Blake (Prof.)

THE VALUE OF LIME AS A FERTILIZER, AND HOW IT SHOULD BE USED,

BY

PROFESSOR BLAKE.

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TO FARMERS.

WITH the hope of engaging the attention of farmers, on the all-important subject of LIME AS A FERTILIZER, we publish, for general distribution, a communication which appeared in *The Land We Love*, from the pen of Professor Blake, of Davidson College, whose practical ability merits the fullest confidence.—Professor Blake's article is clear and comprehensive, enabling the dullest mind to understand the practical operation of Lime, in enriching land. A careful perusal of it will give all the information necessary in applying it. Our lands are cheap, and for that reason, the purchaser can afford to invest more in fertilizers, of which Lime is the most important. We cannot grow clover successfully without Lime, and as Solon Robinson says: "Clover is to agriculture, what faith is to religion—we may go through the whole list of fertilizers, and good works, but we must return to clover and faith at last." It is impossible to say too much with regard to the value of clover in agriculture. Most farmers have a sufficient amount of land to devote a portion exclusively to the cultivation of this plant, which, having been previously dressed with the proper quantity of Lime, makes their farms, and themselves, rich while they are sleeping. Lime! Lime! Lime! farmers of the South! wake up to your interest before it is too late. Stop your "pennywise and pound foolish" policy. For every dollar spent in Lime, and judiciously applied, you will realize hundreds. The land languishes for the want of it, as the sick man does for the want of medicine. It sweetens sour soils—it warms cold soils—it mellows and deepens stiff soils,—and without it, no improvement can be permanent. It is the basis upon which agriculture is built. A large demand for Lime will do more than anything else to cheapen its production. It can, at present, be purchased of J. & E. B. STOWE, near the Wilmington Charlotte & Rutherford Railroad.

J. & E. B. STOWE.

LIME AS A FERTILIZER.

HAVING been frequently asked the value of lime as a fertilizer, and requested to state its specific uses in the economy of the farm, I propose to sum up the best established *practical* results derived from science, and confirmed by the experience of the most judicious authorities on the subject.

Lime is a substance familiarly known to all our farming communities, and is everywhere valued for its varied and important applications—so valued that some have regarded it "the basis of all good husbandry;" and even so excellent a judge as Prof. Johnston declares it to be "the most valuable and most extensively used of all the mineral substances that have ever been made available in practical agriculture."—A fertilizer that can claim such a high encomium from such a source, deserves to have its merits better understood—its nature, its modes of action, its practical results more thoroughly comprehended. We propose to confine our remarks to such points only as are applicable to carbonate of lime and its derivatives, such as quick lime, slaked lime, &c.

In the form in which it is usually offered in the market, and in which, therefore, it is most generally available for the farmer, lime is a caustic alkali, (burnt lime,) and this caustic quality is the main cause of its activity and efficiency in the service of the skilful agriculturist. The food we eat is not in a condition to nourish our bodies as it comes in its crude state from the harvest field—it must be cooked, masticated, and even when swallowed it cannot be taken up by the blood, and distributed through the system for the nourishment of our bodies, till it has been acted on by the gastric and other juices—it must be "digested." So with the plant; its food, too, must, in some sense, be cooked, masticated and digested, before it can be taken up and assimilated by the living organism.

Caustic lime is the cook that prepares the food,—the gastric juice that digests the nourishment for the plant. But while this digesting operation is, perhaps, in the great majority of cases where lime is artificially applied, its most important function, it must not be forgotten that this is not its only office; lime is not only the cook that prepares other food for the growing crop, but is itself essential to the nourishment of the plant, entering into its composition, constituting an important part of its inorganic elements, be-

sides performing other valuable offices to be discussed as we proceed.

These general statements are sufficient to suggest the nature and character of the work which lime accomplishes for the practical farmer, and to show, in a general way, the foundation of its great reputation as a mineral fertilizer. But let us descend to particulars.

