BREAD FROM STONES

A New and Rational System of

Land Fertilization and

Physical Regeneration

By Dr. Julius Hensel
(Agricultural Chemist)

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INTRODUCTION

By Dr. Raymond Bernard (A.B., M.A., Ph.D.)

Dr. Julius Hensel was the greatest figure in the history of agricultural chemistry even if his powerful enemies, members of the octopus chemical fertilizer trust, have succeeded in suppressing his memory, destroying his books and getting his Stone Meal fertilizer off the market. But eventually the truth comes to the fore, and its enemies are vanquished. Julius Hensel's pioneer work in opposing the use of chemicals in agriculture, a half a century later, found rebirth in the Organic Movement which has swept through the world. But Hensel is more modern than the most modern agricultural reformer, for he claimed, on the basis of theoretical chemical considerations, and supported by practical tests, that his Stone Meal can replace not only chemical fertilizers but all animal ones as well.

It was the German agricultural chemist Liebig who first put forward the phosphorus-potash-nitrogen theory of chemical fertilization. This false doctrine Hensel bitterly attacked and in so doing, won the ire of the financial interests behind the sale of chemical fertilizers, which used agricultural authorities and university professors to denounce poor Hensel as a charlatan and his Stone Meal as worthless.

Though his fight against chemical fertilizers was a losing battle and he died as a defeated hero, it took a generation for Hensel's efforts to bear fruit in the modern Organic Movement, which has not given its founder the credit due him.

Bread from Stones

The fight between Liebig, advocate and one-sided chemical fertilization, and Hensel, who advocated a more balanced form of plant nutrition, including the trace minerals which Liebig completely overlooked, was a battle between an opportunist, who sought to further the sales of chemical fertilizers, and a true scientist, interested in humanity's welfare. Though Liebig, with the Chemical Trust behind him, won the battle, Hensel's ideas finally triumphed long several decades after his passing.

Liebig claimed that plants require three main elements - nitrogen, phosphorus and potash - on the basis of which conception chemical fertilizers were manufactured that supplied these elements. On the other hand, Hensel claimed that plants need many more than these three major elements, stressing the importance of the trace minerals, which at that time were ignored. In place of chemical fertilizers, supplying only three elements in an unnatural, caustic form, Hensel recommended the bland minerals of pulverized rocks, especially granite, a primordial rock which contains the many trace minerals that meet all needs of plant nutrition.

Hensel first made his discovery of powdered rock fertilization when he was a miller. One day, while milling grain, he noticed that some stones were mixed with it and ground into a meal. He sprinkled this stone meal over the soil of his garden and was surprised to note how the vegetables took on a new, more vigorous growth. This led him to repeat the experiment by grinding more stones and applying the stone meal to fruit trees. Much to his surprise, apple trees that formerly bore wormy, imperfect fruit now produced fine quality fruit free from worms. Also vegetables fer-

tilized by stone meal were free from insect pests and diseases. It seemed to be a complete plant food, which produced fine vegetables even in the poorest soil.

Encouraged by these results, Hensel put his "Stone Meal" on the market, and wrote extensively on its superiority over chemical fertilizers, while at the same time opposing the use of animal manure, and the nitrogen theory on which it is based, claiming that when plants are supplied with Stone Meal, plenty of water, air and sunshine they will grow healthfully even if the soil is poor in nitrogen, since it was his belief that plants derive their nitrogen from the soil through their lives, and do not depend on the soil for this element.

In opposing this use of chemical fertilizer, Hensel awoke the ire of a powerful enemy, which was resolved to liquidate him - the Chemical Trust. Through unfair competition, Hensel's "Stone Meal" business was destroyed and his product was taken off the market. However, the chief object of attack was his book, "Bread from Stones", in which he expounded his new doctrines of Liebig on which the chemical fertilizer business was based, as well as the "Liebig meat extract". (For Hensel advocated vegetarianism, just as he advocated natural farming without chemicals or manure.) Accordingly, his enemies succeeded in suppressing the further publication of this book and in removing it from libraries, until it became extremely rare and difficult to obtain. It is more fortunate that a surviving copy came into the writer's possession.

