AN

ADDRESS

DELIVERED BEFORE THE

Plymouth County Agricultural Society,

AT THEIR

ANNUAL EXHIBITION,

IN THE TOWN OF BRIDGEWATER,

SEPT. 25, 1850.

BY CHARLES T. JACKSON. M. D..

Chevalier de la Legion d' Honneur.

Assayer to the State of Massachusetts. Late Geologist to Maine, New Hampshire, Rhode Island,
and the United States. Member of the Geological Society of France, of the Imperial
Mineralogical Society of St. Petersburg, etc., etc.

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At a meeting of the Trustees of the Plymouth County Agricultural Society, at Bridgewater, on the 25th of September, 1850 —

"*Voted*, " That the thanks of the Trustees be presented to DR. JACKSON, of Boston, for his able and eloquent address, this day delivered before the Plymouth County Agricultural Society, and that he be requested to furnish a copy for publication."

JESSE PERKINS, Sec'y.

A true copy. Attest,

JESSE PERKINS, Sec'y.

BOSTON, Dec. 2d, 1850.

TO THE TRUSTEES OF THE PLYMOUTH COUNTY AGRICULTURAL SOCIETY.

GENTLEMEN : — In compliance with your request, I furnish a copy of the address I had the honor to deliver before your Society, on the 25th of September last.

Respectfully,

Your Ob't. Servant,

CHARLES T. JACKSON

A D D R E S S .

MR. PRESIDENT, AND

GENTLEMEN OF THE AGRICULTURAL SOCIETY:—

I HAVE been called upon to address you as a former inhabitant of this county, and as one deeply interested in its welfare.

Without making any pretensions to the rank of a practical farmer, I may claim to be somewhat conversant with the operations of many of the best Agriculturists of New England, and to be intimately acquainted with the nature of the soils of several of the States which it was my duty as the State Geologist to Maine, Rhode Island, and New Hampshire, to examine.

By attentive study in the fields with practical farmers, I have endeavored to discover how a chemist could best serve them, while at the same time I have learned how to appreciate their skill, enterprise, and industry, in overcoming those obstacles which are presented by our comparatively poor soils and severe climate.

It affords me great pleasure to be able to state that I have found every where in those States which I have examined, the most praiseworthy desire for improvement in the science of Agriculture, and a readiness to engage in any experiments that gave reasonable promise of success. The universal comfort and general prosperity of our New England farmers, indicates that they do not toil in vain, and that they are generally successful in the cultivation of the soil.

It is not my intention to offer a mere eulogy upon the art of Agriculture, or to present any apology for the first and most important of human labors. We have learned from the most ancient records that the CREATOR of the world planted the first seed, and commanded our first parents to keep the garden, and to "till the ground," and it has pleased HIM so to prepare the earth as to render its cultivation necessary, in all time: thus by a permanent law of nature, establishing forever the art of Agriculture.

By endowing man with reasoning powers, and placing within his reach the means of improvement, a constant necessity requires man to improve the earth, as well as his own mind, and add to the productiveness of the soil, as he replenishes the earth and multiplies its population.

It is the glory of your noble art, that it possesses almost creative powers.

Not only has every seed been made to produce "after its kind," but also to yield still other kinds; not indeed new species, but varieties so improved that they cannot by all the skill of science be identified with the wild plants from which they originated. Who can point out the native or original wild grasses, from which our cereal grains have been produced? — Botanists have suggested that they must have had such origins, but they have not been able to identify the particular species of grasses from which wheat, barley, rye, and oats, have been derived.

Our large, plump, juicy, and mellow apples, are all said to have originated from the bitter and sour wild crab apple, which differs so much from them that it is difficult for us to conceive how those rich fruits were derived from so humble an origin.

From an insignificant and almost tasteless wild fruit, originated all our numerous varieties of delicious pears.

Our large, plump, and luscious peach, would blush at seeing its dry, withered and bitter father; — and our juicy plums would be slow (*sloe*)* to recognize theirs. The apricot and nectarine cannot boast of the excellence of their ancestors. The apricot is said to be a variety of the peach.

From noxious and poison weeds have many of our garden vegetables sprung. The tender and juicy asparagus is supposed to have been, originally, a bitter and disagreeable plant, growing upon the sandy shores of the sea. The cabbage, with its head full of tender and highly nutritious leaves, was originally a weed growing in meadows by the sea shore, and the delicate cauliflower has no better parentage.

* The common plum is said to have been derived from the sloe. The nectarine is considered by some botanists as a distinct species; but there can be no doubt on this point, as the peach itself is nothing more than an improved, or fleshy almond, which bears a similar relation to the peach and nectarine, as the crab does to the apple, and the sloe to the plum.

To prove that the peach and nectarine are essentially the same, it may be mentioned that fruits of both have been found on the same branch; and even an instance is recorded, where a fruit had the smooth surface of the nectarine on one side, and the downy skin of the peach on the other.—*Trees of America, native and foreign*, by D. J. Browne, P. 230. Most of the cultivated plums, damsons, and gages, are varieties of the *prunus domestica*, L., the cultivated plum tree. It is found growing wild in elevated situations in Europe. [De Candolle Prod., 533.] This species, as also the *P. institia*, are considered by some botanists as varieties of the sloe thorn, *P. spinosa*, which is usually a thorny shrub or small tree.—*Report on trees and shrubs of Massachusetts*, by Geo. B. Emerson, Esq., p. 448.

Our mealy potatoe belongs to the same family with the deadly nightshade, and in its wild state, was an insignificant plant, with little tubers not worth digging from the earth, or of eating when they were dug.

The onion was a nauseous shore plant, growing in the sand, like its relation the medicinal squills.

Parsnips, turnips and carrots, in their wild state, were also strong, unpalatable roots, unfit for food.

From small beginnings came our plump, cereal grains, our rich, juicy, and delicious fruits, our nutritious esculents, and savory garden vegetables.

Who, as it were, created wheat, barley and rye, or first put the wild fruits and vegetables in the way of improvement, we may never know.

The ancients ascribed these creations to mythological deities, and thus did the farmers injustice, unless indeed they meant by their fables to deify them, and exalt their labors.

It may be justly claimed that these great agricultural improvements were the work of heads and hands of mortal men like yourselves;—men engaged in practical agriculture; men of genius who believed in improvement, and bravely set about the work in good earnest.

Have we reached the end? Are the powers of nature exhausted? Or shall new and valuable varieties of fruits, grains, bulbs, tubers, and esculent roots, and other delicate and nourishing plants and fruits reward the labors of the experimental agriculturist?

Perhaps it may not be our good fortune to witness any startling result, or any very wonderful improvement arising from the transient experiments made in our day; but who will say what will be the effects of time, and a continually improving culture?

Have we not seen improvements made in a few years that encourage us to expect others? How endless are the varieties of Indian corn, (*zea mays*,) all of which have, it is supposed, been produced from a single species.