There are five modes of action by which mineral manures may profit the growing plant when applied to the soil.

1st. They may themselves become food for the growing crop.

2nd. They may digest and prepare the food already in the soil.

3rd. They may absorb gaseous fertilizers from the atmosphere, and retain them for the future use of the plant.

4th. They may destroy or neutralize substances in the soil which are poisonous or injurious to the crop.

5th. They may improve the mechanical condition of the soil.

Some mineral manures perform one of these offices, and some another, but lime accomplishes them all.

In regard to the first mode of action, chemical analysis settles the question; it shows that lime is present in the ashes of all our field crops, and that in some of them, as clover, peas, turnips, &c., it is a principal ingredient. Hence lime, if it be naturally deficient, may be usefully added to the soil simply as a food for the crop, and, if wholly wanting, its addition becomes an absolute necessity, as no crop could be matured without it.

In regard to the second point, lime may be considered as a specific; the most important service which it generally renders to the plant, when applied in large quantities, is the digestion and preparation of other manures, which, though found in the soil, are not in a condition to be absorbed by the roots, and thus made available, for immediate use.

By its caustic and alkaline properties, lime facilitates the decomposition of all vegetable and animal matters, liberating their nutritive elements, and converting insoluble, into soluble compounds, thus rendering them capable of being absorbed and appropriated.

Even the inert mineral masses of the soil do not escape the digestive action of lime: felspar and other minerals containing the silicates of potash and soda, more readily surrender, in the presence of lime, their treasures of potash and soda; and these alkalies, in their turn, help to convert the insoluble into soluble silicates, and thus supply to our cereals the elements that support their stems, enabling them to bear up against storm and wind; it is the absence of this soluble silica, which lime assists in digesting, that often causes our grain crops to fall to the ground before they are fully matured.

As to the third point, the absorption of fertilizing elements from the air, lime, both directly and indirectly, by its own action, and by its pulverizing effect upon compact soils, exerts a highly

beneficial influence. True, it does not, like plaster of Paris, absorb ammonia directly from the atmosphere, but, what is quite as much to the farmer's interest, it converts the ammonia which may be forming in the soil, into nitric acid, and thus fixes its valuable elements so as to prevent escape into the air. Moreover, we have the highest authority for saying that when organic matter is decomposing, in the soil, ammonia is generated by absorbing nitrogen from the air, and thus, as we have seen that lime promotes this decomposition, it promotes also, the formation of these most valuable manures from atmospheric elements.

In the fourth place, it is well known that lime will counteract the injurious acids, both organic and inorganic, which collect in damp soils where much vegetable matter is decomposing, and which render the land sour and unfavorable to successful cultivation. It is of the nature of an alkali, like lime, to neutralize these acids and make these sour lands sweet and mellow. Lime also decomposes and counteracts the injurious sulphates of iron, of magnesia, and of alumina, all of which sometimes abound to the serious injury of every variety of field crops, and often disappoint the hopes of the industrious laborer.

In the fifth place, that lime affects the mechanical constitution of the soil, would be naturally inferred from what we have seen of its power to decompose the earthy matters which contain the valuable mineral elements of the soil.

Lime, by pulverizing the solid particles, renders the land more loose and friable, at the same time that it liberates the valuable stores of nutritious matter locked up in them. By its chemical action, it makes stiff and heavy clays more light and porous, while its mechanical effect is to render more compact the texture of looser soils.

Lime is thus the busy agent of the farmer, collecting, pulverizing, elaborating, digesting whatever it can find in air, earth or water, and diligently exacting tribute alike from the animal, vegetable and mineral kingdoms, for the use and support of the growing plant: it is not only itself a food, but it also acts as a digester, an absorber, a neutralizer and a mechanical improver. What more could be expected from a single fertilizer? This surely is a great deal, but it is not all.