Dr. Julius Hensel was not only a student of agricultural chemistry, but also biochemistry and nutrition, and he related all these sciences, which

he united into a composite science of life, which he called "Makrobiology". His theory was that the chemistry of life is basically determined by the chemistry of the soil, and that chemicals unbalance and pervert soil chemistry while powdered rocks help restore normal soil mineral balance, producing foods favorable to health and life. His discoveries concerning the value of powdered rocks as soil conditions and plant foods, though rejected and ridiculed when he first proposed them, were adopted by agricultural science nearly a century later, when the application of powdered limestone, rock phosphate and other rocks became standard agricultural practice. Granite, which Hensel recommended as the most balanced of all rocks as a source of soil minerals, was first rejected as worthless, but later appreciated and used as a soil mineralizer.

During the course of his researches, Dr. Hensel found that in the primeval rocks, as granite, lie a potentially inexhaustible supply of all minerals required for the feeding and regeneration of the soil, plants, animals and man. All that is required is to reduce them to a finely pulverized form, so that their mineral elements may be made available to plants. Hensel wrote a book describing his discovery of a new method of creating more perfect fruits and vegetables, rich in all nutritional elements and immune to disease and insect pests, with the result that it produced worm-free fruit without the need of spraying. The foods so produced by rock-meal fertilization were true Organic Super Foods, far superior in flavor and value than those produced under the forcing action of manure or chemical fertilizers.

Hensel was the first to put up a fight against the then growing new chemical fertilizer industry

- a struggle that was continued in the next century by Sir William Howard in England and J. I. Rodale in America. The use of chemical fertilizers, claimed Hensel, leads to the following evil consequences:

(1) It poisons the soil, destroying beneficial soil bacteria, earthworks and humus,

(2) It creates unhealthy, unbalanced, mineral-deficient plants, lacking resistance to disease and insect pests, thus leading to the spraying menace in an effort to preserve these defective specimens,

(3) It leads to diseases among animals and men who feed on these abnormal plants and their products,

(4) It leads to a tremendous expense to the farmer, because chemical fertilizers, being extremely soluble, are quickly washed from the soil by rainfall and needs constant replacement. (Powdered rocks, on the other hand, being less soluble, are not so easily washed from the soil, but keep releasing minerals to it for many years).

The use of various pulverized rocks, as granite, limestone, rock phosphate, etc., in place of chemical fertilizers, will lead, claimed Hensel, to permanent restoration of even poor soils to the balanced mineral content of the best virgin soils; and the rock dust thus applied will remain year after year and not be washed away by rains or irrigation water, as is the case with highly soluble chemical fertilizers. This will be an economic saving to the grower and enable him to sell foods at a lower price than when he must spend large sums on chemical fertilizers. Also, since foods thus mineralized are healthy and immune to plant diseases and insect pests (as Hensel ex-

perimentally demonstrated), there is no need for the expense and dangers of spraying.

Foods raised by Hensel's followers, including many German gardeners and farmers, who were enthusiastic in praise of his method, were found to possess firmer tissue and better shipping and keeping qualities than those raised with animal manure or chemicals. And most important among the advantages of Hensel's agricultural discovery is that foods grown on mineralized soil are higher both in mineral and vitamin content and so produce better health and greater immunity to disease than those grown by the use of chemical fertilizer sprays.

To kill insects by poisons applied to plants does not remove the cause of their infestation, and poisons both the insect as well as the human consumer of the sprayed plant. Only correct feeding of the soil, and consequently of plants by trees, by proper methods of fertilization, thereby keeping them well-nourished, vigorous and free from disease, will accomplish this, for insects do not seem to attack healthy plants. It appears that insects, like scavengers, attack chiefly unhealthy and demineralized plants, not healthy ones. Dr. Charles Northern has performed experiments in which he raised two tomato plants, entwined with each other, in different pots, one being supplied with an abundance of trace minerals, derived from colloidal phosphate, and the other just chemical fertilizer. The tomato plant grown with chemical fertilizer alone was attacked by insects, while the other one given trace minerals was not.

Hensel pointed out that animal manure and chemical fertilizers produce a forced, unnaturally rapid growth of large-sized produce which fail to

acquire the minerals normally secured during a slower, longer development. The result is the production of demineralized, unbalanced plants, which are weakly and unhealthy, falling prey to disease and insect pests. This explains why, coincident with the increased use of chemical fertilizers, during the past century, insect pests steadily increased. So did cancerous conditions among plants, animals and humans, as shown by Keens, an English soil chemist, who presents statistics to show that the increased use of chemical fertilizers is a major cause of the greater incidence of cancer during that last hundred years.