Have not new varieties of fruits been produced, not only from seeds, but also by skilful grafting and budding, with good and appropriate cultivation of the soil? Certainly we do see, in our market places, fruits, that have been so improved within the last half century, as to deserve new names, expressive of excellence.

I would suggest to you that it is highly probable that the wild rice of the lakes and rivers in the north western portions of the United States, which is a highly nutritious grain and very

prolific, now feeding myriads of wild geese, ducks, pigeons and other birds, and supplying winter food to the Indian hunter, might be advantageously introduced into our flowed meadows, and be improved by cultivation. The wild sea kale* has been successfully cultivated in Europe, and is now extensively used for food.

How many other wild plants there may be in this and other countries, that might be introduced and cultivated in our fields, I do not know, but I believe there is still room for improvement, and the mind of the American farmer is active, enterprising, and capable of as great discoveries as have been made in their art, in any portion of the world.

Progress is a law of nature. From the earliest dawn of creation, there has been a constant series of improvements in progress. Geology reveals that the lower orders of sensitive beings gave way to those of a higher grade, until the last term of physical creation was attained in the creation of man, whose improvement, as a rational creature, and an immortal soul, is still destined to be onward and upward.

In celestial space, progress is also indicated, and though we may not comprehend its end and uses, we have reason to believe that it is in harmony with the other plans and operations of the ALL-WISE CREATOR. Astronomers have discovered that no planet ever traverses again the same path, and that the whole solar system, with its sun and magnificent train of worlds, is constantly translated into new regions of space. It is believed by some astronomers, that there is a central sun around which our solar system revolves, and that this imaginary sun is also moving onward in space. Our whole solar system is said to be moving toward the constellation Hercules.

A desire in the human mind merely to repeat the thoughts and operations of others, indicates at best an unworthy indolence. Conservatism in error is obviously a folly, and our adhesion to a custom merely because it is old, or considered established, in this world of change, is an absurdity.

We should keep our minds open for the reception of every new truth, treasure up every new fact and principle, and test their value whenever opportunity offers, or promise of success is reasonable.

I would not advise the running after every project because it is new, nor would I denounce a rational conservatism, but we should be cautious not to deny everything that does not chance to have fallen within our own personal experience.

* The sea kale is extensively cultivated in England, and is highly valued as a substitute for asparagus. It has been cultivated by some gardeners in this country. *Teschemacher (oral comm.)*

The new and startling discoveries which burst upon the world, from time to time, warn us that we may not have known everything before.

Agriculture presents still, a field where advantageous improvements may be made, by the aid of the modern sciences, and we may look to chemistry for most valuable assistance in unfolding the mysteries of the vegetable economy, and in explaining the relations of the soil and atmosphere to plants, and in learning the influence of various substances upon the growth of our usual crops.

How far we may be able to prepare the soil for particular crops by special manures or fertilizers;—how far this may be done economically, is one of the questions now before the world. Whether it is better to make our fertilizing matters highly soluble, and to add them to the soil more frequently, or to render them comparatively insoluble, and allow plants slowly to appropriate them, is a subject of high importance in economical agriculture, and is one which will occupy our special attention.

By chemical analysis of the crops, grown upon any soil, we are enabled to discover exactly how much of each ingredient, essential to the growth of plants, has been removed from it, and, if we sell the produce of the land, we should estimate the nature and amount of the mineral salts we have removed, in order to enable us to restore, in some form, those ingredients to the soil, which would be ultimately exhausted if this were not done.

By analysis of the soil, we learn how much of each of these ingredients exists in it, and by comparison, of the analyses of fertile with those of exhausted soils, the exact difference may be pointed out, and the deficient ingredients may be supplied so as to renovate the soil.

Chemical science is able to discover the cheapest and best methods of rendering soils fertile, and not unfrequently the sources from whence the wanting ingredients may be obtained, by simple processes, may be indicated.

In order to renovate a soil, by restoring the substances removed from it by crops, we must consider what state the matters should be in, for the production of the best effects, and for long continued action. This requires the joint efforts of the chemist and farmer; for practical experiments in the field are necessary for the verification of the researches made in the laboratory; and several years, or an entire rotation of crops is needed, to render the value of a new method of manuring certain.

By hasty generalizations and mere dogmatism, some writers on Agricultural Chemistry have disappointed and disgusted many sensible practical farmers, and the reproaches which have been cast on book farming are too often well merited; but they should be referred to the book makers, and not to the science of Agriculture, which is not responsible for the errors of all its votaries, whether in the laboratory, the garden, or the field. The farmer requires some knowledge of the science of chemistry, to be able to judge of the value of books treating of the chemical principles of his art, and to enable him to understand and apply the results of analytic investigations in his practical operations. His defective knowledge often stands in the way of successful improvements, and he is obliged to restrict his operations to the mere following of specific directions, instead of having all the latitude that chemical principles would allow. It is not to be expected that old farmers will go to school again to learn the principles of the modern sciences applicable to Agriculture. Some, whose taste leads them to scientific reading, will doubtless endeavor to keep up with the progress of science, and inform themselves of what is going on. A few only will be found, whose opportunities will enable them to become proficient in the chemistry of Agriculture, so as to make a safe and practical use of the information they may obtain from books on Chemistry.

An improvement, once introduced, may often be practically adopted and followed by those who do not understand the principles on which it depends, so that one enterprising man may not unfrequently do much good in his neighborhood by instructing, by experimental labors, his brother farmers.

To the rising generation — the young men who will ere long occupy your places — we must look for students in Agricultural Chemistry. They should be taught thoroughly all those principles of science that can be rendered available in Agriculture. For them, agricultural schools should be established on a liberal scale, and every opportunity that could be desired for learning the sciences of Chemistry, Mineralogy, Geology, Botany, Zoology, and the principles and practice of Surveying, with the application of those sciences to the business of practical farming.

While we have good and liberally endowed colleges for the education of young men for the other professions, it is to be regretted that no institutions exist in our country for the education of young farmers in the sciences applicable to rational and practical Agriculture. This deficiency, I trust, will ere long be supplied by the establishment of agri-

cultural schools, upon a basis commensurate with the magnitude and importance of the subject.

It will not be advisable to plant such institutions under the shade of our classical colleges. They will never flourish there; for other studies of a different nature, appropriate to their educational establishments, occupy their attention — and the leaves of ancient literature cast too deep a shade to admit of the growth of modern science in the academic groves.*

An agricultural school should be of an eminently practical character to meet the wants of the community. Every principle taught should be immediately practically illustrated, and the pupil should be required to repeat every operation until he becomes familiar with it, and thus fixes the principle and mode of operation indelibly in his memory. In the field he should be required to work with his own hands; whether with the plough or the compass, he should become familiar with his tools. So also in the laboratory he should be required to do his own work, and in the dissecting room should learn the anatomy of animals, and in the garden and study, that of plants. Much good will result from the establishment of thoroughly scientific and practical agricultural schools, and it is highly desirable that the experiment should be made forthwith. I am confident such institutions will be sustained by the people.