Among the effects of lime, Prof. Johnston enumerates several particulars in which it modifies even the character of the vegetation.—For instance, it alters the natural production of the soil by its tendency to extirpate certain coarse grasses which infest some localities, and prevent the growth of richer and more nutritive kinds. "It kills," he says, "heath, moss, and sour and benty grasses, and brings up a sweet and tender herbage, mixed with white and red clover, more greedily eaten, and more nourishing to the cattle. Indeed, all fodder, whether natural or artificial, is said to be sounder and more nourishing, when grown upon land to which lime has been abundantly applied."

It is said also, that it "improves the quality of almost every cultivated crop:" all kinds of grains, peas, turnips, potatoes, &c., are found to be more suitable for food when grown on well-limed soils. It is claimed that it also "hastens the maturity of the crop," causing the small grains to mature from ten to fourteen days earlier on limed soils than on those unlimed.

The quantity of lime necessary to accomplish these results when applied to cultivated lands, depends upon so many conditions of soil, climate and cultivation that no general rule can be given.

We learn from experiments carefully conducted in England, that "the quantity of pure lime contained in the crops produced upon one acre, during four years rotation, amounted, on an average, to 242 lbs." This gives us about 60 lbs. per acre, actually removed from the soil every year in composition with the vegetable matter, and which was necessary to its growth and healthy development. We thus see how much of this element may be needed for the actual *nourishment* of the plants, and how rapidly soils, not abundantly supplied by nature, must become exhausted of this essential ingredient, if it be not artificially applied. Under such circumstances, lands, which otherwise might be highly productive, may become sterile and useless.

But this statement only includes the lime necessary for a single one of the five uses specified above, and that one ordinarily demanding a less quantity than either of the others. If to this be added the amount sufficient for all the other purposes, we may appreciate more fully the quantities sometimes profitably employed in countries where agriculture is carried to the highest perfection. According to Bossingault, "soil which is without a considerable proportion of the calcareous element, never possesses a high degree of fertility."

A simple calculation will show that where no lime is present in the land, it will require about 400 bushels per acre, to give the small proportion of only one per cent. of lime for a depth of 12 inches below the surface.

Few soils are thus wholly devoid of lime, and much smaller quantities will suffice for all the purposes of agriculture. Bossingault informs us, that, in England, clay lands receive the large amount of "from 230 to 300 bushels of lime per acre, and lighter lands from 150 to 200 bushels." This must be but once for a term of many years. In France the amount applied is greatly less, about 60 or 70 bushels per acre, at intervals of seven or eight years. Johnston tells us that, in Great Britain, a dose is, on an average, from 7 to 10 bushels, per acre, a year. In Flanders, where agriculture has achieved its greatest triumphs, the quantity used is not so large, only 10 or 12 bushels every three years.

In this country the experience is similar to that of Europe.

A practical farmer in Schuylkill county, Pennsylvania, writes: "The quantity (of lime) depends on the kind of soil and after-treatment. Heavy clay can bear

100 or more bushels to the acre, while, on light soils, from 50 to 80 bushels will answer very well." Another report from Chester county, Pennsylvania, says that, "lime is mostly spread on the sod at the rate of 30 to 60 bushels to the acre, once in each course of crops," and, to show the practical results, it is added, "nearly all our land for miles around, was formerly worn out old fields, which would produce nothing, but the application of lime unlocked the hidden treasures of the soil and rendered available, as food for plants, the inert organic matter which it contained. This, accompanied by judicious cultivation and proper rotation of crops, has entirely changed the appearance of our neighborhood. Scarcely an old field is now to be found." Hon. T. G. Clemson, who was formerly connected with the Agricultural Department of the United States Government, remarks that so small a quantity as a bushel to the acre has produced good effects. Gov. Hammond, of South Carolina, one of the most successful, as well as intelligent planters the South has ever had, was accustomed to boat lime, in the condition of shell-marl, twelve miles up the Savannah river, for the use of his plantation, and apply it at the rate of 200 bushels per acre. The writer has witnessed on his light, sandy, pine lands, thus limed, a yield of 38 bushels of corn to the acre, while the same kind of land in an adjacent field, not limed, would scarcely average 10 bushels.—These statements show, at once, the importance of lime as a fertilizer, and the marked difference in the quantity which experience has proved to be best suited to the soil and climate of the several countries mentioned. To apply to thel oose and sandy soil of Flanders, the 200 or 300 bushels, per acre, which the Englishman finds desirable on his compact clay lands, or on his cold and tenacious heath meadows, would be a sad mistake.