The modern Organic Farming movement has accepted and propagated one of Hensel's theories - his opposition to chemical fertilizers and recommendation of powdered rocks in their place - but has failed to appreciate his other main doctrine - his opposition to the use of animal excrements as plant foods. In this respect, Hensel, though he lived in the last century, is far ahead of the Organic Movement and more modern than the most modern agricultural reformer.

Hensel had a great admirer and disciple in England - Sampson Morgan, who founded his "Clean Culture" doctrine on Hensel's philosophy of soil and biological regeneration by the avoidance of chemical or animal fertilizers. While Hensel was more of a theorist, Morgan was a practical farmer and agricultural experimenter, who proved the truth of Hensel's theories by winning the first prize at all agricultural exhibits at which his super-sized, super-quality, disease and blight- free rock-dust fertilized fruits and vegetables were displayed. In Sampson Morgan's "Clean Culture", Morgan's views are presented. In reality they are Hensel's doctrines

transplanted to English soil. The reading of Morgan's book will be a valuable supplement to that of this, to give one a thorough understanding of the subject of Natural Agriculture (i.e., a system of soil culture definitely in advance of Organic Gardening by the compost method).

Practical experience with Hensel's Stone Meal and his non-animal method of soil regeneration, has proven the following:

1. That Stone Meal creates healthier, tastier, more vitaminized and mineralized foods.
2. That Stone Meal creates immunity to insect infestation, worms, fungi and plant diseases of all kinds.
3. That Stone Meal improves the keeping and shipping quality of foods, so that they keep a long time, in contrast to the rapid deterioration of foods given abundant animal manure.
4. That Stone Meal helps plants to resist drought and frost, enabling them to survive when those fed on manure and chemicals perish.
5. That Stone Meal produces larger crops which are more profitable because the farmer is saved the expense of buying chemical fertilizers which are rapidly leached from the soil by rainfall, whereas Stone Meal, being less soluble, is gradually released during the course of years and remain in the soil, being the most economical of fertilizers.
6. That foods raised with Stone Meal are better for human health and the prevention of disease than those grown with chemicals or animal manure.
7. That use of Stone Meal, in place of chemical or animal fertilizers, helps to end the spraying

menace (by removing its cause) is proven by the fact that plants and trees grown with Stone Meal are immune to pests and so require no spraying.

WHAT WILL FERTILIZING WITH STONE DUST ACCOMPLISH?

It will:

1. Turn stones into bread and make barren regions fruitful.
2. Feed the hungry.
3. Cause healthy cereals and provender to be harvested and thus prevent epidemics among men and diseases among animals.
4. Make agriculture again profitable and save great sums of money which are now expended for fertilizers that in part are injurious and in part useless.
5. Turn the unemployed to country life by revealing the inexhaustible nutritive forces which, hitherto unrecognized, are stored up in the rocks, the air and the water.

This it will accomplish.

May this little book be intelligible enough that men, who seem on the point of becoming beasts of prey, may cease their war of all against all and instead of hunting for gold, racing for fame or wasting productive forces in useless labors, choose the better part:

The peaceable emulation in the discovery and directions of the natural forces for evolving nutritive products and the peaceable enjoyment of the fruits which the earth is able to provide in abundance for all. May man use the divine heritage of reason to attain true happiness by discovering the sources whence all earthly blessings flow and thus put an end to self-seeking and greed, to the

increasing difficulties of making a living the anxieties for the daily bread, to distress and crime - such is the aim of this little work, and in this may God aid us!

