oz. Nitrate of Soda.

crop that grows in the garden. The need for Nitrogen is indicated by the pale green color of foliage and slow growth. It is quite easy to be too liberal in using Nitrate; 200 pounds of Nitrate per acre, if used alone, is the quantity to be applied at any one time. One pound of it would give about 30 heaping teaspoonfuls. So 1 to 1½ such spoonfuls to a square

Fertilizer Experiments with Chrysanthemums.

Phosphoric Acid and Potash. Phosphoric Acid and Potash with 1⅛ oz. Nitrate of Soda.

yard, or 3 feet along a row that is 3 feet wide, would be about 100 pounds per acre. The quantity, however, may be larger where the plants — such as cabbage—are half grown and in good condition to grow.

Nitrate of Soda is an ideal fertilizer for all kinds of flowering plants, especially roses. It is as you know, neat and cleanly and harmless (not acid, nor caustic) and every woman who cultivates vegetables and flowers should keep it on hand, to be used as occasion shall demand at the rate of one-half to one teaspoonful to the square yard, or one rose bush.

Instructions for Using Nitrate of Soda on Flowers.

Apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the garden you are fertilizing, at the rate of 200 pounds per acre, before you sow your seeds and before you set out your plants. It may be applied later by hand between the rows at the same rate if you find the earlier time inconvenient.

Our Formula for Flowers.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 lbs. per acre
Acid Phosphate	300 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

OBSERVATIONS UPON THE LEACHING OF SOLUBLE FERTILIZER SALTS FROM CRANBERRY SOILS.

By JOHN H. VOORHEES.

Former Assistant in Charge Cranberry Investigations, N. J. Experiment Station.

In the spring of 1913 the author was detailed by the New Jersey Experiment Station to study the fertilizer requirements of the cranberry. After a survey of the field it was decided to locate the experimental work upon bogs owned and operated by practical growers. Headquarters for this work were located at the bogs of J. J. White, Incorp., situated about three miles northeast of Hanover farms on the P. R. R. in Burlington county. A rather complete series of plots was planned including the separate use of four sources of Nitrogen, — Nitrate of Soda, ammonium sulphate, dried blood 12 per cent., and cotton-seed meal; four sources of phosphoric acid,— acid phosphate, basic slag, phosphate rock and steamed bone; and three sources of potash,— muriate, sulphate and kainit. These materials were not only used separately, but also in complete mixtures in which ammonium sulphate, acid phosphate and muriate of potash were used as constant factors. In each case the fertilized plots received either two pounds of Nitrogen, four of phosphoric acid, or five of potash, and in the case of complete mixtures all of the above quantities were used.

On the bogs of J. J. White the series of plots was laid out in three distinct types of soil; the Savannah, a pure sand mixed with more or less organic matter, deep mud, and deep mud underlaid with iron ore. Wherever possible the plots were made one-twentieth acre in size, one rod wide and eight rods long. (Details of the plan of experiment may be found in 1913 Report, N. J. Agricultural Experiment Station, pages 384-488.)

On June 6, 1913, the first application of fertilizer was made to the plots in these series and observations of the effect of added plant food have been extremely interesting. One occurrence brings out clearly how little an abundance of water affected the lateral movement of soil moisture and leaching of plant food from the soil stores.

On the nights of June 9th and 10th danger of severe frost caused the proprietors to flow the bogs for protection. The series of plots located in the deep mud and iron ore soils (so-called) were completely flooded to a depth varying from a few inches to a foot. The Savannah plots, even though located in the same bogs, were on a higher level and the water only covered one end of the plots, about one-half of each. At first thought it would appear that the lateral movement of the soil water would carry the plant food, especially the soluble salts, Nitrate of Soda, ammonium sulphate, and the potash salts, from one plot to another, and that there would be considerable leaching of plant food into the drainage water, because the water is drawn through the soil into the ditches on its way out; but subsequent observations extending through the remainder of the year showed a distinct line of markation between the fertilized plots and the check plots adjoining. The increased vine growth causing this distinct markation became clearly defined, first with Nitrate of Soda, then ammonium sulphate, and so on through the list of plots, showing more clearly upon the plots which received complete mixtures.

This condition was more particularly true on the "Savannah" soils, and it might be added that yields were greatly increased. Record of yields may be found in 1914 Report of N. J. Agric. Experiment Station or Proceedings 45th Annual Meeting American Cranberry Growers' Association.) Upon the deep mud and iron ore plots the differences and lines of markation were distinguishable but not so clearly defined.

After three years of observation and experience, both experimental and practical, the author is convinced that the loss from leaching is so negligible that he feels no hesitancy in advising growers to apply fertilizers composed of Nitrate of Soda, acid phosphate and muriate of potash as soon as the winter water is drawn from the bogs, about May 20th, before the reflow for insect control, which is a customary practice about the second week in June, and before any flowing which might be necessitated by danger of frost.

NITRATE ON SUGAR CANE.

What It Did for an Acre of Sugar Cane in Porto Rico.

Abstract from Facts About Sugar, September 7, 1918.

(The results of an interesting experiment conducted at Central Aguirre, Porto Rico, during the season 1917-18, to check up the relative values of Nitrate of Soda, of Acid Phosphate, and of a mixture of the two, as fertilizer for sugar cane, are described in the following article. The accompanying illustrations and table show the striking results obtained from the use of the Nitrate.— Ed.)

An Instructive Demonstration.

A recent experiment conducted at Margarita field, Hacienda Carmen of Central Aguirre, Porto Rico, forcibly brings out the gain in sugar yield, with the accompanying higher financial return resulting, when Nitrate of Soda and acid phosphate were used, compared with the returns when acid phosphate was used alone.

The test was made to determine the relative efficiency of acid phosphate — which is the main constituent of the ordinary brands of mixed fertilizer — as compared with Nitrate of Soda.

The cane was grown on adjoining one-acre plots. Applications of the fertilizer materials were made on July 23, 1917, and the cane was cut on May 27, 1918. On one plot 400 pounds of acid phosphate was applied; on the second 400 pounds each of acid phosphate and Nitrate of Soda; on a third, Nitrate of Soda alone, and on the fourth, a check plot, no fertilizer was used. The results obtained are shown in the following table:

Fertilized with 400 lbs. Nitrate of Soda per acre. Yield: 9,600 lbs. Sugar per acre (30 bags).

Fertilized with 400 lbs. Acid Phosphate per acre. Yield: 6,400 lbs. Sugar per acre (20 bags).

Fertilized with 400 lbs. Nitrate of Soda per acre. Yield: 9,600 lbs. Sugar per acre (30 bags).

Check Plot — No Fertilizer. Yield: 7,680 lbs. Sugar per acre (24 bags).

Confirms Hawaiian Practice.

Acre Plots	Sucrose per cent	Purity per cent	Cane yield tons	Sugar yield tons
1. Acid Phosphate....................	18.09	92.50	24.96	3.2
2. Nitrate of Soda and Acid Phosphate	17.38	91.50	38.00	4.7
3. Nitrate of Soda alone..............	16.45	89.20	41.50	4.7
4. Check Plot — no fertilizer..........	17.55	91.40	30.73	3.8

These figures speak for themselves. It is interesting to note that the $16 worth of Nitrate used alone produced an increase of 16.54 tons of cane, yielding 1.5 tons of sugar, over the acid phosphate plot, which, in terms of cash, represented an increased market value of $138. In view of the stress laid so frequently in the past upon the use of the superphosphate variety of mixes, the sources of Nitrogen in such brands being as a rule entirely unknown to the users, the above experiment is illuminating. This experiment substantially and emphatically confirms Hawaiian results and fully endorses Hawaiian sugar cane practice.

THE POSITION OF NITROGEN IN AGRICULTURE, OUR LEADING INDUSTRY

An Address delivered by Dr. William S. Myers, before The American Railway Development Association at their Annual Meeting at San Antonio, Texas.

In his first inaugural Washington said, "Where Agriculture leads all other arts follow." Most of the annual additions to our national wealth come from farming and our agriculture is still growing. The land is the foundation upon which we build our economic structure.

The world taken as a whole is a great farm and our soils are filled with millions of microscopic animal and vegetable life — vast colonies of living things which act and react upon each other. Every square yard is populated with billions of workers and unknown laborers — some helping as soil builders — some helping in the work of unlocking fertility — some, under certain conditions, helping to destroy it.

The average soil is capable of holding more or less one-fifth of its weight in water. The greater the soil population of bacteria bred by proper farming, the greater is its capacity for holding water and soil solutions. Good soils also possess great holding capacity for solids in solution owing to the capacity of soil granules to exercise upon liquids what is known as surface tension. So far as growing crops are concerned a soil without water is as useless as a motor car without gasoline.

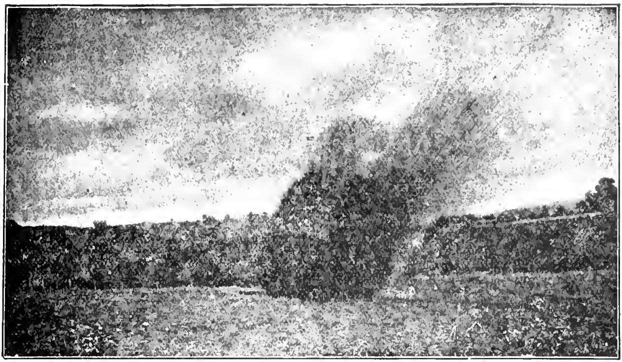
The possibility of utilizing the legumes has been known since the time of the Romans, although they did not know it was nitrogen that was thus captured. The potency of nitrogen in agriculture has been known for years and has been studied especially lately by leading agriculturists.

The wide distribution of this element in nature is remarkable. Its occurrence is universal. We may fly to the uttermost parts of the earth and it is still with us. Throughout the world it remains substantially in the same proportion to the oxygen of the air although the atmosphere is supposed to have been once all nitrogen.

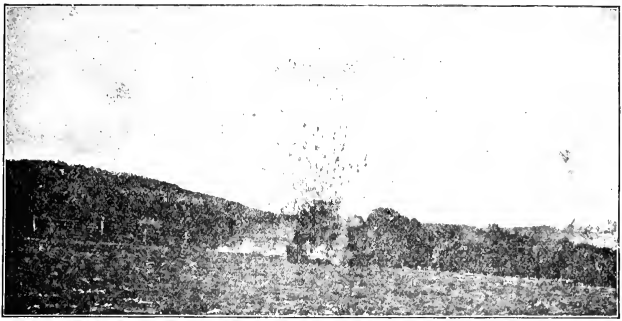
Nitrogen is found free not only in the atmosphere but in certain mineral waters and in volcanic gases. It is never absorbed by animals or plants from its elementary state except through the agency of certain soil bacteria associated with leguminous plants, and when these are located on favorable soils carrying sufficient lime in proper form.

The inactivity of elementary nitrogen is notable. Its compounds, on the other hand, frequently have pronounced and unusual properties, they being the essential components of powerful drugs, of brilliant dyestuffs and of high explosives.

In its combined form it is widely and universally distributed in the animal and vegetable kingdoms in albuminoid or proteid bodies, like the casein of milk or the gluten of wheat. Vast quantities of combined Nitrogen occur in Chile in mineral deposits; it is found combined in all arable soils; also in coal. In



Types of Characteristic Rock Shattering (1).



Types of Characteristic Rock Shattering (2).

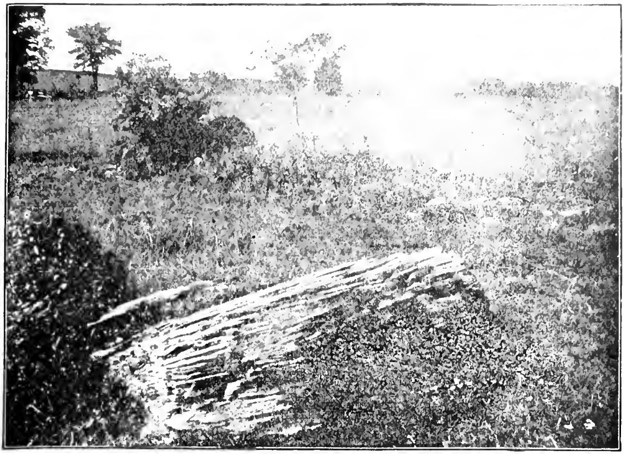
Types of Characteristic Rock Shattering (3).

each of these instances these forms are the product of bacteria or other life. The chemistry and physiology of Nitrogen is the chemistry and physiology of living things. Without Nitrogen there could be no life as we understand it. It is absolutely essential to all organized life. In view of this it is all the more remarkable how completely inert the element Nitrogen is, and how tremendously potent and active are some of its combinations.

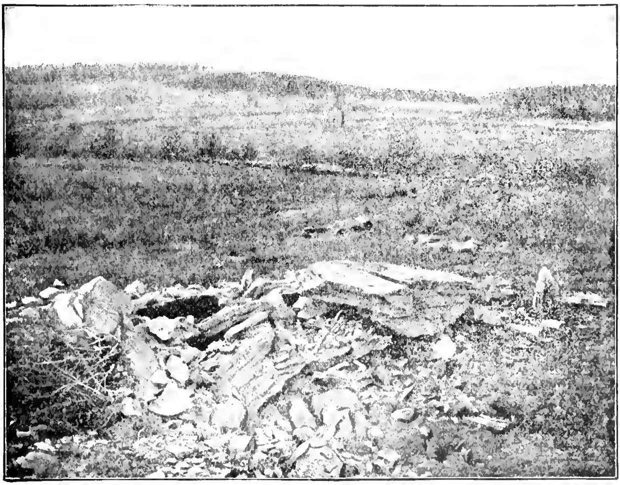
The Nitration or proper predigestion of plant nourishment cannot occur without some basic substance being present and can only best proceed at favorable summer temperatures. At these temperatures, when sufficient moisture is present, this action proceeds normally and thus prepares unavailable forms of Nitrogen for assimilation by growing crops. It cannot proceed when it is too cold or too wet. In most cases, it is the process of Nitration of the non-Nitrate forms of Nitrogen chiefly into the Nitrate form that makes them available for plant growth.

The vegetable world stores and elaborates available Nitrogen into forms suitable for animals, including man, to feed upon and the living processes of animals in turn utilize these forms of Nitrogen for their growth. Without Nitrogen there can be no growth, either vegetable or animal. The key to successful cattle feeding, as is well known, lies wholly in adjusting rations to the gluten carriers.

Nature is always prodigal and these processes while subject to natural law, permit waste from the economic standpoint. Nothing from the physical standpoint, however, is actually lost. Matter merely changes its location.



Rock Before Blasting: One Pound of 40 Per Cent. Dynamite.



Same Rock Shattered by the Explosion of Dynamite.

Nitrogen returns to the atmosphere as generally and continuously as water gravitates to the ocean and remains there accessible to those natural agencies, capable of transforming it from its completely inert form into intensely active forms immediately useful to man. On arable lands under average conditions more Nitrogen goes back to the air than is received from the atmosphere and especially when the lands are much exposed to severe wind and weathering.

A portion of our earth, namely Chile, has by accident or design been set aside as a storehouse for Nitrogen in its most available plant food form. This is capable of providing first aid and continued nourishment against nitrogen soil losses. In recent years, as our soils have become exhausted, has this use multiplied many fold here in our own country.

Looking beyond the sphere of cold dry actualities and expressing imaginative possibilities, an English writer recently suggested the breeding of a new strain of bacteria which would provide in the soil the means of securing all the Nitrogen needed for crops — drawing it thus from the atmosphere and thus greatly increasing crop production. For great populations this would be Utopia indeed. It should be pointed out, however, that bacteria capable of taking Nitrogen from the atmosphere can only thrive on soil well provided with lime, with abundance of moisture and with animal or vegetable matter in well rotted condition, also in abundance. Thus the Garden of Eden is not yet in sight and man's destiny is still to live by the "Sweat of his brow."

Thorough farm management is more important than ever — no fertilizer and no legume can ever substitute for the eye of the Master. There is no royal road to farming any more than there is to learning, but there are helps to farm management and to natural soil resources that are of advantage even to new soils. Plant food deficiencies occur in logical sequence as natural as the setting of the sun. The soil must not be treated as a mine but rather as an instrumentality for the growing of crops.

1. Without Nitrogen. 2. 1/3 Ration of Nitrogen. 3. Full Ration of Nitrogen.

All three fertilized alike with Muriate of Potash and Acid Phosphate.—R. I. Bul. 103.

Soil deficiencies occur most often as to Nitrogen, Phosphorus and Potash. Available Nitrogen is most often deficient in the soils of the Atlantic and Gulf States, but even in our Middle States low crop yields suggest the desirability of supplying available nitrogen for better crops.

According to a recent United States Department Year Book our leading crops remove from the soil much more Nitrogen than phosphorus or potash. It is comparatively easy chemically to determine the amounts of phosphorus and potash but not so easy except by practical crop growing to determine the most profitable amount of available Nitrogen required for individual locations. In the last analysis a practical trial in the field is what counts. The grower must check for himself and constantly study his condition like a business man.

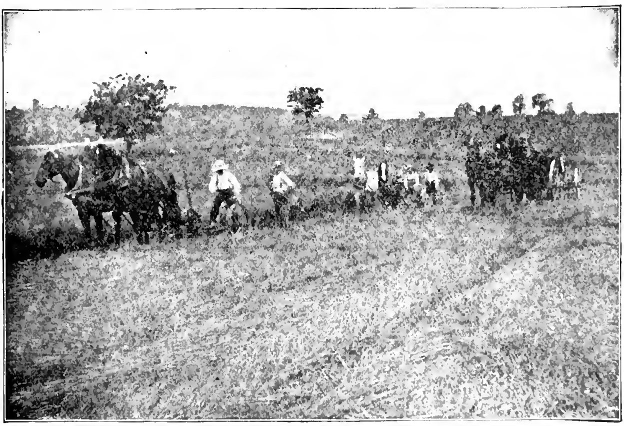
Looking at the Nitrogen subject broadly, we find that during the last quarter century the agricultural use of Chilean Nitrate has increased in this country many times faster than the use of mixed fertilizers.

Although the Chilean Nitrate industry is now nearly 100 years old, Nitrate having been first exported in 1820, there is still enough, it is estimated, to last 300 years. The fact that the use of this All-American product has increased many times faster here in our country, namely, from 16,000 tons per annum in 1899 to nearly 650,000 tons at present, whilst ordinary fertilizer consumption has not much more than doubled in the same period, is not without significance as is also the fact that in 1919 the U. S. Department of Agriculture distributed 150,000 tons of Chilean Nitrate for Agriculture use as such. This did not include what was sold to growers through the regular channels of original trade.

The production and consumption of different forms of commercial Nitrogen has increased faster than the production of phosphorus and potash during that period. From the practical side, therefore, we regard the possibilities of increased crop production from the increased use of Nitrogen as very real and very promising.

In Hawaii where more Nitrogen is used per acre than in any other part of the world, in the growing of sugar cane, the average production per acre is the

Crop of Grass Grown by the Use of Nitrate of Soda.



The Tedders follow the Mowing Machines for rapid curing of heavy crops of hay.

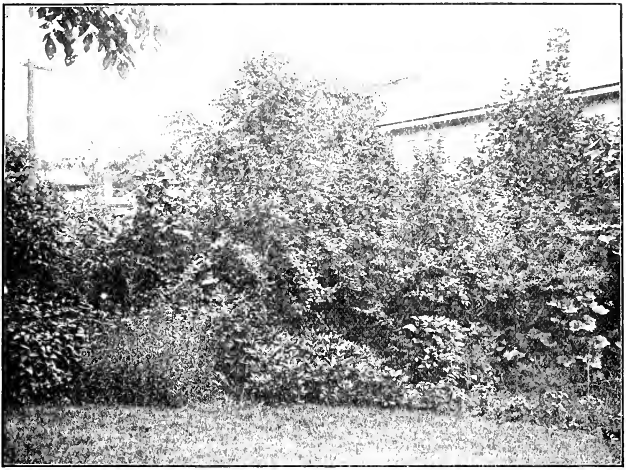
largest in the world having been 52 tons of cane per acre in 1923, and compares to an average for the world of less than one-half that amount. Our production in Louisiana is about 11 tons per acre.

A comparison of our crop yields with those of Germany has been recently made by O. E. Baker of the U. S. Department of Agriculture. The yields per acre in Germany were indicated as being nearly double those of this country. The differences are believed to be due in large measure to the greater proportions of Nitrogen used by German farmers. It is calculated * that European farmers use on an average 600 pounds per acre of a fertilizer carrying 4½ per cent. of available Nitrogen, whereas American farmers use on an average in their fertilizer practice about 300 pounds per acre of fertilizer containing about 3 per cent. of Nitrogen. The German practice is more logical since it corresponds more nearly to restoring to the soil the essential elements of fertility removed by crops and lost by means of natural agencies. Without doubt American practice is slowly approximating European practice and ultimately we shall see larger use by American farmers of available Nitrogen. Whether it will take place to a great extent by increasing the content of available Nitrogen in mixed goods or by the supplementary use of Chilean Nitrate of Soda, remains to be seen.

It is certain that our exports of cotton seed meal and cereals carry out of our country each year a vast tonnage of Nitrogen which will have to be replaced.

* A large proportion of European farmers, especially the more intelligent, use fertilizer simples in preference to mixtures. The total consumption of fertilizer simples and mixtures all told if calculated to an average would disclose an equivalent for comparison on an American basis as above indicated.

We cannot get it rapidly or universally enough from the atmosphere and unless we restore these losses our soils will become poorer and poorer and less and less productive. By the rational use of Chilean Nitrate our plantations and farms could add many thousands



Quick and Luxuriant Growth of Shrubbery, Produced in Two Seasons by the Use of Nitrate. New Jersey.

of bales of cotton and many thousands of bushels of wheat to our annual crops. The necessary Nitrate tonnage from Chile would produce corresponding outbound tonnage for our railways of increased agricultural products. The sale of the products would bring greater prosperity to our farmers and to our factories and incidentally our food supplies would be helpfully increased. The west coast of South

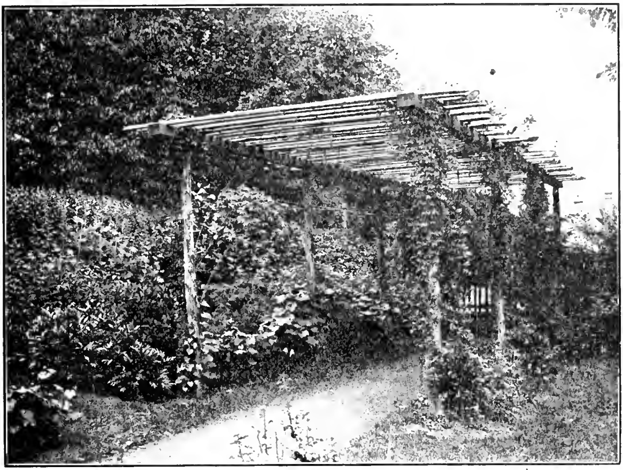
America needs the products of our manufacturers as we need the Nitrate and copper of Chile. These products of All-America thus interchanged would be of mutual and reciprocal benefit.

Thirty-four per cent. of our population now resides in our sixteen southern states — the South is becoming a region of great development. Small holdings are increasing in number.

In the early days of our country the southern states were producing more manufactured products than the rest of the country and it is conceivable that a more brilliant future is yet to come for the Southland.

The growth of railroads has developed the South more than any other single factor. In the Cotton Belt there are 96 miles of railroad to every 1,000 square miles of land compared to 79 miles for that area for the rest of the country. The South produces 58 per cent. of the American tobacco crop.

Fortunately diversification of farming is being developed and the Purnell Bill passed last winter should open opportunity and encouragement for the proper economic development of our individual farm homes. Our agricultural colleges have for years been pleading for diversification of crops. A recent official study of two million five hundred thousand cotton belt farms made by the U. S. Department of Agriculture shows that 23 per cent. have no gardens; 37 per cent. have no milk; 58 per cent. raise no sweet potatoes; 79 per cent. raise no white potatoes and 33 per cent. have no chickens. More than half of these raise no forage; 5 out of every 100 have no stock of any kind. If in any season cotton should fail, these foodless farms would be in a miserable condition and without money to buy food or the barest necessities. In such cases there is no adequate protection against single crop failures. In past years farms at least provided the planter with most of the food his family required. The "Live at Home" project now advo-



Privet Hedge at Left and Vines Showing Result of One Year's Use of Nitrate. New Jersey.

cated by our agricultural authorities is a most commendable one.

Crop rotations which include legumes, give the soils both humus and Nitrogen, ultimately, and in such soils bacteria destructive to Nitrogen compounds of the soil do not thrive so vigorously.

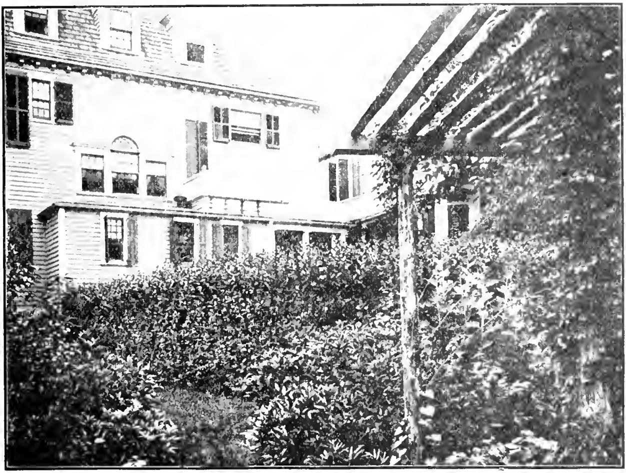
The growing of legumes wherever conditions are favorable and the saving of manures are both to be encouraged. These alone, however, are not sufficient to make up for the great losses of Nitrogen that occur every year through weathering, through denitrating bacteria and crop removals.

It is to be borne in mind that there is not enough Nitrogen in commercial form produced in the world to make up for these annual soil losses, and that the soils of the world will require available Nitrogen in commercial form in increasing quantities. This, in my judgment, is consistent with sound agriculture, and the fertilizer industry is as sound fundamentally as agriculture itself.

It may be borne in mind also that the rate of production of Nitrogenous fertilizers has increased throughout the world as a whole faster than have the other fertilizer products.

It is a source of great satisfaction to know that programs for agricultural progress as proposed by Experiment Stations and Agricultural Colleges have been accepted by railway agricultural representatives and carried out so thoroughly by them in co-operation with agents and with the Agricultural Press. Co-operation along the line of these programs will make for agricultural success in the future. The Agricultural and Industrial Departments of our railways have by their courage and skill played a highly honorable and effective part in these developments.