Enough has been said to show that, comparatively, large quantities of lime are found to be useful in the experience of all those countries, where scientific agriculture has successfully worked out the highest practical results; but each individual must reflect for himself upon the principles involved, and upon their application to his particular case. It may be said, in a general way, that larger portions may be profitably added to stiff and heavy clays, than to light and sandy localities—to wet and marshy lands, than to dry and mellow regions, to deep rich loam, in which vegetable matter abounds, than to poor and exhausted fields. Indeed, as the primary object of using lime is to digest the organic substances already present, it becomes a point of the first importance to have this organic matter abundantly present, and wherever this condition is fully met, as by the roots, grass and leaves of freshly cleared ground, or by green manures ploughed in, or by barn-yard composts, we may confidently use the lime with a liberal hand; but if these conditions be not com-

plied with, damage and disappointment will follow, instead of the rich rewards anticipated.—More lime, also, may be safely applied in cold, than hot climates, and to land subject to deep tillage, than where ploughing is always shallow: for it is plain that a less quantity will suffice to supply the soil, if only four inches deep, than if it be ploughed 12 inches.

Wherever, then, a system of high culture is proposed, both theory and practice suggest that we begin at first with a heavy liming, proportioning the quantity to the quality of the soil, and especially to the amount of organic matter it contains, and that this be followed at the close of every rotation of crops, embracing a period of several years each, with lighter limings. The Flemish rule, which gives the smallest quantity of any of the examples quoted above, requires 10 or 12 bushels, per acre, at the close of every three years, making an average of 3 or 4 bushels annually. This in Flanders yields the best results for the investment. In France and England, experience has indicated a much larger amount.

It need scarcely be added that the ultimate net profits of liming must depend, among other things, upon the cheapness and facility with which lime can be procured at the required locality.

All these points must be carefully weighed, if we would accurately balance the account of loss and gain.

But one thing is certain, that we of the desolated South are hopelessly ruined as an agricultural people, if we do not now avail ourselves promptly of all those artificial aids which are applicable to our case, and which have combined to make other countries agriculturally great.—The same practical wisdom, energy and earnestness which have made the marshes and sandy plains of Flanders the garden of Europe, can convert the abused and wasted regions of the South back again to even more than their primeval fertility and beauty.

The mode of application, like the question of quantity, depends much upon circumstances.

If the application is to be made to clay or boggy and peaty lands, or to such as have large supplies of inert vegetable matter, the lime should be slaked quickly and applied immediately, in a caustic state. When it is required on lighter lands, it should be "air-slaked," or allowed to slake slowly and spontaneously, by absorbing moisture from the atmosphere, as this gives it in a finer powder and somewhat milder form, and therefore, less liable to injure the tender herbage. But for general purposes, especially where the soil is light and poor, it is best that the lime should be well composted with rich vegetable mould, or such decayed vegetable matter as may be available: in this form it can be more regularly scattered, and its caustic power being somewhat masked in the compost, it is less liable to do injury, at the same time that it acts more promptly and efficiently upon the growing crop; this increased efficiency in the composted state is due to the

fact that the digestive processes which lime ordinarily carries on in the soil, have already begun in the compost heaps, thus offering food for ready absorption. On this account, too, the longer it has been in this state the more fertilizing it becomes. It may be added also, with beneficial results to composts of *fresh* animal matters, as it so controls the fermenting process as to cause the valuable elements to form compounds which are not subject to evaporation, while, if lime had not been present, these same elements would have entered into combinations which are highly volatile and liable to escape: it should never be mixed, however, with animal manures which are *already decomposed*, as it expels the gaseous fertilizers existing in the mass before the lime is added. When properly composted with vegetable or animal matter, lime may be applied just as any other rich manure directly to the growing crop, whether it be tender grass, or clover, or grains of any kind: but if it is to be applied in the condition of slaked lime it will not produce its full effect at once upon the soil, and, therefore, as long an interval as possible should intervene between its application and the planting of the crop which it is intended to benefit—as, for instance, in the early fall for the benefit of winter and spring grain.

