THE RESTORATION

OF FERTILITY TO

NEW ENGLAND SOILS

THESIS FOR DEGREE OF M. AGR.

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# THE RESTORATION OF FERTILITY TO NEW ENGLAND SOILS

A treatise especially for the benefit

of New England Farmers.

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THESIS

## PREFACE.

On coming to New England from the middle west and making this eastern country ones residence for a number of years, a person interested in and observant of agricultural conditions and practices must be impressed with the feeling that New England has problems concerning rural development entirely different from the newer sections of the United States. In no one thing has the writer found a more intense and ever growing interest than in a study of the causes that have led up to a condition of soil fertility where the land is said to be "run down" or as more commonly, but wrongly spoken of as "worn out soils", and of the methods of farm management commonly practiced in an effort to handle these lands profitably. It has been the desire of the writer to prepare a paper on this subject, calling attention of New England farmers to some mistakes they are making, and especially to treat in this paper one of the most important farm problems in this section - the use and abuse of commercial fertilizers.

Since this paper is written especially for men actively engaged in tilling the soil, a majority of whom have probably not had the advantages of a course in chemistry or other sciences, an effort has been made to use only such terms in the treatment of the subject as can be easily understood. If by the reading of this paper only a few farmers are induced to pay more attention to making use of the natural sources of fertility on the farm, to be more careful to sonserve the wealth in the soil placed there by nature, and are led to a wiser and more economic use of commercial fertilizers the mission of the paper will have been accomplished.

## Plan and Purpose of the Treatise.

The plan and purpose of the paper here given is as follows:

First:- To give a brief sketch of the influences, social and industrial, which have led to the present condition of New England Agriculture.

Secondly:- To call attention to the fundamental principles which, if practiced, would aid materially in conserving soil fertility, in building up lands depleted of plant food, and in developing a safe and profitable system of farm management.

Thirdly:- To discuss the use and abuse of commercial fertilizers considering the practices which the writer has opportunity to observe season after season.

Fourthly:- To outline for a farmer the methods to use in selecting materials for fertilizer mixtures. Much has been written of a general nature but very little has been done to show the man on the farm the exact methods that will aid him in determining what materials to use and in what quantities to use them. Also to call attention to the principal arguments in favor of "home mixing" of fertilizers and to give specific directions for doing the work.

I. <u>A brief sketch of the social and industrial factors which have brought on the agricultural condition now obtaining in New England</u>.

That section of the United States commonly spoken of as New England comprises the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut, altogether a land area of approximately 66,000 square miles. Surrounded on three sides by water or British possessions it is naturally quite isolated from other sections of the ~~new~~ United States and has suffered somewhat from the lack of competition and the introduction of new ideas which very naturally diffuse from one state to another in more central regions. This geographic isolation causes New England to have problems distinctly peculiar to herself - and all the more interesting.

Geologically the soil is of glacial formation, variable, quite often rough, and discouraging for the farmer. While large areas of smooth land do not exist to any extent, yet in the river valleys soil equal to any in the United States can be found, while the stonier hillsides are admirably adapted to fruit, forest trees, or pasturage.

Settled as it was by the earliest visitors to this country, who knew nothing of the conditions ~~as~~ of the new land which they had come to claim as their own, it is not surprising that mistakes were made and damage done which it will take generations to repair.

Numerous lakes and streams gave New England an admirable chance to develop manufacturing in the earliest stages of that industry in this country, and excellent shipping facilities at home and to foreign countries aided materially in starting such plants long before the use of steam had become general.

The beginning of the Nineteenth Century saw Agriculture comparatively well developed in the Colonies and New England. It was fostered by Daniel Webster, George Washington, Thomas Jefferson, and other noted men. Movements toward the development of agricultural education were made in the first quarter of this century in Maine and Connecticut. Strong agricultural societies were also formed. The approach of the Civil War, the wasteful methods used in handling this shallow soil, the slump in prices which took place about 1870, all contributed toward causing a feeling of discontent, and discouragement throughout rural New England.

About this time large manufacturing plants were built along the rivers, western land "incapable of exhaustion and yielding a hundred fold" was thrown open at low prices, the spirit of unrest and desire for better opportunities set up a tide of immigration of young men and women, sometimes into the nearby factory towns and sometimes into what was then the "unknown west." Entire rural communities were practically depopulated of the younger generation, the older people carried on the home farm as long as they lived, after they had passed away the renter came, and "skinned" all the fertility he could out of the land, leaving it too poor for further profitable rental and the "abandoned farm" was the result. Villages fell into decay, and a general decadence of the religious, social, and moral life followed. Land values dropped to an exceedingly low price, and for a period of two decades New England Agriculture had nearly relapsed into what one writer calls the "dark ages."

But the development of cities and manufacturing centers opened up a new field and the writer is most happy to note that the excellent markets provided, the great strides in the manufacture of labor saving machinery, the development of our United States Department of Agriculture, the state colleges and Experiment Stations, the effort of the states themselves to disseminate information concerning the "new Agriculture" have brought about a repopulation of rural communities, a re-peopling of the abandoned farm, a rejuvination of the villages and an opportunity for wide awake, ambitious young men in New England not found, in the writer's opinion, in any other section of this country at the present time.

II. Fundamental principles underlying the maintenance of soil fertility, which are too often overlooked by the New England farmer.

The future prosperity of any nation rests in a careful maintenance of the natural resources in the soil. Coal, iron, oil, etc. when once exhausted may find substitutes in new inventions or other products, but so far no one has attempted to offer any substitutes for the products of the earth which furnish food, raiment, and those other things which make man's existence on this earth comfortable, and provides what we consider to be necessary factors in our civilization.

It is not necessary then to prove that to save the fertility of the land is the most important problem in the United States today.

New England is not alone in having a depleted soil for reports which come from all sections of the United States indicate that even the lands which have been most recently settled no longer produce what they first did.

Whether or not the so called theory of the "toxic properties of soils" is to supercede those theories known and held to be almost indisputable laws in regard to what constitutes soil fertility will probably be either exploded or proven during the next five years. It is too early in the discussion for farmers to reject those things which we believe to be largely responsible for the maintainence or depletion of the fertility of our lands.

In New England at least the following things are too often overlooked.

1. Necessity of good tillage.

2. Necessity of keeping up a constant and sufficient supply of humus in the soil.

3. That the keeping of live stock and the feeding of farm produce to these, and selling from the farm a finished product is the safest and best system of husbandry.

4. That the attempts to grow one crop without proper rotations and the application of sufficient amounts of manures and fertilizers is a most wasteful system of husbandry and cannot help but have a detrimental effect on the agricultural conditions of the future.

5. Allowing the soil to get into an "acid" or "sour" condition in which case bacteria do not multiply and fertilizers do not give profitable results.