The imperfect state of American Agriculture, and the destructive system of exhaustion of our soils by methods now too extensively in operation, sufficiently indicate the necessity of an immediate reform. Look on the numerous exhausted or impoverished fields of Eastern Virginia, and to the diminishing fertility of the wheat lands of New York, and other

* There is no time to be spared, from the usual college course of study, for the pursuit of the sciences connected with Agriculture, in a thorough practical way, and no other method of studying them will prove of any permanent value. "There are in the whole four years, one hundred and sixty weeks of study. Suppose the student pursues twenty of these branches of learning, [the usual college course,] this will allow eight weeks to each. Seven-eighths of the first year, and one half of the second, are devoted to Latin, Greek, and Mathematics. If we subtract this amount — fifty-five weeks from one hundred and sixty — it leaves one hundred and five weeks to be devoted to the remainder. This will give us six weeks and a fraction to each of the other studies. But this is not all. In order to introduce so many sciences into the period of four years, the student is frequently obliged to carry on five or six at the same time; some occupying him three times, others twice, and others once in a week. In this manner all continuity of thought is interrupted, and literary enthusiasm rendered almost impossible. Such has, to a greater or less degree, been the course pursued by all our colleges." — *President Wayland's Report to the Corporation of Brown University, March 28th, 1850, p. 15.*

States, and you will see that there is something wrong in the systems pursued. You are doubtless aware of some of the causes which are effecting this exhaustion of the soil, and know that it results from the continual removal of certain ingredients from the soil, and selling them in the form of grain and flour, without restoring to it similar substances.

By the analysis of grain we learn what has been removed by it, and by a knowledge of chemistry we may learn how to restore the requisite elements to an exhausted or impoverished soil, so as to render it perpetually fertile, even to the same crops.

Chemistry teaches the *cheapest methods*, and prevents wasteful empirical experiments.

Already, by chemical analysis of the ashes of tobacco, the Virginia planter has learned how to renovate his soil that had been exhausted by numerous crops of that plant. And the cotton planters of the Southern States have caused analyses of cotton and of the seed of that plant to be made, with a view to supplying the materials removed by it from the soil.

It will not be long before our farmers, generally, will learn how to restore to fertility soils that have been, in a measure, impoverished by long cropping; and the Western farmers, instead of abandoning their homes and pushing farther west in search of virgin soils for the growth of wheat, will obtain still larger crops from their old wheat fields, and do so without so much labor as before.

You are aware of the fact that wheat was once profitably raised in this State; and that now, although some few districts are favorable for its growth, that it cannot be generally raised on our soils. This was pretty effectually proved by the unfortunate law, offering a bounty on wheat grown in the State, which resulted in large crops of nearly worthless straw. It was interesting to the geologist and chemist to observe in what particular districts the wheat crop did prove successful, and important hints were derived from those observations. It is a question of considerable practical importance to know, by carefully conducted experiments, whether our granite soils can be so improved as to render them capable of bearing good crops of wheat, and whether this can be done economically.

Indian corn is now known to be best adapted to those soils; but even that crop will exhaust the soil, if we do not take care to return to it those mineral substances which are removed by the grain. If we sold our crops, instead of feeding stock with them, we should rapidly impoverish the soil; but our New England method, of farming for ourselves, and of consuming

the products of the soil upon it, and of restoring the inorganic matters of the crops in the form of farm-yard manure, obviates, in a great measure, the exhaustion of the soil by returning to it those important salts which are in the manures. We should remember, however, that when we sell any animal that has been reared upon the produce of the soil, we dispose of a considerable amount of the phosphates, and other valuable salts which the animal derived from its food, and which all came from the soil, through the medium of the crops raised.

The farmer who raises grain and breeds cattle for a distant market, is continually removing from the soil its essential elements of fertility, and sells the very life-blood of his land. To him, therefore, it is of the very highest importance that he should know the best and cheapest means of renovating his soil, so as to prevent exhaustion and ensure constant and even improving fertility.

To the chemist is he indebted for the discovery of the most certain and cheap processes for effecting this very desirable object; and notwithstanding all that has been said by ignorant persons against science and "book learning," all the substantial improvements made by chemists for the benefit of farmers, will be ultimately adopted; for that powerful incentive, to which "we may never plead in vain"—self-interest—will prompt to their adoption.

Let us, for a moment, glance at the inorganic matters which enter into the composition of our usual crops, and see what ingredients are actually removed from the soil by their cultivation. They are—

BASES.—Potash, Soda, Lime, Magnesia, Oxides of Iron and Manganese.

ACIDS.—Silicic acid, Sulphuric acid, Phosphoric acid, Chlorine.

The acids and bases are here given separately, but in the soil and in plants they are combined with each other, forming various saline compounds, which are generally neutral. We obtain some of them in that state from the ashes of all plants, and when we obtain alkaline matter, it is derived by the decomposition of the organic acid, with which the alkali was originally combined. The saline matters vary in their proportions in different plants and even in the different parts of the same plant.

I do not wish you to suppose that these ingredients exist in the soil in the same state of combination that they do in the plants. On the contrary, it is evident that decompositions take place in them during their circulation in the vessels of

living vegetables, and when we burn a plant, the substances found in the ashes are differently combined from what they originally were in the vegetable tissues.

In the soil, Phosphoric acid occurs in combination with lime, alumina, and oxide of iron, while in the plant, we find a part of it combined with potash, soda, and magnesia, as well as with lime, but never in combination with alumina, which is not an ingredient of the vegetable tissues, and is not found in any plants.

Sulphuric acid may exist in combination with oxide of iron and alumina, in the soil, as well as with lime and magnesia, and the alkalis; but in the plant only, particular combinations of sulphuric acid and of sulphur are found, and they are not the same as occur in the soil in which the plant grows; hence the sulphates are not merely accidentally absorbed, but are essential to the growth of the plant.

Silicic acid in the soil, is combined with potash and soda, and is generally insoluble in water, even when so combined, but by the action of carbonic acid, the insoluble silicates undergo partial decomposition, and carbonate of potash is formed which dissolves a small portion of the silicic acid, and renders it capable of absorption by the plants. Then the silicate of potash is decomposed by organic acids in the plant, and the silica is set free, and is secreted, and forms a part of the tissues, and sheaths the sap vessels, and covers the exterior of the hollow stems of the cerealia or grasses.

Chlorine is found combined with the metallic bases of soda and potash, forming, with sodium, the well known sea salt, chloride of sodium; and with the basis of potash, chloride of potassium, and with those of lime and magnesia, the very soluble chlorides of calcium and magnesium. These salts, absorbed from the soil, also undergo decomposition, and produce other combinations in the plant.

Fluorine, not yet detected in the ashes of plants, must exist in them in small proportions, for it generally accompanies phosphate of lime, and it forms a constituent of the enamel of teeth, and occurs in small proportions in the bones of all animals.