Hermsdorf below Kymast
October 1, 1893

Table of Contents

STONE MEAL AS A FERTILIZER

Articles and Reports by Hensel and His Followers who Successfully Applied his Theory of Stone Meal Fertilization, Using Stone Meal in Place of Chemical Fertilizers and Animal Manure By Dr. Julius Hensel in "Deutsches Adelblatt", January 31, 1892

In cereals, in the seeds of the leguminous plants and of the oil- bearing plants, the mineral substances with which the cellular tissue and the vegetable albumen are combined constitute from 17 to 50 thousand. After combustion of the plant tissue, these mineral constituents remain behind as ashes, and the greater part of the ashes in the seeds consist of phosphoric acid and potassium, while soda, lime magnesium, hydrochloric acid, sulfuric and silica acid with manganese, iron and fluorine are comparatively less in quantity. Only in the oil-producing seeds (mustard, rapeseed, linseed, hempseed and poppyseed) lime and magnesium make a considerable part of the ashes. The following numerical proportion will give a general view:

- Winter wheat has on the average 16 8/10 thousandths of ashes, of which phosphoric acid forms 7 9/10 thousandths and 5 2/10th of potassium.
- Field beans yield 31 thousandths of ashes, of which phosphoric acid forms 16 2/10ths, potassium 7, lime 18, and magnesium 5 thousandths.

- Poppyseed gives 51 5/10th thousandths of ashes of which 16 2/10ths are phosphoric acid, potassium 17, lime 18 and magnesium 5.

From the fact that phosphoric acid and potassium have such a prominence in nutritive crops, it was easy to draw this conclusion: "That potassium and phosphoric acid are the most necessary fertilizers, and the more phosphoric acid the better." But this conclusion is erroneous and has caused us much injury since Liebig made this statement.

Liebig and his successors have overlooked the fact, that phosphoric acid is so uniformly distributed in the plant world that it does not amount in the average to more than one-tenth of the mineral constituents. If during the process of ripening phosphoric acid strongly accumulates in the seeds, that it constitutes not merely 10 but 30 to 50 per cent of the ashes, this is explained by the fact that the acid passes from the stems, stalks and leaves into the seeds, leaving the straw very poor in phosphoric acid, as may appear from these proportions:

(a) The straw of winter wheat has in the average 46 thousandths of ashes, of which only 2 2/10ths thus about l/20th or 5 per cent, consists of phosphoric acid. The rest consists of 6 potassium, 0.6 soda, 2.7 lime, 1.1 magnesium, 1.1 sulfuric acid, 0.8 hydrochloric acid and 31 thousandths of silica acid. The latter (silicon) only amounts to 0.3 of one thousandth in the winter grain thus in comparison with the straw only one thousandth.

(b) The straw of field beans furnishes 45 thousandths of ashes, of which only 2.9 are phosphoric acid, thus l/15th or 6 1/2 per cent, while in

ashes of the seeds it constitutes 36 per cent. The other substances contained in bean straw are 19.4 thousandth potassium, 0.8 soda, 12 lime, 2.6 magnesium, 1.8 sulfuric acid, 2.0 hydrochloric acid and 3.2 silica acid. On account of this small quantity of silica, bean straw is soft, while wheat straw, rich in silica, is hard.

(c) The straw of poppy give about 48 1/2 thousandths of ashes, of only 1.6 of phosphoric acid, in poppy straw phosphoric acid constitutes only l/30th of the ashes, while in the seeds it amounts to l/3rd. So considerable, amounting to the tenfold, if the difference. The rest of the ashes of the straw of poppy consists of 18.4 potassium, 0.6 soda, 14.7 soda, 14.7 lime, 3.1 magnesium, 2.5 sulfuric acid, 1.3 hydrochloric acid and 5.5 silica acid.

These examples adduced are to a certain degree typical of cereals, leguminous plants and oil-yielding plants and they explain why leguminous and oily plants need more lime in the soil than cereals. On the whole, when we take the average of 70 or 80 analyses of field crops, which also include the roots, stems and leaves, we come to the conclusion that phosphoric acid constitutes about one-tenth of the mineral constituents, while potassium, soda, lime, magnesium, silica, sulfuric acid, chlorine and fluorine contribute to the remaining nine- tenths. Furthermore, potassium and soda are present on the average in the same amount of weight as lime and magnesium. These four bases amount to about eight-tenths of the whole quantity of the ashes, and it is found in practice that these bases may to a considerable degree act as substitutes for one another, without perceptibly varying the form and the organic constituents of these plants.

According to these facts a fertilizer which would satisfy the natural demand of supplying the minerals necessary for the construction of plants should contain to one part of phosphoric acid eight parts of potassium, soda, lime and magnesium, if we are willing to leave out of our count phosphoric, hydrochloric and silica acid.