Tillage. Nothing will do more to improve the chemical and physical conditions of the soil than proper tillage. Its importance has been recognized since the earliest days of the ancient nations. Not only is it necessary to practice tillage in order to get the land into condition to receive the seeds but tillage of the right kind and at the right time promotes soil ventilation, conserves moisture, or helps dry out the soil whichever condition is needed, encourages the growth of bacteria, makes soils warmer, renders plant food available, kills weeds, and causes a marked, all around, improvement in the land.

The writer receives letters not infrequently telling of lands that have not been plowed for fifteen or twenty years, and each letter almost invariably closes with the request that advice be given as to how a good crop of potatoes, clover, sweet corn, or some other highly specialized crop can be grown the coming season without more tillage than ordinary plowing and harrowing. Usually these persons intend to use large amounts of expensive fertilizers to produce the crop. It is clear to any Agriculturist that this method is wrong, and that those who attempt to farm in this way will find nothing but failure awaiting them. The writer is exceeding glad to note that the introduction of modern implements into the east is rapidly revolutionizing farming methods and that more and better tillage is being practiced than was the case fifteen or twenty years ago.

The importance of humus. When a soil is not plowed quite frequently and vegetable matter in the shape of stable manures or green manuring crops is not incorporated with it, the humus is by decomposition gradually "burned" out. When one examines one of these fields before spoken of, which has not been plowed for ten to twenty years, he finds it practically devoid of organic matter. We have known for ages that humus gave color to soils which helped them to absorb heat, that it acted as a sponge increasing the water holding capacity, that it added plant food, and that it made what one terms "a rich soil" in comparison with a "poor" one, but it is only since recent discoveries have been made in Agricultural Bacteriology that we have found another most important office for humus in the soil. While very little is known as yet of soil bacteria yet one thing is certain, the numbers of these vary in the soil with the amount of humus present - the greater the amount of humus, the larger the number of bacteria. The biological effects of bacteria are even at this time known to be most beneficial, and any increase in numbers of bacteria help in the actions which determine the state of fertility of soils.

In the absence of live stock to furnish the required amount of stable manure every good farmer should plan a rotation of crops so that every few years a green crop can be turned under. Rye, barley, buckwheat, oats, and clover can all be easily grown in New England. These supplemented with a reasonable amount of plant food from commercial fertilizers will build up these run down lands more quickly and cheaply than any other way.

It may not be out of place to emphasize at this point the value of clover as a soil rejuvinator. In no place in the world does red clover grow better,. when given proper conditions, than in New England. The writer has been able during the past five years to grow five tons of cured red clover hay to the acre on a heavy clay soil in Maine.

Clover, beans, alfalfa, cow peas, and soy beans, by the aid of bacteria working in the soil and storing up in small tubercles on the roots of the plants, have the power of adding large quantities of nitrogen to the soil. Various authorities say that the second crop and roots of an ordinary red clover crop will add from 100 lbs. to 200 lbs. of nitrogen per acre. Considering the high price of nitrogen it behooves every farmer to take advantage of this and grow clover at least once during each rotation.

Many failures to grow clover successfully have been reported, but to the writer's knowledge every one of these is due either to poor seed or to a condition of the soil decidedly unfavorable to the growth of the crop. I have found by practical experience that the following conditions are essential. (1) Good tillage in order to get proper soil ventilation. (2) Good drainage; clover roots will not penetrate a "water logged" soil. The water table should be at least three feet below the surface and is much better if six to ten feet below. (3) A non-acid soil. Clover is classed among the "lime loving" plants and does not thrive for any length of time in a "sour" soil. The over -

coming of this condition is treated later in this paper. (4) A soil must be medium rich in order to grow clover. It is sometimes necessary to sow rye, barley, or buckwheat and turn these crops under in order to get land into proper shape. (5) Bacteria of the proper kind, if drainage, humus, and proper tillage, are provided, and the acidity is corrected, the conditions will be good for the growth of bacteria and soil inoculation for red clover is not necessary in New England. Of course if the growing of alfalfa or any other crop which has not been grown here to any extent is attempted, it may be necessary to introduce bacteria of the proper kind.

The lack of live stock. Fifty or seventy-five years ago a large amount of live stock was kept on the farms of New England. For some reason the farmers of this section ceased to breed live stock about the time the stock lands of the middle and south west were opened for settlement. Recently at a Farmers' Institute at which the writer was present this question was asked of about one hundred and fifty farmers, "How many of you are raising any young stock on your farms?" and only three raised their hands. Lack of live stock of course means that the fodder crops instead of being fed are sold entirely from the farm, carrying with them large amounts of fertility. It is almost impossible, at least very unprofitable, to replenish the fertility taken away by the purchase of commercial fertilizers, and probably in 99% of such cases it is never done.

It should not be inferred that there is no live stock in New England for the dairy industry is a large industry and a goodly number of dairy cows are kept. But even in the dairy industry many dairy farmers do not attempt to grow the feed for their animals. The writer has had it said to him many times by apparently prosperous farmers that "I cannot afford to raise feed for my cows. It's too much work to cultivate the land, and I prefer to buy western feeds." Here again is a reason for there being an insufficient amount of tillage carried on resulting in the usual gradual depletion of soil fertility. The writer has never felt in sympathy with this argument, and considers the lack of live stock with the accompanying results as one of the primary causes for the agricultural conditions generally.

<u>The growing of one crop continuously</u>. New England is naturally fitted for specialized Agriculture and a wide range of specialization can be practiced. "Hay" potatoes and sweet corn grow better than in any other region with which the writer is familiar. There is always a danger of depleting the fertility in the soil when any region finds that it can grow one crop with great success. The lack of live stock and the desire to cultivate little land has led the New England farmer to look about for a crop which would apparently, at least, yield a good income without the outlay of much capital and labor. He has found it in the hay crop. The growing of hay under the present system is one of the worst mistakes a man can make for no system of husbandry carries so much fertility away from the farm when crops are sold as does grass or grain farming. The following table taken from "Soils" by Fletcher shows the loss of plant food in one year from 160 acres of land under different systems of farming.

| System | Lbs. Phos. Acid | Lbs. Potash | Lbs. Nitrogen |
|---|---|---|---|
| All grain | 2460 | 4020 | 5600 |
| Mixed grain and general | 1003 | 1047 | 2594 |
| Mixed potato and general | 991 | 2435 | 2363 |
| Stock | 35 | 59 | 898 |
| Dairy | 76 | 85 | 809 |

The ordinary practice in New England is to seed a piece of land down, leave it for eight, ten, or a dozen years, cut the hay off each year, and on many farms brought under the observation of the writer, no fertilizer of any kind is applied during that time. The hay is sold and of course whatever is received is considered largely as profit for very little labor has been expended. To call the attention of farmers to what such a practice means an ordinary farm problem is here taken, a man cuts and sells from his farm in one year fifty tons of hay at $10.00 a ton.