In passing it should be noted that in the most highly civilized parts of the world railway development is the highest. Before the railroads all industrial development was local. Every community was like China—hermit-like, undeveloped and obliged to be self-sustaining. Early last century an all-land haul of 500 miles from Philadelphia to Pittsburg on a ton of goods cost $125.00. Europe and the U. S. have more railway mileage than any other portions of our earth. The highly organized economic devel-



Hedge of California Privet Three Years Old, Fertilized for Three Years with Nitrate. New Jersey.

opment of these portions of our globe has been most remarkable. To a large extent it has been in proportion to the development of transportation facilities.

The railway man has an opportunity for observation wider by far than the average citizen and his views by virtue of this opportunity are bound to be broadminded. His opportunities for service are therefore unusual in respect to public relations.

Your attitude towards the unenforceable obligations in your sphere of action has been fine and admirable. Your service has been unstinted. Your work more than any other agency has put souls into the bodies of corporations.

The test of an institution or of a corporation or of a nation lies in its attitude toward the unenforceable obligations of life. I do not mean merely in respect to the attitude towards "scraps of paper." All of us here are aware of the obligations of the written word, but what is our attitude toward the unenforceable? One of the oldest treaties in this country was between William Penn and the Indians.

This was never sworn to and never broken, but it worked admirably.

The measure of a man in all his relations in life is his attitude towards his unenforceable obligations. In our hearts we know that the communities we serve will measure us by it.

GRADES OF HAY AND STRAW.

Adopted by the National Hay Association.

Hay.

No. 1 Timothy Hay: Shall be timothy with not more than one-eighth (1/8) mixed with clover or other tame grasses properly cured, good color, sound and well baled.

Standard Timothy: Shall be timothy with not more than one-eighth (1/8) mixed with clover or other tame grasses, fair color, containing brown blades, and brown heads, sound and well baled.

No. 2 Timothy Hay: Shall be timothy not good enough for No. 1 not over one-fourth (1/4) mixed with clover or other tame grasses, fair color, sound and well baled.

No. 3 Timothy Hay: Shall include all hay not good enough for other grades, sound and well baled.

Light Clover Mixed Hay: Shall be timothy mixed with clover. The clover mixture not over one-third (1/3) properly cured, sound, good color and well baled.

No. 1 Clover Mixed Hay: Shall be timothy and clover mixed, with at least one-half (1/2) timothy, good color, sound and well baled.

Heavy Clover Mixed Hay: Shall be timothy and clover, mixed with at least one-fourth (1/4) timothy, sound and well baled.

No. 2 Clover Mixed Hay: Shall be timothy and clover mixed with at least one-third (1/3) timothy, reasonably sound and well baled.

No. 1 Clover Hay: Shall be medium clover not over one-twentieth (1/20) other grasses, properly cured, sound and well baled.

No. 2 Clover Hay: Shall be clover sound, well baled, not good enough for No. 1.

Sample Hay: Shall include all hay badly cured, stained, threshed or in any way unsound.

Choice Prairie Hay: Shall be upland hay of bright, natural color, well cured, sweet, sound, and may contain 3 per cent. weeds.

No. 1 Prairie Hay: Shall be upland and may contain one-quarter (1/4) midland, both of good color, well cured, sweet, sound, and may contain 8 per cent. weeds.

No. 2 Prairie Hay: Shall be upland, of fair color and may contain one-half midland, both of good color, well cured, sweet, sound, and may contain 12½ per cent. weeds.

No. 3 Prairie Hay: Shall include hay not good enough for other grades and not caked.

No. 1 Midland Hay: Shall be midland hay of good color, well cured, sweet, sound, and may contain 3 per cent. weeds.

No. 2 Midland Hay: Shall be fair color or slough hay of good color, and may contain 12½ per cent. weeds.

Packing Hay: Shall include all wild hay not good enough for other grades and not caked.

Sample Prairie Hay: Shall include all hay not good enough for other grades.

Straw.

No. 1 Straight Rye Straw: Shall be in large bales, clean, bright, long rye straw, pressed in bundles, sound and well baled.

No. 2 Straight Rye Straw: Shall be in large bales, long rye straw pressed into bundles, sound and well baled, not good enough for No. 1.

No. 1 Tangled Rye Straw: Shall be reasonably clean rye straw, good color, sound and well baled.

No. 2 Tangled Rye Straw: Shall be reasonably clean, may be some stained, but not good enough for No. 1.

No. 1 Wheat Straw: Shall be reasonably clean wheat straw, sound and well baled.

No. 2 Wheat Straw: Shall be reasonably clean, may be some stained, but not good enough for No. 1.

No. 1 Oat Straw: Shall be reasonably clean oat straw, sound and well baled.

No. 2 Oat Straw: Shall be reasonably clean, may be some stained, but not good enough for No. 1.

Alfalfa.

Choice Alfalfa: Shall be reasonably fine leafy alfalfa of bright green color, properly cured, sound, sweet, and well baled.

No. 1 Alfalfa: Shall be reasonably coarse alfalfa of a bright green color, or reasonably fine leafy alfalfa of a good color and may contain 2 per cent. of foreign grasses, 5 per cent. of air bleached hay on outside of bale allowed, but must be sound and well baled.

Standard Alfalfa: May be of green color, of coarse or medium texture, and may contain 5 per cent. foreign matter; or it may be of green color, of coarse or medium texture, 20 per cent. bleached and 2 per cent. foreign matter; or it may be of a greenish cast of fine stem and clinging foliage, and may contain 5 per cent. foreign matter, all to be sound, sweet, and well baled.

No. 2 Alfalfa: Shall be of any sound, sweet and well baled alfalfa, not good enough for standard, and may contain 10 per cent. foreign matter.

No. 3 Alfalfa: May contain 35 per cent. stack-spotted hay, but must be dry and not to contain more than 8 per cent. of foreign matter; or it may be of a green color and may contain 50 per cent. foreign matter; or it may be set alfalfa and may contain 5 per cent. foreign matter, all to be reasonably well baled.

No grade Alfalfa: Shall include all alfalfa not good enough for No. 3.

The Alfalfa, Cow Pea and Clover Question.

This class of plants has the property of taking inert Nitrogen from the air and transforming it into combinations more or less useful as plant food. This feature is of great value to agriculture, but not so much from the plant food point of view as from the fact that these plants are rich in that kind of food substance commonly called "flesh formers." Liberally fertilized, and not omitting Nitrate in the fertilizer, we have a crop containing more nitrogenous food (protein or flesh formers) than the Nitrogen actually given as fertilizer could have made by itself.

The most common plants of this class are: Alfalfa, alsike clover, crimson clover, red clover, Japan clover, cow peas, lupines, Canadian field peas, the vetches, etc. All these forage crops should be sown after clean culture crops. The best method of fertilizing is to apply from 300 to 500 pounds of fertilizer early every autumn; in the spring broadcast 200 pounds of Nitrate of Soda, and repeat with about 100 pounds after each cutting. It is true that clovers ***may*** supply their own nitrogenous plant food, but this is an experiment experienced farmers do not often repeat. A fair green crop of clover, for example, removes from the soil some 160 pounds of Nitrogen, while in 500 pounds of Nitrate of Soda there are less than 100 pounds. Undoubtedly, the Nitrogen taken from the air is a great aid, but we should not expect too much of it. The method of seeding clovers depends much upon locality and soil needs with reference to previous crops. Crimson clover and Canadian field peas are usually sown in August, after earlier crops have been removed, or even in corn fields. Red clover is commonly sown in the spring on wheat or with oats.

WHEAT.

The soil for this grain, fall planting, ranges from a clay loam to a moderate sandy loam. For spring wheat, moist peaty soils are used. Wheat is usually grown in rotation, in which case it nearly always follows corn, or a clean culture crop. The nature of cultivation is too well known to require mention here.

Both spring and winter wheat are commonly fertilized crops, particularly the latter. The average fertilizer for wheat should contain Nitrogen, phosphoric acid and potash. This fertilizer is applied with the

Wheat.

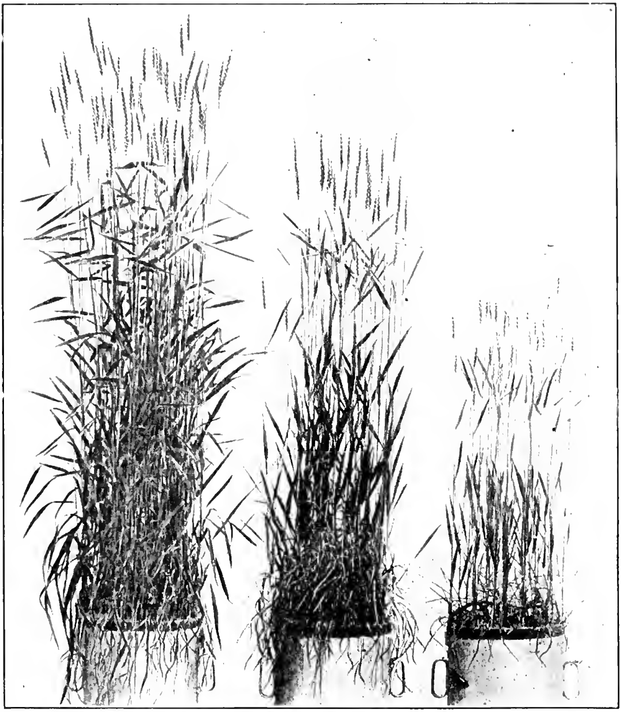
Wheat — 14 Bushels.
Average product per acre for the U. S. of wheat with average farm fertilization.

Wheat — 37 Bushels.
The product of an acre of wheat fertilized with Nitrate of Soda, Phosphates and Potash.

seed, and at the rate of 500 pounds to the acre. Nitrate of Soda is also applied broadcast as a dressing, soon after the crop shows growth in the spring, at the rate of 100 pounds per acre. Like all grains, wheat should have its Nitrate plant food early, and in the highly available, easily digested nitrated form, such as is only to be found commercially as Nitrate of Soda.

The plant food needs of a crop of 30 bushels of wheat per acre amounts to about 70 pounds of Nitro-

Fertilizer Experiment with Wheat.



Phosphoric Acid and Potash with 1 oz. Nitrate of Soda. Yield: $3\frac{1}{5}$ oz. Grain.	Phosphoric Acid and Potash with $\frac{1}{4}$ oz. Nitrate of Soda. Yield: $1\frac{1}{2}$ oz. Grain.	Phosphoric Acid and Potash without Nitrate of Soda. Yield: $\frac{1}{2}$ oz. Grain.

gen, 24 pounds of phosphoric acid, and 30 pounds of potash; this includes the straw, chaff and stubble. One hundred pounds of Nitrate of Soda supplies about 15 pounds of Nitrogen, so that the quantity mentioned for application is a minimum quantity. Much has been said of legume Nitrogen for wheat, the crop being generally grown in rotation. Whatever Nitrogen the clover may have gathered, a crop of timothy and a crop of corn must be supplied before the wheat rotation is reached. In all cases where the acre yields have fallen off, a broadcast dressing of Nitrate of Soda should be given.

Drill in with the wheat in the fall a mixture of 150 pounds of acid phosphate and 50 pounds of Nitrate of Soda per acre. If your land is sandy, add 50 pounds of sulphate or muriate of potash to the above. Early in the spring, sow broadcast 50 more pounds of Nitrate of Soda per acre.

Land sown to wheat in the fall and seeded down with timothy and clover giving a heavy crop, followed by a heavy hay crop the following year, proved the beneficial after-effect of the Nitrate and that the Nitrate had not leached away as so many critics claim, and further that the soil had not been exhausted.

Professor Massey writes in regard to the effect of Nitrate of Soda on Wheat, as follows:

"I have made several experiments with Nitrate of Soda. The first was on wheat in Albemarle County, Virginia. I used 200 pounds per acre on part of the field which had been fertilized with 400 pounds acid phosphate in the fall. The result was 9 bushels per acre more than on the rest of the field, and a stand of clover, while none of any account stood on the rest of the field."

Instructions for Using Nitrate of Soda on Wheat.

As soon as frost leaves the ground in the spring, apply the Nitrate of Soda by broadcasting it evenly, by hand or by machine, over the entire surface of the wheat field you are fertilizing, at the rate of 100 pounds per acre, which is equal in bulk to one bushel.

Formula for Wheat.

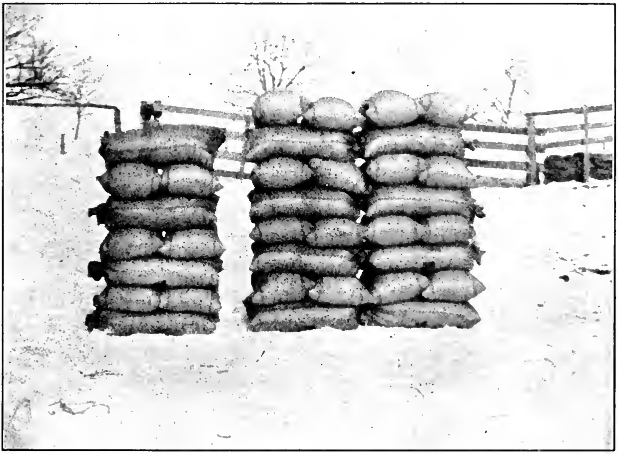
Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	150 lbs. per acre
Acid Phosphate	150 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate or muriate of potash to the acre every other year.

OATS.

This grain does well on nearly all types of soil, but responds freely to good treatment. There is a vast difference in the quality of oats when grown on poor or rich soils. Perhaps no other crop so effectually conceals impoverishment; at the same time the feeding value of oats grown on poor soil is very low. In the North oats are sown in the spring, and usually after corn or a turned down clover sod. In such cases the crop is rarely ever given fertilizer, but shows an excellent return from a broadcast dressing of 100 pounds of Nitrate of Soda per acre. The crop has strong foraging powers, and will find available mineral plant food where a wheat crop would utterly fail. On soils pretty badly exhausted, an application of 400 pounds of fertilizer will yield a profitable return,

Oats.



30 Bushels.	65 Bushels.
Average product per acre, for the U. S. of oats, with average farm fertilization.	The product of an acre of oats fertilized with Nitrate of Soda.

provided the dressing of Nitrate is not omitted. Under any condition of soil or fertilizing, a sickly green color of the young crop shows need of Nitrate of Soda plant food, and the remedy is a dressing of Nitrate. In seeding, use two or three bushels to the acre.

Autumn dressings of Nitrate are used frequently in Europe, and in connection with minerals a dressing of as much as three hundred (300) pounds of Nitrate per acre is used annually.

Instructions for Using Nitrate on Oats.

As soon as you sow the oats in the spring, apply the Nitrate of Soda by broadcasting it evenly, by hand or machine, over the entire surface of the oat field at the rate of 100 pounds per acre. In bulk this is equal to about one bushel.

Formula for Oats.

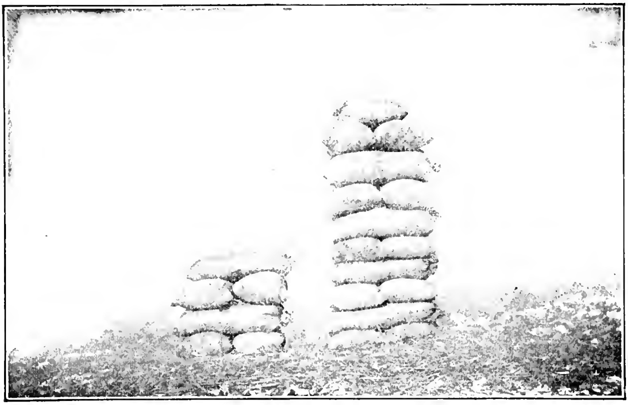
Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	150 lbs. per acre
Acid Phosphate	150 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate or muriate of potash to the acre every other year.

RYE.

This is another illustration of the necessity of care in the use of fertilizer Nitrogen. Rye does best on light soils so long as they are not too sandy, but if the soil is rich in vegetable matter, or if a fertilizer is used containing much organic ammoniate, the grain yield will be disappointing; the crop fails to mature in season because the nitration of organic Nitrogen or humus is generally greatest during the warm days of midsummer, and a constant supply of available Nitrate is being furnished at a time when the crop should commence to mature. The crop needs Nitrate, but it should be supplied during the earlier stages of growth. Use at first a general fertilizer, 500

Rye



Rye — 18 Bushels.
Average product per acre for the U. S. of rye with average farm fertilization.

Rye — 36 Bushels.
The product of an acre of rye fertilized with Nitrate of Soda, phosphates and potash.

pounds per acre. As soon as the crop shows growth, in the spring apply 100 pounds of Nitrate of Soda to the acre, broadcast.

Instructions for Using Nitrate of Soda on Rye.

Just as soon as growth starts in the spring, or a little earlier if possible, apply the Nitrate of Soda by broadcasting it evenly, by hand or by machine, over the entire surface of the rye field you are fertilizing, at the rate of 100 pounds per acre, which is equal in bulk to one bushel.

Formula for Rye.

Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	150 lbs. per acre
Acid Phosphate	150 lbs. per acre

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate or muriate of potash to the acre every other year.

BUCKWHEAT.

This crop does well on almost all kinds of soil, but should follow a grain or hoed crop — that is, a clean cultivation crop. On thin soils use about 400 pounds of general fertilizer to the acre, applied just before seeding, or even with the seed. Heavy soils do not require fertilizing for this crop, as it has exceptional foraging powers, and will find nourishment where many grain crops would starve. As soon as the plants are well above ground, broadcast 100 pounds of Nitrate of Soda per acre, both on strong and light soils. Use one bushel of seed per acre on thin soils, but a heavier application on richer soils.

In many places in Europe the cereals, like oats and wheat, are planted or sown in rows and cultivated as we cultivate Indian corn. It is claimed that this increases yield materially, and helps to avoid lodging; it also requires less seed per acre.

Buckwheat.

No Nitrate.
Yield, 19 bushels per acre.

Fertilized with 125 lbs. Nitrate of Soda per acre.
Yields: 38 bushels per acre.

Another method in vogue is to sow less seed per acre broadcast and use more fertilizer, so that the individual stalks are stronger and bigger.

ORANGE GROVES IN FLORIDA.

An orange that weighs a pound would sell in New York for a dime. When it takes as many as six to weigh a pound they are almost worthless.

Results at Highgrove.

Yields of 3 plots of equal size.

4 Boxes Oranges with no Fertilizer.	9 Boxes Oranges Fertilized with Acid Phosphate Alone.	15 Boxes Oranges Fertilized with Nitrate of Soda and Acid Phosphate.

Satisfactory results have been obtained in Florida by fertilizing during the cold season. About two months before the period of growth begins, apply to each full-grown tree a mixture of 7 pounds of 14 per cent. acid or superphosphate and 4 pounds of sulphate of potash, by working them into the soil; after which 4 pounds of Nitrate of Soda may be likewise applied. The working of the soil must not be so deep or thorough as to start the growth of the tree. An excess of Nitrate is to be avoided, but the amount mentioned is not too much. Nitrate of Soda is a predigested Nitrogen. There is a danger of loss of Nitrogen in other forms as they must generally be made available as food, and during this comparatively long process much of it may be lost by rains and leaching, since they suffer in fact from many days of long exposure to the adverse condition.

In the case of your particular soil, it may well be that it is sufficiently rich in potash, and therefore, may not require a large application of it. In any event, the grower must be governed by the condition of his grove and the general character of soil and climate in his particular locality.

The early decay of orchards as well as failure to set fruit buds, is largely a matter of lack of plant food. Orchards should have Nitrate, applied early in the season, as late supplies of Nitrogen are liable to cause a heavy setting of leaf buds at the expense of next year's fruit. The ordinary ammoniates are not satisfactory for orchard work, as they continue to supply available ammonia all through the season; not enough in the early part of the year to properly set the fruit, hence severe dropping; too much late in the year when none is needed and which causes the formation of leaf rather than fruit buds. The soil between the trees should be regularly tilled, much as in corn growing. That it is not generally done is no argument against the value of such cultivation methods.

How It Was Done at Corona, California.

The rows were trenched eight inches deep, just outside the drip of the trees, and the fertilizers spread in the trench opposite the whole width of each tree. This was done on two sides of each row in the same direction, then covered by the plow. This, the only plowing, was done on March 7, 1918. The application of fertilizers in trenches is found to give the best results in the orange groves of this section.

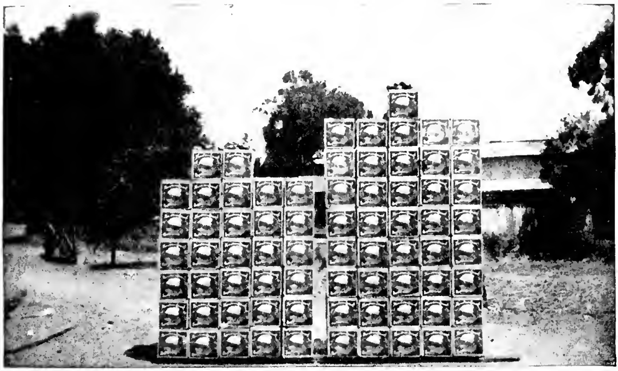
Six after-cultivations to a depth of five or six inches were given. These six cultivations were made during the fore part of each of the months of March, April, May, June, July and August. The March cultivation consisted of a thorough disking. The other five cultivations were made with the ordinary orchard cultivator.

The above trench fertilizing was done parallel with irrigation furrows up one side and down the other, nothing being applied on the other two sides. This has given good results and the above method is recommended to California citrus fruit growers.

Citrus Growing in California.

The one-tenth of an acre plot of orange trees at Corona fertilized with Nitrate of Soda and acid phosphate at the rate of 320 pounds of each per acre yielded at the rate of 411 boxes of high quality fruit. A plot alongside fertilized without Nitrate gave a rate of yield of only 322 boxes per acre of inferior fruit. ***This difference of yield of 89 boxes per acre due to the use of Nitrate shows an increase in value***

Results at Corona.



32.2 Boxes Oranges. Yield of 1/10 acre fertilized with Acid Phosphate alone.

41.1 Boxes Oranges. Yield of 1/10 acre fertilized with Nitrate of Soda and Acid Phosphate.

of produce equivalent to $324.85. Each 100 pounds of Nitrate of Soda used in this case added a rate of profit to the grower's income of $101.52 per acre.

The best source of Nitrogen for citrus fruits is Nitrate of Soda, because of its instant availability. Growth is promoted at once after application is made. It is taking chances to apply any nitrogenous fertilizer not immediately available because of the tendency to prolong growth unduly and to delay maturity; and it is fatal to apply high grade fertilizers too late. In California on alkaline soils or soils having alkaline tendencies the application of Nitrate of Soda with an equal quantity of acid phosphate or superphosphates tends to diminish black alkali present.

Instructions for Using Nitrate on the Citrus in California.

Under ordinary conditions in California — for full-grown orange trees — we advise applying Nitrate early in March or even the middle of February, and following the application immediately after by disking or harrowing in the material to the depth of five or six inches.

When it is used alone, Nitrate may be used at the rate of two hundred (200) pounds to the acre.

It can be used more profitably at the rate of four hundred (400) pounds to the acre if four hundred (400) pounds of dry acid or superphosphate be used with it. Both materials should be dry.

Four hundred pounds of Nitrate is equal in bulk to about four bushels.

We believe the second procedure is the more profitable as a rule, and we have no hesitation in recommending it in preference to the use of Nitrate alone. The earlier the application, the better the results.

After plowing in the material in February, the orchard should be cultivated every thirty (30) days until August, preferably in the fore part of each month. The last cultivation is done best by a disk harrow.

Formulas for full-grown citrus trees in tabular form are as follows:

	Rates per Acre
Nitrate of Soda alone..........	200 lbs.
or preferably	
Nitrate of Soda...............	400 lbs.
Acid, or Superphosphate.......	400 lbs.

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

These formulas it is believed will also be found very satisfactory for both full-grown lemon trees and full-grown grapefruit.

SOILS AND OTHER FACTORS IN RELATION TO CROP PRODUCTION IN CALIFORNIA.

The use of Chilean Nitrate is increasing year by year in England, and it is coming to be more and more appreciated there, as well as on the continent of Europe.

In fact, everywhere in the world where there is progressive and enlightened experiment work, the unique qualities of Chilean Nitrate are putting it ahead of every other nitrogenous plant food. No reputable authority in the world has ever advocated such large quantities of Chilean Nitrate per acre as would result in any abnormal accumulation of alkali. Moreover, the use of acid phosphates, associated as they are commercially with sulphate of lime, converts any black alkali residue into harmless forms of soda. The vast majority of soils in the United States, probably 95 per cent., have a tendency to grow acid rather than to grow alkali; and Chilean Nitrate is, therefore, highly beneficial in such cases.

The use of potash salts tends to leave acid residuals, and when phosphates and potashes are used rationally, and in quantities suitable for normal plant feeding, the question of Chilean Nitrate leaving abnormal amounts of alkaline residues becomes a purely fanciful one, and is not worthy of the serious attention of a practical business horticulturist or farmer.

In all our literature, the rational and not the irrational use of fertilizers is recommended, i. e., normal amounts of the three elements of fertility. The use of Chilean Nitrate alone is not recommended except at the rate of 100 or 200 pounds per acre, which is a trifling tonnage application; and we always advise when larger amounts are used, that the horticulturist or farmer use as much in quantity of acid phosphate.

The vast majority of farm lands of our country, where so-called "Complete" fertilizers have been used, have the tendency to become sour and acid; and Chilean Nitrate could not only be used indefinitely with an extremely beneficial effect in this particular connection, but there is an immediate general need for it.

An acre of ground one foot deep is the active service part of the soil, and, to a large extent, its chemical composition determines its usefulness. This service soil weighs on an average 2,000 tons per acre.

There is enough sulphate of lime or gypsum present, as well as acid, in the average acid phosphate, to materially help the black alkali of many alkaline soils, but gypsum alone may be used also for correcting alkali.

Since we never recommend the use of Chilean Nitrate alone, except at the rate of from one hundred to two hundred pounds per acre, this relatively small amount could have no material influence whatever in increasing the alkali content of soils. The continued use of Nitrate under rational methods of fertilizing, would not add to, but rather diminish the quantity of alkali in the soil. The associated gypsum and acid phosphate thus used would tend to loosen heavy clay soils which need improvement in texture and the acid residues from these materials would likewise benefit alkaline soils.