Such a fertilizer, however, is found in every primitive rock. Primitive rocks do not, indeed, contain more than one per cent of phosphoric acid, but that is quite sufficient; it is, indeed, the measure wisely appointed by the Creator of all things, for the other constituents of granite, porphyry, etc., which serve for the nourishment of plants, consist of about six per cent of potassium and soda and two per cent of lime and magnesium. The residue of the rock serves as a substance dispersed between the basic substances to keep them apart, and they are dissolved out of their combination with silica acid only as they are applied to use. Thence we receive such wholesome cereals from mountainous countries, e.g., from Hungary, encircled by the Carpathian Mountains, in contrast with prevalence of diseases due to the composition of the blood of men and animals in the exhausted plains which are supplied with stable manure.

If we wish to grasp quickly and completely the correctness and importance of mineral manure, we need only to consider the cases of Uruguay and Argentina or of Egypt; or, to mention an example from our proximate vicinity, that of the principality of Birkenfield.

In Uruguay and Argentina the live stock is estimated at about thirty-two million (beef, sheep and horses). Of these they are now killed for export each year about one and a quarter million

and the bones of these animals are carried by the shiploads to Hamburg, in order to be worked up into bone-black to be used in the sugar refineries. It is self-evident that the animals take the phosphate of lime for their bones from the grass they eat. But the grass draws the necessary nitrogen from the air, for they use no fertilizers, and the phosphate of limes, which continually passes from the country in the form of bones, is received by the grass from the inexhaustible calcareous porphyritic mud which is carried down through millions of gorges from the Cordilleras by the mountain streams and which flow as a primitive manure into the eastern plains. In Egypt this is effected by the Nile mud, which the mountain streams bring down and which is conveyed by the Nile in fructifying abundance to the Delta, which thereby becomes the granary of Egypt.

But we need not go so far eve. The little principality of Birkenfield demonstrates the fertility of the primary rocks which the mountains of the Hundsruecken supplies in the form of argillecious slate. It is a little Argentina. The trade in cattle plays an important part in Birkenfield. Besides this, oil factories, linen factories and beer breweries prove that cereals and oil plants, rich in phosphorus, and among them flax, rich in potassium, find there good nutritive supplies. The forests consist mainly of deciduous trees and harbor much game. Trees need phosphoric acid for their roots, trunks and bark, and the game needs phosphate of lime for the bones. The ashes of oak wood and beech wood contain 6 per cent of phosphoric acid, and that of the horse-chestnut contain 7 per cent. So richly does the argillaceous slate furnish the nutritive elements for the

growth of plants and especially the right quantity of phosphoric acid.

In contrast with these natural fertilizers what has our prudent and learned fertilizing with phosphoric acid effected? It has brought it about that we don't know how to save ourselves from the phylloxera, the nematodes, hay-worm, spring-worm and sourworm, nor from the fungi causing rust and blight. The more phosphoric protoplasm which accumulates in seeds and fruits as an essential condition of their existence. If we wish to limit these plagues to a sufferable degree we must supply our fields that have been deluged with phosphoric acid with natural plant food, with pulverized rocks, with lime and gypsum.

Of many communications received, which confirm the above, we would like to cite a few which are especially instructive, as it shows that these evils have become so great as to urgently demand relief. The representative of a great vineyard estate on the upper Rhine writes as follows:

"For years I have seen clearly that we make a great mistake in our cultivation of fields, gardens and vineyards, but only on reading your books have I seen that all our methods of fertilizing hitherto have been onesided, and that, therefore, they are ineffectual. Stable manure on some soils and for some crops may be sufficient, but it is not a universal fertilizer. We see this plainly here in the Rheingau, in the young vines, which are manured every two or three years with cow dung, and indeed, great quantities of it. A gladsome, luxuriant growth and a rich yield of grapes are **not** produced, though we furnish the grape vines with the potassium, phosphoric acid and nitrogen in so great quantities that the shoots, the grapes and the leaves ought to display the utmost

luxuriance; but instead of this everything in the vineyards here looks sickly and poor. I should, therefore, be very glad and grateful to you if you would give us your views about this. It would be of great benefit, not only to ourselves, but to the whole of the Rheingau, and wherever grape vines are cultivated, to be delivered from the miseries of the spring-worm, hay-worm and sour-worm, the phylloxera and the **Peronospora viticola,** and if this can be done by your method all cultivators of the grapevine will exclaim: God be praised!