The analysis of mixed grasses is as follows:-

| | Nitrogen | Potash | Phosphoric Acid |
|---|---|---|---|
| | 1.37 | 1.54 | 0.37 |
| Multiply by 20 cwt. in a ton | | | x 20 |
| Pounds of these elements in one ton of hay. | 27.40 lbs. | 30.8 lbs. | 7.4 lbs. |
| Multiply by 50 tons | | | x 50 |
| | 1370 lbs. | 1540 lbs. | 370 lbs. |

| | | |
|---|---|---|
| 1370 lbs. Nitrogen | a 18 ¢ per lb. | 246.60 |
| 1540 lbs. Potash | a 4½ ¢ " " | 68.70 |
| 370 lbs. Phosphoric Acid | a 5 ¢ " " | 18.50 |
| Worth of fertilizer removed in 50 tons | | $ 325.80 |
| 50 tons of Hay | a $10. | $ 500.00 |

$500.00 - $325.80 = $ 174.20

What is received for land rental, labor, etc., if only the amount of plant food taken out is put back into the land?

When it is understood generally that this, so far as maintaining soil fertility is concerned, is one of the most wasteful practices, and that future generations must inevitably suffer it would seem that all intelligent and thinking men would no longer continue such work.

A further need too in this direction is a more definite system of rotations, It is just as easy for a man to divide his farm into several fields, no matter how large or small they may be, and put these through a definite system of rotation as it is to go to some part of each field and plow up a small "patch." Rotations have several advantages among which these might be mentioned. A good system of rotation conserves soil fertility, usually gives a larger income, and lessens the liability to insect and disease injury. Of course a man must practice a rotation which fits the needs of his farm, and also allows him to develop some one desired line of work more than others.

Good dairy farmers throughout New England are quite generally practicing the following rotations:

1st year Potatoes.
2nd year Corn (for silage).
3rd year Oats or other grain (seeded with clover and grass).
4th year Clover or mixed hay.
5th year Clover or mixed hay.

The potato growers of Aroostook County, Maine, after several years of trying to grow nothing but potatoes are quite generally practicing the following three year system:

1st year Potatoes
2nd year Grain (seeded to clover).
3rd year Clover
(Repeat the rotation).

Either of the above are well planned rotations because in each is found a money crop or feed for animals, one or two cultivated crops which cleanse the land, and a clover crop, the best crop in nothern latitudes for building up the land.

A well planned rotation will do infinitely more toward keeping up the fertility of the land than large amounts of commercial fertilizers.

The prevalence of an "acid or sour soil". Many instances have been brought to the writers attention where after good preparation of the soil, careful selection of seed, and proper fertilization had all been carefully attended to the crop obtained was not satisfactory. In many of these cases and particularly with some crops failure is no doubt due to the chemical condition of the land. Most of our cultivated crops do best when the soil is in a neutral or slightly alkaline condition. Crops use much lime in making their growth, and continued cropping together with the decomposition of organic matter which produces acids in the soil may so deplete the soil in lime that it has an "acid" or "sour" reaction.

For ages it has been known that lime in its various forms was of great value in agriculture. For many years it was believed that lime was a fertiliser. In the light of modern knowledge this belief is no longer held but it has been proven beyond a doubt that lime has an indirect rather than a direct benefit on both soils and plants.

Wheeler of Rhode Island in various bulletins says that "Lime unites with acid substances in the soil, by which action the soil is sweetened or its natural acidity (sourness) is overcome or reduced."

"It renders Potash, Phosphoric Acid, and Nitrogen more available. It tends to make heavy clay soils more friable, and light sandy soils more compact."

"It causes plants to be stronger. Nitrification immediately stops in acid soils."

"Certain plants like the clovers and alfalfa are classed as "lime loving" plants and most of the grasses thrive best in soils where lime is present, and soil bacteria are unable to do their beneficial work in a sour soil."

The writer is aware that there is so much difference in the course of treatment that ~~it has~~ soils have undergone, that statements of a general nature regarding the use of lime must be made advisedly. After many examinations of soils from different sections of New England, and from much observation, it may be stated in a general way, that in grass and clover production much of the land, except in regions which are naturally of a limestone formation, would be greatly benefited by a frequent application of lime.

Wheeler of the Rhode Island Station gives the following lists of plants as being visibly affected by liming.

Those much benefited by liming.

| | |
|---|---|
| Clover | Oats |
| Timothy and most grasses | Buckwheat |
| Strawberries | Barley |
| Tobacco | Cauliflower |
| Celery | Ruta Bagas |
| Onions | Cabbages |
| Carrots | Beets |
| Soy Beans | Spinach |

Lettuce

Those injured or not improved by liming are

| | |
|---|---|
| Millet | Potatoes |
| Red Top | Corn |

Blackberries.

Lands in an acid or sour condition will not respond to heavy applications of commercial fertilizers and must first be neutralized by some material - lime at present probably being the quickest, cheapest, and best for this purpose.

There are several methods by which this sourness or acidity in soils may be detected. Two of these are easily used by the farmer and together may be considered as a reliable guide. The first is by the character of the vegetation found growing, and the second is by the litmus paper test. Sorrel, Moss, Cinque-foil, Daisies, Buttercups, and other noxious weeds found growing where clover and cultivated grasses fail to make a stand are good indications of this acid condition.

The litmus paper test, while not considered very reliable by some authorities, in a majority of instances taken with the native vegetation gives corroborating testimony. The test is a simple one. Blue litmus paper is procured from an apothecary, small samples of soil are gathered from different sections of the field, mixed together in a tea cup and slightly moistened with water. Take a piece of litmus paper two inches long and one inch wide and put one end of it down into the moist soil, leave a few moments, remove the paper from the soil, rinse it off in clean water and if the soil is acid the paper will be turned a decided red, the deepness of the color depending upon the amount of acid contained in the soil.

When both of these tests have been used, and one is convinced that there is acid present in the soil, this condition may be corrected by the use of lime in quantities varying from one-half to one ton or more to the acre. As a rule sandy soils require a less amount than heavy clay soils. This should be applied after plowing and harrowed into the soil. Since lime is quite insoluble it is better not to use it as a top dressing on grass land.

Lime can be obtained in three forms from the lime kilns. As air slaked, as fresh lump lime, and as finely ground lime ready for distribution. It varies in strength according to the form. Air slaked lime is fresh quick lime which has taken up quite an amount of moisture. One hundred pounds of freshly burned lump lime is equal to about 175 pounds of air slaked lime for agricultural purposes. The finely ground agricultural lime is hydrated or slaked to a greater or less extent and so a larger quantity of this should be used than would be necessary of the lump lime.

The labor which must be used and sometimes the loss which occurs in slaking lime in large quantities often makes it advisable for a farmer to purchase and use the finely ground agricultural lime.