In this connection, it is important to observe that care must be exercised, in soils containing black alkali, to avoid materially increasing the content of carbonate or bi-carbonate of lime, since this would help promote the destruction of humus. It is, therefore, suggested for these particular soils, that the large and constant use of lime be avoided. When lime is needed, have your soil examined by an expert, and do not put on any more lime in any form than advised for your particular case. In other words, take good care to preserve your humus. Do not destroy it by excessive liming on any account. Neither wetness nor stickiness will result from the rational use of Chilean Nitrate. The productivity of all soils may be increased by the right use of it.

All arid soils lack Nitrogen on account of having but little natural humus in them, hence the application of Chilean Nitrate should give profitable crop increases.

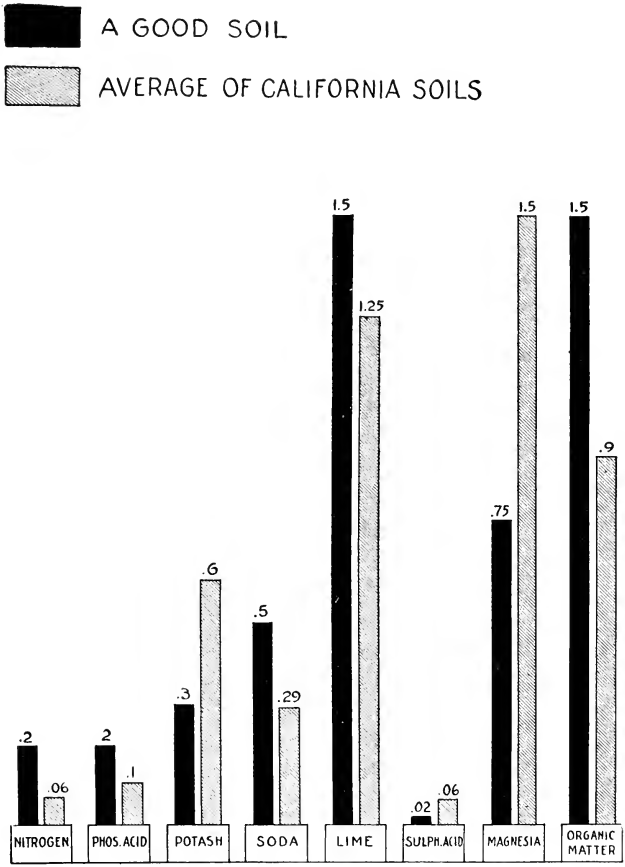


CHART NO. 1

Figures on California soils taken from Hilgard's Book on Soils, and from R. R. Snowden. Figures on elements necessary in an excellent soil taken from the average of many authorities in both United States and Europe.

SOME "CONCRETE FACTS ON FERTILIZATION" IN CALIFORNIA.

Taken from "Data compiled by Nitrate Fertilizer Company, Inc., Los Angeles, California."

Explanation of Chart No. 1, on Soils.

This chart is presented to show the elements that should be in the soil and their relation to one another. It is contrasted with the average of a great number of soil analyses taken in various agricultural centers in California. The chart is not intended to show any actual existing condition, but is merely a guide to show in a general way what elements are sufficient in the soil and what elements need to be applied to the soil. The grower's individual soil analysis may be profitably compared with this chart, which will show in a fairly accurate measure any deficiencies that may occur in a specific case.

This chart shows the total elements in the soil — not taking into consideration the availability — hence the greatest value of this chart is to show the relation of one element to another. The soil may contain 3 per cent lime and the plant suffer from lack of lime, due to the fact that the lime is in an unavailable form.

It would be impracticable to determine the average relation of available plant food to unavailable plant food because of the extreme variances encountered. However, in individual cases this may be determined to a fair degree of accuracy by a study of the past performance and treatment of the soil together with a soil analysis.

This chart points out the necessity of first building up the soil to contain a sufficient amount and relation of elements. After this has been accomplished, then comes the problem of proper fertilization, which can be successfully based on some ratio of what the crop being grown takes out of the soil, at the same time considering the necessity of supplying elements to the soil in a proportion that will keep the soil in a perfect balance for continual maximum production.

Table of Chart No. 1.

	Nitrogen	Phos. Acid	Potash	Soda	Lime	Sul. Acid	Mag.	Organic Matter
An excellent soil...	.2	.2	.3	.5	1.5	.02	.75	1.5
Average Calif. soil..	.06	.1	.6	.29	1.25	.06	1.5	.9

What Various Crops Take Out of the Soil in Pounds per Acre.

Crops	No. lbs.	Nitrogen	Phos. Acid	Potash
Apples	17,000	22.10	1.70	32.30
Apricots	16,000	30.40	9.60	46.40
Blackberries (ea. 1 ton produced)	.....	3.00	1.80	4.00
Cranberries (ea. 1 ton produced)	.....	3.10	.60	1.80
Currants (ea. 1 ton produced)	.....	3.10	2.20	5.40
Almonds	1,200	8.43	2.45	11.94
Cherries	8,000	18.32	5.76	22.16
Grapes	14,000	22.40	12.60	37.80
Lemons	22,800	34.20	13.68	61.56
Oranges	17,500	27.13	11.38	60.38
Olives	4,000	7.20	4.80	34.40
Peaches	16,000	16.00	8.00	38.40
Pears	20,000	18.00	6.00	16.60
Plums	12,000	21.60	2.40	28.80
Prunes	6,000	9.60	4.20	18.60
Raspberries (ea. 1 ton produced)	.....	3.00	9.60	7.00
Strawberries (ea. 1 ton produced)	.....	3.00	2.20	6.00
Walnuts	1,500	8.10	2.10	12.27
Asparagus	5,000	20.00	6.00	37.50
Cabbage	30,000	114.00	33.00	129.00
Onions	30,000	42.00	12.00	30.00
Peas	7,000	250.60	58.80	70.70
Potatoes (White)	15,000	31.50	10.50	43.50

Crops	No. lbs.	Nitrogen	Phos. Acid	Potash
Potatoes (Sweet)	10,000	24.00	8.00	37.00
Tomatoes	40,000	64.00	20.00	108.00
Lettuce	aver. crop	41.00	17.00	71.00
Cantaloupes (est.)	aver. crop	57.00	16.00	100.00
Barley	2,500	44.00	20.50	13.50
Corn	2,000	37.40	14.00	8.00
Oats	1,200	24.72	9.84	7.44
Rice	3,500	37.80	6.30	3.15
Sorghum	2,500	37.00	20.25	10.50
Wheat (Spring)	1,200	28.32	8.40	4.68
Sugar Beets	40,000	173.40	116.16	387.44
Cotton (total crop)	1 bale	64.35	22.37	51.33

EXPLANATION

This table does not include all the elements or plant foods, required by various crops, such as lime, soda, sulphur, etc., which are just as important, even though required in some cases in lesser amounts. Whereas we have searched practically all sources of available information, we have been unable to secure complete or authentic information on the quantities of plant foods required by plants other than Nitrogen, Phosphoric Acid and Potash. Incomplete figures show that as a general rule lime is required in quantities similar to potash, and soda similar to phosphoric acid.

With regard to fruits, the crop only has been considered, as no complete information is available on the quantities of plant food required by the leaves and wood, but it is known that they require as much, if not more, plant food than the crop. The leaves and wood require more nitrogen in proportion to other elements than taken out by the crop.

The above figures are based upon the finding of the University of California Agricultural Extension Service, Myers "Food for Plants," for Cotton—Alabama Experiment Station.

Green Manure.

The growing of legume cover crops is one of the most economical forms of supplying the necessary organic matter. Nitrogen is also supplied by legumes in two ways: First, through the Nitrogen constituent in its roughage which is plowed under; second, through the Nitrogen formed in nodules on its roots.

According to "Feeds & Feeding" by Henry the average Nitrogen content in the green roughage of legumes is one-half of one per cent. In regard to the amount of Nitrogen supplied from the nodules formed on the roots it is practically impossible to figure this correctly as it depends upon the root structure of the plant and the quantity of nodules formed. Also when figuring the Nitrogen value of legumes it must be taken into consideration that legumes take Nitrogen from both the soil and the air.

As soil Nitrogen becomes available it is taken up by the legume and is turned back to the soil in the form of organic Nitrogen which requires to be decomposed before it can again be used as plant food. In this transaction 63 per cent of original soil Nitrogen is lost. Legumes, however, take Nitrogen from the air and by so doing offset this loss of soil Nitrogen and supply a small amount of organic Nitrogen in addition.

It must be remembered that the main value of cover crops is the organic matter they supply. The Nitrogen can be supplied and in a more available and economical form.

There are two main divisions of cover crops: Summer cover crops, which should be of the shallow root variety, and winter cover crops which are of the deep rooting variety.

Summer cover crops should be plowed in before the second week in July. After that time they will compete with the fall growth of the trees—a dangerous thing when quality and maximum production is desired. This is also true of winter cover crops, which should be plowed under by the first of March.

Grain cover crops are not desirable as they directly compete with the trees. Wild oats do harm.

Irrigation furrows should be constructed so they are not as deep as the plowed under cover crop. This allows the water to carry the food to the roots.

Functions of Nitrogen.

1. Develops wood growth, insuring healthy, strong trees.

2. Develops leaf growth, making healthy leaves of a dark green color, which enables the plant to take in the necessary supply of carbon dioxide.

3. Promotes quantity, quality and good-sized vegetables.

4. Makes up the tissues of the fruit, thus insuring a good size.

5. Most of the essential Nitrogen is taken up by the plant at an early period in the growth, hence early applications of Nitrogen hasten maturity, and late and too great applications tend to retard maturity by forcing leaf and wood growth at a time when the plant should be concentrating on developing and sweetening its fruit.

Analysis of Various Nitrogenous Fertilizers.

Nitrate of Soda 15½% Nitrogen, 25% Sodium. Recovery of Nitrogen by crop, 62½%.

Nitrate of Lime 12% Nitrogen, 26% Calcium. Recovery of Nitrogen by crop, 62½%.

Sulphate of Ammonia 20½% Nitrogen, 22% Sulphur. Recovery of Nitrogen by crop, 47½%.

Dried Blood 13½% Nitrogen. Recovery of Nitrogen by crop, 38½%.

Fish Meal (average) 8½% Nitrogen, 4% available Phosphoric Acid. Recovery of Nitrogen by crop, 38½%.

Tankage and "Brand" or Mixed Fertilizers are taken up later.

The average Nitrogen recovery by crop is 38½% in tankage.

The average Nitrogen recovery by crop is 40% to 50% in mixtures, according to the sources of Nitrogen.

Nitrate of Soda.

It is not necessary to use Potash with Nitrate of Soda in California, as it is a proven and accepted fact that Soda releases unavailable Potash from the soil. California soils average extremely high in Potash and low in Soda, hence applications of Nitrate of Soda are generally beneficial in balancing the bases and making available Potash — thus supplying a necessary plant food. In 400 pounds of Nitrate of Soda there is 146 pounds of Soda. The average crop requires from 40 to 100 pounds of Soda and 60 pounds will be required and dispelled in releasing Potash.

For example, refer to R. R. Snowden's work dated October, 1923, wherein he quotes the University of California as follows: "According to California Bulletin No. 93, page 37, a crop of 12,800 pounds of Oranges per acre, equivalent to about 2 boxes per tree, will take out 46.7 pounds of Soda. Ninety-two pounds of Potash required by this crop will require 60.5 pounds of Soda to release it from the silicates, whereby this amount of Soda becomes practically insoluble. Then, according to the same authority, the tree body and leaves contain a larger percentage of Soda in the ash and more ash than the fruit does. According to this estimate, there can be no possible sodium residue."

Through the use of Nitrate of Soda the effect of over-nitration is practically impossible, as the Soda element releases unavailable Potassium, which in a balanced soil insures the fruit of a fine texture, a thin skin and sweet flavor.

The Nitrogen in Nitrate of Soda is in a plant food form, which permits the application of Nitrogen at the time the plant requires the food. There is no danger of the Nitrogen becoming available at too late a date, which will cause delay in maturity, a forced growth, with a resultant poor quality and sour fruit.

Nitrate of Lime.

When used with superphosphate especially, this combination is not as good a balance as Nitrate of Soda, as there will be an unbalance between bases. In certain cases calcium is very essential, but can be supplied to the soil in the form of calcium carbonate much more economically and effectively. The calcium, of which there is 105 pounds to each 400 pounds of nitrate of lime, is in a soluble form. Calcium or lime does not release potash from the soil, therefore potash must be added, as it is an essential plant food. The crop recovery of Nitrogen is the same from nitrate of lime as from Nitrate of Soda (62 per cent). It will take 515 pounds of nitrate of lime to supply the same amount of Nitrogen contained in 400 pounds of Nitrate of Soda.

Gypsum.

Gypsum, supplying both calcium and sulphur, and being neutral (neither acid nor base) is generally the cheapest and most logical single soil builder to use when sulphur is required or when there is any trace of black alkali. In cases where the calcium content is exceptionally high and the physical condition of the soil is good, applications of inoculated sulphur might be more economical and satisfactory.

A mixture of inoculated sulphur and lime in the right proportion, however, will have somewhat the same effect as gypsum. If sulphur and calcium are both needed, cost ought to be the big factor in determining whether to use gypsum or lime and sulphur.

Functions of Gypsum.

1. Gypsum neutralizes black alkali.
2. Gypsum supplies both calcium and sulphur.
3. Improves the mechanical condition of the soil, etc.
4. Promotes the development of beneficial bacteria through the calcium it supplies.
5. Helps in the decay of organic matter.

By comparing the functions of lime with gypsum, the following main differences should be noted:

1. Whereas lime corrects acidity, gypsum does not.
2. Whereas gypsum neutralizes black alkali, lime does not.

A further discussion of the value and use of gypsum is given later.

Ground Sulphur.

Ground sulphur, 97 per cent to 100 per cent pure, is in an unavailable form until bacteria change it to a sulphate, hence it may remain useless in the soil for years. There is now an inoculated sulphur on the market which contains sulphating bacteria and thus becomes available as plant food within a very short time, and will give excellent results the first year.

Sulphur should not be used continually unless other fertilizers are added. It acts strongly on the other elements and will soon deplete the soil. It will also cause a sour or acid condition.

Occasional applications are especially good on leguminous crops, which require considerable amounts of sulphur as plant food.

What Burbank Said.

"After testing a great variety of fertilizers on my orchard and experimental grounds, I find that the Nitrate of Soda and Thomas slag phosphate have given the best results at the least expense, and I shall not look further at present, as my trees, bulbs, plants, flowers and fruits have been, by the use of about 150 pounds each per acre, nearly doubled in size and beauty in almost every instance. The above-named fertilizers have more than doubled the product of my soil at a very small outlay per acre.

Where the Nitrate of Soda is used, I find a greatly increased ability in trees to resist drought, and lack of cultivation."

"Luther Burbank is the greatest originator of new and valuable forms of plant life of this or any other age," says David Starr Jordan, President of Leland Stanford Junior University, California.

Character in "Pomona Uses White Magic" Representing Chilean Nitrate of Soda.

APPLE GROWING IN THE UNITED STATES.

The Apple is the most important commercially of American fruits. The annual average production for the five-year period, 1920-1924, is placed at 181,531,-200 bushels, with an annual average value for the corresponding period of $208,370,000, thus ranking eighth in the value of all crops. The value of the 1924 crop was $212,193,000; based on a yield of 179,-443,000 bushels.*

Below is given a table showing the production, average price per bushel, and total value of the crop for the years 1920-1924:

Year	Total Production	Average Price per Bushel	Total Value of Crop
1920	223,667,000	$1.148	$256,770,000
1921	99,002,000	1.680	166,343,000
1922	202,702,000	.986	199,848,000
1923	202,842,000	1.022	202,696,000
1924	179,443,000	1.18	212,193,000

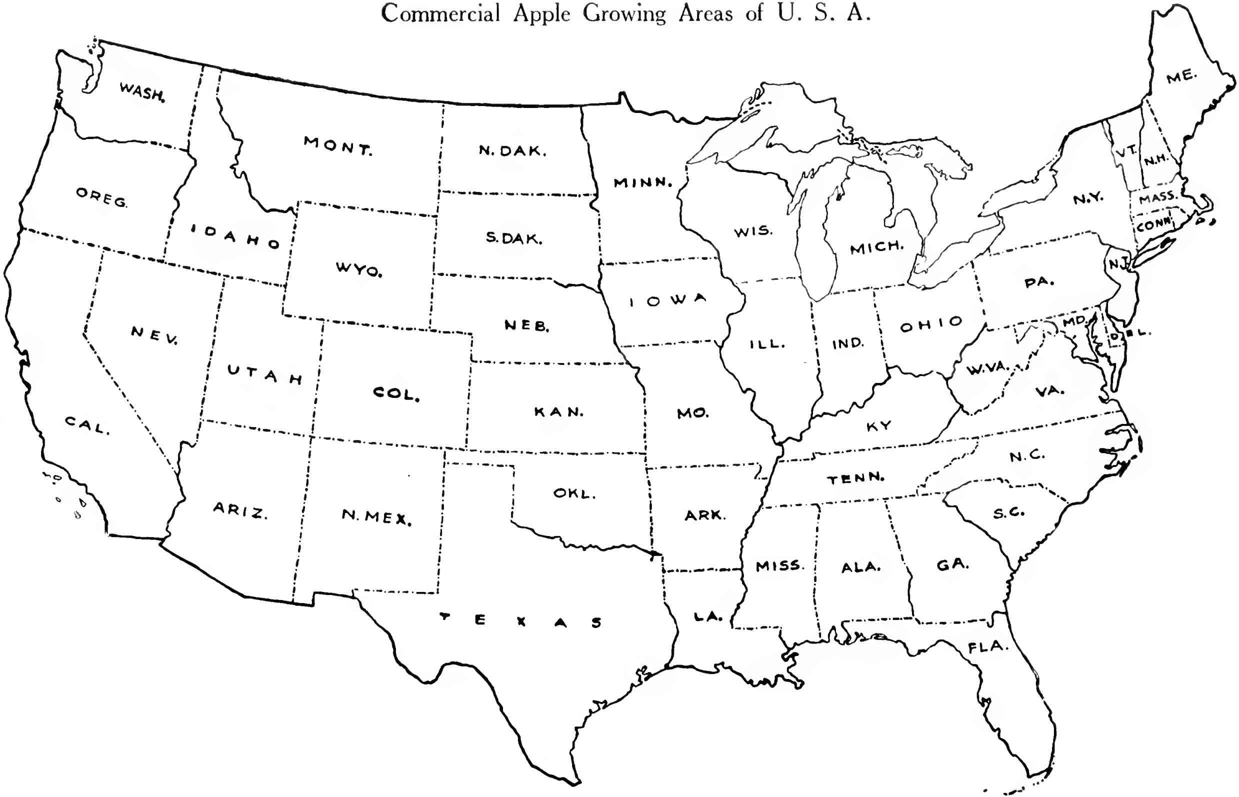
Commercial Area.

In 1924, the rank of the seven leading Apple States, according to production, was as follows:

State	Production		Value
1. New York	23,800,000	Bus.	$25,704,000
2. Washington	23,000,000	"	32,200,000
3. Virginia	15,184,000	"	12,755,000
4. Ohio	8,325,000	"	10,906,000
5. California	7,370,000	"	8,991,000
6. Michigan	7,333,000	"	8,360,000
7. West Virginia	7,000,000	"	6,650,000

* All figures are taken from United States Department of Agriculture, "Agriculture Year Book," and from reports contained in "Crops and Markets," published by the Department.

Commercial Apple Growing Areas of U. S. A.



The Agricultural Experiment Stations of the United States.

It should be noted from the preceding table that while in 1924 New York had a greater production than Washington, the total value of the crop was less, being 25,704,000, as against $32,200,000, for Washington.

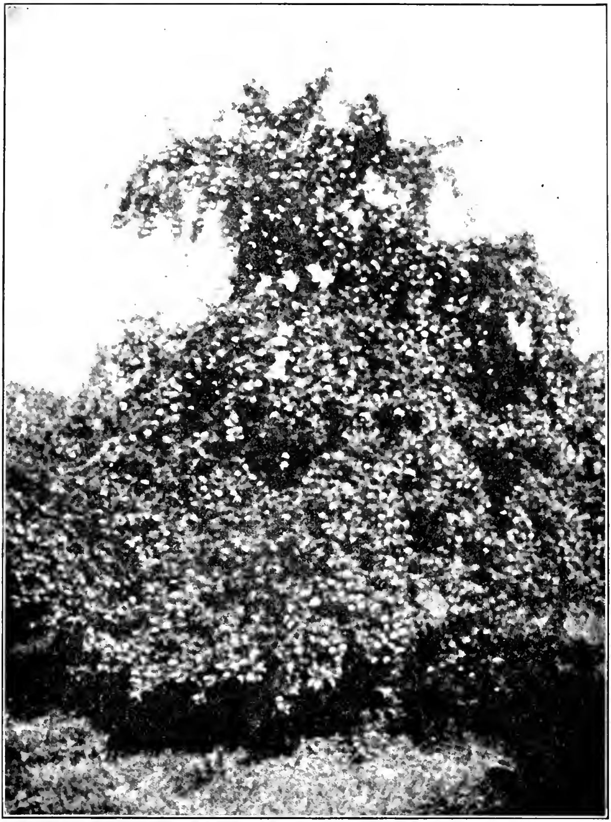
It is of interest that in 1923 Washington ranked first in total production, producing 33,000,000 bushels, New York being second with 25,000,000 bushels. In 1922 New York was first with 36,000,000 bushels, Washington producing 25,775,000 bushels. Thus the leadership in Apple production swings back and forth between these two States.

Climatic Requirements.

Since the critical period in apple culture is at blossoming time, it is desirable to locate an orchard in a region where damp and cold weather is not prevalent at this time. Rolling to hilly land is generally to be preferred, because of the natural air drainage. Also there is less danger of loss from frost on a north or northeast slope. A large body of water near an orchard provides some protection by promoting uniformity of temperature.

Soil Requirements.

A deep, friable, loamy soil, with good drainage, is most suitable for apples. They are most productive and longest-lived on a clay loam. Apples thrive, however, on a wide range of soils, the different varieties being adapted to different soil conditions. In planting an orchard, the grower should, as far as



A Typical Fertilized Tree of Plot 8 in the Brown Orchard. When Photographed, in 1912, This Tree Carried 26.6 Bushels of Fruit, While the Best Unfertilized Tree in the Experiment Yielded Only 7.9 Bushels. Bedford County, Pa.

possible, know the adaptability of the varieties in question to his soil, and should make his selections accordingly.

The richer soils naturally produce better growth than those deficient in plant food. Planting apples on thin soils is not advised, but excellent fruit is raised on soils of only moderate fertility, if a system of regular culture, cover cropping and fertilization is followed.

Establishing the Orchard.

Before planting an orchard, the soil should be plowed deep and receive thorough preparation. In case hardpan or a stratum of rock is near the surface, dynamiting may be advisable. The grower should be certain that he is buying good nursery stock, free from insect or disease pests. Strong, one-year-old "whips" are considered most desirable for planting.

The distance at which apple trees are planted varies with the different varieties, according to their size, but it is seldom less than 30 feet apart for permanent trees.

There are three principal systems of laying out the orchard: (1) square, (2) hexagonal and (3) quincunx. In the first the trees are set at the intersection of two series of equidistant parallel lines drawn at right angles to each other, and forming squares; in the second each tree is equidistant from the six trees which surround it in the form of a hexagon; and in the last each tree is equidistant from the four trees which surround it in the form of a square. When set 30 by 30 feet, 48 trees are required for an acre.

In setting apple trees, other fruits, such as peaches or early-bearing varieties of apples, are often set between the apples that are intended to be permanent. These enable the grower to realize some revenue from the orchard before the permanent trees begin to bear. When the trees begin to crowd, the fillers can be removed. The grower must not make the mistake of

Tompkins, Kings, and Other Varieties in the Johnston Orchards, Showing the Value of Our General Orchard Fertilizer. These Trees Had Not Borne Well Before Fertilization, but This Is Their Third Successive Crop. Lawrence County, Pa.

allowing these temporary trees to remain too long, as they will crowd the permanent trees and jeopardize their productivity. An annual crop is considered a better companion crop for a young orchard. It should be a crop which requires early cultivation —

that is, a crop which does not require stirring of the soil after August — for the young trees make their growth early in the season and from August on are maturing their wood and getting ready for the winter.

In any scheme of intercropping, a certain portion of the land should be reserved for the exclusive use of the trees — no less than eight feet along each side of each row of trees when young — and as the trees grow this area should be increased. The annual crop should receive its own fertilization, in order not to draw from the food supply of the young trees.

Where the winters are not too severe, planting in the fall is desirable, since this enables the trees to become established and get a quick start in the spring. In the northern regions spring planting is advised.

After setting, the tree is "headed back" in order to give it a balanced top. One-year-old trees are usually cut back to 24 inches.

Cultivation.

Three methods of cultivation may be followed: clean culture, tillage cover-crop culture, and sod-mulch culture. The two latter are generally accepted as the best methods under the average conditions, but the sod-mulch is preferable for hilly sections. Clean culture should be practiced first, two or three years after which the orchard may be thrown into permanent sod, or the system of tillage with cover-cropping may be followed. In the tillage and cover-cropping system, the orchard should be plowed in the spring and cultivated at intervals until July or August, according to climatic conditions, when a cover crop may be sown. Alfalfa, one of the clovers, vetch, cowpeas, soy beans, rye, oats, buckwheat and other crops are used as covers. A leguminous crop is usually considered preferable.

Pruning.

Only a bare outline of the principles of pruning apples may be given here. The purposes of pruning, briefly are:

1. To preserve the proper balance between top and root system at the time of setting out.
2. To prune to the best size and shape.
3. To remove all dead, diseased, and injured wood.
4. To make the top open in order to admit sunlight.
5. To regulate the number of limbs composing the top.
6. To fix the branches at the proper height above the ground.
7. To do away with a weak crotch and crossing or interfering branches.
8. To promote the right amount of wood growth.
9. To regulate the number and the distribution of wood and fruit-bearing buds.

Several types of pruning are practiced. The Central Leader type provides a strong upright central limb with side branches, uniformly distributed about it. The Open Center type has no central leader, but usually two to four main branches joining the trunk at the crotch, and giving a vase-shaped top. The Double Headed type comprises three chief parts:

(1) a short central limb extending upright from the trunk; (2) a tier of main branches radiating from the point where this central limb joins, or rather, extends out of the trunk; and (3) another tier of main branches, radiating from the upper extremity of the central limb and above the first tier.