Some authorities, as Waring's Elements of Agriculture, and the American Muck Book, by Browne, with much plausibility, urge the use of a "lime and salt mixture" as containing more valuable qualities, both for manuring and digesting, than lime itself. This mixture is obtained by slaking fresh burnt-lime with water thoroughly saturated with salt, using the materials in the proportion of three bushels of lime to one of salt.

The lime decomposes the salt, giving us chloride of lime and carbonate of soda, both valuable agents in promoting the fertility of the soils. To secure the more perfect combination of the lime and salt, the brine should not all be applied at once, but at intervals of a day or two, in order to give time for the changes to take place more thoroughly; and even after the slaking is completed, ten or twelve days should elapse before the mixture is used. There can be no doubt of the value of this compound, especially in cases where salt would be a desirable manure on its own account.

For evident reasons lime, when intended to benefit the land generally, should always be as evenly distributed, and as thoroughly incorporated with the soil as possible: it should not, however, be ploughed in very deeply as it has naturally a constant tendency to descend in the soil; and because, also, while near the surface, it is more easily reached by the air, which is essential to those digestive functions which constitute its chief value.

When quick-lime is added in large quanties to soils naturally wet, and which have not been sufficiently drained, the lime may form into a mortar, and become hardened to such a degree as to obstruct the free passage of water and air, as well as of the roots

of the plants. Under such circumstances, of course, the lime would be an injury, and the remedy for the evil, thorough draining. On soils which are light, dry and poor in vegetable matter, a heavy application of pure lime would also prove injurious by rendering the land too open, and by its chemical effects causing the crop to "burn" as it is called.—In each of these cases, if the lime be added in a well composted state, all the evil consequences are at once averted, at the same time that additional supplies of warmth and nourishment are given to stimulate the growth of vegetation. Indeed, the opinion is maintained by some that lime may be indefinitely added without injury, provided we, at the same time, proportionally increase the organic elements of the soil.—Whether this be correct or not, it is certainly true that what is ordinarily spoken of as the exhausting effect of lime, is only the effect of the larger crops which it causes the soil to yield, and which, of course, requires more of the elements of the soil for its growth and maturity—what is needed under such circumstances is not less lime, but more organic food.

It frequently has happened that even so valuable a fertilizer as lime has been wholly abandoned in particular localities in consequence of unskilful applications, or hasty inferences from partial experiments. Of course where nature abundantly supplies the soil with this important element, artificial additions would be waste of time and money. So, in like manner, when lime is applied, as in some parts of England, at the rate of from 40 to 60 bushels to the acre at the end of each rotation of crops, embracing a period of 4 or 5 years, it would be no argument against the moderate use of this agent, if after a lapse of years, these large additions should produce no sensible effects whatever in consequence of the soil having become fully saturated.—And, again, the time which is required for uncomposted lime to take its effect upon the soil is a fruitful source of discouragement and often of the abandonment of this valuable fertilizer. An experimental farmer, reporting his results for the first year writes, "I applied 100 bushels (of lime) to the acre on a corn stubble and planted again in corn, but saw very little profit to the crop."—In reference to the same soil and the same liming at the end of the third year he writes: "For the past two seasons I have mowed the finest of grass." Lime, though a most efficient and valuable fertilizer, is slow in developing its finest results—indeed it scarcely exhibits fully its true character, unless when applied in the composted state, till the second or third year after its application.