Farmers in New England, and Maine especially, who are having difficulty in obtaining good grass - and particularly clover, should investigate the condition of their land and see if it is in an acid condition, and if this unfavorable condition is found, steps should be at once taken to remove the cause. An application of 1000 pounds of lump lime, equivalent to about 1400 pounds of "agricultural lime", or to 1750 pounds of air slaked lime, should be applied to light soils after plowing and thoroughly harrowed in. Lime being quite insoluble in water gives very little benefit when applied as a top dressing on sod land. About 1800 pounds to 2000 pounds fresh lime should be used on heavy clay soils in the same manner.

The experience which the writer has had in handling a Maine farm and the results obtained throughout this state and Rhode Island leads him to recommend the use of lime without hesitation when the land shows acid indications as spoken of in this paper, especially before an attempt is made to grow clovers, alfalfa, or grass crops. Money expended for lime can usually be deducted from that formerly put into commercial fertilizers and better results will be obtained.

The foregoing brief discussion of the principal things which, if practiced, would materially keep up the fertility in soils is not exhaustive. It has seemed to the writer that these things were too often overlooked by practical farmers, and that attention should be called to them before taking up that question which every farmer is deeply interested in – the subject of commercial fertilizers.

III. <u>The Commercial Fertilizer Question</u>.

The greatest outlay of money that the average New England farmer makes is for commercial fertilizers. In the absence of live stock to furnish manure, tillage to "sweeten" and improve the soil, rotations to aid in keeping up fertility, he turned to the buying of commercial fertilizers as a means of increasing and keeping up the yield of the crop. It has seemed easy to drive to the village, get a few sacks of these materials, apply them to the land and await a "bounteous" harvest. But commercial fertilizers cannot take the place of those things above mentioned and many a disappointed farmer has there been at the end of a season.

New England has been the "harvesting ground" for the fertilizer companies in the past. Some years ago before the enactment of inspection laws and the desire of a few individuals in the fertilizer business to make that business a more honorable one, the commercial fertilizers sold on the market were of a very uncertain grade. Every one, farmer, fertilizer manufacturer, and college or station worker is glad to add testimony to the fact that as a general thing the fertilizers sold on the markets today are as representated, and well suited to the crops for which they are intended. There is one thing yet - they cost the farmer too much money, and it is the purpose of this part of this paper to explain some things about fertilizing materials not generally understood by farmers, to give to them some suggestions as to the selecting of fertilizing materials, to point out that by buying chemicals and mixing these materials together at the farm from 25% to 33% can be saved, and to give directions for doing this work.

Can soils be examined and their fertilizing needs determined? This question has been asked by letter and personal question of the writer many times during the past few years. Often accompanying the letter is a sample of soil - sometimes in a small pill box and again in a tomato can - may be received. Advice is even asked as to the kind and amounts of different fertilizers to use. When a letter is written to the sender of the soil saying that no examination of value to him can be made, he usually feels that he has been "turned down" and that we are not interested in his case. So far as a chemical analysis itself is concerned, it could be made, but nearly all samples of soil when analyzed and the determinations made would show several hundred pounds of nitrogen, potash, and phosphoric acid to the acre: Plant food exists in the soil in two forms, available and unavailable. (Terms are explained later.) All the plant food comes out in the chemists test. It is the available that interests the farmer at that moment. The unavailable will in due time, through the process of nature, gradually become available.

Another important consideration in the answering of this question is that no small sample of soil sent for analysis represents the entire field from which it was taken, neither does that particular field represent the entire farm.

The physical condition of the soil, its water holding capacity, humus content, etc., are all equally as important as plant food.

For these several reasons then a chemist cannot by means of

analysis at his hands tell a farmer anything of practical value from a sample of soil sent in. There is, however, a simple method by which a man can obtain accurate knowledge of what the fertilizer requirements of his farm are. This method consists of carrying out some plot tests. While a little extra labor is involved yet everyone should do this and it may be that when the fertilizer requirements of the farm are known many hundreds of dollars in fertilizer bills can be saved.

A plan recommended by Snyder of the Minnesota Station and others for the testing of a farm to determine what fertilizers to use is as follows: A convenient way is to take plats 1/20 of an acre in size, using any crop that happens to be growing, and select land which is as uniform as possible and give the whole area the same preparation up to the time of fertilizing. Eight plots are necessary to make a good test. The amounts of fertilizer applied to each plot are shown in the following diagram. Leave spaces of three feet between plots.

| | | | |
|---|---|---|---|
| Plot 1<br><br>No Fertilizer | Plot 2<br><br>8 lbs. Nitrate Soda<br>16 lbs. Acid Phosphate<br>8 lbs Sulphate Potash | Plot 3<br><br>8 lbs. Nitrate Soda<br>16 lbs. Acid Phosphate | Plot 4<br><br>8 lbs. Nitrate Soda<br>16 lbs. Sulphate Potash |
| Plot 5<br><br>8 lbs Nitrate Soda | Plot 6<br><br>16 lbs Acid Phosphate<br>8 lbs Sulphate Potash | Plot 7<br><br>8 lbs Sulphate Potash | Plot 8<br><br>16 lbs. Acid Phosphate |

By watching the growth on the different plots and comparing yields, one should be able to tell what the fertilizer requirements are. The results should be verified for two or three years. Such tests carefully carried out will give more accurate information than all the chemist's tests which might be obtained.

The interpretation of a fertilizer formula. In the past the fertilizer companies have stated tha analysis of the different brands described in the little booklets distributed among farmers in terms which only a trained chemist could comprehend and know the meaning of. While most companies have adopted a mofe simple statement yet there are still several things that should be explained to a farmer.

Commercial fertilizers ordinarily contain materials furnishing three elements of plant food, namely : Nitrogen, potash, and phosphoric acid. These thred are the ones which are taken up in the largest quantities by plants in making their growth.

It is proper in this place to caution farmers against buying any particular brand. Names such as "Mortgage lifters" "Big crops" "Sure crop phosphate" are only terms used to draw attention. Buy a fertilizer according to the amount of nitrogen, potash, and phosphoric acid it contains. Directions are given a little later for determining this.

The percentage of nitrogen in most fertilizers is expressed in terms of ammonia. So far as scientists can tell plants do not use "ammonia" in making their growth, but nitrogen, combined with potash, sodium, lime, and other matérials in the soil to form "nitrates". Nitrogen expressed in terms of ammonia requires larger figures to represent the percentage contained which is to the advantage of the manufacturer.

In like manner potash is stated as "equal to sulphate of potash" and phosphoric acid is stated in terms of "bone phosphate". If an analysis

states that "potash is equal to sulphate of potash 18.6% , it means the same as 9.3% actual potash ($K_2O$), or if a formula states that phosphoric acid is equal to 35% bone phosphate it really means that the brand contains 15.9% phosphoric acid.