The Modified Leader is a compromise between the Central Leader and Open Center types, combining the good features of the two. It provides for a main central limb up to a certain point, where, by careful pruning over a period of years, it is diverted off to the side somewhat and loses itself into the side branches, thus leaving the top of the tree open for the admission of sunlight. This promises to become the most popular type of pruning.

Pruning is generally done when the trees are dormant, the period from November to April being the usual pruning time. Summer pruning is practiced only under special circumstances.

Thinning.

This is an important feature of commercial orchard management. Probably the greatest advantage obtained by it is the increase in the size of the remaining apples. As a rule the thinning should be done in the South as soon as the May drop is over, and in the North after the June drop. The development of seeds drains the energies of the tree. Hence thinning at a later period will not influence the size of the apples as greatly. Great care must be taken in thinning, not to injure the fruit spurs. As a general practice the apples should be left from five to eight inches apart.

Nitrogen and Phosphates vs. Nothing, in Brown Orchard. The Fertilized Trees, to the Left, Have Averaged 498 Bushels per Acre Annually for Six Years. Their Normal Unfertilized Yield for the Same Period Was 208 Bushels. Bedford County, Pa.

Insects and Diseases.

Probably the most serious enemies of the apple are the codling moth, the plum curculio, the aphis, scab, cedar rust, bitter rot and apple blotch. A number of other insects and diseases, however, cause much injury.

Among the insects, the San Jose scale, oyster-shell scale, apple red bug, the tent caterpillar, the apple-tree borer, the bud-moth, canker worms, leaf hopper and the fruit-tree loaf roller are the most common.

Other diseases include sooty blotch, fly speck, blister canker, collar rot, fire blight, apple rosette, and Baldwin spot. Limited space prevents a detailed description of methods of control, but general spraying recommendations are given.

1100-Acre Tonoloway Mountain Side Orchard of the American Fruit Growers, Inc., at Hancock, Maryland.

Spraying.

Perfect apples cannot be hoped for from trees which have not been sprayed. There are five principal sprays which are generally used: the Delayed

Dormant, the Pink Bud, the Petal Fall or Calyx, the Cluster Spray when the apples are about the size of hazel nuts, and the Mid-Summer Spray. In some localities more are required. The Horticultural Department of each State Agricultural College issues its spray formulæ and directions as to how many sprays are required for its state. Every apple grower should apply for these directions to his local Experiment Station or Agricultural College.

Benefits to Be Secured by the Use of Nitrate of Soda on Apples.

The use of Nitrate of Soda on young trees provides them with strength to make rapid and healthy growth. A well and consistently nourished tree comes into bearing early in its life without impairing the productiveness of the mature tree. A mature orchard will give heavier yields, if it has made consistent healthy growth each year since its planting.

Old, neglected orchards are generally deficient in their supply of nitrogen and over-supplied with carbohydrates. They can be restored and put upon a paying basis through pruning, spraying, and the use of Nitrate of Soda.

Under such conditions Nitrate may be applied heavily — up to 15 or 16 pounds per tree — until the balance between the carbohydrates and the Nitrates has been restored, which will be evidenced by their restored fruitfulness.

The questions of proper pruning, soil management and fertilization are all interrelated in their effects on tree growth and yield, and are big problems to the fruit grower.

Nitrate of Soda enables the trees to retain their leaves for a longer period and this permits the tree to continue its storing of food for its spring work. Nitrate of Soda applied in the spring, just as the buds begin to swell, gives the tree Nitrogen immediately, which enables it also to use the food reserves it has stored up. This strong application increases the percentage of bloom set.

Nitrate of Soda thus used early in the spring, just at the time the tree needs it, will develop strong blooms. It can be used when the ground is cold, as it does not require the action of soil bacteria to make it available, as do other forms of nitrogen.

In cold climates, where early heavy frosts occur, there is some danger in making too late spring applications since so used Nitrate is apt to prolong the growth of the tree and an early autumn frost may injure the immature fruit buds or wood prior to the time of their settling down for the winter.

Trees which have been kept in a healthy growing condition by the proper use of Nitrate of Soda are much more resistant to disease.

The terminal growth which trees make is usually a good indication as to whether they are properly nourished. Young trees, before they come into full bearing, should make a yearly terminal growth of from twelve to eighteen inches. Mature trees should make a growth of from seven to eleven inches.

The color of the leaves is another indication of the condition of the tree. If the leaves are not a good healthy green, it indicates that they cannot fulfill their chief function of manufacturing food.

To attain annual crops, the trees must have sufficient food to make their strength enough to produce big healthy fruit spurs and fruit buds, and to enable the fruit spurs to set fruit buds for the following year.

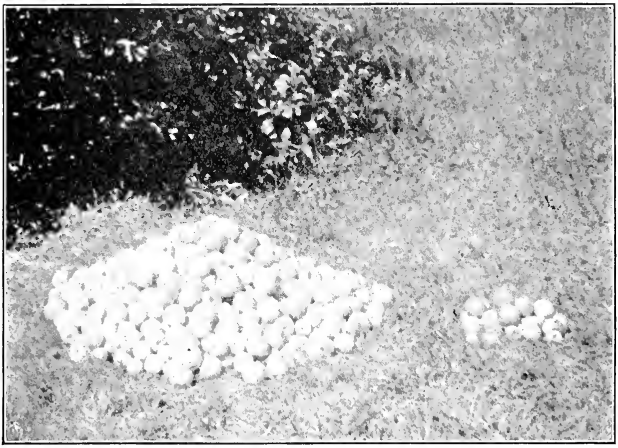
Harvesting.

The ripeness of the apple is indicated by the ease with which it will separate from the twig, its color, its size, the color of the seeds and the tendency to drop. The early, or so-called "summer" varieties, ripen in July in the medium latitudes, and the ripening period extends well into October for the winter varieties.

Much more attention is now given to the grading and packing of apples than in previous years, and better marketing methods are being perfected. Mechanical sorters, or "sizers," are commonly used. In the West there are three principal grades: Extra Fancy, Fancy and C Grade. Boxed apples of uniform grade and attractive packing command a much better price than apples sold in open baskets, topped hampers, or barrels. Large quantities of apples are kept in cold storage, thus insuring a more even distribution on the market.

Varieties.

No definite varieties can be recommended as the "best" under all circumstances. Usually in each apple-growing district there are four or five well-known and established varieties that can be relied upon. The grower would do well to select the bulk of his new plantings from this list, and to plant new



Average Yield per Tree from Nitrated Plot — 13.2 Bushels.

Average Yield per Tree from Unnitrated Plot — 2.1 Bushels

A. C. Robinson's Rome Beauty Orchard, Proctorsville, Ohio.

varieties only in limited quantities. Keeping qualities, size, flavor, color and rate of bearing also are important points of consideration.

Fertilization.

On all but exceptional soils, some artificial fertilizer will pay the apple grower. Of all the essential plant-food elements, nitrogen has been demonstrated to be the most important for apples.

The soil requirements vary so widely that no general formula for fertilizer applications can be given accurately. To get best results, the grower must study the growth of his trees; and he can gauge his fertilization by their behavior.

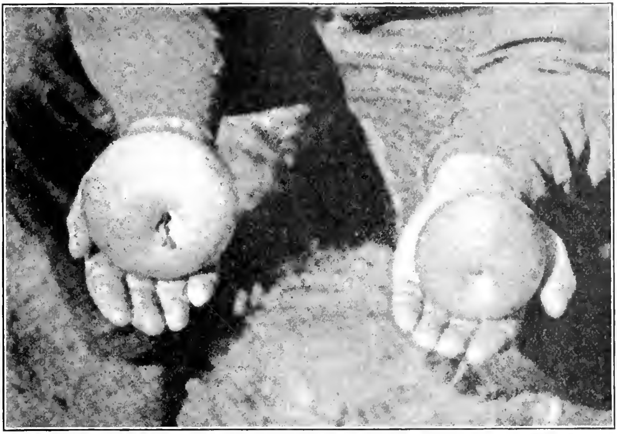
Stable manure, applied at the rate of eight to ten tons per acre annually, is a good fertilizer. However, the supply of manure is very limited, and commercial fertilizers have given equally good results and their use is becoming more common.

Nitrate fertilization should be considered a necessity for orchards. In starved sod orchards, increased yields of one hundred to three hundred per cent or more are not uncommon following the use of Nitrate of Soda. In orchards in fair condition of vigor, increased yields of fifty to one hundred per cent have been obtained.

In cultivated orchards, the cover crop is greatly increased by the use of Nitrate, which benefits the trees indirectly, and there are many cases on record where the crop yields are heavily increased by its use.

INSTRUCTIONS FOR USING NITRATE OF SODA ON APPLES.

Apply the Nitrate of Soda by broadcasting it evenly over the area covered by the outer two-thirds of the branches. With young trees, care must be taken not to apply the Nitrate close to the trunk. In full-grown orchards, apply well out beyond the spread of the branches in order to conform with the usual distribution of the feeding roots. The heaviest applications should be made over the area covered by the outer two-thirds of the branches.



Average Size of Apples from Nitrated and Checked Plots, A. C. Robinson's Rome Beauty Orchard, Proctorsville, Ohio.

The Nitrate should be applied after the buds begin to swell but before they burst, as this will give the tree the nitrogen early enough to increase its "bloom set." The tree also needs it at this period for making its fruit-spur growth, which is generally completed within three weeks after blossoming time.

Rates of Application of Nitrate of Soda on Apples.

1 to 2 year old orchard	— ½ lb. Nitrate per tree
8 year old orchard	— 3 lbs. Nitrate per tree
12 year old orchard	— 5 lbs. Nitrate per tree
Full bearing orchard	— 6 to 8 lbs. Nitrate per tree

Results of Investigation on the Fertilization of Apple Trees at State Agricultural Experiment Stations.

That nitrogen is the limiting element of plant-food in many apple orchards is indicated by the results of investigations on the fertilization of apple trees, conducted for a number of years past at several state Agricultural Experiment Stations.

Studies over a period of five years at the Maine Agricultural Experiment Station are summarized in their Bulletin 322 as follows:

"Annual applications of a complete 5-8-7 fertilizer to mature Ben Davis apple trees under cultivation, at the rate of 7 and 14 lbs. per tree, over a period of five years did not increase the yield as compared with check trees which received no fertilizer.

"Two annual applications of Nitrate of Soda to mature Ben Davis apple trees in sod, at the rate of 6 and 12 lbs. per tree, more than doubled the yield of fruit. The use of 20 cents worth of Nitrate of Soda per tree resulted in an increased yield of more than one barrel of fruit per tree. Six pounds of Nitrate was as effective as 12 pounds in this experiment.

"These results are in accord with most fertilizer experiments throughout the country. Applications of phosphoric acid and potash seldom, if ever, cause increased yields of apple trees.

"Nitrogen may not increase the yield of apple trees grown on fertile soil under a system of cultivation and cover crop. Apple trees grown on a poor soil, or under the sod-mulch system of culture, will usually respond to applications of nitrogenous fertilizers.

Mature trees should receive from 5 to 10 lbs. of Nitrate of Soda per tree. The proper amount to apply will depend on the natural fertility of the soil, the system of culture, the age, size and variety of the trees. In general, the mature tree should make a terminal growth of 6 to 10 inches."

Trees from Nitrated Row in Stewart Plots at Pennsylvania State College.

At the Ohio Station * large increases were procured from applications of Nitrate to neglected orchards in sod:

1. Nitrogen was the only element of fertility which was of direct benefit to the apple trees themselves from the standpoint of fruitfulness and vigor.

* Ohio Agr. Exp. Sta. Mo. Bul., Vol. IV., No. 1.

2. Applications of Nitrate of Soda alone (five pounds per tree) increased the average yield in some instances as much as 450 per cent, and in three experiments averaged a cash gain per acre of $125.75 per year for five years.

Ohio experiments have also shown more profitable yields from a fertilizer mixture containing 5.6 per cent available nitrogen than one of only 3½ per cent available nitrogen.

Studies over a period of six years at the Pennsylvania Agricultural Experiment Station * brought out the following conclusions:

1. Applications of nitrogen and phosphates and of manure were very beneficial. Potash was of little service.

2. Nitrate of Soda alone gave a large increase in yield over the check plots, with a still greater increase when acid phosphate was applied with the Nitrate. The increase in one case was as much as 1,100 bushels per acre.

3. The beneficial effects of nitrogenous fertilization were evident by the middle of the second season.

4. The gains from fertilizations have not been transitory. In some experiments they were greater in the sixth and last year of the experiment than at any other time.

5. Nitrogenous fertilizers when applied too late in the season retarded somewhat the maturity of the fruit.

6. For this reason, the apples on the too-late Nitrate-treated tree did not have so good a color as

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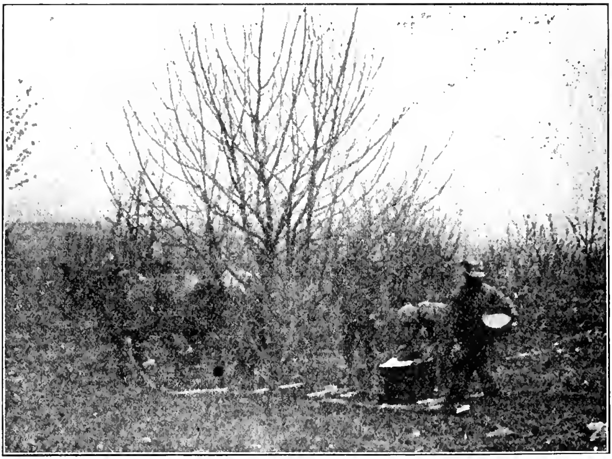
* Pa. Agr. Exp. Sta. Bul. 121. Also Fertilization of the Apple Orchard by John P. Stewart,—Pub. by Chilean Nitrate Committee.

those on the check trees, when the latter were picked; but when left on the trees until the same degree of maturity was reached, the Nitrate-treated fruit showed a better color than the checks.

7. The application of Nitrate is recommended not later than the middle of July.



Method of Applying Nitrate of Soda to Apple Trees.

8. It is concluded that more Nitrogen and less potash than commonly recommended should be used on the average orchard in need of fertilization.

9. When the crop is light, smaller applications are required, because of the natural tendency of the trees to develop a sufficient number of fruit buds in the off season. In the full years the applications should be

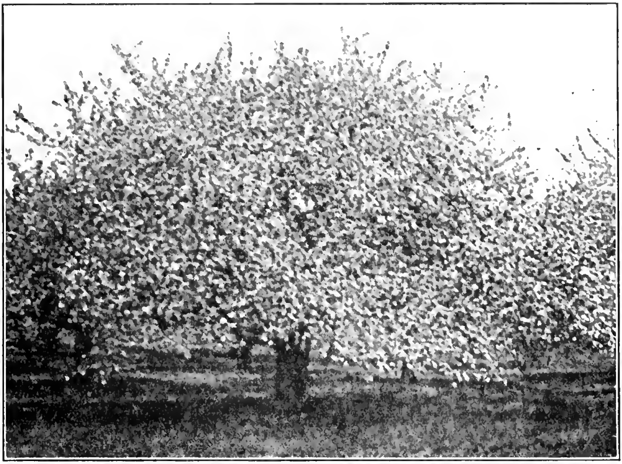
rather liberal to prevent the total absence of a crop the following year.

Professor Fred C. Sears, Professor of Pomology, Massachusetts Agricultural College, in his book on Productive Orcharding, states:

"The best fruit men practice fertilizing. Go into any orchard section and you will find that the most progressive and successful growers, as a rule, are the men who fertilize highly. Usually the man succeeds in proportion as he fertilizes. The man who fertilizes year after year, whether he has a crop of fruit on his trees or not, is the man who usually has a crop. The man who is noted in a section as applying fertilizers in large quantity is usually also noted as a man who harvests bumper crops. This is not conclusive proof, because these men also care well for the orchards in other ways. But it is very suggestive, particularly the fact that the generous feeder usually succeeds better than the moderate feeder."

In Cornell Extension Bulletin No. 75, published by the New York State College of Agriculture at Cornell University, Ithaca, N. Y., Mr. Joseph Oscamp says:

"Fruit growers have been urged in the past to apply potash, phosphorus, and lime to their soils. However, there has been no pronounced indication that the application of any of these elements to the orchard has been directly profitable on any but the most impoverished soils. Nitrogen is the only element that, without question, has produced beneficial results when applied to apple trees, and even this benefit is not ordinarily to be expected in young cultivated orchards where cover crops are being used. Nitrogen may be applied in the form of a leguminous cover crop, of manure or of commercial fertilizers. Nitrate of Soda is one of the most common and useful forms of chemical plant food. It becomes immediately available to the tree, and encourages an early and vigorous growth.



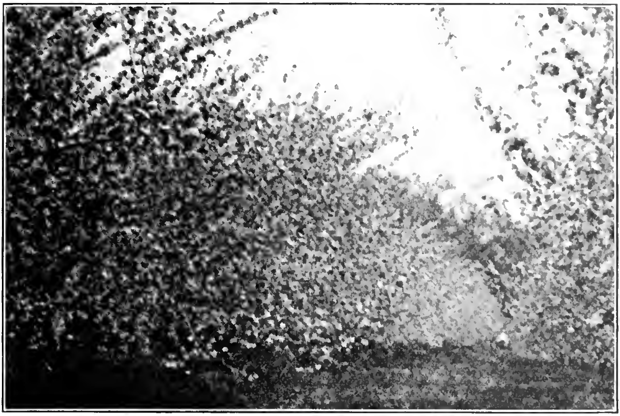
Renovated Baldwin Tree in Orchard at Conyer's Farm. Greenwich, Connecticut.

"In connection with all fertilizing problems, indeed, as well as with other orchard matters, a close observation of the trees is desirable. The experienced grower knows by the length of terminal growth, the color of the bark and of the leaves, and other outward manifestations of the tree's health, whether or not food conditions are satisfactory. One of the first indications of a lack of proper nourishment is the character of the foliage. The leaves on a well-fed tree are numerous, large, and dark green in color. They hang on in the fall until killed by freezing weather.

"The leaves on a tree suffering from lack of food are small in size and rather pale green in color, and this is largely in proportion to the extent of starvation. The leaf fall of a starved tree may be as early as August or September. The new growth on the ends of the main branches of a starved tree is often below eight inches in length, whereas eighteen inches is more normal and gives earlier and better results. Much, however, depends on the season, the variety, the individuality of the tree, and other obscure factors, so that no arbitrary figures can be laid down. The beginner would do well, however, to study the trees closely and early come to understand these symptoms of their well being. If a satisfactory condition of vigor exists, it is advisable to leave well enough alone, but if starvation in any degree is present, it is certainly worth while to correct it."

In Bulletin 174 of the West Virginia Experiment Station, it is stated that, "Of the three common elements of plant food, nitrogen is the only one that has been uniformly beneficial in the orchard that responded favorably to the use of fertilizers. It was of greatest value when applied in readily-available form, such as Nitrate of Soda. The value of phosphorus seems to be merely in its effects upon cover crops and sod coverings. Potassium is rarely beneficial."

In Oregon, as reported in Bulletin 141 of the Oregon Agricultural Experiment Station, the influence of fertilizers on devitalized trees was tested. The orchards were cultivated but had no cover crops. Starved trees responded to the applications of Nitrate



Seventeen-Year-Old McIntosh Orchard at Conyer's Farm. Greenwich, Connecticut.

of Soda by out-yielding the check trees eleven to one in one orchard, and twenty-four to one in another. Application before blossoms open is recommended in Oregon.

The Indiana Agricultural Experiment Station Annual Reports of 1920 and 1921 state that experiments at their station, begun in 1917, have shown remarkable increases in yield as a result of the applications of nitrogenous fertilizers, fertilized trees in 1920 producing about three times as much as the check trees. Trees in sod in 1919 showed a greater response to Nitrate of Soda than those under clean cultivation.

Some Results Obtained from Orchards Where Nitrate of Soda Has Been Used.

At the Experiment Farm Orchard in Clermont County, Ohio, where experiments are being conducted under tillage, cover-crop culture and grass-mulch culture, five pounds of Nitrate of Soda per tree for four years under grass-mulch culture yielded 683 per cent more than the trees in the check plot.

	Year	5 lbs. Nitrate	Nothing
Average	1922	206.0 lbs.*	41.2 lbs.*
yield	1923	176.6 "	37.2 "
per tree	1924	328.8 "	12.2 "

From a plot which is under tillage and a soy-bean cover-crop culture, the yield was, from all varieties:

	Year	5 lbs. Nitrate	Nothing
Average	1922	128.5 lbs.*	82.9 lbs.*
yield	1923	134.5 "	70.0 "
per tree	1924	395.2 "	89.5 "

At the Massachusetts Agricultural College at Amherst an experiment is being conducted on 12-year-old McIntoshes under sod-culture as against clean cultivation, which has run for four years.

* The average weight of a bushel of apples is 48 lbs.

	Year	Sod Culture, with 300 lbs. Nitrate of Soda per acre	Cultivation without Nitrate
Average	1921	130 lbs.*	77 lbs.*
yield	1922	371 "	264 "
in pounds	1923	259 "	158 "
per tree	1924	389 "	168 "
Four-year average		287 lbs.*	167 lbs.*

Per cent increase due to Nitrate of Soda — 72%.

In the Round Hill Orchard at Winchester, where the Virginia State College Experiment Station has conducted experiments on 25-year-old York Imperials for four years, one tree which had had seven pounds of Nitrate of Soda for four years yielded 762 pounds in 1924; one tree from check plot yielded only 244 pounds.

Average Yield per Tree in Pounds.

Year	7 lbs. Nitrate	Nothing
1923	356.2*	174.8*
1924	456.0	192.5

In a Rome Beauty Orchard in Southern Ohio, where the Extension Department of the Ohio State University is conducting experiments on plots which have had no fertilizer for a period of three years, the average response per tree the second year from the use of five pounds of Nitrate of Soda and five pounds of acid phosphate was, from the fertilized plot 13.2 bushels; from the check plot 2.1 bushels.

* The average weight of a bushel of apples is 48 lbs.

Michigan Agricultural College, at their experiment plots in the Warren-Farrand Orchard, gave the following average yield per tree from Nitrate and check plots:

Year	Nitrate	Check Plots
1921	245.6 lbs.*	86 lbs.*
1922	184.6 "	113.7 "
1923	486. "	181.5 "
1924	494.5 "	118.6 "

At Owensville, Ohio, the Ohio State Agricultural College is conducting an experiment on 12-year-old Grimes Golden apples under cultivation with a cover crop of soy beans. Five pounds of Nitrate yielded an average of 13 bushels per tree as against the yield of 1½ bushels per tree from the check plot under the same culture without Nitrate.

The Tonoloway Orchard of the American Fruit Growers, Inc., at Hancock, Maryland, has applied five pounds of Nitrate of Soda to a unit of 4573 York Imperials for four years. The average yield per tree was:

Year	Bushels
1922	11.29
1923	8.74
1924	11.11

The acreage planted to York Imperials in the rest of the orchard which received no Nitrate followed the usual biennial habit of this variety.

* The average weight of a bushel of apples is 48 lbs.

In an experiment conducted with Mr. C. L. Page of Billerica, Massachusetts, to determine the increase in size of fruit and length of terminal growth, the following results were obtained:

Average growth on Nitrated trees ..—6½ inches
Average growth on check trees .... —4½ inches

The Nitrated trees averaged per tree 16.8 bus. apples over 2½ in. The Nitrated trees averaged per tree 6.2 bus. apples under 2½ in.	Average yield 23 bus. per tree.
Check trees averaged per tree 8.8 bus. apples over 2½ in. Check trees averaged per tree 7.2 bus. apples under 2½ in.	Average yield 16 bus. per tree.

In Bulletin No. 87 of the Connecticut Agricultural College Extension Service, W. H. Darrow says:

"Nitrate fertilization should be considered a necessity in the sod orchard. Except possibly on the richest soils, nitrogenous fertilizers have been profitable in all sod orchards where used. Increased yields of 100 to 300 per cent or more are not uncommon following the use of a quickly available nitrogenous fertillizer in starved sod orchards. Increased yields of 50 to 100 per cent have been obtained in orchards in fair condition of vigor.

"The results obtained from fertilization in one Connecticut orchard are given below:

Per Acre Yields With and Without Nitrogen Fertilization.

Orchard of A. E. Johnson, Bethlehem, Conn.
Trees 24-26 years of age.

	Check Plot	Fertilized Plot	Gain for Fertilization
1922	144 bu.	568 bu.	424 bu.
1923	96 "	123 "	27 "
1924	214 "	553 "	339 "
3 year average.....	151⅓ bu.	414⅔ bu.	263⅓ bu.

The fertilized plot received Nitrate of Soda at the rate of eight lbs. per tree in 1921, six lbs. per tree in 1922, five lbs. per tree in 1923 and four to five lbs. per tree in 1924. In 1923 eight lbs. of acid phosphate per tree were also applied."

Addendum.

The estimated five-year average value of these crops, namely, tobacco, potatoes and apples, for the years 1914-18 is reported as follows, cotton being added for comparison:

Apples	$ 184,774,000
Tobacco	208,426,000
Potatoes	372,239,000
Cotton	1,097,039,000

The largest single apple growing area in the United States begins in York County, Pennsylvania, and runs southwest in a section perhaps not far from one hundred miles down to fifty miles in width through Maryland, western Virginia and western North Carolina.

Some apples are also grown in eastern Maryland and southwestern New Jersey, as well as in the eastern counties of New York state along the Hudson Valley, and also in the heart of New England. The northwestern counties of New York state grow apples commercially also.

Table Showing the Number of Pounds of Nitrogen, Phosphoric Acid and Potash Withdrawn per Acre by an Average Crop (For U. S. 1920 Fgures Supplied by New Jersey State Agricultural Experiment Station, March 14th and 15th, 1924).

Crop	Per Acre Yield (lbs.)	Nitrogen (lbs.)	Phosphoric Acid (lbs.)	Potash (lbs.)
Barley	1,233.6	21.6	9.3	6.2
Beans	642.0	25.7	7.9	8.3
Buckwheat	907.2	13.6	5.4	2.7
Cabbage	17,400.0	52.2	17.4	69.8
Corn	1,736.0	36.4	12.3	6.9
Cotton Lint	170.8	0.58	0.17	0.78
Cotton Seed	314.0	10.0	3.8	3.65

Table Showing the Number of Pounds of Nitrogen, Etc.—Continued.