Lime is also distinguished for the permanence of its effects as a fertilizer. There is known to chemists a mysterious power called "disposing affinity," for the want of a better name, by which one substance while in the presence of another, is induced or influenced to enter into combinations which it would not form in the absence of the influencing

body. This is the nature of many of the changes brought about in the soil by lime, and it is by virtue of this disposing power that it continues to act and retain its peculiar qualities as a fertilizer. The permanence of its action is further increased by its slight solubility; at the ordinary temperature it takes about 750 pounds of water to dissolve one of lime even in the caustic state, and still less can be dissolved after it has been acted on by the carbonic acid of the air. Thus it remains for a long time in the soil performing its important offices. It is said to produce sensible effects upon the crop after the lapse of 20 or 30 years, and some insist that a good supply, once added to the soil, never wholly ceases to be felt. This persistence in the effects of lime is a high merit, and one which insures to the farmer, sooner or later, if judiciously used, an ample interest upon his investment.

We have already seen that when lime is to be applied in the slaked condition, except in the case of stiff clays or rich vegetable mould, it should be slowly "air-slaked," because, in the latter case, it is not only more completely pulverized, but also of a milder character, as the caustic quality of about one-half of it is neutralized by combination with the carbonic acid of the air. As a labor-saving consideration, this slaking process should take place in the field, since, thereby, from one-fourth to one-half of the weight, and a large increase of the bulk, caused by the slaking, will be saved from transportation.

To effect this it may be piled up in heaps and covered with earth in the field, and left till it completely crumbles to powder: the covering of earth protects it from heavy rains which might convert it into mortar, and also from too free access of air which tends to change it back into the state in which it was before it was burnt. When prepared for distribution this may be accomplished by drawing it out from a cart into little heaps, from five to seven yards apart, and in quantities proportioned to the amount we desire to apply per acre, after which it can be evenly scattered. Some, to accomplish the distribution more regularly, check off the land into little squares of convenient size, and apply a given quantity to each square.

Such is a general statement of the facts that seem to be best established in regard to lime as a fertilizer.

It may be useful, in conclusion, for convenient reference, to sum up the most important points of a practical character.

Lime, then, is useful to the farmer as food for his crop—as a digester of the animal, vegetable, and mineral manures in his soil—as an absorbent, indirectly, of valuable manures from the atmosphere—as a neutralizer of injurious acids and other poisonous compounds—as a pulverizer of his stiff clay soils, and as a general stimulant which improves both the quantity and quality of his produce.

The quantity of lime to be used depends on the character of the soil—on the abundance of organic

matter—on the kind of cultivation—on the character of the climate—on the quantity already present in the soil, and on the cost of lime in the market where it is used.

The mode of application depends on the object chiefly aimed at. If to pulverize compact tenacious *clay* lands, the caustic, water-slaked condition is best;—if to act upon the *mineral* matter of lighter soils the milder, air-slaked form will do the work; but if to digest *organic* matter, or to serve the general purposes of a manure to enrich the soil and give it warmth and energy—to stimulate the plant and promote a prompt development, or whatever else may be deemed necessary, the composted state is greatly preferred.

Hence, every farmer should have his cattle-lots, and horse-stalls abundantly supplied with leaves, straw, grass and organic matter of every kind, to be trampled by his stock, and ultimately thrown into compost heaps with lime and vegetable mould, or peaty matter, which will absorb all the gases that might otherwise escape. The quantity of lime for these purposes need not be great. We have seen that, though in many cases large amounts may be profitably applied where it can be cheaply obtained, yet even very small quantities are highly useful, and experience indicates that these small quantities, frequently repeated, are more beneficial than larger amounts applied but once.

Let each farmer then do what he can, even if his efforts are confined to a few acres; for the time has come when our people must abandon the old system of extensive planting, and concentrate their time, energy, and means upon comparatively small areas of land, which, to be remunerative, must be stimulated to their highest capacity by all the appliances of science and art.

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