By using the following table any one can convert the analysis into any terms desired.

| To convert | | multiply by |
|---|---|---|
| ammonia into an equivalent of | nitrogen | 0.8235 |
| nitrogen " " " " | ammonia | 1.214 |
| nitrate of soda " " " " | nitrogen | 16.47 |
| bone phosphate " " " " | phosphoric acid | 0.458 |
| phosphoric acid " " " " | bone phosphate | 2.183 |
| muriate potash " " " " | potash | 0.632 |
| sulphate potash " " " " | potash | 0.54 |
| actual potash " " " " | sulphate potash | 1.85 |

(Table taken from Vorhees' "Fertilizers.")

To show what is meant by a fertilizer formula the following is taken from a booklet of one of the leading fertilizer companies.

Guaranteed Analysis.

| | |
|---|---|
| Nitrogen equal to ammonia | 3.00 to 4.00% |
| Soluble phosphoric acid | 6.50 to 8.00% |
| Reverted " " | 1.50 to 2.00% |
| Available " " | 8.00 to 9.00% |
| Insoluble " " | 2.00 to 3.00% |
| Total " " | 10.00 to 11.00% |
| Potash - actual | 6.00 to 7.00 % |

It will appear at once that there are terms in the above formula with which the man without a knowledge of chemistry is unfamiliar.

In the first place the farmer in selecting a fertilizer need not consider the last column of figures. The analysis will no doubt meet the first column but may not the second.

The ammonia can be converted into nitrogen in the following way.

ammonia 3% X 0.8235 = 2.40% nitrogen.

The phosphoric acid is stated in several ways. Soluble has reference to that which will dissolve in water. Reverted that which has combined with some other material such as lime, and is no longer soluble in water. Available that which is in a form which can be taken up by plants. Insoluble not in a form which can be used by plants, and total the sum of all. In selecting a fertilizer, unless it is known that the phosphoric acid all comes from bone, it is safer to figure only on the available.

The potash in this formula is stated in terms of actual potash which is as it should be.

The fertilizer formula under discussion reduced to its proper terms should read

| | |
|---|---|
| Nitrogen | 2.40% |
| Available Phosphoric Acid | 8.00% |
| Actual Potash | 6.00% |

In buying a fertilizer the statements should be reduced to this form.

The formula means further that the fertilizer company guarantees 2.40% of the 2000 lbs. (ton) to be nitrogen, 8% to be available phosphoric acid, and 6% potash.

The number of pounds of plant food contained in this fertilizer can be found as follows:

| | | | |
|---|---|---|---|
| 2.4% X 2000 lbs | = | 48 lbs | nitrogen |
| 8% X 2000 lbs | = | 160 lbs | phosphoric acid |
| 6% X 2000 lbs | = | 120 lbs | potash |
| Total | | 328 lbs. | plant food |

It will be seen that 328 lbs. of the ton is of value and (2000 - 328 = ) 1672 lbs. waste material. This waste material may be due to the impurities in the fertilizing materials themselves (none of the crude chemicals are pure as will be seen later) or to cheap material used as filler to dilute the chemicals, and help make weight.

By examining any fertilizer formula in the way here suggested a good estimate of its real value can be obtained.

The difference in value between a high grade and low grade fertilizer. There is always a tendency on the part of men when money is to be expended to buy the cheaper article. Many cases have come to the writer's attention where men have gone to fertilizer dealers and inquired the price of goods, and on being told that one grade was $25.00 a ton and another $40.00 a ton have immediately replied that they would take the $25.00 goods. This as has been explained before is a wrong basis. Look to the amount of plant food contained and buy the brand that gives the most of this for the money. As a general thing the high grade goods are always cheapest. An illustration of each kind will explain the difference.

Low grade selling for $25.00

Analysis

| | |
|---|---|
| Nitrogen | 0.82% |
| Available Phosphoric Acid | 7.00% |
| Potash | 1.00% |

.82% X 2000 lbs = 16.4 lbs. nitrogen

7% X 2000 lbs = 140. lbs. phosphoric acid

1% X 2000 lbs = 20. lbs. potash

Total plant food 176.4 lbs.

$25.00 ÷ 176.4 lbs = 14 ¢ lb. cost of plant food

<u>High grade selling at $40.00</u>

**Analysis**

| | |
|---|---|
| Nitrogen | 3.7% |
| Available Phosphoric Acid | 7.0% |
| Potash | 10.0% |

3.7% X 2000 lbs = 74 lbs. nitrogen

7.0% X 2000 lbs = 140 lbs. phosphoric acid

10.0% X 2000 lbs = 200 lbs. potash

Total plant food 414 lbs.

$40.00 ÷ 414 lbs = 9 ¢ per lb. cost of plant food

Comparing the two above in another way

414 ÷ 176.4 = 2.3 (Ratio between the two. High grade contains 2.3 times as much plant food as low grade.)

$25.00 X 2.3 = $57.50. What it would cost to get as much plant food in a low grade fertilizer at $25.00 a ton as one can get for $40.00 in the high grade.

One other thing should be considered in this comparison. The materials used in the high grade are better than those used in the low grade. The fertilizer companies estimate that it costs $11.00 a ton to manufacture and sell their goods. Then

<u>Low</u> $25.00 - $11.00 = $16.00 to go into materials

<u>High</u> $40.00 - $11.00 = $29.00 " " " "

The explanation just given would seem ~~ought~~ to be sufficient so that no one who reads this will make the mistake of buying low grade goods.

<u>Classification of Materials</u>. The materials used in making fertilizers may be classified into three classes:

1. Those furnishing nitrogen.
2. Those furnishing potash.
3. Those furnishing phosphoric acid.

<u>Agricultural characteristics of nitrogen</u>. Nitrogen is the most expensive fertilizing element the farmer has to buy, costing at the present time 18 ¢ per lb. in the more common materials which furnish it. It is easily lost from the soil by leaching hence care should be taken not to use more of the available forms than would be taken up in one growing season. Nitrogen tends to produce leaf and stem growth, and to retard rather than encourage maturity in plants. The materials such as nitrate of soda and sulphate of ammonia are quickly available, while those from organic sources like bone and tankage act more slowly.

The nitrogen of the air, as has already been mentioned, should be trapped by the use of clover and other leguminous plants in order to avoid buying so much in the form of commercial fertilizers.

The liquid portions of stable manure are also rich in this element and every effort should be made to prevent the loss of nitrogen from this material by heating and leaching.

For convenience the principal nitrogenous fertilizers are tabulated in the following way giving source, composition, availability, and price.

Prices and composition may fluctuate somewhat from year to year, so by simply substituting current quotations for those here given the problems can be solved anew at any time.

Table No. 1.