The minerals constituting the substantial basis of all soils must contain all the fixed elements found in plants grown upon them; but it often happens that they contain too small proportions of the most important elements, to furnish, for a length of time, the inorganic constituents of crops that are removed from the soil.

The native forest, every year, pays its tribute of deciduous foliage, and thus, in part, renovates the soil; but still more by

the ultimate decay of the aged trunks of trees, is the soil replenished with the materials drawn from it by them during their growth, and, for interest, is added those materials which the trees had withdrawn from the atmosphere. The organic matter thus derived, acts on the mineral ingredients of the soil, various acids being produced which dissolve the tardily decaying minerals in the soil.

Thus, forest trees do not rob the soil of any of its constituents, and it remains ever able to renew their growth.

Fire, though it dissipates the organic matters, leaves all the fixed saline matters of wood in its ashes, and by the sudden addition of so much readily soluble mineral matter, alters the character of the soil, so as to enable it to bear plants and trees that did not grow upon it before.

Thus we see an abundant growth of raspberry bushes and of oak trees where a pine forest had been destroyed by fire; those bushes and trees requiring a larger proportion of potash than pine trees. By comparing the composition of the ashes of the oak and the pine, this difference will be at once noticed:

The ashes of the oak, *Quercus Robur*, contains. That of pitch pine, *Pinus Picea*.

Potash,	64.64	21.75
		and Soda 6.76
Lime,	4.89	1.54
Magnesia,	5.57	16.79
Chloride of Sodium,	0.98	0.57
Phosphate of Iron,	2.61	Ox. Iron 1.31
Sulphate of Lime,	4.73	
Phosphoric Acid,	15.62	39.65
Silex,	0.96	11.71

— *Annales de Chem. et Phar. Wohler.*

The oak contains more alkaline matter than the pine and less phosphoric acid. Hence we can at once understand why the oak grows on the soil where a pine forest has been destroyed by fire. The red raspberry is also remarkable for the large proportion of potash it contains, and every spot where a fire has been kindled in the woods of Maine, is, in a few years, covered with an abundant growth of this plant. So also in New Hampshire, the raspberry springs up in luxuriance on burnt lands. The raspberry also clings closely to rocks, and thrives best near granite ledges and old stone walls, on account of the alkaline matter they yield to its roots. New soils, rich in potash minerals, are not unfrequently overgrown very soon by raspberry and blackberry vines. In order to estimate the importance of the saline matters removed from the soil by crops, let us examine the results obtained by Boussingault, a

distinguished chemist and agriculturist of France. He estimates the proportions of inorganic matter contained in each year's crop of grass from his meadows, as follows :

Phosphoric Acid,	1254 pounds
Sulphuric Acid,	627 "
Chlorine,	602 "
Lime,	4155 "
Magnesia,	1672 "
Potash and Soda,	5456 "
Silicic Acid,	7312 "
	<hr/>
	21078 "

These meadows receive an annual supply of fresh ooze from waters of the Vosges, so that the soil does not require an artificial supply of manure. The hay, being consumed by his cattle, their manure goes to supply the uplands, so that the saline matters used on his ploughed land really come from the alluvium deposited annually on his meadows by the overflowing water.

Suppose that there had been no restoration of these matters to the soil of his meadow, and that he had sold his hay, it is obvious that there would have been a large removal of valuable salts from the soil, and his land would, in the course of time, become exhausted or impoverished, so as to be unproductive.

Mr. Owen Mason, of Providence, Rhode Island, has estimated the amount and proportions of inorganic matters removed from the soil of Mr. Adam Anthony's farm, in North Providence, in the course of eight years, as follows. The crops raised were alternate growths of millet and clover.

Potash,	424.92 pounds
Soda,	131.92 "
Lime,	532.88 "
Magnesia,	64.08 "
Silicic Acid,	390.40 "
Sulphuric Acid,	113.88 "
Phosphoric Acid,	108.12 "
Chlorine,	58.64 "
Oxide of Iron, &c.,	5.96 "
	<hr/>
	1830.80 in all.

"It is doubtful," says Mr. Mason, "if the cultivator ever suspected that he carried to his barn *two casks of potash, two casks of lime, one cask of soda, a carboy of oil of vitrol, a large demijohn of phosphoric acid*, and a variety of other matters, contained in his fourteen tons of fodder, which were as certainly

stowed away in his mows, as if conveyed thither in casks and carboys.*

Since all plants, from the majestic oak to the most humble herb, contain and require for their existence, the elements of the soil above pointed out, and the cereal grains, especially, abound in phosphates, we cannot fail to perceive that it is necessary that we should make provision for restoring to the soil, in some form or other, those important elements which are removed by the crops, and which, like the phosphates, exist in the soil quite sparingly.

From what I have already said respecting the use of phosphate of lime, and of other phosphates derived from it by decomposition in the circulation of plants, you will perceive that it is regarded as one of the most important ingredients of the soil, and that it ought to be supplied by manures which we spread on the land.

The basis of the bones of all animals is phosphate of lime, and it is derived by animals from their food, the plants drawing it from the soil.

Ground bones or bone dust, is a valuable manure, but is slow in its action. If we wish to hasten its absorption by plants, it is necessary to decompose it by means of sulphuric acid, adding thirty pounds of common oil of vitrol to one hundred pounds of bones, and then drying up the pasty mass by mixing it with leached ashes and soil, so as to convert the whole into a dry powder, capable of being strewn upon the soil broadcast. The ashes act chemically as well as mechanically upon this mixture, phosphates of the alkalies resulting from decomposition of the silicates of potash and soda. I have mentioned leached ashes, because it is the cheapest, and will answer the purpose, but unleached ashes may be used with still greater benefit, a larger proportion of phosphate of potash being formed.

A native mineral phosphate of lime, called apatite, and asparagus stone, is found in the rocks. It is rather a rare mineral in this vicinity, and there are but few localities in the world where a large supply of it can be obtained. The British government sent Prof. Daubeny to Estramadura, in Spain, to examine the most abundant locality of it known in Europe, but it was not found to exist in sufficient quantities to repay the expense of bringing it to England. The experiments tried with samples of it, by Prof. Daubeny, proved it to be equal in value to ground bones.

* Unpublished lecture delivered before the Providence Franklin Society, by Mr. Owen Mason.

I have the pleasure of stating that Mr. Francis Alger and myself, during the month of June last, discovered an important vein of this mineral in Hurdstown, N. J., and, by my advice, Mr. Alger has purchased the vein, and will soon introduce the prepared mineral into agricultural use in this state. The native phosphate of lime contains also a small proportion of fluorine and chlorine, so as to render it capable of supplying the materials needed in our granite soils. It is obvious that the mineral phosphate of lime will answer full as well for supplying phosphates to plants, as the phosphate of lime of bones, and since it is free from any admixture with carbonate of lime, it will not require so much sulphuric acid to decompose it.

In St. Lawrence county, New York, a considerable quantity of native phosphate of lime is found in the form of crystals of a bright green color. I am not aware of any experiments having been made with it in practical agriculture.