Crop	Per Acre Yield (lbs.)	Nitrogen (lbs.)	Phosphoric Acid (lbs.)	Potash (lbs.)
Cowpeas	552.0	17.1	5.5	6.6
Flax Fiber	1,736.0	14.6	3.5	17.4
Flax Seed	347.2	15.1	5.6	3.3
Hay	3,140.0	62.0	16.0	49.9
Hops	1,332.0	22.6	14.7	20.0
Oats	1,126.0	22.5	9.0	6.8
Onions	21,278.0	58.9	19.2	46.8
Peanuts	1,710.0	61.6	12.0	7.7
Potatoes	6,576.0	23.0	9.9	32.9
Rice	1,809.0	19.9	3.6	1.8
Rye	767.2	13.0	6.5	4.6
Soy beans	948.0	50.2	17.1	19.0
Sugar Beets	17,000.0	34.0	17.0	76.5
*Sugar Cane (La.)	30,000.0	60.0	30.0	135.0
Sweet Potatoes	5,694.0	14.2	5.7	28.5
Tobacco	796.1	31.8	4.0	47.8
Tomatoes	8,400.0	16.8	5.9	29.4
Wheat	840.0	16.8	7.1	4.2
*Sugar Cane, Hawaii	78,000.0	156.0	78.0	351.0

The average relative percentages of Nitrogen, phosphoric acid, and potash thus removed from the soil by these crops is therefore as follows:

Nitrogen	28.6 per cent.
Phosphoric Acid	9.9 per cent.
Potash	25.5 per cent.

Translated into commercial fertilizer terms, the comparison is as follows:

	What Nature Requires	What the Average Brand Supplies
Nitrogen	2.86	2.00
Phosphoric Acid	0.99	8.00
Potash	2.55	2.00

INCREASED CROP YIELDS DUE TO THE USE OF 100 POUNDS OF NITRATE OF SODA.

Points for Consideration as to Relation of Prices of Farm Products to Nitrate of Soda Prices.

From the farmer's point of view, when a reduction in the price of cotton and produce happens, it is to be deplored, but in such a case it should be considered whether abstention from the use of Nitrate is a wise way of meeting the situation. The utility of a fertilizer obviously depends upon its productivity, which is not affected by its price, and an increase in the latter justifies abandonment of the fertilizer only when its productivity ceases to be profitable. The profit to be reasonably expected from the use of Nitrate of Soda is not so materially interfered with by any ordinary rise in its price as to economically justify any substantial reduction in its consumption.

Agricultural authorities have established by careful experimentation that 100 pounds of Nitrate of

Soda when applied to the following crops has produced under proper conditions ***increased*** yields as tabulated:

Apples	50-75 bushels.
Apricots	96 lbs.
Asparagus	100 bunches.
Bananas	1,167 lbs.
Barley	400 lbs. of grain.
Beans (white)	225 lbs.
Beets	4,900 lbs. tubers.
Cabbages	6,100 lbs.
Carrots	7,800 lbs.
Castor Beans	50 lbs.
Celery	30 per cent.
Corn	280 lbs. of grain.
Cotton	200 lbs. seed cotton.
Ensilage Corn	1.18 tons.
Grape Fruit	29 boxes.
Hay, upwards of	1,000 lbs. barn cured.
Hops	100 lbs.
Mangels	123.7 bushels
Oats	400 lbs. of grain.
Onions	1,800 lbs.
Oranges	22 boxes.
Peaches (dried)	56 lbs.
Pecans	37 lbs.
Potatoes	3,600 lbs. tubers.
Prunes	975 lbs. (dried).
Raisin Grapes	347 lbs.
Rye	300 lbs. grain.
Strawberries	200 quarts.
Sugar Beets	1,330 lbs.
Sugar Cane	2.40 tons of cane (Tropics)
	1.17 tons of cane (Louisiana).
Sugar (from Sugar Cane)	322 lbs. (Tropics).
	224 lbs. (Louisiana).
Sugar Mangels	1.6 tons.
Sweet Potatoes	3,900 lbs. tubers.
Tobacco	75 lbs.
Tomatoes	100 baskets.
Turnips	37 per cent.
Walnuts	106 lbs.

Increased Yield by the Use of Nitrate of Soda.

The increased yields of crops resulting from a top-dressing with Nitrate of Soda are most striking. In an article recently published by Dr. E. J. Russell, Director of the Rothamsted Experimental Station, the following figures are given. On an ordinary farm where the land, while in fairly good heart, has not been over well done, a farmer may reasonably expect the following increases from a top-dressing of 1 cwt. of Nitrate of Soda.

	Per 1 Cwt. Nitrate of Soda	Per 1 Cwt. Superphosphate or High Grade Basic Slag
Wheat, grain	4½ bushels	0 to 1¼ bushels.
Wheat, straw	5 cwt.	½ to 5 cwt.
Barley, grain	6½ bushels	2 to 3 bushels
Barley, straw	6¼ cwt.	0 to 2 cwt.
Oats, grain	7 bushels	1 to 3½ bushels.
Oats, straw	6 cwt.	0 to 2 cwt.
Hay	8 to 10 cwt.	—
Mangolds	32 cwt.	20 cwt.
Swedes	20 cwt.	20 to 40 cwt.
Potatoes	20 cwt.	10 cwt.

For purposes of comparison the effect of phosphates is shown also.

INVESTIGATIONS RELATIVE TO THE USE OF NITROGENOUS FERTILIZER MATERIALS, 1898-1907.

Official Abstract of a Paper read by Professor E. B. Voorhees, before The International Congress of Applied Chemistry held in London, June, 1909.

By Edward B. Voorhees, Sc.D. (Director), and Jacob G. Lipman, Ph.D. (Soil Chemist and Bacteriologist), Agricultural Experiment Station, New Jersey, U.S.A.

Ten years ago denitrification was believed to possess an economic significance. A considerable number of agricultural chemists thought that the destruction of Nitrate by denitrifying bacteria involved losses of nitrogen in all cases where Nitrate and animal manures were used together. The experiments recorded here were planned, primarily, to determine whether such losses of Nitrogen really occur in field practice. The data collected in the course of ten years supply some definite information in this connection; and furnish, moreover, much important information bearing on other phases of the nitrogen question.

The experiments have been carried on in large galvanized iron cylinders 4 feet long, 23.5 inches in diameter, and open at both ends. The cylinders were sunk in the ground until only about 2 inches of the upper portion projected above the level of the surrounding soil. Uniform amounts of gravelly subsoil were placed in the cylinders and firmly tramped down. Weighed quantities of surface soil were then placed in the cylinders. In order to enhance the accuracy of the data collected, each treatment was carried out in triplicate. There were secured thus 20 series, each consisting of three small plats. Series 1 has received no applications whatsoever; series 2, applications of acid phosphate and potassium chloride repeated annually; and the remaining series various nitrogenous materials in addition to the acid phosphate and potassium chloride. Also the nitrogenous materials have since been applied annually. The following diagram shows the treatment for each series: .

Diagram of Experiment.

Series	a	b	c
1. Check	0	0	0
2. Minerals	0	0	0
3. Manure, solid, fresh	0	0	0
4. Manure, solid and liquid, fresh	0	0	0
5. Manure, solid, leached	0	0	0
6. Manure, solid and liquid, leached	0	0	0
7. Sodium Nitrate, 5 gms.	0	0	0
8. Sodium Nitrate, 10 gms.	0	0	0
9. Manure, solid, fresh; nitrate, 5 gms.	0	0	0
10. Manure, solid, fresh; nitrate, 10 gms.	0	0	0
11. Manure, solid and liquid, fresh; nitrate, 5 gms.	0	0	C
12. Manure, solid and liquid, fresh; nitrate, 10 gms.	0	0	0
13. Manure, solid, leached; nitrate, 5 gms.	0	0	0
14. Manure, solid, leached; nitrate, 10 gms.	0	0	0
15. Manure, solid and liquid, leached; nitrate, 5 gms.	0	0	0
16. Manure, solid and liquid, leached; nitrate, 10 gms.	0	0	0
17. Ammonium sulphate	0	0	0
18. Dried blood	0	0	0
19. Manure, solid, leached; ammonium sulphate	0	0	0
20. Manure, solid, leached; dried blood	0	0	0

The Nitrate was applied at the rate of 160 pounds and 320 pounds per acre, respectively. The ammonium sulphate and dried blood were applied in amounts equivalent to the larger application of Nitrate. The different manures were applied in amounts sufficient to furnish about 4 gms. of nitrogen per cylinder. Calculated on the acre basis the manures were applied at the rate of about 16 tons.

The crops were grown in regular rotation, and consisted of the following: Corn, oats, wheat and timothy. The oats crops were followed in each case by a so-called residual crop whose function it was to take up such available nitrogen compounds as were not utilized by the main crops.

Analyses were made of all of the main crops and residual crops. In the case of the wheat, the grain and the straw were analyzed separately. In the case of the timothy, the first cutting and aftermath were analyzed separately. The analytical material for the ten years included, therefore, more than a thousand crop samples. Records were made of the yields of dry matter, of the proportions of nitrogen in the dry matter of each crop, of the total nitrogen in each crop, of the proportion of manure and fertilizer nitrogen recovered, and of the relative availability of the several nitrogenous materials employed. In addition to these careful analyses were made of the soil samples drawn from the several cylinders at the end of each rotation.

The results secured may be briefly summarized as follows:

1. There was a marked falling off in the yields between the first and second rotation, especially in the soils which had received no applications of animal manure.

2. The nitrogen compounds in liquid manure were

much superior to those in solid manure as a source of nitrogen to crops.

3. Larger applications of nitrogen were invariably followed by larger yields of this constituent in the crops.

4. Nitrate, ammonium sulphate and dried blood, when applied in equivalent amounts, were found to possess an unequal value. Nitrate was superior to ammonium sulphate, and the latter was superior to dried blood as a source of nitrogen to crops.

5. In the presence of Nitrate, the manure and humus nitrogen were utilized more thoroughly than in its absence.

6. Under certain conditions, Nitrate or other readily available nitrogen compounds, may hasten the depletion of the soil nitrogen.

7. Ammonium sulphate and dried blood intensified the development of acidity in the cylinder soils.

8. The proportion of nitrogen in the crops was readily affected by the nitrogen treatment. It was also affected by the character of the crop itself.

9. In the first rotation, the fresh manures produced dry matter relatively somewhat richer in nitrogen than that produced by the leached manures; in the second rotation this relation was reversed.

10. The solid and liquid manure, fresh, produced dry matter relatively somewhat richer in nitrogen than that produced by the solid, fresh.

11. The smaller application of Nitrate when used together with manure, produced dry matter relatively poorer in nitrogen than that produced by the larger application of Nitrate under the same conditions.

12. The wide range in the proportionate content of nitrogen in the crops, shows clearly that greater care should be exercised in measuring out the nitrogen to our cultivated crops.

13. Out of every 100 pounds of nitrogen applied in the form of Nitrate, there were recovered in the first rotation 62.76 pounds, and in the second rotation 61.42 pounds. The corresponding returns for ammonium sulphate were 49.51 pounds and 37.01 pounds respectively; and for the dried blood 47.89 pounds and 32.05 pounds respectively. This indicated that the acidity in the soils of series 17 and 18 had increased sufficiently to interfere with the normal growth of the plants.

14. Out of every 100 pounds of nitrogen applied in the form of animal manures, there were recovered in the first rotation less than 25 pounds, and in the second rotation less than 30 pounds.

15. A comparison of the crop yields in the first and second rotation, shows that the animal manures have a marked cumulative effect.

16. The corn crops seem to have utilized a smaller proportion of the nitrogen applied than was utilized by the oats and wheat.

17. The fresh manures were utilized better than the leached manures.

18. The solid and liquid, fresh, was utilized better than the solid, fresh.

19. The solid and liquid, leached, was utilized better than the solid, leached.

20. The smaller applications of Nitrate were utilized to about the same extent as the larger applications.

21. The equivalent quantities of Nitrate, ammonium sulphate, and dried blood were utilized in the order named.

22. The animal manures when used together with the larger applications of Nitrate, were utilized to better advantage than when they were used together with the smaller application.

23. The Nitrate and ammonium sulphate when used together with solid manure, leached, were utilized in the order named.

24. The proportion of nitrogen recovered in the crops ranged from 62.09—22.31 per cent.

25. With the returns from the Nitrate nitrogen taken as 100, the relative availability of the other nitrogenous materials was as follows:

	First Rotation	Second Rotation	Both Rotations
Sodium Nitrate	100.0	100.0	100.0
Ammonium sulphate	78.9	60.3	69.7
Dried blood	76.3	52.2	64.4
Solid manure, fresh	32.9	39.0	35.9
Solid and liquid, fresh	50.4	55.6	53.0
Solid manure, leached	33.8	44.0	38.9
Solid and liquid, leached	36.6	49.7	43.1

26. Nitrate, and ammonium sulphate showed practically no residual effect. Dried blood showed a slight residual effect.

27. The animal manures showed a very pronounced residual effect.

28. Notwithstanding the annually repeated applications of manure, together with relatively large amounts of Nitrate, there is no marked evidence of denitrification.

29. All of the cylinder soils lost considerable quantities of nitrogen.

TWENTY YEARS' WORK ON THE AVAILABILITY OF NITROGEN IN NITRATE OF SODA, AMMONIUM SULPHATE, DRIED BLOOD AND FARM MANURES.

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(Reprinted from "Soil Science.")

During the last twenty-five years the fertilizer industry in the United States has developed rapidly. From a comparatively small tonnage in the early nineties it has grown to more than 7,000,000 tons in 1917.

As the industry has grown the number of materials that go to make up the fertilizers has also increased greatly. Many by-products that were formerly allowed to go to waste are now carefully saved and worked up in the fertilizer factory. This is especially true of the nitrogenous materials which, under normal conditions, form the most expensive part of the fertilizer.

The movement to save these waste materials containing nitrogen came none too early, for it was the depletion in the soil of this element that was largely responsible for the run-down and abandoned farms in the older sections of the United States. For this element, most crops show a quicker response than for any other, and conversely, a falling off in yield will come sooner with a deficiency of nitrogen than of any other element. A supply of available nitrogen aids the plant in getting a good start so that its leaves may begin early to elaborate food from the air and its roots may reach out for the water of the soil which holds in solution mineral plant-food.

Since nitrogen is supplied in many different forms, it at once becomes a question as to which of these is most efficient in crop production. Far too little attention has been given to this important question. Too often a certain material has been chosen because there was among farmers a general impression that this particular material was better than some other, when, as a matter of fact, there was no scientific basis for such conclusion. As an example, nitrogen from organic sources has been preferred by many because it was believed that organic matter thus supplied would be of great value in improving the physical condition of the soil, but in making this choice farmers overlooked the possibility of using a more readily-available material which would increase the crop residues sufficiently to more than make up for the small amount of organic matter contained in the few hundred pounds of dried blood, fish or tankage. Also, there is a widespread impression that the loss of nitrogen is greater when Nitrate is used, than when organic nitrogen is used. But experiments both in this country and abroad show beyond a doubt that the crop yields and the percentage of nitrogen recovered in the crop were greater (and hence the loss must have been less) when Nitrate was used than when organic sources of nitrogen were used.

The question of availability of nitrogenous fertilizers began to receive serious consideration at several of the leading European experiment stations some 30 years ago and much valuable information has been accumulated by these stations.

About 10 years later the subject began to receive attention in this country and it is a satisfaction to find that the results obtained here are fairly in accord with the findings of the European investigators.

Fairly complete reviews of this early work have been given in recent publications (2,3) and no attempt will be made here to cover this field.

The completion in 1917 of 20 years' work in which a comparison is made of the materials mentioned in the title of this paper would seem to justify the publication at this time of a brief summary of the work. A detailed account covering the first 15 years of this work has already been published (3). Much of this need not be repeated, but the results of the last five years are of value as confirming the earlier work.

Experimental.

The work was originally outlined under the broad heading "Investigations Relative to the Use of Nitrogenous Materials," and this included: (a) a determination of the yield of dry matter and nitrogen in crops from soils receiving various treatments under controlled conditions; (b) the percentage of nitrogen in the crop as affected by the treatment; (c) the utilization of nitrogen in different materials; (d) the relative efficiency of nitrogen in different materials; (e) the residual effects of nitrogenous substances; (f) denitrification and (g) the effect of special treatment on the income and outgo of nitrogen in the soil.

As the work has progressed, more and more attention has been given to the utilization and relative efficiency of nitrogen in different materials, and it is this phase of the work which is to receive consideration in this paper.

In order that the work might be under more perfect control, it was carried out in galvanized iron cylinders, open at both ends and having a diameter of 23½ inches and a depth of 4 feet. These cylinders were set on the ground so that about 2 inches remained above the ground level. Thus the contents of the cylinders are isolated so that the roots of the crops growing in them are prevented from getting mineral plant-food from outside sources. The subsoil is a gravelly sandy material such as occurs where the cylinders are located, but the top soil is a loam (Penn loam) brought from another source, an 8-inch layer of which was placed in each cylinder on top of the subsoil, each cylinder receiving the same weight of the thoroughly mixed soil.

When the work was begun all the soils were given a liberal treatment of lime in the form of ground limestone and with the exception of one series which does not enter into this discussion, all have received annual dressings of acid phosphate and potassium chloride at the rate of 640 pounds and 320 pounds per acre, respectively. Thus nitrogen is made the limiting factor insofar as human control can provide. Various combinations of manure and fertilizer were arranged, but it is sufficient to report here only on the four nitrogenous materials mentioned in the title.

One series received the phosphoric acid and potash, but no nitrogen, in order that it might be used as a check. Thus if a certain amount of nitrogen is recovered in the crop from the nitrogen-treated cylinder, and it is desired to calculate the percentage of the applied nitrogen that was recovered, it is necessary first to deduct from the total amount of nitrogen recovered in the crop, the amount recovered from the check cylinder, and thus account for the soil nitrogen that the crop used.

It is at once obvious that this cannot be an absolutely correct method of determining the percentage recovered, since in those cylinders to which nitrogenous fertilizers have been applied, the plant will make a quicker start and the roots go farther in search of the nitrogenous materials of the soil than in the check cylinders where there is a pronounced deficiency of available nitrogen, and thus the check fails to be a ***true*** check. In this way it happens that the recovery may ***apparently*** be more than 100 per cent. as shown in Series 8B, for the years 1901 and 1910. However, there appears to be no way of overcoming this error so long as the work is carried out in the natural soil and if one starts with an artificial soil, other and more serious difficulties arise.

In this work no effort has been made to analyze the roots, since it would be well-nigh impossible to do this correctly, and even if it could be done the same error would be introduced. The roots and stubble are left just as under field conditions so that the residual effects of these may be observed.

To draw conclusions from 1 to 2 years of such work would be manifestly unfair, but when it is carried on for a period of 10 or 20 years, seasonal differences, differences due to the unequal decomposition of organic matter and differences due to slight errors, which are sure to creep in now and then, are largely smoothed out and results are obtained which can be accepted with a fair degree of confidence. The confidence in such results is strengthened when it is found that they check with similar work conducted in other places or even in other countries.

The work was started in these cylinders in the spring of 1898 with corn as the first crop in the rotation. Four 5-year rotations have been carried out as follows:

First Rotation

1898	Corn
1899	Oats (millet)
1900	Oats (corn)
1901	Wheat
1902	Timothy (two cuttings)

Second Rotation

1903	Corn
1904	Oats (corn)
1905	Oats (corn)
1906	Wheat
1907	Timothy (two cuttings)

Third Rotation

1908	Corn
1909	Oats (corn)
1910	Oats (corn)
1911	Rye and oats
1912	Timothy (two cuttings)

Fourth Rotation

1913	Corn
1914	Oats (corn)
1915	Oats (corn)
1916	Wheat
1917	Timothy (two cuttings)

The corn following the oats is grown as a residual crop (without further addition of fertilizers) to utilize any nitrogen which the oat crop may have failed to get. All corn is planted thick and harvested as forage rather than as mature corn. Oats are harvested as oat-hay just before maturity, and wheat is harvested at maturity and saved as grain and straw.

Nitrogenous materials are applied for each main crop in the rotation as follows:

Cylinder 4B, farm manure, at the rate of 16 tons per acre.

Cylinder 8B, Nitrate of Soda, at the rate of 320 pounds per acre.

Cylinder 17B, ammonium sulfate, equivalent to 320 pounds of Nitrate of Soda per acre.

Cylinder 18B, dried blood, equivalent to 320 pounds of Nitrate of Soda per acre.

Thus a careful record is kept of the amount of nitrogen applied each year and of the yield of dry matter from each cylinder. From determinations of the amount of nitrogen in the dry matter the total amount of nitrogen removed by the crop each year is easily calculated.

Yield of Dry Matter.

The yield of dry matter under the four different treatments for the 20 years is shown in table 1, averages being given for two 10-year periods and also for the entire 20 years. For each 10-year period the yield has been largest with the manure, though it is less for the second 10-year period than for the first, which would indicate that with manure at the rate of 16 tons per acre the fertility of the soil is not being fully maintained. The lowest yield is from 18B where dried blood is used as the source of nitrogen. Here again the average yield is less for the second 10-year period than for the first. For plots 8B and 17B, which receive Nitrate of Soda and ammonium sulfate, respectively, the average yields for the first 10 years are essentially the same for the two treatments, but for the second 10 years the average for the Nitrate of Soda treatment is considerably above that for the ammonium sulfate; furthermore, the average yield with ammonium sulfate is, like the yield with dried blood and farm manure, less for the second than for the first 10-year period. With the Nitrate of Soda, however, the figures are reversed that is, the average yield for the second 10 years is somewhat above that for the first 10 years.

The question may well be raised as to why the average yields on 4B, 17B and 18B should be less for the second 10-year period than for the first, while the yield on 8B has been well maintained for the 20 years. Since phosphoric acid and potash have been supplied each year in liberal amounts, and lime has been used at stated intervals, it would seem clear that the falling off in yield must be due to a deficiency of available nitrogen, notwithstanding the fact that cylinders 17B and 18B receive each year just as much nitrogen as 8B, while 4B receives more than two and one-half times as much as 8B.

TABLE 1

Yield of Dry Matter with Different Nitrogenous Materials.

First 10-Year Period						Second 10-Year Period					
Year	Check *	4B	8B	17B	18B	Year	Check *	4B	8B	17B	18B
	gm.	gm.	gm.	gm.	gm.		gm.	gm.	gm.	gm.	gm.
1898.	291.1	467.1	393.9	401.0	341.8	1908.	169.0	326.0	331.0	286.0	228.0
1899.	146.6	354.1	184.5	190.5	186.3	1909.	164.0	208.0	244.0	217.0	218.0
1900.	238.1	387.2	317.0	310.1	307.9	1910.	214.0	422.0	338.0	287.0	276.0
1901.	126.0	342.2	331.0	300.0	239.4	1911.	68.0	236.0	160.0	117.0	126.0
1902.	86.2	147.8	150.9	143.9	115.6	1912.	88.0	221.0	187.0	153.0	115.0
1903.	160.3	315.0	183.0	291.0	216.0	1913.	177.2	390.5	312.5	228.5	286.5
1904.	118.7	262.0	170.0	167.0	160.0	1914.	137.0	285.8	222.4	196.9	198.3
1905.	125.7	262.0	226.0	209.0	191.0	1915.	103.7	231.2	211.0	178.3	147.5
1906.	98.3	316.0	244.0	226.0	144.0	1916.	91.4	250.9	217.3	181.6	112.9
1907.	107.3	237.0	168.0	133.0	172.0	1917.	71.1	229.0	208.0	167.0	139.0
Average†	149.8	309.04	236.83	237.15	207.4	Average‡	128.3	280.04	243.12	201.23	184.72

* Phosphoric acid, potash and lime, no nitrogen.
† First ten years.
‡ Second ten years.

Data presented heretofore, and which are confirmed by results hereafter to be presented, show that of the four materials, Nitrate of Soda is most effective in crop production, that is, the crop is able to utilize or win back a larger percentage of nitrogen in this form than in any of the other forms. With a given amount of nitrogen, therefore, the crop yield can be better maintained over a period of years by the use of nitrogen in the form of Nitrate of Soda than in the other forms, provided the soil is one that does not allow rapid leaching.

This apparently is what has happened in this case. With the gradual exhaustion of *soil* nitrogen, which was made available by the use of lime, and the failure of the ammonium sulfate, blood and manure to give back in the form of crops as large a proportion of the applied nitrogen as the Nitrate of Soda, the yields with the former became gradually less.

The fact that cylinder 4B gave the largest average yield through 20 years must not be taken as meaning that the treatment given this cylinder is necessarily the best or most effective. It will be remembered that this cylinder receives cow manure at the rate of 16 tons per acre annually, the cost of which would be much in excess of the cost of 320 pounds of Nitrate of Soda or its equivalent in ammonium sulfate or dried blood, and therefore the larger yield does not necessarily mean an efficient use of the applied nitrogen. As a matter of fact, the work shows this to be the least efficient of the four forms.

Percentage of Nitrogen Recovered in the Crops.

Reference has already been made to the method of calculating the percentage of nitrogen that is recovered in the crop. The recoveries for the four

TABLE 2

Percentage of Nitrogen Recovered from Different Materials.

First 10-Year Period					Second 10-Year Period				
Year	4B	8B	17B	18B	Year	4B	8B	17B	18B
1898.....	28.15	63.75	66.06	58.18	1908.....	16.97	42.77	24.20	27.38
1899......	51.48	48.45	58.27	44.58	1909.....	18.25	80.64	54.94	49.04
1900.....	36.18	77.55	69.47	57.25	1910.....	54.74	110.74	62.12	51.22
1901......	41.78	110.26	91.91	68.71	1911.....	20.98	64.10	48.46	41.59
1002......	11.48	32.06	23.64	14.32	1912.....	29.11	49.16	27.45	10.96
1903.....	20.20	30.84	34.38	20.97	1913.....	27.63	32.92	15.50	40.26
1904......	38.91	46.19	39.26	33.68	1914.....	52.46	74.35	67.86	56.55
1905......	30.10	68.77	56.05	34.01	1915.....	32.13	64.10	52.53	48.12
1906......	44.94	81.81	30.80	24.78	1916.....	36.60	68.96	57.53	20.26
1907......	33.85	45.10	27.47	42.48	1917.....	27.95	55.77	41.75	29.41
Average*..	33.71	60.48	49.73	39.90	Average†..	31.68	64.35	45.23	37.48
Average‡..	32.69	62.42	47.48	38.69					

different treatments covering the 20 years are shown in table 2. The averages for the period are as follows:

4B.......... 32.69 per cent. (manure)
8B.......... 62.42 per cent. (Nitrate of Soda)
17B.......... 47.48 per cent. (ammonium sulfate)
18B.......... 48.69 per cent. (dried blood)

This means that of 100 pounds of nitrogen applied in the four different forms approximately one-third, three-fifths, one-half, and two-fifths, respectively, are

* First ten years.
† Second ten years.
‡ Twenty years.

recovered or won back in the crop.[1] As has already been mentioned, these figures agree quite closely with results reported from European countries, and they also confirm earlier work carried out at this Station. But even so, they are not satisfying figures. We at once ask why there is this enormous loss of nitrogen and especially why the loss is so much greater with the organic materials than with the Nitrate of Soda and ammonium sulfate. If the loss is to be attributed to the leaching out of the materials, then it would seem that the figures should be reversed. Unquestionably, a certain amount of loss takes place in this way, but this cannot explain the loss of over two-thirds from the manure against a little more than one-third from Nitrate.