I answered that the usual manure does not lack any necessary ingredient, but there is in it **too much of some things,** i.e., of nitrogen and phosphoric acid. Men must return to the original material, restore to the soil its natural original qualities by bringing to the fields soil that has not been exhausted, which may be done in the form of powdered primitive rocks mingled with sulfates and carbonate of lime and magnesium. The correctness of such belief is attested by the following correspondence with a landscape gardener and nursery man from the Rheinprovinz:

"We would like to ask you for some information as to what we had best use for manuring our nurseries. We have clayey, deep, light soil, formerly a forest. We cultivate roses, fruit trees and forest trees, also evergreen plants, firs and various kinds of cypresses. It is quite peculiar that quinces and other fruits in the second year after grafting absolutely refuses to grow any more despite the use of stable manure, iron slag and Chilean nitrate."

I answered that deep, clayey forest soil, while retaining its clay and silica, has been deprived of its basic constituents (potassium, soda, lime and

magnesium) which in the process of time have passed over into the wood of the roots and of the trunks, and that the only thing promising relief is fresh rock meal. For are not the Balkan countries the home of the roses, and do not the Haemus Mountains consist of porphyry, granite and gneiss, but not of stable manure and clay? Do not cypresses grow in the region of the Appennines, which furnish the nourishing material from their granite and gneiss. And do not firs grow on mountains of granite and porphyry? Finally fruit? The Bohemian Mountains furnish it in abundance, and indeed free from worms. This latter fact, that **the use of Stone Meal causes worms to cease,** was lately confirmed by Dr. Fischer, M.D., of Westend, near Charlottenburg, who introduced Stone Meal manure two years ago in his garden, situated on a sandy soil. He reported about it in the January number of the Deutsche Pomologen Verein. From a third letter I quote as follows:

"I am glad to see a chemist who has the courage to openly oppose the swindle of the artificial manures. Within a series of ten years I bought at least $17,000 worth of artificial fertilizers, of which sum over $6,000 was paid for Chilean nitrate. I harvest more every year, but what? Nothing but straw, lodged grain and cereals of low grade. For the last two years I have bought, in addition, animal manure and lime, and I find that at a slight expense, everything is being changed and that the field will again bring in what I lost in former years. When the Thomas phosphate was introduced, as it was cheap, I used at once 2000 cwt. With 7 cwt. per acre an effect was indeed seen, but what was it that acted? Surely only the lime. What you have affirmed I have long felt. That many of us agriculturists are

faring so badly if for the most part owing to this nuisance of our artificial, expensive and useless fertilizers."

A fourth letter with an excerpt, but which I will conclude, contains the following:

"Twenty years ago, while in office in Alsatia, I endeavored to make myself acquainted and familiar with all manner of subjects. I was less to the idea of mineral fertilizers or manures, when I head and saw that in the intersecting valleys of the Vosges Mountains the winter torrents covered the lowlands with granite debris, which after a few years become very fruitful soil; but I had no opportunity or passion to follow out this idea any further, which is now, however the case."

Every such letter contains new confirmatory facts. I have quite a collection of such correspondence, but will not weary you by quoting more.

STONE MEAL MANURE

by Dr. Julius Hensel
in Pioneer, July 22, 1892

"Bread from stones; and thus forsooth
The Bible words maintain their truth."

I have before this taken occasion, in the "Deutsche Adelblatt", to show that calling the stone dust "manure" is really not correct, as it is superior to the so-called manures in this, **that it restores the natural conditions for the growth of crops,** while manures only present an artificial help and thus a makeshift. The whole state of the case is as follows:

In the beginning plants grew without any artificial addition from the soil formed of disintegrated material from the mountains. The carbonic acid of the air combined with the basic constituents, potassium, soda, lime, magnesium, iron and manganese, which were combined in the disintegrated rock material with silicate acid, alumina, sulfur, phosphorus, chlorine and fluorine, and with the cooperation of moisture by the operation of the heat and light of the sun, it produced vegetable cell tissue.