In England, every fossil containing phosphate of lime is sought for with avidity by intelligent farmers, and such materials are dissolved in sulphuric acid and water, and sprinkled on the soil, and by this means the land is made doubly productive. Even coprolites are used when they contain but ten per cent. of phosphates, and rocks containing a few fossil bones are readily sold. Peruvian guano contains about half its weight of phosphates, and those salts are its most permanent fertilizing materials. In fish manure, the bones which consist of phosphate of lime remain in the soil a long time after the animal matter has disappeared, and act favorably on vegetation. One of the best farmers of Rhode Island informed me that he regarded the bones of menhaden as the most permanent and valuable of manures, and he extracted the oil from the fish for sale, and used the refuse for manure on his land to great advantage. Horn piths, consisting of bony matter, may be very advantageously used for making the prepared phosphates for agricultural use, and I hope never to see them thrown away or employed in mending roads, as was formerly done.

It is possible that there may be some persons here who do not sufficiently appreciate the value of inorganic matter, like phosphate of lime, as a constituent of plants, but when they look to the composition of the frame work of animals, they will perceive that bread would cease to be the staff of life if it did not consist partly of stone; for the bones of our bodies consist chiefly of phosphate of lime deposited in cartilaginous cells; and if our food did not contain that mineral, we should have no bones, and could have no existence.

The mother's milk, if it was not charged with this indispensable ingredient, would not nourish and support the child, or solidify its bony framework. Most of the mineral constituents of plants are useful in the animal economy, and some of them are as essential as the more abundant combinations of carbon, hydrogen, oxygen and nitrogen, which constitute the principal and more directly nutritive matter that forms our food. Phosphorus, sulphur, chlorine, iron, potash, soda and magnesia, with numerous salts, enter into the composition of every one of our bodies, and are essential to life and health.

The adult animal, whose bony fabric is completed, is enabled to spare a large proportion of its phosphate of lime in nourishing and forming the bones of its young, and the mother acts as a medium between the vegetable kingdom and her offspring in preparing its food, her milk containing all the elements of nutrition in the most favorable condition for easy assimilation.

Potash and soda are well known as important mineral elements of plants, and they are also known to be valuable manures when presented to the growing plant in proper combinations. Their origin is to be traced to the mineral world, feldspar and mica, two of the most abundant minerals, constituting granite, gneiss, and mica slate rocks, furnishing them by their slow decomposition in the soil.

Those minerals contain from 12 to 16 per cent. of potash and soda, combined with silicic acid. They are insoluble in water, but by means of carbonic acid, disengaged by decaying vegetable matter, the silicates are decomposed and carbonates of the alkalies are formed, which are soluble in water, and go to nourish plants, and serve as solvents of the humus of the soil, so that it can be absorbed by plants.

The vegetable acids, derived from decaying peat and rotten wood, also have the property of slowly acting upon feldspar and mica, and separate the alkaline matter. A small proportion of the silex is also dissolved by the action of the liberated alkalies, and goes into the vegetable economy, forming a part of the solid structure of the sap vessels, and shielding the surface of delicate hollow stems with a layer of glass, serving to prevent their destruction by mildew and rust, while it prevents the loaded stem from breaking down under its burden of grain.

Ashes of plants containing these alkalies and soluble silicates is one of the best of fertilizers, and may be justly regarded as an universal manure, containing all those inorganic elements that are known to be constituents of plants.

Leached ashes, although deprived of part of its alkaline matter, is valuable as a manure, for it is capable of yielding still

more to the searching powers of the rootlets of plants, and contains other materials, insoluble in a great measure in water, which are capable of being slowly taken up by growing vegetables. Experience has proved that 200 bushels of leached ashes will render fertile for many years the sandy soil of a pine barren, which before was a waste of blowing sand.

Lime, in the state of carbonate, and in combination with various organic acids of the soil, is also a valuable manure, and operates favorably for a long term of years, enabling soils that were before unproductive, to bear heavy crops of grain.

Magnesia enters into the composition of all plants, though in smaller proportions than the other mineral ingredients I have named. In the state of phosphate, it is a constituent of both vegetables and animals. It is found in soils generally combined with siliceous matter, and is slowly eliminated by the decomposition of the minerals containing it.

Oxides of iron and manganese abound every where in all soils, and we need not trouble ourselves to supply them by composts or manures of any kind. They exist in all plants and animals in small proportions.

Sulphuric acid exists in soils in combination with lime, magnesia, alumina, oxide of iron, and the alkalies, and goes into the circulation of plants, generally in the combination with lime, ammonia, and the fixed alkalies. It is not only separated in part from its mineral combinations during its circulation in plants, but is actually reduced in some of them, sulphur being known to exist in a free state in most of the cruciferous plants, such as the mustard, turnip, cabbage, and cauliflower. Every housewife is familiar with the action of mustard on a silver spoon, the blackening being due to the action of sulphur, which combines with the silver.

Sulphate of lime or gypsum, is supposed to owe part of its fertilizing power to its exchange of elements with carbonate of ammonia arising from the decomposition of animal manures, sulphate of ammonia and carbonate of lime resulting; but it is certain that clover and some other plants also appropriate sulphate of lime in its undecomposed state. Sulphate of ammonia is the most powerful of the soluble sulphates, for it conveys nitrogen and hydrogen to the plant as well as sulphuric acid. It is not known exactly how this saline manure acts, but it has been proved, by experiment, to be one of the most powerful, acting favorably when used in the minute proportions conveyed by a steep for seed: this being the German secret of raising grain from prepared seed without manure, a secret which made so much noise in the agricultural world a few years since.

Chlorine, in combination with the metallic bases of the alkalies,

and with those of magnesia and lime, enters into the composition of all plants, and is always found in such combinations in their ashes. In some places, sea salt operates favorably as a saline manure, and increases generally the crops of grass. It is also favorable to the plum tree, and to vegetables which flourish best near the sea shore. It is not known what part the chlorides play in the vegetable economy, but their constant presence seems to indicate that they are in some way useful.

Oxides of iron and manganese doubtless perform useful functions in the vegetable economy, for they are always found in the ashes of plants. The oxide of iron, derived from vegetable food, enters into the composition of blood, and is supposed to be one of the vehicles for the transportation of oxygen to different parts of the body, in the circulating blood. These oxides being universally present in the soil, there is no need of supplying them by artificial means. More frequently we have to neutralize the action of their salts, for some of the soluble salts of oxide of iron are highly injurious, and destroy tender herbaceous plants. Lime and ashes are the most common amendments used in case sulphate of iron exists in the soil, and by their action new and valuable saline manures are produced.

The few mineral substances I have named, are the chief inorganic constituents of plants of all kinds. Hence they are universal fertilizers, and we have to examine the soils to ascertain their presence, and the proportions in which they exist, and to determine the condition that is most favorable to vegetation. We have also to ascertain the cheapest and best methods of supplying those ingredients that are wanting, or are deficient in quantity, or to alter the condition or combinations of those that are not in their most favorable state.