It is well known that organic materials must undergo certain transformations in the soil before the nitrogen can become available, and it seems that during these transformations nitrogen as ammonia, Nitrate or as elemental nitrogen must be lost in considerable quantities. As bearing on this it may be pointed out that Russell and Richards (5) have shown by laboratory experiments with manure that in addition to the loss of ammonia by volatilization there is still a loss amounting to 15 per cent. or more of total nitrogen, and they have gone further and shown that during decomposition there is an evolution of gaseous nitrogen. This they believe com-

[1] Or if we assign to Nitrate nitrogen a value of 100, then the relative availability of the four materials stands as follows:

Nitrate of soda	100.0
Ammonium sulfate	76.1
Dried blood	62.0
Manure	52.4

pletes the account of the loss. This loss, they claim, does not go on under wholly anaerobic or wholly aerobic conditions but under mixed anaerobic and aerobic conditions which arise when manure is being produced. They explain further that in the natural manure heap nitrogen is also lost as gaseous ammonia as well as in the form of nitrogen gas.

It is very probable that in a more limited way, similar changes take place when organic compounds are placed in the soil and that a part of the loss of nitrogen noted in our experiments must be thus accounted for. It is a well-known fact that when an organic substance like cottonseed meal or dried blood is mixed with soil and incubated in the laboratory for a few days, escaping ammonia may be detected, and from this it is a natural conclusion that when large quantities of organic matter are placed in the soil under natural conditions, some ammonia will be lost by volatilization, especially when the temperature and moisture conditions are favorable. This then, together with the evolution of gaseous nitrogen, would in part at least explain the heavy loss of nitrogen where manure was used at the rate of 16 tons per acre.

A discussion of this subject would not be completed without a brief reference to the effect of cultivation on nitrogen losses.

Shutt[1] for example has shown that when the prairie soils of Saskatchewan were left undisturbed the loss of nitrogen was slight, but as soon as cultivation was commenced losses set in.

[1] Cited by Russell (4).

Russell (4) refers further to losses of nitrogen as follows:

> One of the Broadbalk wheat plots receives annually 14 tons of farmyard manure per acre containing 200 pounds of Nitrogen. Only a little drainage can be detected and there is no reason to suppose that any considerable leaching out of Nitrates occurs, but the loss of Nitrogen is enormous amounting to nearly 70 per cent. of the added quantity.
>
> The condition for this decomposition appears to be copious aeration, such as is produced by cultivation and the presence of large quantities of easily decomposable organic matter. Now these are precisely the conditions of intensive farming in old countries and of pioneer farming in new lands, and the result is that the reserves of soil and manurial Nitrogen are everywhere being depleted at an appalling rate.

Russell refers to the recuperative actions that are going on, but says: "One of the most pressing problems at the present time is to learn how to suppress this gaseous decomposition and to direct the processes wholly into the Nitrate channels.

In a paper on the Nitrate content of cultivated and uncultivated soils, Blair and McLean (1), have called attention to the loss of nitrogen from cultivated soils and also to the low recovery from nitrogen applied as organic materials. They point out that land under cultivation is gradually being depleted of its store of nitrogen even when nitrogenous fertilizers are applied each year and that the average recovery of nitrogen applied in the form of fish scrap for a period of nine years, was only 36.36 per cent.

With the same nitrogen treatment soils allowed to run wild just about maintained their nitrogen content, while the carbon content of these soils was slightly increased.

The recovery of nitrogen in the four different treatments for the 20 years is shown by the curves in figure 1. A study of these curves shows that the high points are generally reached in either the first or second year of oats, and in the wheat year, while the low points occur almost invariably in the corn and timothy years. It is not entirely clear whether this is a seasonal variation or a crop characteristic.

It is certain, however, that the utilization of the residual nitrogen by the corn crop which follows the oats, helps to explain the high recovery for the years when oats are grown.

Conclusions.

In a 5-year rotation on Penn loam soil well supplied with phosphoric acid, potash and lime, crop yields were better maintained over a period of 20 years with Nitrate of soda at the rate of 320 pounds per acre than with an equivalent amount of ammonium sulfate or dried blood. For several years the latter gave results about on a par with the Nitrate, but an average of the second 10-year period shows a considerable falling off with these materials as compared with the Nitrate. This is no doubt due in part to the fact that the Nitrate, being immediately available, gives the plant an early start which tends to keep it in the lead and to the further fact that in the transformation of the ammonium salt and the organic material into nitrates, there is a considerable loss of nitrogen, possibly as ammonia gas or gaseous nitrogen or both. The loss cannot all be attributed to a leaching out of the materials, even though the nitrification of ammonia and organic residues may go on throughout a large portion of the year.

In the above-mentioned rotation cow manure at the rate of 16 tons per acre gave somewhat larger yields than Nitrate of Soda, but the increased yields were not sufficient to justify the increase in the cost of nitrogen.

Furthermore, the average yield with the manure was less for the second 10-year period than for the first, while the reverse is true with the Nitrate of Soda. Thus it is shown that with 16 tons of manure per acre annually, the crop yield is not being maintained, while with Nitrate of Soda at the rate of 320 pounds per acre annually it is increasing slightly, as shown by the average for the second 10-year period.

The percentage of nitrogen recovered in the crop was greater with the nitrate than with any of the other materials, the 20-year average being as follows:

	Per cent.
Nitrate of Soda	62.42
Ammonium sulfate	47.48
Dried blood	38.69
Cow manure	32.69

The average recovery with Nitrate for the second 10-year period was 64.35 per cent. as against 60.48 per cent. for the first 10-year period, whereas the average recovery with the ammonium sulfate, dried blood and manure was all less for the second 10-year period than for the first.

This is in agreement with the crop yields, and indicates a diminishing efficiency for the ammonium sulfate, blood and manure, and a gradual increase in efficiency for the Nitrate of Soda.

The work shows that when properly used Nitrate of Soda alone as a source of nitrogen may be depended upon to maintain crop yields over a long period, and that a given amount of nitrogen in this form is more effective than an equivalent amount in the form of ammonium sulfate, or organic materials.

Its effect is to produce larger crops per unit of nitrogen, and these crops, in turn, leave behind in the soil larger crop residues, and with carbonate of lime to aid in their decomposition these furnish a sufficient supply of organic matter to keep the soil in good physical condition.

References.

(1) Blair, A. W., and McLean, H. C. 1917. Total nitrogen and carbon in cultivated land and land abandoned to grass and weeds. In Soil Sci., v. 4, no. 4, p. 283-294.

(2) Coleman, D. A. 1917. The influence of Sodium Nitrate upon transformations in soil with special reference to its availability and that of other nitrogenous manures. In Soil Sci., v. 4, no. 5, p. 345-432.

(3) Lipman, J. G., and Blair, A. W. 1916. Investigations relative to the use of nitrogenous plant foods: 1898-1912. N. J. Agr. Exp. Sta. Bul. 288.

(4) Russell, E. J. 1915. Soil Conditions and Plant Growth, new ed., p. 83, Longmans, Green and Co., New York.

(5) Russell, E. J., and Richards, E. H. 1917. The changes taking place during the storage of farmyard manure. In Jour. Agr. Sci., v. 8, p. 495-563.

COST OF TRANSPORTATION OF FERTILIZERS.

A striking illustration of the difference in the cost of transportation by four different ways is given below:

To transport a ton by

Horse power, 5 miles;
Electric power, 25 miles;
Steam cars, 250 miles;
Steamships on the lakes, 1,000 miles;

costs the same amount in each case and the same amount of money will haul a ton

5 miles on a common road,
15 miles on a well-made stone road,
25 miles on a trolley road,
250 miles on a steam railway,
1,000 miles on a steamship.

It will be seen that the same amount of money it takes to haul a given amount of produce five miles on a public highway of the United States will pay the freight for 250 miles on a railroad and 1,000 miles on a steamship line on the lakes. This is too great a difference, as will be admitted by all, and when we think of the fact that the railroad companies are ever at work repairing and improving their highways while the farmer is apparently so little awake to his own interests in regard to furnishing himself with better roads, we wonder why it is. The lesson seems plain and clear, and, as progressive farmers, let us continue to aid the good road movement throughout the country.

Nitrate of Soda is essentially a seaboard article; supplies at interior points are not always available, hence the ports of entry are as a rule the best sources of supply.

The improvement of our water-ways, so long urged by us, seems at last to be in sight; and farm chemicals at lower rates should ultimately be expected, even at interior points.

It has been the custom of the railroad companies to discriminate heavily and unfairly against Nitrate of Soda by charging almost prohibitory chemical rates, instead of equitable fertilizer rates, and it is hoped by correctly designating the material, the discrimination will not be practiced.

Farm newspapers, generally, are quite willing to publish wholesale quotations on all those things which the farmer has to sell, and they have not, as a rule, published wholesale quotations on those articles which he has to buy. Among the latter, agricultural chemicals occupy a position of prime importance, not only as to actual effect on farm prosperity, but as to the actual amount of cash which the farmer has to spend, for his produce comes out of the soil and its amount and quality is determined by the character of the chemicals he puts into it. Agricultural journals generally should make a continued effort in the direction of enhancing his purchasing power, by endeavoring to make him more prosperous.

OF GENERAL INTEREST.

Average Annual Rainfall in the United States.

Place	Inches	Place	Inches
Neah Bay, Washington	123	Hanover, New Hampshire ..	40
Sitka, Alaska	83	Ft. Vancouver	38
Ft. Haskins, Oregon	66	Cleveland, Ohio	37
Mt. Vernon, Alabama	66	Pittsburgh, Pennsylvania ...	37
Baton Rouge, Louisiana	60	Washington, D. C.	37
Meadow Valley, California ..	57	White Sulphur Springs, Va..	37
Ft. Towson, Oklahoma	57	Ft. Gibson, Oklahoma	36
Ft. Meyers, Florida	56	Key West, Florida	36
Washington, Arkansas	54	Peoria, Illinois	35
Huntsville, Alabama	54	Burlington, Vermont	34
Natchez, Mississippi	53	Buffalo, New York	33
New Orleans, Louisiana	51	Ft. Brown, Texas	33
Savannah, Georgia	48	Ft. Leavenworth, Kansas ..	31
Springdale, Kentucky	48	Detroit, Michigan	30
Fortress Monroe, Virginia ..	47	Milwaukee, Wisconsin	30
Memphis, Tennessee	45	Penn Yan, New York	28
Newark, New Jersey	44	Ft. Kearney	25
Boston, Massachusetts	44	Ft. Snelling, Minnesota	25
Brunswick, Maine	44	Salt Lake City, Utah	23
Cincinnati, Ohio	44	Mackinac, Michigan	23
New Haven, Connecticut	44	San Francisco, California ...	21
Philadelphia, Pennsylvania ..	44	Dallas, Oregon	21
New York City, N. Y.	43	Sacramento, California	21
Charleston, South Carolina ..	43	Ft. Massachusetts, Colorado.	17
Gaston, North Carolina	43	Ft. Marcy, New Mexico	16
Richmond, Indiana	43	Ft. Randall, Dakota	16
Marietta, Ohio	43	Ft. Defiance, Arizona	14
St. Louis, Missouri	43	Ft. Craig, New Mexico	11
Muscatine, Iowa	42	San Diego, California	9
Baltimore, Maryland	41	Ft. Colville, Washington	9
New Bedford, Massachusetts	41	Ft. Bliss, Texas	9
Providence, Rhode Island ..	41	Ft. Bridger, Utah	6
Ft. Smith, Arkansas	40	Ft. Garland, Colorado	6

Amount of Barbed Wire Required for Fences.

Estimated number of pounds of Barbed Wire required to fence space for distances mentioned, with one, two or three lines of wire, based upon each pound of wire, measuring one rod (16½ feet).

	1 line	2 lines	3 lines
1 square acre	50⅔ lbs.	101⅓ lbs.	152 lbs.
1 side of a square acre ..	12⅔ lbs.	25⅓ lbs.	38 lbs.
1 square half-acre	36 lbs.	72 lbs.	108 lbs.
1 square mile	1,280 lbs.	2,560 lbs.	3,840 lbs.
1 side of a square mile ..	230 lbs.	460 lbs.	690 lbs.
1 rod in length	1 lb.	2 lbs.	3 lbs.
100 rods in length	100 lbs.	200 lbs.	300 lbs.
100 feet in length	6$\frac{1}{16}$ lbs.	12⅛ lbs.	18$\frac{3}{16}$ lbs.

Business Rules for Farmers.

The way to get credit is to be punctual in paying your bills. The way to preserve it is not to use it much. Settle often; have short accounts.

Trust no man's appearances — they are deceptive — perhaps assumed, for the purpose of obtaining credit. Beware of gaudy exterior. Rogues usually dress well. The rich are plain men. Trust him, if any, who carries but little on his back. Never trust him who flies into a passion on being dunned; make him pay quickly, if there be any virtue in the law.

Be well satisfied before you give a credit that those to whom you give it are men to be trusted.

Sell your goods at a small advance, and never misrepresent them, for those whom you once deceive will beware of you the second time.

Deal uprightly with all men, and they will repose confidence in you, and soon become your permanent customers.

Beware of him who is an office seeker. Men do not usually want an office when they have anything to do. A man's affairs are rather low when he seeks office for support.

Trust no stranger. Your goods are better than doubtful charges. What is character worth, if you make it cheap by crediting everybody?

Agree beforehand with every man about to do a job, and, if large, put it into writing. If any decline this, quit, or be cheated. Though you want a job ever so much, make all sure at the outset, and in case at all doubtful, make sure of a guarantee. Be not afraid to ask it — the best test of responsibility — for, if offence be taken, you have escaped a loss.

How Deep in the Ground to Plant Corn.

The following is the result of an experiment with Indian Corn. That which was planted at a depth of

1	inch, came up in..................	8½ days.
1½	inches, came up in...............	9½ days.
2	inches, came up in...............	10 days.
2½	inches, came up in...............	11½ days.
3	inches, came up in...............	12 days.
3½	inches, came up in...............	13 days.
4	inches, came up in...............	13½ days.

The more shallow the seed was covered with earth, the more rapidly the sprout made its appearance, and the stronger afterwards was the stalk. The deeper the seed lay, the longer it remained before it came to the surface. Four inches was too deep for the maize, and must, therefore, be too deep for smaller kernels.

How Grain Will Shrink.

Farmers rarely gain by holding on to their grain after it is fit for market, when the shrinkage is taken into account. Wheat, from the time it is threshed, will shrink two quarts to the bushel or six per cent. in six months, in the most favorable circumstances.

Hence, it follows that ninety-four cents a bushel for wheat when first threshed in August, is as good, taking into account the shrinkage alone, as one dollar in the following February.

Corn shrinks much more from the time it is first husked. One hundred bushels of ears, as they come from the field in November, will be reduced to not far from eighty. So that forty cents a bushel for corn in the ear, as it comes from the field, is as good as fifty in March, shrinkage only being taken into account.

In the case of potatoes — taking those that rot and are otherwise lost — together with the shrinkage, there is but little doubt that between October and June, the loss to the owner who holds them is not less than thirty-three per cent.

This estimate is taken on the basis of interest at seven per cent., and takes no account of loss by vermin.

One hundred pounds of Indian meal is equal to 76 pounds of wheat, 83 of oats, 90 of rye, 111 of barley, 333 of corn stalks.

Carrying Capacity of a Freight Car.

This Table is for Ten-Ton Cars.

Whiskey	60 barrels	Lumber	6,000 feet
Salt	70 barrels	Barley	300 bushels
Lime	70 barrels	Wheat	340 bushels
Flour	90 barrels	Flaxseed	360 bushels
Eggs	130 to 160 barrels	Apples	370 bushels
Flour	200 sacks	Corn	400 bushels
Wood	6 cords	Potatoes	430 bushels
Cattle	18 to 20 head	Oats	680 bushels
Hogs	50 to 60 head	Bran	1,000 bushels
Sheep	80 to 100 head	Butter	20,000 pounds

Length of Navigation of the Mississippi River.

The length of navigation of the Mississippi River itself for ordinary large steamboats is about 2,161 miles, but small steamers can ascend about 650 miles further. The following are its principal navigable tributaries, with the miles open to navigation:

	Miles		Miles
Minnnesota	295	Wisconsin	160
Chippewa	90	Rock	64
Iowa	80	Illinois	350
Missouri	2,900	Yellowstone	474
Big Horn	50	Ohio	950
Allegany	325	Monongahela	110
Muskingum	94	Kanawha	94
Kentucky	105	Green	200
Wabash	365	Cumberland	600
Tennessee	270	Clinch	50
Osage	302	St. Francis	180
White	779	Black	147
Little White	48	Arkansas	884
Big Hatchie	75	Issaquena	161
Sunflower	271	Yazoo	228
Tallahatchie	175	Big Black	35
Red	986	Cane	54
Cypress	44	Ouachita	384
Black	61	Boeuf	55
Bartholomew	100	Tensas	112
Macon	60	Teche	91
Atchafalaya	218	D'Arbonne	50
Lafourche	168		

The other ten navigable tributaries have less than fifty miles each of navigation. The total miles of navigation of these fifty-five streams is about 16,500 miles, or about two-thirds the distance around the world. The Mississippi and its tributaries may be estimated to possess 15,500 miles navigable to steamboats, and 20,221 miles navigable to barges.

Number of Years Seeds Retain Their Vitality.

Vegetables	Years	Vegetables	Years
Cucumber	8 to 10	Asparagus	2 to 3
Melon	8 to 10	Beans	2 to 3
Pumpkin	8 to 10	Carrots	2 to 3
Squash	8 to 10	Celery	2 to 3
Broccoli	5 to 6	Corn (on cob)	2 to 3
Cauliflower	5 to 6	Leek	2 to 3
Artichoke	5 to 6	Onion	2 to 3
Endive	5 to 6	Parsley	2 to 3
Pea	5 to 6	Parsnip	2 to 3
Radish	4 to 5	Pepper	2 to 3
Beets	3 to 4	Tomato	2 to 3
Cress	3 to 4	Egg-Plant	1 to 2
Lettuce	3 to 4		
Mustard	3 to 4	Herbs.	
Okra	3 to 4	Anise	3 to 4
Rhubarb	3 to 4	Caraway	2
Spinach	3 to 4	Summer Savory	1 to 2
Turnip	3 to 6	Sage	2 to 3

How to Measure Corn in Crib, Hay in Mow, Etc.

This rule will apply to a crib of any size or kind. Two cubic feet of good, sound, dry corn in the ear will make a bushel of shelled corn. To get, then, the quantity of shelled corn in a crib of corn in the ear, measure the length, breadth and height of the crib, inside of the rail; multiply the length by the breadth and the product by the height; then divide the product by two, and you have the number of bushels of shelled corn in the crib.

To find the number of bushels of apples, potatoes, etc., in a bin, multiply the length, breadth and thickness together, and this product by 8, and point off one figure in the product for decimals.

To find the amount of hay in a mow, allow 512 cubic feet for a ton, and it will come out very generally correct.

How to Treat Sunstroke.

Take the patient at once to a cool and shady place, but don't carry him far to a house or hospital. Loosen the clothes thoroughly about his neck and waist. Lay him down with the head a little raised. Apply wet cloths to the head, and mustard or turpentine to the calves of the legs and the soles of the feet. Give a little weak whiskey and water if he can swallow. Meanwhile, let some one go for the doctor. You cannot do more without his advice.

Sunstroke is a sudden prostration due to long exposure to great heat, especially when much fatigued or exhausted. It commonly happens from undue exposure to the sun's rays in summer. It begins with pain in the head, or dizziness, quickly followed by loss of consciousness and complete prostration.

Business Laws in Brief.

Ignorance of law excuses none.
It is a fraud to conceal a fraud.
The law compels no one to do impossibilities.
An agreement without consideration is void.
Signatures made with lead-pencil are good in law.
A receipt for money paid is not legally conclusive.
The acts of one partner bind all the others.
Contracts made on Sunday cannot be enforced.

A contract made with a minor is invalid.

A contract made with a lunatic is void.

Contracts for advertising in Sunday newspapers are invalid.

Each individual in a partnership is responsible for the whole amount of the debts of a firm.

Principals are responsible for the acts of their agents.

Agents are responsible to their principals for errors.

A note given by a minor is void.

It is not legally necessary to say on a note "for value received."

A note drawn on Sunday is void.

A note obtained by fraud, or from a person in a state of intoxication, cannot be collected.

If a note be lost or stolen, it does not release the maker; he must pay.

The indorser of a note is exempt from liability if not served with notice of its dishonor within twenty-four hours of its non-payment.

How to Rent a Farm.

In the rental of property, the greater risk is always on the landlord's side. He is putting his property into the possession and care of another, and that other is not infrequently a person of doubtful utility. These rules and cautions may well be observed:

1. Trust to no verbal lease. Let it be in writing, signed and sealed. Its stipulations then become commands and can be enforced. Let it be

signed in duplicate, so that each party may have an original.

2. Insert such covenants as to repairs, manner of use and in restraint of waste, as the circumstances call for. As to particular stipulations, examine leases drawn by those who have had long experience in renting farms, and adopt such as meet your case.

3. There should be covenants against assigning and underletting.

4. If the tenant is of doubtful responsibility, make the rent payable in installments. A covenant that the crops shall remain in the lessor's till the lessee's contracts with him have been fulfilled, is valid against the lessee's creditors. In the ordinary case of renting farms on shares, the courts will treat the crops as the joint property of landlord and tenant, and thus protect the former's rights.

5. Every lease should contain stipulations for forfeiture and re-entry in case of non-payment or breach of any covenants.

6. To prevent a tenant's committing waste, the courts will grant an injunction.

7. Above all, be careful in selecting your tenant. There is more in the man than there is in the bond.

Philosophical Facts.

The greatest height at which visible clouds ever exist does not exceed ten miles.

Air is about eight hundred and fifteen times lighter than water.

The pressure of the atmosphere upon every square foot of the earth amounts to two thousand one hundred and sixty pounds. An ordinary sized man, supposing his surface to be fourteen square feet, sustains the enormous pressure of thirty thousand, two hundred and forty pounds.

The barometer falls one-tenth of an inch for every seventy-eight feet of elevation.

The violence of the expansion of water when freezing is sufficient to cleave a globe of copper of such thickness as to require a force of 27,000 pounds to produce the same effect.

During the conversion of ice into water one hundred and forty degrees of heat are absorbed.

Water, when converted into steam, increases in bulk eighteen hundred times.

In one second of time — in one beat of the pendulum of a clock — light travels two hundred thousand miles. Were a cannon ball shot toward the sun, and were it to maintain full speed, it would be twenty years in reaching it — and yet light travels through this space in seven or eight minutes.

Strange as it may appear, a ball of a ton weight and another of the same material of an ounce weight, falling from any height will reach the ground at the same time.

The heat does not increase as we rise above the earth nearer to the sun but decreases rapidly until, beyond the regions of the atmosphere, in void, it is estimated that the cold is about seventy degrees below zero. The line of perpetual frost at the equator is 15,000 feet altitude; 13,000 feet between the tropics; and 9,000 to 4,000 between the latitudes of forty and forty-nine degrees.

At a depth of forty-five feet under ground, the temperature of the earth is uniform throughout the year.

In summer time, the season of ripening moves northward at the rate of about ten miles a day.

The human ear is so extremely sensitive that it can hear a sound that lasts only the twenty-four thousandth part of a second. Deaf persons have sometimes conversed together through rods of wood held between their teeth, or held to their throat or breast.

The ordinary pressure of the atmosphere on the surface of the earth is two thousand one hundred and sixty pounds to each square foot, or fifteen pounds to each square inch; equal to thirty perpendicular inches of mercury, or thirty-four and a half feet of water.

Sound travels at the rate of one thousand one hundred and forty-two feet per second — about thirteen miles in a minute. So that if we hear a clap of thunder half a minute after the flash, we may calculate that the discharge of electricity is six and a half miles off.

Lightning can be seen by reflection at the distance of two hundred miles.

The explosive force of closely confined gunpowder is six and a half tons to the square inch.

Facts for the Weatherwise.

If the full moon rises clear, expect fine weather.

A large ring around the moon and low clouds indicate rain in twenty-four hours; a small ring and high clouds, rain in several days.

The larger the halo about the moon the nearer the rain clouds, and the sooner the rain may be expected.

When the moon is darkest near the horizon, expect rain.

If the full moon rises pale, expect rain.

A red moon indicates wind.

If the moon is seen between the scud and broken cloud during a gale, it is expected to send away the bad weather.

In the old of the moon a cloudy morning bodes a fair afternoon.

If there be a general mist before sunrise near the full of the moon, the weather will be fine for some days.

Farmers' Barometers.

If the chickweed and scarlet pimpernel expand their tiny petals, rain need not be expected for a few hours, says a writer.

Bees work with redoubled energy before a rain.

If flies are unusually persistent either in the house or around the stock, there is rain in the air.

The cricket sings at the approach of cold weather.

Squirrels store a large supply of nuts, the husks of corn are usually thick, and the buds of deciduous trees have a firmer protecting coat if a severe winter is at hand.

Corn fodder is extremely sensitive to hygrometric changes. When dry and crisp, it indicates fair weather; when damp and limp, look out for rain.

A bee was never caught in a shower; therefore when his bees leave their hive in search of honey, the farmer knows that the weather is going to be good.

How to Preserve Eggs.

To each pailful of water, add two pints of fresh slaked lime and one pint of common salt; mix well. Fill your barrel half full with this fluid, put your eggs down in it any time after June, and they will keep two years, if desired. A solution of silicate of soda, commonly known as water glass, is also used for the same purpose.

Estimating Measures.

A pint of water weighs nearly 1 pound, and is equal to about 27 cubic inches, or a square box 3 inches long, 3 inches wide and 3 inches deep.

A quart of water weighs nearly 2 pounds, and is equal to a square box of about 4 by 4 inches and 3½ inches deep.