The gaseous substances, carbonic acid (carbon dioxide), watery vapor and the nitrogen of the air require the firm forms of vegetable cellular tissue and vegetable albumen solely through the basic foundation of potassium, soda, lime and magnesium, without which no root, stalk, leaf or fruit is found; for whether we burn the leaves of maples or of beech trees, the roots of burdocks or of willows, grains of rye or wood, straw or linen,

pears, cherries or rape seed, there always remains a residuum of ashes which, in various proportions consists of potassium, soda, lime, sulfuric acid, fluorine and silica. With respect to nitrogen, this with watery vapor forms in the presence of iron, which is present in all soils, becoming ammonia according to the formula N_2 H_6 O_3 Fe_2- N_2 H_6 Fe_2 O_3 (all iron rust that is formed in the nightly dew out of metallic iron, Fe_2 O_2, contains ammonia, as Eilard Mitscherlich has proved.)

The solidification of the cellular tissue arising from carbonic acid and water will be best understood by comparing it with the process of the formation of hard soap by the combination of oil with soda, potassium, lime or any other basic substance, as, e.g., oxide of lead, quicksilver or iron. Ammonia also forms soap with oxidized oil, oleic acid. We can hardly find any better comparison by which to explain the solidification of the atmospheric vapors (carbonic acid, water, nitrogen and oxygen) in combinations with earthy substances, or in substitution for the latter with ammonia into vegetable substance, than on the one side, this process of saonification and, on the other hand, the soil substance which is the basis of soap.

The production of oil substance consists in this, that combustible substances (hydrocarbons) are generated from burned-up substances (carbonic acid and water) and this characterizes in the main the nature of the universal vegetation of plants. A burning stearine candle is transformed into carbonic acid gas and watery vapor, but these aeriform products, in combination with earths, are again transmuted into combustible wood, sugar, starch and oil by the operation of the

sun. Wherever new earth comes into activity, as at the foot of mountains, there is found a vigorous growth of plants, especially when a sufficiency of carbonic acid clings to the rock as in the Jura regions.

The road from Basel to Biel is very instructive in this respect. On the contrary, it is seen that in densely populated regions, as, e.g., in China and in Japan, after a cultivation of many thousands of years, the earth, exhausted of the material that forms cells, is of itself unwilling to produce as many nutritive plans as men and animals used for their sustenance; but as had been perceived that the nourishment which has been consumed, in so far as it has not been used in the new formation of lymphatic fluid and blood, being therefore superfluous, leaves the body through the digestive canal although chemically disintegrated and putrefied, nevertheless produces new vegetation when this material is brought on the fields and is mixed with earth; in China they collect with great care not only whatever has passed through the intestinal canal, but also the product of the bodily substance which is consumed by respiration, which is eliminated through the secretion of the kidneys and which also gives an impulse to new growth.

One or the other must take place. Either unexhausted new soil or the restoration of the nutrition consumed in the soil of the fields. Where the latter has not been done, as by the first European settlers in America, the crops decreased and the settlers moved from the east further to the west, in order to gain enough cereals from these as yet unexhausted soil for export to Europe. Now they have also come to see in America that they cannot continue thus, as there are no more domains

without owners into which they can immigrate without let or hindrance.

But how is it with us in Germany in this respect? After the soil would not yield any more, despite deep plowing, the cycle instituted in China was also put into practice. They had to see that the solid and liquid manure of the domestic animals, brought on the fields, produced a new growth, and the dungheaps began to be valued. By the aid of this dung the fields were kept fertile, although this was a mere makeshift. This makeshift has become a familiar one for several centuries, so that even in the time of our great-grandfathers, the saying was in vogue, "Where there is no manure nothing will grow".

So eventually what was a mere makeshift has become the regular rule. As a consequence of this traditional view, the conclusion followed: In order to get a large quantity of manure we must keep as many cattle as practicable. In this it was overlooked that the cattle would require again as much acreage for their nutrition, and the ground thus used could not be used to raise grain, so that in such an economy it was necessary to work the fields for the sake of the cattle, not for the sake of the men. but finally the thoughtful and bookkeeping farmers had to come to the conclusion that the raising of cattle only pays in mountainous districts, or in districts like the marshes of Holstein, which are kept fruitful by the continual washing down of Geest rocks.