The relative proportions of the different mineral salts, required for each different crop, is a study of much interest, and this inquiry is now occupying the attention of distinguished chemists, who will, in the course of time, discover much that will prove useful in directing the labors of the husbandman.

In the present advanced state of chemical science, new analyses of plants and of the soil can be advantageously made, and the highest skill of analytic chemistry is required in this most important department of agricultural science. Rude and imperfect analyses are of no use, and only tend to lead the farmer astray. Hence all the "short cut methods" proposed in newspapers should be discarded, as leading to error, and as injurious to society.*

* The agricultural newspapers formerly abounded with "easy methods of analyzing the soils," but happily we do not see them so often at this day.

ORGANIC MANURES.

Although it is evident that the first vegetation of our globe grew without the aid of organic manures, or those derived from the decay of organic matter, either of vegetable or animal origin, and we know that the lower classes of plants, such as lichens, and mosses will grow without any other nourishment than what they derive from rocks, water, and the atmosphere; still it is no less certain, that profitable agriculture cannot be carried on without the aid of decomposing vegetable and animal substances.

Vegetable matters by decay produce acids, and these acids decompose the minerals in the soil, and form neutral combinations with the alkaline and earthy bases, rendering many of them soluble in water.

They also absorb and fix the ammonia, generated by the decay of animal matters, and form valuable soluble compounds, which are digestible by plants.* These acids may be called the vegetable acids of the soil.

The most common acids formed by the decay of vegetable substances in humid soil are humic acid, apocrenic acid, ulmic acid, and crenic acid, and a matter called extract of humus. Besides these, there are neutral substances, called humin, ulmine, and coal of humus, which, by the action of the air, are changed into other substances, and become soluble in water.

These vegetable acids of the soil, form combinations with the various alkaline and earthy matters, and are carried with them into the circulation of living plants, in which the organic substances are assimilated or converted into the sap of the plant, and ultimately into the substance of its tissues.

Animal matters, whether solid or liquid, by decomposition always form alkaline matter, chiefly ammonia, and its salts. This alkali corrects the acidity of the soil, combines with the vegetable acids, extracts them from their insoluble compounds, and renders them highly soluble in water. It decomposes noxious mineral salts, such, for example, as sulphate of iron and sulphate of alumina, and forms, with the sulphuric acid, one of the most valuable saline manures, the very salt which has acquired so much celebrity for its fertilizing properties when used as a steep for seeds.

From what has just been said, it appears that science explains and justifies the experience of ages, which has proved that is best to mix animal and vegetable matters together in forming compost manures. Knowing that urine, by decom-

* This I have proved by direct experiments with apocrenate of potash.

position, forms carbonate of ammonia, we are prepared to understand the necessity of mixing it in compost with peat and gypsum, so as to retain matters that would otherwise fly away in a gaseous form.

Carbonic acid gas is composed of one atomic equivalent of carbon or charcoal, and two of oxygen or vital air. It is this gas which sparkles in a glass of the beverage called soda water, and that which causes the foam in a bottle of beer, cider, or champaign wine. It constitutes a small portion of the general atmosphere, and is exhaled in the breath of every animal, and is also produced by the combustion of wood and coals. It will not support animal respiration, but, on the contrary, is poisonous when inhaled into the lungs. This gas is the supporter of respiration in plants, is absorbed by their foliage, and, whenever the sun shines on them, the leaves decompose the carbonic acid which they have absorbed, appropriate the carbon, and throw forth pure oxygen gas, or vital air, into the atmosphere, which goes to supply the breath of life to animals. So that it is true, that our respiration, in part, feeds the vegetable world, and that we receive back our breath in the form of fruit, flowers, and fuel, and the air is restored to its healthful composition through this marvellous property of living vegetation. Dumas, the French chemist, says, that the leaves of plants absorb carbonic acid with so much avidity, that when a branch of fresh foliage is placed within a glass globe, and the air is blown rapidly through with a blast bellows, it loses all its carbonic acid in its passage over the leaves, provided the sun shines on the plant at the time. In darkness, this action does not take place. Hence, it is evident, that the sun's rays serve to nourish plants, by aiding in the decomposition of carbonic acid gas.

A portion of the carbonic acid of the air is dissolved by rain, and penetrates with it into the earth, and there aids in the decomposition of the materials of granite rocks, forming carbonates of potash and soda from the silicates of those bases. Aquatic vegetation also feeds, in part, on the carbonic acid of rain water, and absorbs the carbon, and gives out oxygen gas to support the respiration of fishes, which soon return carbonic acid to the water to repay the plants.*

Thus nature performs a series of the most interesting chem-

* This operation of sub-aqueous plants I have witnessed on the coast of Lake Superior. The lake water generally contains about two and a-half per cent. of its bulk of air dissolved in it. Among aquatic plants, *free* oxygen is seen bubbling through the water.

ical experiments, and keeps up forever the circulation of the life-supporting matters required by the two great living kingdoms. AMMONIA OF THE AIR. Carbonate of ammonia has been supposed to be a constituent of the general atmosphere, but there is reason to believe that it exists only near the surface of the earth, and arises from decaying animal matters, the effluvia of which consist partly of this volatile salt.

Many ammonia-producing organic matters, exist in rain and snow water, and the first snow that falls is well entitled to the name of the "poor man's manure," for it brings down with it a very considerable proportion of ammoniacal matters, which are found in the form of a yellow organic substance, which is quickly converted by mineral acids into salts of ammonia. This yellow matter, found in snow and rain water, has been named by Zimmerman, pyrrhine, and, according to the researches of Dr. A. A. Hayes, it is the chief source of the ammonia found in the atmosphere. The well known superiority of rain water over spring water, as a fertilizer, may be due to the presence of this highly nitrogenized and easily decomposable organic matter in rain water. It is, as before observed, especially abundant in the first rains, which fall after a long drought, and hence, those rains produce such marvellous effects, so far surpassing those produced by terrestrial or spring water. (See Memoir on the supposed existence of ammonia in the general atmosphere, by A. A. Hayes, read at the American Association for the Advancement of Science, August, 1850.)

Did time permit, we might examine into the systems of agricultural practice, investigate the theory of composting, liming, and the use of ashes, guano, and saline manures generally, and explain the effects of these various fertilizers. We might also shew the various methods of reclaiming peat-bogs, and of converting them into rich meadows and corn fields.

Irrigation might also claim a share of our attention, for in spite of the old Spanish proverb in relation to irrigation, that

"In Valencia,
Flesh is grass,
Grass is water,
Men are women,
And women nothing!"

we could shew that on many a dry hill side, and pasture, heavy crops of good substantial grass, capable of making excellent beef and stout muscular fibre in those who eat it, might be raised, by the action of a trickling overflow of water, from a narrow ditch, carried along by the hill side, and fed by some brook or pond, from whence the water might, by proper con-

trivances, be derived. Irrigation is practised in Smithfield, Rhode Island, with advantage, and I have witnessed its favorable effects. There are many farms in this county where it could be used favorably and at little cost.