Nitrogenous Materials - 1908 Quotations

| Material | Source | Composition | | | Availability | Price per ton |
|---|---|---|---|---|---|---|
| | | Nitrogen % | Potash % | Phos. Acid % | | |
| Nitrate Soda | Mined in Chili | 15% | | | Quickly | $56.00 |
| Sulphate of Ammonia | By-product from several industries. | 20% | | | Quickly | $72.00 |
| Nitrate of Potash | Mined in Germany | 15% | 45% | | Quickly | $96.00 |
| Tankage | Slaughter Houses | 5 - 9% | | 9 - 15% | Slowly | $25 - $35. |
| Dried Blood | " | 6 - 13% | | | Medium | $30 - $45. |
| Meat Meal | " | 10 - 14% | | | Slowly | $25 - $40. |
| Dry ground Fish | Fish factories | 8 - 11% | trace | trace | Slowly | $30.00 |
| King Crab | Sea Costs | 10% | " | " | Slowly | $30.00 |
| Ground Bone | Slaughter Houses | 3% | | 22% | Slowly | $27.00 |
| Cottonseed Meal | Cottonseed | 6 - 7% | trace | trace | Slowly | $30.00 |
| Castor Pomace | Castor oil Industry | 6 - 7% | " | " | Slowly | $25.00 |
| Linseed Meal | Flaxseed | 5 - 6% | " | " | Slowly | $30.00 |
| Guanas (Best grades) | Islands in So. Sea | 10% | " | 12% | Quite available | $35.00 |

It will be noticed in the table just given that some of these materials contain one or more other elements besides nitrogen.

Materials furnishing potash. There are two sources of potash fertilizers.

1. Wood ashes

2. German potash salts.

Wood Ashes. Up to the time that coal began to be so universally used as fuel, wood ashes were a valuable product as a source of potash. Of late years they have been scarce, and great care should be used if they are to be purchased to see that they have not lost their fertilizing value. They are vaulable chiefly for the potash and lime which they contain, and if allowed to leach may lose nearly all of the first named element.

The value of wood ashes depends on the kind of wood from which they have come, (hard woods producing more valuable ashes than soft), the amount of dirt they contain, and how they have been stored.

Good, hard wood ashes, unleached, have an analysis about as follows:

5 - 6% Potash

1 - 2% Phosphoric Acid

28 - 32% Lime

Leached ashes analyze much less, usually about

1 - 2% Potash

1% Phosphoric Acid

25 - 30% Lime

In buying ashes one should know the analysis of the particular lot purchased, and should see that they are dry and have not been leached.

Computed at the present prices of potash, phosphoric acid, and lime a ton of the hard wood, unleashed ashes given above would be worth

5% X 2000 lbs = 100 lbs. Potash in 1 ton.

1% X 2000 lbs = 20 lbs. Phosphoric Acid in 1 ton.

30% X 2000 lbs = 600 lbs. Lime in 1 ton.

| | | | |
|---|---|---|---|
| 100 lbs Potash | a 4½¢ per lb | = | $ 4.50 |
| 20 lbs Phosphoric acid | a 5 ¢ " " | = | $ 1.00 |
| 600 lbs Lime | a 40¢ per cwt | = | $ 2.40 |
| Price at which the same elements could be purchased in chemicals . | | | $ 7.90 |

Computed in the same way the leached ashes would be worth about $3.90 a ton.

Table No. 2 - Potash Materials.

| Material | Source | Composition | | | Availability | Price |
|---|---|---|---|---|---|---|
| | | Potash % | Nitrogen % | Phos. Acid % | | |
| Wood ashes | Farms and factories where wood is burned | 5 - 6 | | 1 - 2 | Readily | ? |
| Muriate of Potash | German mines | 48 - 52 | | | Quickly | $43.00 |
| Sulphate of Potash | " | 48 - 52 | | | " | $48.00 |
| Nitrate of Potash | " | 45 | | | " | $96.00 |
| Kainit | " | 12 - 13 | | | " | $12.00 |
| Double sulphate of potash and magnesium | " | 26 | | | " | $25.00 |

Unlike nitrogen potash is fixed by natural agencies in the soil and such great care need not be taken in the use of it. It is believed that the source from which the potash comes affects the quality of certain crops like potatoes and others in which much starch is found. For such crops it is best to use potash in the form of sulphate.

An excess af potash in the soil gives strength to grains and causes the kernels to be plumper. In the case of fruit, the quality at ripening is also made better by liberal applications of this element.

Materials furnishing phosphoric acid. Technically speaking only those materials containing phosphoric acid can be spoken of as phosphates. The term "phosphate", however, is in a popular way improperly applied to all kinds of fertilizer materials. Another term "superphosphate" is commonly used. The work "superphosphate" refers to a raw phosphate which has been treated in some way to make it more quickly available.

Phosphoric acid is more easily fixed in the soil than either of the other two elements. When lime is present it combines with this readily forming phosphate of lime, a valuable form, which is not easily leached out of the soil.

Phosphoric acid aids the maturity of seed and fruit. It also is supposed when present in sufficient amounts to give color and plumpness to grains and fruits especially.

The phosphates form the basis of most commercial fertilizers.

Table No. 3 - Phosphates.

| Material | Source | Composition Phos.Acid % | Nitrogen % | Potash % | Availability | Price |
|---|---|---|---|---|---|---|
| South Carolina Rock | Rocks in S.C. | 12 - 18 | | | Slowly | $10 - $12 |
| Acid Phosphate | S.C.Rock treated | 14 - 18 | | | Quickly | $14 - $18 |
| Tankage | Slaughter Houses | 10 - 15 | 5 - 9 | | Slowly | $25 $30 |
| Ground Bone | " | 20 - 22 | 3 - 4 | | " | $25 - $30 |
| Bone Black | Waste product refining sugar | 32 - 36 | | | " | ? |
| Steamed Bone | Slaughter Houses | 35 - 40 | trace | | " | ? |
| Florida Phosphate | River beds Florida | 18 - 30 | | | " | $18 - $30 |
| Basic Slag | Waste product steel mfg. | 15 - 20 | | | " | $18 |
| Phosphatic Guanos | Given under Nitrogenous | | | | | |

These tables have been given in this form in order that they may be referred to in selecting and putting together materials for home mixtures, the next subject to be taken up.

IV. <u>The "Home Mixing of Fertilizers", Something Every Farmer Should Understand.</u>

It has been previously noted in this paper that it costs the fertilizer manufacturer about $11.00 a ton to sell his goods. This amount represents the cost of maintaining the fertilizer plant and equipment, interest on the investment, travelling men's expenses, advertising, agents' commissions, and interest on notes taken in payment for goods delivered. It is possible for any farmer, or better a club of farmers or a grange to purchase the raw materials, and mix them together at the farm thereby saving the most of this additional cost.

It would be sufficient if the saving of money was all that had been gained, but there are other things in favor of doing this. When home mixing is done, the grade of materials used is known and a fertilizer mixed with the special needs of your own farm,after you find what the needs of the soil are, by the method already outlined, can be made.