A gallon of water weighs from 8 to 10 pounds, according to the size of the gallon, and is equal to a box 6 by 6 inches square and 6, 7 or 7½ inches deep.

A peck is equal to a box 8 by 8 inches square and 8 inches deep.

A bushel almost fills a box 12 by 12 inches square and 15 inches deep. In exact figures, a bushel contains 2150.42 cubic inches.

A cubic foot of water weighs nearly 64 pounds (more correctly 62½ pounds), and contains from 7 to 8 gallons, according to the kind of gallons used.

A barrel of water almost fills a box 2 by 2 feet square and 1½ feet deep, or 6 cubic feet.

Petroleum barrels contain 40 gallons or nearly 5 cubic feet.

Square Measure.

144 sq. inches = 1 sq. foot.
9 sq. feet = 1 sq. yard.
30¼ sq. yards = 1 sq. rod.
160 sq. rods = 1 acre.
43,560 sq. feet = 1 acre.
640 acres = 1 sq. mile.
2.47 acres = 1 hectare.

Facts for Builders.

One thousand shingles, laid 4 inches to the weather, will cover 100 square feet of surface, and 5 pounds of shingle nails will fasten them on.

One-fifth more siding and flooring is needed than the number of square feet of surface to be covered because of the lap in the siding and matching.

One thousand laths will cover 70 square yards of surface, and 11 pounds of lath nails will nail them on. Eight bushels of good lime, 16 bushels of sand, and one bushel of hair, will make enough good mortar to plaster 100 square yards.

A cord of stone, 3 bushels of lime and a cubic yard of sand, will lay 100 cubic feet of wall.

Five courses of brick will lay one foot in height on a chimney; 16 bricks in a course will make a flue 4 inches wide and 12 inches long, and 8 bricks in a course will make a flue 8 inches wide and 16 inches long.

Cement 1 bushel and sand 2 bushels will cover 3½ square yards 1 inch thick, 4½ square yards ¾ inch thick, and 6¾ square yards ½ inch thick. One bushel cement and 1 of sand will cover 2½ square yards 1 inch thick, 3 square yards ¾ inch thick, and 4¼ square yards ½ inch thick.

Number of Brick Required to Construct Any Building.
(Reckoning 7 Brick to each Superficial Foot)

Superficial Feet of Wall	Number of Brick to Thickness of					
	4 Inch	8 Inch	12 Inch	16 Inch	20 Inch	24 Inch
1	7	15	23	30	38	45
2	15	30	45	60	75	90
3	23	45	68	90	113	135
4	30	60	90	120	150	180
5	38	75	113	150	188	225
6	45	90	135	180	225	270
7	53	105	158	210	263	315
8	60	120	180	240	300	360
9	68	135	203	270	338	405
10	75	150	225	300	375	450
20	150	300	450	600	750	900
30	225	450	675	900	1,125	1,350
40	300	600	900	1,200	1,500	1,800
50	375	750	1,125	1,500	1,875	2,250
60	450	900	1,350	1,800	2,250	2,700
70	525	1,050	1,575	2,100	2,625	3,150
80	600	1,200	1,800	2,400	3,000	3,600
90	675	1,350	2,025	2,700	3,375	4,050
100	750	1,500	2,250	3,000	3,750	4,500
200	1,500	3,000	4,500	6,000	7,500	9,000
300	2,250	4,500	6,750	9,000	11,250	13,500
400	3,000	6,000	9,000	12,000	15,000	18,000
500	3,750	7,500	11,250	15,000	18,750	22,500
600	4,500	9,000	13,500	18,000	22,500	27,000
700	5,250	10,500	15,750	21,000	26,250	31,500
800	6,000	12,000	18,000	24,000	30,000	36,000
900	6,750	13,500	20,250	27,000	33,750	40,500
1000	7,500	15,000	22,500	30,000	37,500	45,000

Weight of a Cubic Foot of Earth, Stone, Metal, Etc.

Article	Pounds	Article	Pounds
Alcohol	49	Cider	64
Ash wood	53	Chestnut	38
Bay wood	51	Earth, loose	94
Brass, gun metal	543	Glass, window	165
Blood	66	Gold	1,203⅔
Brick, common	102	Hickory, shell bark	43
Cork	15	Hay, bale	9
Cedar	35	Hay, pressed	25
Copper, cast	547	Honey	90
Clay	120	Iron, cast	450
Coal, Lackawanna	50	Iron, plates	481
Coal, Lehigh	56	Iron, wrought bars	486

Weight of a Cubic Foot of Earth, Stone, Metal, Etc.

Article	Pounds	Article	Pounds
Ice	57½	Pine, red	37
Lignum Vitæ wood	83	Pine, well seasoned	30
Logwood	57	Silver	625¾
Lead, cast	709	Steel, plates	487¾
Milk	64	Steel, soft	489
Maple	47	Stone, common, about	158
Mortar	110	Sand, wet, about	128
Mud	102	Spruce	31
Marble, Vermont	165	Tin	455
Mahogany	66	Tar	63
Oak, Canadian	54	Vinegar	67
Oak, live, seasoned	67	Water, salt	64
Oak, white, dry	54	Water, rain	62
Oil, linseed	59	Willow	36
Pine, yellow	34	Zinc, cast	428
Pine, white	34		

What a Deed to a Farm in Many States Includes.

Every one knows it conveys all the fences standing on the farm, but all might not think it also included the fencing stuff, post rails, etc., which had once been used in the fence, but had been taken down and piled up for future use again in the same place. But new fencing material, just bought, and never attached to the soil, would not pass. So piles of hop poles stored away, if once used on the land and intended to be again so used, have been considered a part of it, but loose boards or scaffold poles merely laid across the beams of the barn, and never fastened to it, would not be, and the seller of the farm might take them away. Standing trees, of course, also pass as part of the land; so do trees blown down or cut down, and still left in the wood where they fell, but not if cut and corded up for sale; the wood has then become personal property.

If there is any manure in the barnyard or in the compost heap on the field, ready for immediate use, the buyer ordinarily, in the absence of any contrary agreement, takes that also as belonging to the farm, though it might not be so, if the owner had previously sold it to some other party and had collected it together in a heap by itself, for such an act might be a technical severance from the soil, and so convert real into personal estate; and even a lessee of a farm could not take away the manure made on the place while he was in occupation. Growing crops also pass by the deed of a farm, unless they are expressly reserved; and when it is not intended to convey those, it should be so stated in the deed itself; a mere oral agreement to that effect would not be, in most states, valid in law. Another mode is to stipulate that possession is not to be given until some future day, in which case the crops or manures may be removed before that time.

As to the buildings on the farm, though generally mentioned in the deed, it is not absolutely necessary they should be. A deed of land ordinarily carries all the buildings on it, belonging to the grantor, whether mentioned or not; and this rule includes the lumber and timber of any old building which has been taken down, or blown down, and packed away for future use on farm.

Hints for Farmers.

Vincent's Remedies for farm animals have been used with considerable success for several years, and they are recommended here as being worthy of trial.

First for Horses. When horses have chills, or have taken cold, or have colic, 15-20 drops of Aconite in a teacup of warm water will start perspiration, and if the horses are kept heavily blanketed, if the ailments are not more than ordinary, they will come out of them in good condition.

For Cattle. When cows get chilled, and if for any reason after dropping calves, the cows appear to shake, 15 drops of Aconite in a teacup of warm water will start perspiration, and if the cows are kept well blanketed, they will come out of the trouble without further treatment, unless the ailments are more than usual.

For Calves. A disease which has killed many fine young animals, even under the best conditions, is known as "scours." Vincent's cure in this case is a teaspoonful of Essence of Peppermint in half a teacup of warm water. This is to be administered after feeding night and morning, and is almost a certain cure, having saved the lives of many valuable calves.

For Sheep. A disease known as "stretches," caused by some stoppage in the bowels, can be frequently remedied by raising the sheep by its hind legs and holding it in that position for some minutes. In nine cases out of ten, a permanent cure is effected. This is worth remembering on account of many sheep having died from this cause.

Relative Value of Different Foods for Stock.

One hundred pounds of good hay for stock are equal to:

Articles	Pounds	Articles	Pounds
Beets, white silesia	669	Lucern	89
Turnips	469	Clover, Red, Dry	88
Rye-Straw	429	Buckwheat	78½
Clover, Red, Green	373	Corn	62½
Carrots	371	Oats	59
Mangolds	368½	Barley	58
Potatoes, kept in pit	350	Rye	53½
Oat-Straw	347	Wheat	44½
Potatoes	360	Oil-Cake, linseed	43
Carrot leaves (tops)	135	Peas, dry	37½
Hay, English	100	Beans	28

To Revive Ferns.

Nitrate of Soda dissolved in water should be given to ferns that are small or weak, one-quarter of an ounce of Nitrate to a gallon of water. One-half an ounce of Nitrate to a gallon of water should be used on plants that are large and vigorous. Soot and salt are also good to use occasionally.

Capacity of Cisterns for Each 10 Inches in Depth.

25 feet in diameter holds	3,059 gallons
20 feet in diameter holds	1,958 gallons
15 feet in diameter holds	1,101 gallons
14 feet in diameter holds	959 gallons
13 feet in diameter holds	827 gallons
12 feet in diameter holds	705 gallons
11 feet in diameter holds	592 gallons
10 feet in diameter holds	489 gallons
9 feet in diameter holds	396 gallons
8 feet in diameter holds	313 gallons
7 feet in diameter holds	239 gallons
6½ feet in diameter holds	206 gallons
6 feet in diameter holds	176 gallons
5 feet in diameter holds	122 gallons
4½ feet in diameter holds	99 gallons
4 feet in diameter holds	78 gallons
3 feet in diameter holds	44 gallons
2½ feet in diameter holds	30 gallons
2 feet in diameter holds	19 gallons

Surveyor's Measure.

7.92 inches 1 link, 25 links 1 rod, 4 rods 1 chain, 10 square chains or 160 square rods 1 acre, 640 acres 1 square mile.

Strength of Ice of Different Thickness.

Two inches thick — will support a man.

Four inches thick — will support a man on horseback.

Five inches thick — will support an eighty-pound cannon.

Eight inches thick — will support a battery of artiilery, with carriages and horses.

Ten inches thick — will support an army; an innumerable multitude.

Amount of Oil in Seeds.

Kinds of Seed	Per Cent Oil	Kinds of Seed	Per Cent Oil
Rapeseed	555	Oats	6½
Sweet almond	47	Clover hay	3
Turnip seed	45	Wheat bran	4
White mustard	37	Oat straw	4
Bitter almond	37	Meadow hay	3½
Hempseed	19	Wheat straw	3
Linseed	17	Wheat flour	3
Indian corn	7	Barley	2½

How to Kill Poison Ivy.

Spraying with arsenate of soda (one pound to twenty gallons of water) will kill all vegetation. One application, if the plants are young and tender, will do this. In the middle of the summer, however, they should be cut down first, and more than one application given.

To Find the Number of Plants to the Acre.

Divide the number of square feet in an acre, which is 43,560, by the multiplied distance the plants are set each way. For instance: Suppose the plants are set two feet apart and the rows are four feet apart. Four times two are eight; dividing 43,560 by eight we have 5,445, the number of plants to the acre when set 2 feet by 4 feet. If set 5 by 1, there are 8,712 plants to the acre, etc.

Savings Banks Compound Interest Table.

Showing the amount of $1.00, from one year to fifteen years, with compound interest added semi-annually, at different rates:

	Three Per Cent	Four Per Cent	Five Per Cent
One year	$1.03	$1.04	$1.05
Two years	1.06	1.08	1.10
Three years	1.09	1.12	1.15
Four years	1.12	1.17	1.21
Five years	1.16	1.21	1.28
Six years	1.19	1.26	1.34
Seven years	1.23	1.31	1.41
Eight years	1.26	1.37	1.48
Nine years	1.30	1.42	1.55
Ten years	1.34	1.48	1.63
Eleven years	1.38	1.54	1.72
Twelve years	1.42	1.60	1.80
Thirteen years	1.47	1.67	1.90
Fourteen years	1.51	1.73	1.99
Fifteen years	1.56	1.80	2.09

Results of Saving Small Amounts of Money.

The following shows how easy it is to accumulate a fortune, provided proper steps are taken. The table shows what would be the result at the end of fifty years by saving a certain amount each day and putting it at interest at the rate of six per cent.:

Daily Savings	The Result	Daily Savings	The Result
One cent	$ 950	Sixty cents	$ 57,024
Ten cents	9,504	Seventy cents	66,528
Twenty cents	19,006	Eighty cents	76,032
Thirty cents	28,512	Ninety cents	85,537
Forty cents	38,015	One dollar	95,041
Fifty cents	47,520	Five dollars	405,208

Nearly every person wastes enough in twenty or thirty years, which, if saved and carefully invested, would make a family quite independent; but the principle of small savings has been lost sight of in the general desire to become wealthy.

Time in Which Money Doubles at Interest.

Rate	Simple Interest	Compound Interest
Two per cent	50 years	35 years, 1 day
Two and one-half per cent	10 years	28 years, 26 days
Three per cent	33 years, 4 months	23 years, 164 days
Three and one-half per cent	28 years, 208 days	20 years, 54 days
Four per cent	25 years	17 years, 246 days
Four and one-half per cent	22 years, 81 days	15 years, 273 days
Five per cent	20 years	14 years, 75 days
Six per cent	16 years, 8 months	11 years, 327 days

One dollar loaned one hundred years at compound interest at three per cent. would amount to $19.25, at six per cent. to $340.00.

How to Measure an Acre.

In measuring an acre by yards, the usual practice is to lay off 70 yards in length by 70 yards in width. This, though only approximate, may be considered near enough for practical purposes; but as 70 yards each way encloses 4,900 square yards, this area exceeds one acre by 60 square yards.

To determine an accurate acre it may be measured 70 yards in length by 69⅐ yards in width. The same result will be obtained by measuring 220 feet in length and 198 feet in width, or by measuring 73¼ yards in length by 66 yards in width.

Laying Out Plots.

In laying out an acre in the manner described above, the sides of the area would be of equal, or approximately equal length.

If the length or width of any field or plot be known, the required width or length to enclose an acre may be ascertained simply by dividing the known distance in yards or feet into the number of square yards (4,840) or square feet (43,560) contained in one acre.

A forty-rod field is 220 yards, or 660 feet, in length.

Dividing 4,840 by 220, we obtain 22, the width in yards required to give one acre. Therefore, 20 rods (110 yards) by 22 yards would represent half an acre; 10 rods (55 yards) by 22 yards, one-quarter acre, and so on.

A Planter's Guide.

Showing the number of plants required to plant one acre at various distances apart.

Distance Feet.	No. of Plants.	Distance Feet.	No. of Plants.
1	43,560	9	537
1½	19,360	10	435
2	10,890	12	302
2½	6,969	15	193

Distance Feet.	No. of Plants.	Distance Feet.	No. of Plants.
3	4,840	18	134
3½	3,556	20	108
4	2,722	24	75
5	1,742	25	69
6	1,210	28	55
7	889	30	48
8	680		

Tables of Weights and Measures.

Avoirdupois Weight.

16 drams	= 1	ounce
16 ounces	= 1	pound
7,000 grains	= 1	"
14 pounds	= 1	stone
100 "	= 1	hundredweight or central
20 hundredweight	= 1	ton

Dry Measure.

2 pints	= 1	quart
8 quarts	= 1	peck
4 pecks	= 1	bushel

Liquid Measure.

4 gills	= 1	pint
2 pints	= 1	quart
4 quarts	= 1	gallon

A cubic foot of water weighs almost 1,000 oz., and contains almost 6¼ gallons.

Surface, Square or Land Measure.

144	square inches	= 1	square foot
9	square feet	= 1	square yard
30¼	square yards	= 1	square rod
160	square rods or 4,840 sq. yards	= 1	acre
10	square chains	= 1	acre
640	acres	= 1	square mile

Cubic or Solid Measure.

1,728 cubic inches	= 1 cubic foot
27 cubic feet	= 1 cubic yard
128 cubic feet	= 1 cord

Measures of Length.

Mile Geographical, Admiralty Knot, or Nautical

Mile, 6,080 Feet	= 1.15 Mile Statute.
League	= 3 Miles.
Degree	= 60 Geographical, or 69.121 Statute Miles.
Inch, in.	= 72 Points or 12 Lines.
Nail, 1/16 yd	= 2¼ Inches.
Palm	= 3 Inches.
Hand	= 4 Inches.
Quarter (or a Span)	= 9 Inches.
Foot	= 12 Inches.
Cubit	= 18 Inches.
Yard	= 36 Inches.
Pace, Military	= 2 Feet 6 Inches.
Fathom	= 6 Feet.
Rod, Pole, or Perch	= 5½ Yards.
Chain (100 Links)	= 22 Yards (4 Poles).
Link	= 7.92 Inches.
Cable's Length	= 100 Fathoms, 600 Feet.
Furlong	= 40 Rods, 220 Yards.
Mile	= 8 Furlongs, 80 Chains, 320 Rods, 1,760 Yards, 5,280 Feet, 63,360 Ins.

Weights of Agricultural Commodities by the Bushel.

Unless a bushel by measure is specially agreed upon, it must weigh the number of pounds set opposite each article.

Bushels	Weight in Dominion Standard Lbs.
Barley	48
Beans	60
Buckwheat	48

Bushels	Weight in Dominion Standard Lbs.
Bituminous Coal	70
Blue Grass Seed	14
Castor Beans	40
Clover Seed	60
Hemp Seed	44
Indian Corn	56
Lime	70
Malt	36
Mangels	50
Oats	34
Peas	60
Potatoes	60
Rye	56
Timothy Seed	48
Turnips	50
Wheat	60

Methods Used in the Application of Nitrate.

In orchards, gardens and comparatively small field areas, Nitrate may be conveniently broadcasted by hand from a pail, hand-sowing hopper or directly from the wagon box in which the Nitrate has been brought to the scene of operations.

On larger areas — no special fertilizer sowing machine being available — the Nitrate may be rapidly and efficiently distributed by means of the fertilizer-sowing attachment of a modern grain drill. In this way the Nitrate — alone or mixed with phosphate, or potash, or both — should be drilled in usually prior to seeding or planting. Subsequent applications of Nitrate — if required — to the growing crops may be topdressed by means of the same machine with disks raised sufficiently to avoid interference with the young growing plants.

In very light applications of Nitrate greater ease and uniformity in its distribution may be attained by first mixing it with an approximately equal bulk of dry, loamy soil.

The importance of applying the Nitrate early cannot be too strongly emphasized.

How to Use Nitrate in the Vegetable Garden.

In order to obtain the full benefit from its use, the Nitrate should be applied early — preferably by scattering it broadcast over the surface soil, just before planting — and lightly worked in by rake or hoe.

For application around growing plants the Nitrate should, first of all, be mixed with equal or double its bulk of dry loamy soil. This will permit its more uniform distribution and prevent scorching of wet foliage.

For leafy crops — especially cabbage and spinach — further applications of Nitrate may be made at intervals of a week or ten days during the early part of the season of growth, the frequency and rate of application desirable being indicated by the appearance of the crop.

Rates of Application per 200 Square Feet.

For cabbage, cauliflower, celery, lettuce, spinach, and Swiss chard, Nitrate may be applied at planting time at the rate of 1½ pounds per 200 square feet, with subsequent application, if and when required.

For beets, carrots, onions, parsnips and radishes a single application of Nitrate at the rate of 1½ pounds will suffice.

For corn and tomatoes apply one pound of Nitrate per 200 square feet.

For citrons, cucumbers, squash, melons, etc., apply one pound of Nitrate at planting, followed, if required, by occasional smaller applications.

For beans and peas, one-half to three-quarters of a pound of Nitrate may be applied at planting time.

Weights and Measurements.

1 oz. per square yard equals 300 lbs. per acre.
1 lb. per 200 square feet equals 220 lbs. per acre.
2 lbs. per sq. rod (16½ ft. x 16½ ft.) equals 320 lbs. per acre.

If planted twelve (12) inches apart, 3 rows 3 feet long would equal one square yard; or 10 rows 20 feet long would equal 200 square feet; or 8 rows 34 feet long would equal one square rod (16½ ft. x 16½ ft.), of which there are 160 in an acre.

Analyses of Commercial Fertilizing Materials.

Name of substance	Moisture	Nitrogen	Potash	Phosphoric acid		
				Available	Insoluble	Total
I. Phosphatic Manures						
Apatite						36.08
Bone-ash	7.00					35.89
Bone-black	4.60					28.28
Bone-black (dissolved)				16.70	0.30	17.00
Bone meal	7.47	4.12		8.28	15.22	23.50
Bone meal (free from fats)		6.20				20.10
Bone meal (from glue factory)		1.70				29.90
Bone meal (dissolved)		2.60		13.53	4.07	17.60
S. Carolina rock (ground)	1.50			0.60	27.43	28.03
S. Carolina rock (floats)						27.20
S. Carolina rock (dissolved)				11.60	3.60	15.20
II. Potash Manures						
Carnallite			13.68			
Cotton-seed hull ashes	7.33		23.80			8.50
Kainit	3.20		13.54			
Krugite	4.82		8.42			
Muriate of potash	2.00		52.46			
Nitrate of potash	1.93	13.09	45.19			
Spent tan-bark ashes	6.31		2.04			1.61
Sulph. potash (high grade)	1.25		38.60			
Sulph. potash and magnesia	4.75		23.50			
Sylvanite	7.25		16.65			
Waste from gunpowder works	2.75	2.43	18.00			
Wood-ashes (unleached)	12.00		5.50			1.85
Wood-ashes (leached)			1.10			1.40
III. Nitrogenous Manures						
Castor pomace	9.98	5.56	1.12			2.16
Cotton-seed meal	6.80	6.66	1.62			1.45
Dried blood	12.50	10.52				1.91
Dried fish	12.75	7.25	0.45	0.35	5.20	8.25
Horn and hoof waste	10.17	13.25				1.83
Lobster shells	7.27	4.50				3.52
Meat scrap	12.09	10.44				2.07
Malt sprouts	7.40	4.04	2.20			1.70
Nitrate of soda	1.25	15.65				
Nitre-cake	6.00	2.30	0.40			
Oleomargarine refuse	8.54	12.12				0.88
Sulphate of ammonia	1.00	20.50				
Tankage	13.20	6.82		5.02	6.23	11.25
Tobacco stems	10.61	2.29	6.44			0.60
Wool waste	9.27	5.64	1.30			0.29
IV. Miscellaneous Materials						
Ashes (Anthracite coal)			0.10			0.10
Ashes (bituminous coal)			0.40			0.40
Ashes (corn-cob)			23.20			
Ashes (lime-kiln)	15.45		0.86			1.18
Ashes (peat and bog)	5.20		0.70			0.50
Gas lime	4.40	0.30				

Analyses of Commercial Fertilizing Materials — Cont.

Name of substance	Moisture	Nitrogen	Potash	Phosphoric acid		
				Available	Insoluble	Total
IV. Miscellaneous Materials —*Continued*						
Marls (Maryland)	1.73	.....	1.25	.....	.....	0.38
Marls (Massachusetts)	18.18	.....	.....	.....	.....	1.05
Marls (North Carolina)	1.50	.....	0.04	.....	.....	0.56
Marls (Virginia)	15.98	.....	0.49	.....	.....	0.09
Muck (fresh)	76.20	0.30	.....	.....	.....	.....
Muck (air-dry)	21.40	1.30	.....	.....	.....	.....
Mud (fresh water)	40.37	1.37	0.22	.....	.....	0.26
Mud (from sea-meadows)	53.50	0.20	0.20	.....	.....	0.10
Peat	61.50	0.75	.....	.....	.....	.....
Pine straw (dead leaves or pine needles)	7.80	0.30	0.10	.....	.....	0.20
Shells (mollusks)	.....	0.10	0.04	.....	.....	0.03
Shells (crustacea)	.....	6.20	0.20	.....	.....	2.30
Shell lime (oyster shell)	19.50	.....	0.04	.....	.....	0.20
Soot	5.54	.....	1.83	.....	.....	.....
Spent tan	14.00	0.20	0.10	.....	.....	0.04
Spent sumach	30.80	1.00	0.30	.....	.....	0.10
Sugar-house scum	50.20	2.10	.....	.....	.....	.....
Turf	19.29	1.94	.....	.....	.....	.....

Analyses of Farm Manures.

Taken Chiefly from Reports of the New York, Massachusetts and Connecticut Experiment Stations.

Name of Substance	Moisture	Nitrogen	Potash	Phosphoric acid
Cattle (solid fresh excrement)	......	0.29	0.10	0.17
Cattle (fresh urine)	......	0.58	0.49	......
Hen manure (fresh)	......	1.63	0.85	1.54
Horse (solid fresh excrement)	......	0.44	0.35	0.17
Horse (fresh urine)	......	1.55	1.50	......
Human excrement (solid)	77.20	1.00	0.25	1.09
Human urine	95.90	0.60	0.20	0.17
Poudrette (night soil)	......	0.80	0.30	1.40
Sheep (solid fresh excrement)	......	0.55	0.15	0.31
Sheep (fresh urine)	......	1.95	2.26	0.01
Stable manure (mixed)	73.27	0.50	0.60	0.30
Swine (solid fresh excrement)	......	0.60	0.13	0.41
Swine (fresh urine)	......	0.43	0.83	0.07

Analyses of Fertilizing Materials in Farm Products.