Sub-soil ploughing, by giving greater depth to the tilth, removing cold and stagnant waters, and bringing into action the valuable salts which had settled into the deeper soil, is one of the greatest improvements of modern agriculture, and has caused two blades of grass to grow where but one grew before, and given a considerable extension to the root crops, by allowing them to penetrate deeper into the soil, and draw more steadily their supply of moisture. This improvement has given celebrity to its active and intelligent expounder and advocate, (Mr. Smith, of Deanston, England.) It has been used to advantage by many good farmers in this country.

Under-draining, by tile drains, the last and most costly improvement of English agriculture, has been practised to a very limited extent in this country, but sufficiently to prove its great value, as a means of improving cold and wet soils.

It may now and then be worth while to drain in this way a valuable piece of land, or a garden, but its cost is so great that few persons will use it in general farming, in a country where land is so cheap as it is with us.

It would doubtless be useful to discuss the value of fish manures, and to consider the best methods of converting them and slaughter-house offal into nearly inodorous, but highly concentrated manures something like guano—to explain the best methods of forming that kind of manure, called by the farmers of Rhode Island “fish pie,” (not a very savory dish)—to explain how fish could be used without carrying an infectious taint or odour or bringing a swarm of myriads of ugly green flies to cover our farms, and to take possession of our dwellings; but we have not time to enter upon the examination of these subjects, each of which would consume an hour in its discussion. I may however say, that by making fish into a compost, with swamp muck, or peat, well sprinkled with ground gypsum and lime, nearly all the disagreeable odour may be prevented, and the fish will be converted into several substances, all of which will prove useful as manures. This experiment has been tried successfully.

Dr. Robert Hare, of Philadelphia, one of the most distinguished Chemists of our country, has invented a method of forming an artificial guano directly from fish, by the agency sulphuric acid. He has secured letters patent for this invention, but will, I understand, ere long give it to the public. By his

process the nitrogenized matters of the fish are directly converted into sulphate of ammonia, while the carbonaceous matter is changed into a sort of humus, and the bones are changed into superphosphate and sulphate of lime, all which matters are good manures.

Concentrated manures rarely succeed at first in the hands of practical farmers, for they use them too freely, and thus destroy the tender plants. This was the first experience of most of our farmers with that powerful manure guano. They have now learned how to use it with safety and effect. It should always be largely diluted or mixed with soil, or be spread, one half on the surface and ploughed in, and the other half may be harrowed in. It should not be put in a hill, but always should be sown or spread broad cast.

It can be also used advantageously in peat composts. Not a particle of the ammonia then escapes, for the acids of the peat combine with it and fix it in a non-volatile state.

In England, the humidity of the climate, prevents guano from killing the plants, as it sometimes does with us, under our burning summer sun, and in our dry and parched soil; hence it has proved more generally successful in England than with us.

Peat, by its strong retentive power holds twenty-five per cent. of water in its substance, even when dry enough for fuel. Its tendency then is to prevent drought, and it forms the safest basis for all composts, and is the best material to place under stalls to absorb liquid manures. Ground gypsum, mixed with it, augments its power of taking up ammoniacal gases, and of decomposing carbonate of ammonia, fixing the ammonia as a sulphate.

By high manuring, it is perfectly practicable to raise on most of the soils of this county, seventy-five bushels of corn per acre. I have seen more than one hundred bushels per acre, raised on similar granite soil in New Hampshire. The question with the farmer is, can this be done profitably? Is it better for him to spend money and labour for manure, or to rest satisfied with fifteen or twenty bushels of corn per acre without expending anything for manures?

These questions each will consider and reply to for himself. My own opinion, derived from observations made quite extensively, in New England, is that where materials for the formation of the basis of compost exist, it is advantageous to manufacture manures even though some of the materials like guano might have to be purchased.

Where cattle are kept in sufficient numbers, barn-yard manures will of course take the place of all others, but if the farmer would make the most of this manure, he will convert it into

compost with peat, gypsum, ashes, and in some cases with the addition of lime. Lime is a powerful decomposing agent, and must never be mixed with animal manures, unless they are first mixed with peat or swamp muck, for the ammonia would otherwise be lost.

Finished composts, or thoroughly rotted manures are generally preferable since they are more soluble and are free from seeds of weeds and grasses. I have seen compost heaps made five years in advance. The composts cost but little money, and yet were of excellent quality. By availing himself of all the refuse of his house and stalls, even to the soap-suds and waste water of the sink, and causing every such matter to run into his peat heap, this compost was kept always forming, and when deemed saturated sufficiently it was removed and replaced by fresh peat. By addition of a marly clay, containing about ten per cent. of carbonate of lime, the compost was completed and answered admirably on both uplands and meadows.*

Leached ashes is a cheap and excellent manure for light sandy soil. I have seen in a neighbouring State† a barren sandy plain rendered fertile by spreading upon it 200 bushels of leached ashes per acre, and cultivating millet and clover for eight years, no other manure being added during that time, and the crops being removed. By the stubble left, as analysis has proved, the soil became annually enriched in vegetable matter, and gained three per cent. of organic matter in eight years. The ashes enabled the plants to grow, and they drew on the atmosphere for a considerable supply of carbon, derived from carbonic acid gas, so that even the stubble, to say nothing of the crops removed, proves that mineral manures, such as ashes, enable the crops to appropriate a larger portion of carbon from the air. I have seen seventy-five bushels of corn and three and a half tons of hay produced per acre, on a peat bog that was thirty feet deep, and had been properly drained and cultivated.‡

I have witnessed the valuable effects of lime both in composts and when spread on the soil. This mineral amendment and manure is not generally understood or well managed, hence there is great diversity in opinion among farmers as to its value. It is certain, that the beneficial effects of lime are very rarely seen the first year, and it is certain that it acts favorably in two or three years after it is spread on the soil, and that its fertilizing properties remain for a great number of years.§

* Judge Hays's farm, South Berwick, Maine.

† Rhode Island, Adam Anthony's farm.

‡ Elias Phinney's farm, Lexington.

§ Levi Bartlett's farm, Warner, N. H. Read also his papers.

If lime is used in composts its beneficial action may at once be seen. It makes a very cheap and useful compost with peat, or swamp muck, nearly equal in value to barn yard manure though rather slower in its operation.*

In all trials of the value of manures it is necessary to carry the experiments through an entire rotation of crops, for four years, and a comparison should be kept up with other portions of land not manured or treated by other methods, as standards of comparison. Most of the agricultural experiments of farmers are imperfect for want of such comparative trials.

The numerous, and constantly improving market gardens in the neighborhood of cities, prove that the fertility of soils may not only be retained, but even be annually augmented by the judicious use of manures.