Successful home mixing depends on several things.

1. Selection of the proper materials.
2. Putting them together in proper proportions.
3. Mixing them thoroughly together.

There is no secret to "home mixing" as many seem to suppose. Any fertilizer formula can be duplicated. Before attempting to practice this on the farm, it is necessary to study several phases of the question. The things one should determine are:

1. Relative cost of plant food in materials of the same class.

2. What proportion of each source should be used.

3. The needs of the crop the fertilizer is being made for.

4. The determination of the proper amounts of each.

The writer has found many farmers who would be glad to mix the fertilizers at home but do not do so because they cannot determine for themselves the above points. The following problems given at this time are for the purpose of aiding in this work and showing the simple arithmetical work necessary.

How to determine the relative cost of plant food in two materials. Suppose for instance that it is wished to determine the relative cost of nitrogen in nitrate of soda and sulphate of ammonia. Referring back to table No. 1 it is found that nitrate of soda is 15% nitrogen. Then one ton of nitrate has:

15% X 2000 lbs. or 300 lbs. Nitrogen

Nitrate of soda costs $56.00 a ton.

Then $56.00 ÷ 300 lbs = $.18 2/3 per lb. for Nitrogen

Taking sulphate of ammonia in the same way.

20% X 2000 lbs. = 400 lbs. Nitrogen

$72.00 ÷ 400 lbs. = $ .18 per lb. for Sulphate of Ammonia

In selecting any material the availability and effect of that material on the crop ~~that~~ should be considered as well as the price.

To fix a uniform valuation on the price of the three elements from different sources, the Directors of the New England states meet in March each year for this purpose.

The schedule of vaulations for 1908 is as follows:

| | Cents per pound. |
|---|---|
| Nitrogen in nitrates | 18½ |
| in ammonia salts | 17½ |
| Organic nitrogen in dry and fine ground fish, meat and blood, and in mixed fertilizers | 20½ |
| in fine bone and tankage | 20½ |
| in coarse bone and tankage | 15 |
| Phosphoric acid, water-soluble | 5 |
| citrate-soluble | 4½ |
| in fine ground bone and tankage | 4 |
| in coarse bone and tankage | 3 |
| in cotton seed meal, castor pomace and ashed | 4 |
| in mixed fertilizers, if insoluble in ammonium citrate | 2 |

When it is desired to compare for instance the cost of nitrogen in nitrate of soda with that in tankage, a material which also contains phosphoric acid, the problem is a little more complicated.

The cost of nitrogen in nitrate of soda has already been computed at 18 2/3 ¢ a lb.

To find what the nitrogen in tankage costs it is first necessary to find the value of the phosphoric acid in that material.

Table No. 2 gives the composition of tankage as 5½ % nitrogen, 16% phosphoric acid, and costs $26.00 a ton. Referring to the schedule of valuation it is found that phosphoric acid in bone tankage is worth 4¢ a lb.

5½% X 2000 lbs. = 110 lbs. Nitrogen in one ton tankage

16% X 2000 lbs. = 320 lbs. Phosphoric Acid in one ton tankage

320 X 4¢ a lb. = $12.80 what the Phosphoric Acid in the tankage is worth.

$26.00 - $12.80 = $13.20 cost of Nitrogen in tankage

$13.20 ÷ 110 = 12¢ per lb. cost of Nitrogen.

In like manner by referring to the tables and the schedule of prices the value of any material as compared with any other material can be determined.

<u>The selection of materials and the duplication of formulae.</u> After the relative cost of plant food from different sources has been determined the next step is to determine the kind and quantity of the different materials it takes to make a mixture of a desired analysis.

The kind of materials to select depends, besides cost, on whether or not the crop occupies the whole season in making its growth or only a few weeks. In seeding down, corn, potatoes, or other crops which occupy the land the entire season nitrogen should be selected from both the quickly and slowly available sources. If for instance all the nitrogen was taken from nitrate of soda, this element of plant food might be lost before the end of the season, so some of it is used from tankage, ground bone, or other slowly available source. With potash and phosphoric acid so much care need not be exercised as both of these elements are retained in the soil until taken out by the crops.

As an illustration to use in order to show the method employed in figuring out the necessary amounts of materials to make a mixture of a certain grade, the common high grade potato fertilizer so widely purchased in the east will be used. This fertilizer has an analysis about as follows:

Nitrogen equal to ammonia 4%

Available Phosphoric Acid 6%

Potash (actual) 10%

It will first be necessary to convert the ammonia into an equivalent of nitrogen. This is done as follows: (table has already been given)

4% ammonia X .8235 = 3.3% Nitrogen

The corrected formula then reads

| | |
|---|---|
| Nitrogen | 3.3% |
| Available Phosphoric Acid | 6 % |
| Potash | 10 % |

The next question is - how many pounds of nitrogen, phosphoric acid, and potash is there in a ton of fertilizer of this grade. We find the following amounts:

3.3% X 2000 lbs = 66 lbs. Nitrogen

6 % X 2000 lbs = 120 lbs. Phosphoric Acid

10% X 2000 lbs = 200 lbs. Potash

If then we put materials of a high grade together in proportions to give the above amounts of these elements, if the materials are fine and dry, and if they are thoroughly mixed together we ~~would~~ will have a fertilizer equal in value to mixed goods of the same grade.

It is generally considered in this kind of a fertilizer that about one-third of the nitrogen should be taken from a very available source and the remaining two-thirds from a source more slowly available. Suppose nitrate of soda, tankage, acid phosphate, and sulphate of potash are used to make this mixture, using one-third of the nitrogen from nitrate of soda.

1/3 of 66 lbs. Nitrogen = 22 lbs. Nitrogen

2/3 of 66 lbs. Nitrogen = 44 lbs. Nitrogen

Referring back to table No. 1 it is found that nitrate of soda is 15% nitrogen.

Dividing 22 lbs. the amount of nitrogen required from nitrate, by the 15% will give the number of pounds required.

22 lbs. ÷ 15% = 147 lbs. Nitrate of Soda.

In like manner the number of pounds of tankage to furnish the 44 lbs. of nitrogen is determined. One grade of tankage analyzes 5% nitrogen, 15% phosphoric acid.

44 lbs. ÷ 5% = 880 lbs. tankage to give 44 lbs. Nitrogen.

But the tankage also contains phosphoric acid. This must be determined. It is not best to consider that more than 12% of the 15% phosphoric acid in the tankage is available, so

12% X 880 lbs. = 105 lbs. Phosphoric Acid in 880 lbs. Tankage.

The formula that is being used calls for 120 lbs. of Phosphoric Acid, then

120 lbs. - 105 lbs. = 15 lbs. Phosphoric Acid yet to get.