Name of Substance	Moisture	Nitrogen	Potash	Phosphoric acid
Hay and Dry Coarse Fodders.				
Blue melilot	8.22	1.92	2.80	0.54
Buttercups	......	1.02	0.81	0.41
Carrot tops (dry)	9.76	3.13	4.88	0.61
Clover (alsike)	9.93	2.33	2.01	0.70
Clover (Bokhara)	6.36	1.77	1.67	0.44
Clover (mammoth red)	11.41	2.23	1.22	0.55
Clover (medium red)	10.72	2.09	2.20	0.44
Clover (white)	......	2.75	1.81	0.52
Corn fodder	......	1.80	0.76	0.51
Corn stover	28.24	1.12	1.32	0.30
Cow-pea vines	9.00	1.64	0.91	0.53
Daisy (white)	9.65	0.28	1.25	0.44
Daisy (ox-eye)	......	0.80	2.23	0.27
Hungarian grass	7.15	1.16	1.28	0.35
Italian rye-grass	8.29	1.15	0.99	0.55
June grass	......	1.05	1.46	0.37
Lucern (alfalfa)	6.26	2.07	1.46	0.53
Meadow fescue	9.79	0.94	2.01	0.34
Meadow foxtail	......	1.54	2.19	0.44
Mixed grasses	11.26	1.37	1.54	0.35
Orchard grass	8.84	1.31	1.88	0.41
Perennial rye-grass	9.13	1.23	1.55	0.56
Red-top	7.71	1.15	1.02	0.36
Rowen	12.48	1.75	1.97	0.46
Salt hay	5.36	1.18	0.72	0.25
Seradella	7.39	2.70	0.65	0.78
Soja bean	6.30	2.32	1.08	0.67
Tall meadow oat	......	1.16	1.72	0.32
Timothy hay	7.52	1.26	1.53	0.46
Vetch and oats	11.98	1.37	0.90	0.53
Yellow trefoil	......	2,14	0.98	0.43
Green fodders.				
Buckwheat	82.60	0.51	0.43	0.11
Clover (red)	80.00	0.53	0.46	0.13
Clover (white)	81.00	0.56	0.24	0.20
Corn fodder	72.64	0.56	0.62	0.28
Corn fodder (ensilage)	71.60	0.36	0.33	0.14
Cow-pea vines	78.81	0.27	0.31	0.98
Horse bean	74.71	0.68	1.37	0.33
Lucern (alfalfa)	75.30	0.72	0.45	0.15
Meadow grass (in flower)	70.00	0.44	0.60	0.15
Millet	62.58	0.61	0.41	0.19
Oats (green)	83.36	0.49	0.38	0.13
Peas	81.50	0.50	0.56	0.18
Prickly comfrey	......	0.42	0.75	0.11
Rye grass	70.00	0.57	0.53	0.17
Seradella	82.59	0.41	0.42	0.14
Sorghum	......	0.40	0.32	0.08
Spanish moss	60.80	0.28	0.26	0.30
Vetch and oats	86.11	0.24	0.79	0.09
White lupine	85.35	0.44	1.73	0.35
Young grass	80.00	0.50	1.16	0.22

Analyses of Fertilizing Materials in Farm Prod.— Cont.

Name of Substance	Moisture	Nitrogen	Potash	Phosphoric acid
Straw, Chaff, Leaves, etc.				
Barley chaff	13.08	1.01	0.99	0.27
Barley straw	13.25	0.72	1.16	0.15
Bean shells	18.50	1.48	1.38	0.55
Beech leaves (autumn)	15.00	0.80	0.30	0.24
Buckwheat straw	16.00	1.30	2.41	0.61
Cabbage leaves (air-dried)	14.60	0.24	1.71	0.75
Cabbage stalks (air-dried)	16.80	0.18	3.49	1.06
Carrots (stalks and leaves)	80.80	0.51	0.37	0.21
Corn cobs	12.09	0.50	0.60	0.06
Corn hulls	11.50	0.23	0.24	0.02
Hops	11.07	2.53	1.99	1.75
Oak leaves	15.00	0.80	0.15	0.34
Oat chaff	14.30	0.64	1.04	0.20
Oat straw	28.70	0.29	0.88	0.11
Pea shells	16.65	1.36	1.38	0.55
Pea straw (cut in bloom)	......	2.29	2.32	0.68
Pea straw (ripe)	......	1.04	1.01	0.35
Potato stalks and leaves	77.00	0.49	0.07	0.06
Rye straw	15.40	0.24	0.76	0.19
Sugar-beet stalks and leaves	92.65	0.35	0.16	0.07
Turnip stalks and leaves	89.80	0.30	0.24	0.13
Wheat chaff (spring)	14.80	0.91	0.42	0.25
Wheat chaff (winter)	10.56	1.01	0.14	0.19
Wheat straw (spring)	15.00	0.54	0.44	0.18
Wheat straw (winter)	10.36	0.82	0.32	0.11
Roots and Tubers.				
Beets (red)	87.73	0.24	0.44	0.09
Beets (sugar)	84.65	0.25	0.29	0.08
Beets (yellow fodder)	90.60	0.19	0.46	0.09
Carrots	90.02	0.14	0.54	0.10
Mangolds	87.29	0.19	0.38	0.09
Potatoes	79.75	0.21	0.29	0.07
Rutabagas	87.82	0.21	0.50	0.13
Turnips	87.20	0.22	0.41	0.12
Grains and Seeds.				
Barley	15.42	2.06	0.73	0.95
Beans	......	4.10	1.20	1.16
Buckwheat	14.10	1.44	0.21	0.44
Corn kernels	10.88	1.82	0.40	0.70
Corn kernels and cobs (cob meal)	10.00	1.46	0.44	0.60
Hemp seed	12.20	2.62	0.97	1.75
Linseed	11.80	3.20	1.04	1.30
Lupines	13.80	5.52	1.14	0.87
Millet	13.00	2.40	0.47	0.91
Oats	20.80	1.75	0.41	0.48
Peas	19.10	4.26	1.23	1.26
Rye	14.90	1.76	0.54	0.82
Soja beans	18.83	5.30	1.99	1.87
Sorghum	14.00	1.48	0.42	0.81
Wheat (spring)	14.75	2.36	0.61	0.89
Wheat (winter)	15.40	2.83	0.50	0.68

Analyses of Fertilizing Materials in Farm Prod.— Cont.

Name of Substance	Moisture	Nitrogen	Potash	Phosphoric acid
Flour and Meal.				
Corn meal	13.52	2.05	0.44	0.71
Ground barley	13.43	1.55	0.34	0.66
Hominy feed	8.93	1.63	0.49	0.98
Pea meal	8.85	3.08	0.99	0.82
Rye flour	14.20	1.68	0.65	0.85
Wheat flour	9.83	2.21	0.54	0.57
By-products and Refuse.				
Apple pomace	80.50	0.23	0.13	0.02
Cotton hulls	10.63	0.75	1.08	0.18
Cotton-seed meal	......	6.52	1.89	2.78
Glucose refuse	8.10	2.62	0.15	0.29
Gluten meal	8.53	5.43	0.05	0.43
Hop refuse	8.98	0.98	0.11	0.20
Linseed cake (new process)	6.12	5.40	1.16	1.42
Linseed cake (old process)	7.79	6.02	1.16	1.65
Malt sprouts	10.28	3.67	1.60	1.40
Oat bran	8.19	2.25	0.66	1.11
Rye middlings	12.54	1.84	0.81	1.26
Spent Brewers' grains (dry)	6.98	3.05	1.55	1.26
Spent brewers' grains (wet)	75.01	0.89	0.05	0.31
Wheat bran	11.01	2.88	1.62	2.87
Wheat middlings	9.18	2.63	0.63	0.95
Dairy Products.				
Milk	87.20	0.58	0.17	0.30
Cream	68.80	0.58	0.09	0.15
Skim-milk	90.20	0.58	0.19	0.34
Butter	13.60	0.12	......	......
Butter-milk	90.10	0.64	0.09	0.15
Cheese (from unskimmed milk)	38.00	4.05	0.29	0.80
Cheese (from half-skimmed milk)	39.80	4.75	0.29	0.80
Cheese (from skimmed milk)	46.00	5.45	0.20	0.80
Flesh of Farm Animals.				
Beef	77.00	3.60	0.52	0.43
Calf (whole animal)	66.20	2.50	0.24	1.38
Ox	59.70	2.66	0.17	1.86
Pig	52.80	2.00	0.90	0.44
Sheep	59.10	2.24	0.15	1.23
Garden Products.				
Asparagus	......	0.32	0.12	0.09
Cabbage	......	0.30	0.43	0.11
Cucumbers	......	0.16	0.24	0.12
Lettuce	......	0.20	0.25	0.11
Onions	......	0.27	0.25	0.13

Fertilizer Experiments on Meadow Land.

(Kentucky Agricultural Experiment Station, Bulletin No. 23, February, 1890.)

On low and decidedly wet land:

English Blue Grass.

Fertilizer Used per Acre	Amount Per Acre in Pounds	Yield of Hay in Pounds Per Acre
Sulphate of potash	160	3,000
Muriate of potash	160	2,950
Nitrate of soda	160	3,100
Sulphate of ammonia	130	3,600
No fertilizer	....	2,850
Stable manure	20 loads	2,970
Tobacco stems	4,000	4,700

Fertilizer Experiments on Meadow Land.

Timothy.

Kind of Fertilizer Used	Amount Per Acre in Pounds	Yield of Hay in Pounds Per Acre
Sulphate of potash	160	1,900
Muriate of potash	160	2,320
Nitrate of soda	160	2,670
Sulphate of ammonia	130	2,520
No fertilizer	....	1,620
Stable manure	20 loads	2,200
Tobacco stems	4,000	3,350

Time Required for the Complete Exhaustion of Available Fertilizing Materials and the Amounts of Each Remaining in the Soil During a Period of Seven Years.

(From Scottish Estimates.)

On Uncultivated Clay Loam.

Kind of Fertilizer Used	Exhausted (in years)	Per cent remaining in soil unexhausted at the end of each year						
		1	2	3	4	5	6	7
Lime	12	80	65	55	45	35	25	20
Bone metal	5	60	30	20	10	00	00	00
Phosphatic guanos	5	50	30	20	10	00	00	00
Dissolved bones and plain superphosphates	4	20	10	5	00	00	00	00
High grade ammoniated fertilizers, guano, etc.	3	30	20	00	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barnyard manure	5	60	30	20	10	00	00	00

On Uncultivated Light or Medium Soils.

Kind of Fertilizer Used	Exhausted (in years)	Per cent remaining in soil unexhausted at the end of each year						
		1	2	3	4	5	6	7
Lime	10	75	60	40	30	20	15	..
Bone meal	4	60	30	10	00	00	00	..
Phosphatic guano	4	50	20	10	00	00	00	..
Dissolved bones and plain superphosphates	3	20	10	5	00	00	00	00
High-grade ammoniates, guanos.	3	30	20	00	00	00	00	00
Cotton-seed meal	4	40	30	20	10	00	00	00
Barnyard manure	4	60	30	10	00	00	00	00

On Uncultivated Pasture Land.

Kind of Fertilizer Used	Exhausted (in years)	Per cent remaining in soil unexhausted at the end of each year						
		1	2	3	4	5	6	7
Lime	15	80	70	60	50	45	40	35
Bone meal	7	60	50	40	30	20	10	00
Phosphatic guano	6	50	40	30	20	10	00	80
Dissolved bone, etc.	4	30	20	10	00	00	00	00
High grade ammoniated guanos.	4	30	20	10	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barnyard manure	7	60	50	40	30	20	10	00

The figures given above are used in fixing the rental for new tenants. In this country no such careful estimates have been made.

Amounts of Nitrogen, Phosphoric Acid, and Potash Found Profitable for Different Crops Under Average Conditions per Acre.

(Taken Chiefly from New Jersey Experiment Stations Reports.)

	Nitrogen Pounds	Phosporic Acid Pounds	Potash Pounds
Wheat, rye, oats, corn	16	40	30
Potatoes and root crops	20	25	40
Clover, beans, peas and other leguminous crops	..	40	60
Fruit trees and small fruits	25	40	75
General garden produce	30	40	60

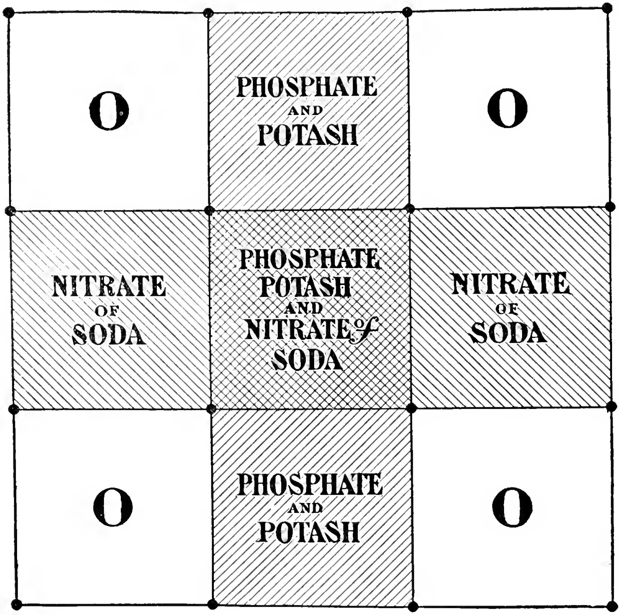
Rotation in Crops.

In the changed conditions of agriculture elaborate systems of crop rotation are no longer necessary. With the help of chemical fertilizers and the judicious use of renovating crops farmers are no longer subject to rigid rule, but may adapt rotations to the varying demands of local market conditions.

Some American Rotations.

1. Potatoes.	1. Potatoes.
2. Wheat.	2. Wheat.
3. Clover.	3. Grass, timothy and clover.
4. Clover.	4. Grass, timothy and clover.
5. Wheat, oats or rye.	5. Corn.
1. Roots.	1. Roots.
2. Wheat.	2. Wheat.
3. Clover.	3. Clover.
4. Clover.	4. Clover.
5. Corn, oats or rye.	5. Wheat.
	6. Oats.

Plan for Top-Dressing Experiments.



The above simple plan for Top-Dressing Experiments has been in satisfactory use in Europe for several years. The plots may be of any size from a square 20 feet x 20 feet, and upwards. The squares marked O are not fertilized, and serve as check plots. The Nitrate application recommended for a square 20 feet x 20 feet is one pound, which is equivalent to one hundred pounds to the acre.

Table of Quantities of Seed Required per Acre.

	Sow (if alone) per Acre
Agrostis stolonifera — See Creeping Bent	2 bushels
Agrostis canina — See R. I. Bent	3 bushels
Agrostis vulgaris— See Red Top	3 bushels
Agrostis vulgaris — Fancy	20 lbs.
Alopecurus pratensis — See Meadow Foxtail	3 to 4 bushels
Arrhenatherum avenaceum — See Tall Meadow Oat Grass	4 to 5 bushels
Avena elatior — See Tall Meadow Oat Grass	3 bushels
Awnless Brome Grass	20 to 25 lbs.
Alsike or Hybrid Clover	8 lbs.
Alfalfa Clover	20 to 25 lbs.
Artichokes	8 to 10 bushels
Australian Salt Bush	2 lbs.
Barley	Broadcast, 2 to 2½ bushels; Drilled, 1½ to 2 bushels
Beet Sugar	6 to 8 lbs.
Bermuda Grass	6 lbs.
Bromus inermis — See Awnless Brome Grass	20 to 25 lbs.
Bokhara Clover	10 lbs.
Broom Corn	8 to 10 lbs.
Buckwheat	1 bushel
Bean, Field	Drilled, 1 bushel
Canada Blue Grass	3 bushels
Cynodon dactylon — See Bermuda Grass	6 lbs.
Creeping Bent or Fiorin	2 bushels
Crested Dog's Tail	1½ bushels
Cynosurus cristatus — See Crested Dog's Tail	1½ bushels
Cow Grass — See Mammoth Red Clover	10 to 12 lbs.
Crimson or Carnation — See Scarlet Clover	14 lbs.
Corn, Dent and Flint	8 to 10 qts.
Corn, Fodder	Broadcast, 2 bushels; Drilled, 1 bushel
Corn, Pop	6 to 8 qts.
Carrots	4 lbs.
Cotton	15 lbs.
Dactylisglomerata — See Orchard Grass	3 bushels
Douras	8 to 10 lbs.
English Blue Grass — See Meadow Fescue	2½ bushels
English or Perennial Rye Grass	2½ to 3 bushels
Festuca elatior — See Tall Meadow Fescue	2½ bushels
Festuca heterophylla — See Various Leaved Fescue	3 bushels
Festuca ovina— See Sheep's Fescue	2½ bushels
Festuca ovina tenuifolia — See Fine Leaved Sheep's Fescue	3 bushels
Festuca pratensis — See Meadow Fescue	2½ bushels
Festuca rubra— See Red Fescue	2½ bushels
Festuca duriuscula — See Hard Fescue	2½ bushels
Fine Leaved Sheep's Fescue	3 bushels
Flax Seed	½ to ¾ bushel
Fiorin — See Creeping Bent	2 bushels
Grasses, Permanent Pasture Mixtures	3 bushels
Grasses, Permanent Pasture Clover for above	10 lbs.

	Sow (if alone) per Acre
Grasses, Renovating Mixture	1 bushel
Grasses, Lawn	5 bushels
Herd's Grass (of the South) — See Red Top	3 bushels
Herd's Grass (of the North) — See Timothy	½ to 1 bushel
Hungarian Grass — See Hungarian Millet	1 bushel
Hard Fescue	2½ bushels
Italian Rye Grass	3 bushels
June Grass— See Kentucky Blue	2 to 3 bushels
June Clover — See Red Clover	10 to 12 lbs.
Japan Clover	14 lbs.
Johnson Grass	1 bushel
Jerusalem Corn	5 lbs.
Kaffir Corn	8 to 10 lbs.
Kentucky Blue Grass	3 bushels
Lupines	2 to 3 bushels
Lolium italicum — See Italian Rye Grass	3 bushels
Lolium perenne — See English Rye Grass	2½ to 3 bushels
Lucerne— See Alfalfa	20 to 25 lbs.
Lespedeza striata — See Japan Clover	14 lbs.
Meadow Foxtail	3 to 4 bushels
Meadow Fescue	2½ bushels
Mammoth or Pea Vine Clover	10 to 12 lbs.
Medicago sativa — See Alfalfa	20 lbs.
Millo Maize — See Douras	8 to 10 lbs.
Millet, German and Hungarian	1 bushel
Millet, Pearl, Egyptian, Cat-Tail or Horse Millet	Drills, 5 to 6 lbs.; Broadcast, 8 lbs.
Millet, Japanese	Drills, 10 lbs. per acre; Broadcast, 15 lbs.
Mangels	6 to 8 lbs.
Melilotus alba — See Bokhara Clover	10 lbs.
Onobrychis sativa — See Sainfoin	3 to 4 bushels
Orchard Grass	3 bushels
Oats	3 bushels
Parsnips	6 lbs.
Poa nemoralis — See Wood Meadow Grass	2 bushels
Poa pratensis — See Kentucky Blue	2 to 3 bushels
Poa trivialis — See Rough Stalked Meadow Grass	1½ bushels
Poa arachnifera — See Texas Blue Grass	6 lbs.
Poa compressa	3 bushels
Phleum pratense — See Timothy	½ to 1 bushel
Potatoes	12 to 14 bushels
Peas, Field	3 bushels
Peas, Cow	2 bushels
Pea Vine Clover — See Mammoth Clover	10 to 12 lbs.
Perennial Red Clover — See Mammoth Clover	10 to 12 lbs.
Rape, English	2 to 4 lbs.
Red Top	3 bushels
Red Top, Fancy	20 lbs.
Rhode Island Bent	3 bushels
Red or Creeping Fescue	2½ bushels
Rough Stalked Meadow Grass	1½ bushels
Red Clover (Common or June Clover)	10 to 12 lbs.
Reana luxurians — See Teosinte	6 to 8 lbs.

	Sow (if alone) per Acre
Rye	1½ bushels
Rutabaga	2 to 3 lbs.
Sorghum Halapense — See Johnson Grass	1 bushel
Sweet Vernal — true perennial	3½ bushels
Sheep's Fescue	2½ bushels
Smooth Stalked Meadow Grass — See Kentucky Blue	2 to 3 bushels
Sweet Clover — See Bokhara Clover	10 lbs.
Scarlet Clover	14 lbs.
Sainfoin	3 to 4 bushels
Sorghums	8 to 10 lbs.
Sugar Beet	6 to 8 lbs.
Sugar Canes	8 to 10 lbs.
Sunflower	4 qts.
Swedish Clover — See Alsike	8 lbs.
Soja Bean	¾ bushel
Texas Blue Grass	6 lbs.
Tall Meadow Oat Grass	4 to 5 bushels
Tall Meadow Fescue	2½ bushels
Timothy or Herd's Grass of the North	½ to 1 bushel
Trifolium pratense — See Red Clover	10 to 12 lbs.
Trifolium pratense perenne — See Mammoth Clover	10 to 12 lbs.
Trifolium repens — See White Clover	8 lbs.
Trifolium incarnatum — See Scarlet Clover	14 lbs.
Trifolium hybridum — See Alsike Clover	8 lbs.
Teosinte	6 to 8½ lbs.
Turnips	2 to 3 lbs.
Turnips, Rutabaga, Russian or Swedish	2 to 3 lbs.
Vetch, Spring (Tares)	2 bushels
Vetch, Sand or Winter	1 bushel
Various Leaved Fescue	3 bushels
Wood Meadow Grass	2 bushels
White or Dutch Clover	8 lbs.
Wheat	1½ bushels

Reference Table for Vegetable Seed Sowers.

Kind of Vegetable	Dates for Sowing Vicinity, New York City. North, later; South, earlier. As a general rule, it is pretty safe to allow six days difference in planting for every hundred miles of latitude.		Best temperature to germinate	Days needed to germinate	Ready for use from seed sown	Distance Table		Seed required for 100 feet of drill	Seed required for an acre
	Under glass	Open ground				Apart in rows	Rows apart		
Asparagus, seeds	....	April and May	60°	20 to 28	3 to 4 years	....	....	2 oz.	4 to 5 lbs.
" roots	....	April	....	....	....	1 ft.	2 ft.	....	....
Beans, dwarf	....	May 15th to Aug. 1st.	75°	6 to 10	45 to 75 days	3 in.	2 ft.	1 qt.	1 bu.
" pole	....	May 15th to June 15th	80°	6 to 10	65 to 100 "	3 ft.	4 ft.	....	10 to 12 qts.
" lima	....	" "	80°	6 to 10	65 to 90 "	3 ft.	4 ft.	....	10 to 12 qts.
Beets	....	April to August	60°	7 to 10	60 to 75 "	4 in.	1 ft.	2 oz.	5 to 6 lbs.
Borecole (kale) for spring use	....	August and September	70°	6 to 10	85 to 120 "	2 ft.	2½ ft.	¾ oz.	1 to 2 lbs.
" " for fall use	....	June	70°	6 to 10	85 to 120 "	2 ft.	2½ ft.	¾ oz.	1 to 2 lbs.
Brussels sprouts	....	April to July	70°	6 to 10	100 to 120 "	1½ ft.	2½ ft.	....	1 lb.
Cabbage, early	February	April	70°	6 to 10	100 to 125 "	1½ ft.	2 ft.	....	½ lb.
" late	....	May and June	70°	6 to 10	120 to 180 "	2½ ft.	2½ ft.	....	½ lb.
Carrot, early	....	April	60°	10 to 15	65 to 85 "	4 in.	1½ ft.	1 oz.	4 lbs.
" late	....	May to July	60°	10 to 15	100 to 120 "	5 in	2 ft.	1 oz.	4 lbs.
Cauliflower, early	February	April	70°	6 to 10	100 to 115 "	1½ ft.	2½ ft.	....	½ lb.
" late	....	May and June	70°	6 to 10	100 to 135 "	2 ft.	3 ft.	....	½ lb.
Celery	....	April	60°	12 to 20	125 to 150 "	6 in.	3 to 5 ft.	1 oz.	1 lb.
Corn, sugar	....	May 10th to July 10th	75°	8 to 10	60 to 100 "	3 ft.	4 ft.	....	¼ bu.
Cucumber	....	May 15th to July 15th	80°	6 to 8	60 to 85 "	4 ft.	4 ft.	....	2 to 3 lbs.
Egg plant	March	....	80°	10 to 14	125 to 160 "	2½ ft.	2½ ft.	....	½ lb.
Endive	February	April to August	60°	6 to 10	75 to 100 "	1 ft.	1 ft.	1 oz.	3 lbs.
Kohl Rabi	....	April to July	70°	6 to 8	65 to 85 "	1 ft.	2 ft.	....	½ lb.
Leek	February	April and May	60°	6 to 10	120 to 160 "	6 in.	1½ ft.	1 oz.	5 to 6 lbs.
Lettuce	February	April to August	60°	6 to 10	75 to 100 "	1 ft.	1 ft.	1 oz.	2 to 3 lbs.
Melon, musk	....	May 15th to June 15th	80°	6 to 10	90 to 120 "	4 ft.	4 ft.	....	2 to 3 lbs.
" water	....	" "	80°	8 to 12	100 to 125 "	8 ft.	8 ft.	....	4 to 5 lbs.
Onion seed	February	April and May	60°	6 to 10	120 to 150 "	3 in.	1 ft.	1 oz.	5 to 6 lbs.
" sets	....	" "	....	....	....	3 in.	1 ft.	3 pts.	....
Parsley	....	" "	60°	18 to 24	90 to 100 "	4 in.	1 ft.	¾ oz.	5 to 6 lbs.
Parsnip	....	April	60°	12 to 18	100 to 150 "	6 in.	1 ft.	½ oz.	5 to 6 lbs
Peas, wrinkled	....	April 15th to July 1st	70°	5 to 10	50 to 75 "	2 in.	2 to 4 ft.	1 qt.	2 to 3 bu.
" smooth	....	April 1st to Aug. 1st	65°	5 to 10	50 to 65 "	2 in.	2 to 4 ft.	1 qt.	2 to 3 bu.
Pepper	March	....	80°	10 to 14	135 to 150 "	2 ft.	2½ ft.	....	½ lb.
Potatoes	....	April 15th to June 1st	70°	15 to 25	75 to 100 "	10 in.	2½ ft.	....	10 to 12 bu.
Pumpkins	....	May 20th to June 20th	80°	6 to 10	100 to 125 "	8 ft.	8 ft.	....	4 to 5 lbs.
Radish	....	April 1st to Sept. 15th	60°	4 to 6	25 to 50 "	2 to 4 in.	1 to 1½ ft.	1 oz.	9 to 10 lbs.
Salsify	....	April and May	60°	8 to 12	125 to 160 "	6 in.	1½ ft.	1½ oz.	8 to 10 lbs.
Spinach	....	April to Sept. 15th	60°	6 to 12	60 to 75 "	4 in.	1 to 1½ ft.	1 oz.	10 to 12 lbs.
Squash, summer	....	May 15th to July 1st.	80°	6 to 10	60 to 75 "	4 ft.	4 ft.	....	3 to 4 lbs.
" winter	....	May 20th to June 20th	80°	6 to 10	100 to 125 "	8 ft.	8 ft.	....	3 to 4 lbs.
Tomato	Feb. and Mar.	June 1st	80°	6 to 10	125 to 150 "	3 ft.	3 ft.	....	¼ lb.
Turnip	....	April to September	70°	4 to 7	60 to 75 "	6 in.	1 to 1½ ft.	¾ oz.	1 to 2 lbs.

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