The farmer in the country, remote from cities, cannot purchase manures, and must learn to make them from cheap materials. By mixing with peat, swamp muck, dead leaves, rotten straw, or rotten wood, the alkaline and earthy matters that will combine with the acids, or by adding any ammonia-producing matters, such as liquid manures of the stalls, and all waste liquids of the house, also ground or burnt bones, gypsum, slaughter house offal, dead animals, night soil, or any such matters, excellent and cheap composts may be formed.

Wherever drains can be laid from the house, through the vault to the barn yard, the arrangement may be so made as to save the trouble of transporting the waste matters to the compost heap. This I have seen most conveniently arranged, the waste water of the sink drains, passing over an inclined plane of plank in the vault, and then going directly to the muck heap in the barn yard, so that all waste water of the house went to the compost heap and cleansed the inclined plank in its way, thus proving both economical and cleanly.†

When the farmer purchases fertilizing substances to spread on his soil, it is very important to him to know exactly what the soil requires, so that he may waste nothing, and supply the deficient matters.

He should know also what degree of solubility manures should possess, in order to act most favorably. Nature does not indicate the use of *very soluble* matters; they would infiltrate into the sub-soil, and soon be too far removed from the rootlets of plants to be available to the crop, and most certainly would be lost in the course of a year or two. The best method is, so to manage the elements, as to bring slowly and gradually into a

* L. Bartlett.

† Judge Hayes's farm, South Berwick, Me.

soluble state the substances the crop requires, and thus to improve on nature by following her suggestions.

“ For Nature ever faithful is,
To such as trust her faithfulness.”

To drench a field with a solution of potash, soda, or ammonia, would serve to exhaust the soil by extracting at once the organic matters which nature had stored up for a long continued supply.

The rain would wash away the solution and ere long it would reach that common receptacle of saline matter, the ocean, and would leave the field barren. The first effect of the alkaline solution on the soil would be to produce a large crop, but the soil would rapidly decline in fertility. Thus it would be a poor method to use saline manures in this way.

By the use of leached ashes, we eliminate alkaline matter gradually, just as it is needed by growing plants, and it is found by experience that leached ashes is nearly as valuable in the long trial, as recent ashes.

It is obvious to the chemist, that ashes produces a better effect than could be derived from the alkali if separated and applied by itself.

So also we should find that pure phosphoric, or sulphuric acids, would not answer for manures, but would be destructive to plants; nor would their most soluble salts prove most economical.

Nature presents in sparingly soluble combinations her most rare and precious fertilizers. The phosphates are the most rare of all, and seldom do we find the phosphoric acid in combination with any bases that form soluble salts with it, but on the contrary it is generally found in combination with lime, alumina, and oxide of iron, and forming not more than three tenths per cent. of the soil.

Sulphate of lime, or gypsum, is also a sparingly soluble salt. It is slowly decomposed by the action of carbonate of ammonia, and, little by little, sulphate of ammonia is produced, and is ready to meet the wants of growing plants, while, at the same time, carbonate of lime is formed by the union of the carbonic acid of the carbonate of ammonia, with the lime, of the sulphate of lime.

This again is decomposed by the freshly forming organic acids, produced by the decay of vegetable matters in the soil, and carbonic acid gas is disengaged and goes to decompose the silicates of the alkalies, while the organic lime salts, are absorbed and digested by the living plants; so that there are numerous combinations and decompositions always going on

around the roots of the plants ; chemical changes, which have by some been attributed to the mysterious powers of life.

It might be expected, that I should discuss the value of different breeds of cattle, and point out the various improvements that have been made. I admit the importance of the subject, and wish that time and my own knowledge would permit me to enter upon its examination ; but although I have admired the new and beautiful varieties of live stock that have been imported into the country, and have been delighted at witnessing the valuable results which have been attained by many distinguished cattle breeders, I do not profess to be sufficiently acquainted with the subject, to advise those who have a more full and experimental knowledge of such matters.

I would also willingly detail to you what I have seen in the triumphs of the orchardist, and expatiate on the interesting operations of budding and grafting, and of the marvelous operations of restoring both bark and roots to mutilated trees, and shew the superiority of dendral surgery, over the more destructive operations of animal surgery, the former adding limbs, while the latter removes them, but our time and your patience must now be nearly exhausted, and I forbear. I leave this subject with less reluctance, because I am aware that many members of this society are far better acquainted with the arts to which I refer than I can be, for I have been but a looker on, while the farmers have done the work.

I cannot close this portion of my address without alluding to the labours of that distinguished agriculturist, the late Elias Phinney, Esq., of Lexington, a gentleman to whom I am indebted for many of the observations to which I have referred, and whose well balanced and beautiful orchards stand as monuments of his unsurpassed skill in the management of trees.

I may say, with truth, that in every department of agriculture, he was truly a model farmer, and to no individual am I so much indebted as to him for valuable facts and useful suggestions. I would also acknowledge my obligations to that scientific farmer, Levi Bartlett, Esq., of Warner, N. H., and to Judge Hayes, of South Berwick, Maine.

I have devoted the largest portion of this address to suggestions concerning the best methods of fertilizing soils, knowing that on such improvements the profits of agriculture must ultimately depend. With an increasing population the value of land will necessarily rise, and in order to render it valuable for culture, it must be improved with a degree of skill rivalling that of the English farmer.

A nation, to be truly independent, should be able to produce

its own food and clothing, and draw from the earth the metals required for the prosecution of the arts of civilized life.

The first requisite is food, and hence the nation's energy should be devoted to the encouragement of agriculture. Manufactures and commerce depend on agriculture and mining, the two fundamental arts on which all others rest.

The destiny of our country is indicated by the nature, extent, and capacity of our material resources. Enterprise, skill, and industry, we have inherited from our ancestors, and have cultivated with success. To nature we must look for materials on which we are to operate, and we may with confidence and pride point to the extent of our domain, and ask, if such a country, embracing twenty degrees of latitude and fifty-nine degrees of longitude, with every natural resource that could be desired, cannot sustain the hundreds of millions of people who are destined to dwell on this continent?

Yes, gentlemen, we have, and shall have "bread enough, and to spare," for ages yet to come, and for millions yet unborn. And with the augmenting population shall spring up new improvements in the arts, and agriculture improved and renovated shall be able to sustain in abundance every man to his acre.

Let no internal dissensions interrupt our progress, or sever the union of our confederacy. Let us suppress all feelings of hostility to our fellow-men, and look on the whole human family as brethren, not only

"From Mississippi's proud majestic flood,
To where St. Croix meanders through the wood,"

but farther yet, to the whole family of man. In our own country, let patriotism like the railroad's iron bands unite the sister States, never to be disunited. Let the sympathy of all Americans flow, like the streams of intelligence along the electric wires, which are rapidly covering our continent with their reticulated web, and meet with a response in all parts of our land.

Then with brotherly love uniting us and with emulation in well doing, under the providence of God, we may look forward, with sublime confidence, that we may become a great people, "zealous of good works," and our country shall become an example to the world, a desirable asylum for oppressed man, a home of the brave, the just, and the free.