Acid phosphate is a good source to use this remaining 15 lbs. from. Referring back to table No. 2 we find that acid phosphate analyzes 15% phosphoric acid. Then

15 lbs ÷ 15% = 100 lbs Acid Phosphate necessary to use to make up the required Phosphoric Acid.

Coming next to potash, since this is to be a potato formula, potash in the form of sulphate should be used. 200 lbs. of potash are required. Table No. 3 shows that sulphate of potash analyzes 50% potash. Then

200 lbs ÷ 50% = 400 lbs. Sulphate of Potash necessary to satisfy the formula.

Bringing the foregoing results together into a more concise form

| | | |
|---|---|---|
| 147 lbs Nitrate of Soda gives | 22 lbs Nitrogen | |
| 880 lbs Tankage gives................ | 44 lbs. " | |
| | 66 lbs " | Amt Required |
| | 105 lbs. Phosphoric Acid | |
| 100 lbs. Acid Phosphate gives | 15 lbs. " " | |
| | 120 lbs. " " | Amount Required. |
| 400 lbs. Sulphate of Potash gives | 200 lbs Potash " " | |
| 1527 lbs. weight of mixture. | | |

It will be seen at once that the materials do not weigh 2000 lbs. but they contains as much nitrogen, potash, and phosphoric acid as a ton of mixed goods of the same grade, hence have just as high an agricultural value. If it is desired to add a filler to bring the weight up to a ton, add 673 lbs. of dry road dust, sifted coal ashes, land plaster, or any other dry, fine material, excepting lime. The writer does not consider the addition of a "filler" at all necessary when the materials added together give as much weight as these do. In the applying of this, if one half ton of a mixed fertilizer was to be used on an acre 769 lbs. of the home mixture would be its equivalent. To use other rates figure a proportionate amount.

It has been stated that one of the principal things in favor of "home mixtures" was the lesser cost. What is the cost of the fertilizer which has just been compounded? This grade sells in Maine for $38.00 a ton.

The cost of the home mixture is as follows:-

| | | | |
|---|---|---|---|
| 147 lbs Nitrate Soda | a $56. ton | | 4.11 |
| 880 lbs. Tankage | a $27. " | | 11.88 |
| 100 lbs. Acid Phosphate | a $16. " | | .80 |
| 400 lbs. Sulphate Potash | a $ 48. " | | 9.60 |
| Cost of Materials | | | $ 26.39 |
| Freight | a 15¢ per cwt. | | 2.25 |
| Labor of Mixing | | | .50 |
| | | | $ 29.14 |

$38.00 - $29.14 = $8.86 per ton saved.

Freight has been estimated at 15¢ a cwt. this being considered an average rate. The materials can be thoroughly mixed as described later for 50¢ a ton. This saving is about an average difference between the mixed and the unmixed goods. Where several neighbors, or a grange, club together freight rates can be reduced.

The materials can be purchased of most of the fertilizer companies.

<u>Other home made mixtures</u>. By following the directions that have been given a mixture of any desired analysis can be made.

The following are a few examples of home made mixtures for different crops.

## Seeding Down Fertilizer.

Seeding down fertilizer analyzing

3½% Nitrogen

7% Phosphoric Acid

5% Potash

can be made from

100 lbs. Nitrate of Soda (15% Nitrogen)

1200 lbs. Tankage (5% Nitrogen, 15% Phosphoric Acid)

200 lbs. Muriate Potash (50% Potash)

1500 lbs.

Use 300 to 600 lbs. to the acre.

Grass, Grain and Seeding Down Fertilizer.

Grass, grain, and seeding down fertilizer analyzing

3% Nitrogen

7% Phosphoric Acid

4% Potash

can be made from

133 lbs. Nitrate of Soda (15% Nitrogen)

800 lbs. Tankage (5% Nitrogen, 12% available Phosphoric Acid)

200 lbs. Acid Phosphate (15% Phosphoric Acid)

160 lbs. Muriate Potash (50% Potash)

1293 lbs.

Use from 300 lbs to the acre up to any amount desired.

Top Dressing for Grass Land

300 lbs. Nitrate of Soda (15% Nitrogen)

300 lbs. Muriate Potash (50% Potash)

600 lbs. Acid Phosphate (15% Phosphoric Acid)

1200 lbs.

Use 300 to 500 lbs. to the acre just about the time the grass begins to start in the spring.

It will be noticed in this mixture that the materials selected are all very soluble, dissolving with the first rain that falls. By using 350 lbs. of this to the acre on the University of Maine farm we are usually able to double our hay crops in yield.

Directions for the home mixing of fertilizers. The apparatus needed to successfully home mix fertilizers is as follows:

1. Shovels.
2. Platform scales.
3. Tight board floor.
4. Screen similar to that used by stone masons for sifting gravel.

After the materials have been purchased the required amounts of each should be weighed out and placed in separate piles on the floor. It is convenient to weigh out and mix the equivalent of one ton at a time. If any lumps are contained in the materials, break them up at this time with a wooden tamper. Make a larger pile in the center of the smaller ones by shoveling in layers of each material. After all have been combined in one larger pile, shovel this over into another pile allowing the new pile to be coneshaped. (This allows each material to sort of distribute itself and run down the sides of the pile. Lumps, if there are any, also run out.) Shovel back and forth until the materials are thoroughly mixed together , usually five or six shovelings are sufficient. Finally throw the material through the screen, then shovel into sacks, weighing and tagging each bag with the kind and amount of fertilizer contained in each sack on each bag.

The application of fertilisers. There are various opinions held as to what is the best method of applying fertilisers. If one will take the trouble to make a calculation it will be found that even when large amounts are used to the acre only a small fraction of an ounce falls on each square foot of ground.

Whether or not it is best to put all the fertiliser in the drill at the time of planting, partly in the drill and partly broadcast on top after planting, or all broadcast before or after planting depends on different conditions, circumstances, and crops. It has been the writer's experience that since the feeding rootlets of crops are distributed very thoroughly throughout the top few inches of soil that partly broadcast and partly in the drill is the better method. One thing is very sure whichever method is used, be thorough in the application of the material and see that it is evenly distributed.

The writer has tried to point our and call the attention of New England farmers to some things which, if practiced, would build up more quickly the "run down" farms of New England and maintain the fertility after it has once been returned to the soil. It is desired to reiterate one thing here, and that it that a more careful study and economic use should be made of commercial fertilizers in the future than has been done in the past.

The writer firmly believes that more tillage, the keeping of larger numbers of live stock, the growing of clover, a carefully planned rotation, the development of specialized farming, and a more judicious use of commercial fertilizer will not only restore the lost fertility to New England soils, but will develop a system of Agriculture which shall make this eastern country with its beautiful scenery, its traditions, its culture, not only one of the most prosperous agricultural sections of the United States, but a land of the most delightful farm homes in the world.

[illegible] USE ONLY