I can only summarize here. As above said, the dungheap had been recognized as the augmenter of fertility and dungheaps were considered as the natural condition, **sin qua non,** for the growth of crops, although this was by no means founded on the natural order, but was only a makeshift.

Bread from Stones

When once the rule was established that when the stable manure would no more suffice some people recommended artificial manure. As these people gave themselves great airs of learning, the well-educated large landowners fell into their net, even more than the simple peasants, and therewirth the general retrocession of agricultural produce in the level regions was for some time at least fixed and sealed.

It may easily be seen that oxen and cows, no matter how high their cost, charged no salary for producing their manure. It was otherwise with the chemists and the dealers in artificial manure. These not only demanded to be nourished themselves, but also desired from the gain produced by their business to educate their children, to build their magazines, to pay their traveling agents and to increase their capital. This business like all those which supply necessaries proved so remunerative that one of the greatest houses dealing in artificial manures in a short time has made millions, which were paid them by the farmers without receiving and equivalent; for in spite of the most energetic application of artificial manures the crops steadily decreased. How could it be otherwise? **Plants need potassium, soda, lime, magnesium, iron, manganese, sulphur, phosphorus and fluorine, and in artificial fertilizers they only received expensive potassium, phosphoric acid and nitrogen for their nourishment.**

The consequence of this showed itself first of all in frequent bankruptcies of agriculturists. But besides this, nitrogenous fertilizers in the form of Chilean nitrate have caused a predominance of cattle diseases. That hares and deer have been found dead in numbers of places which have been

fertilized with Chilean nitrate I have read in at least twenty newspapers, and it has also been reported to me by eye-witnesses. As in the open air so also in the stables. No normal animal bodily substance can be formed from fodder manured with nitrogen, especially no wholesome milk equal to that from cows feeding on mountain herbs.

It is not to be computed how great an injury to health in men and animals has been caused by stable manure. Milk produced from ammoniacal plants paved the way by which the destructive spirit diphtheria has swooped down after measles, scarlatina, scrofula, pneumonia had become the familiar companions of the Germans, who before were strong as bears. Artificial manure at last put the crown on the work of destruction.

How could this happen? Very simply. Liebig was the first agricultural chemist. He found that the ashes which remained from grain mainly consisted of phosphate of potassium. From this he concluded that phosphate of potassium must be restored to the soil, and that was very one-sided. Liebig had forgotten to take the straw into account, in which only small quantities of phosphoric acid are found, because this substance during the process of maturing passes from the stalk into the grain. If he had not only calculated the seed, but also the roots and the stalks, he would have found what we know at this day, that in the whole plants there is as much lime and magnesium as potassium and soda, and that phosphoric acid forms only the tenth part of the sum of these basic constituents.

Unfortunately Liebig also was of the opinion that potassium and phosphoric acid has to be res-

tored to the soil as such, while anyone might have concluded that instead of the exhausted soil, we must supply earthy material from which nothing has been grown. Such untouched earthy material of primitive strength we get by pulverizing rocks in which potassium, soda, lime, magnesium, manganese, and iron are combined with silica, alumina, phosphoric acid, fluorine and sulphur. Among these substances, fluorine, which is found in all mica minerals, has been neglected by Liebig and by all his followers, and has never been contained in any artificial manure. But we know from later investigations that fluorine is regularly found even in the white and yellow of bird's eggs, we must acknowledge it is something essential to the organism. Chickens get this fluorine and the other earthy constituents when they have a chance to pick up little slivers of granite. Where this is denied them, as in a wooden hen house, they succumb to chicken cholera and chicken diphtheria.

We men are not as well off as the birds of the heavens. We must eat the soup prepared for us by the dealers in artificial manures. Since these sell no fluorine our cereals suffer a lack of fluorine, and so no normal bony substance can be formed without fluorine. In the same degrees as the number of dealers in fertilizers increased, the army of dentists and the erection of orthopedic institutes increased but the latter were unable to remove the curvature of the spine in our children.. The enamel of the teeth needs fluorine, the albumen and the yolk of the eggs require fluorine, the bones of the spine require fluorine.

How rich, how strong and how healthy will we Germans be when we make our mountains tributary to yield new soil from which new

cereals may be formed. We need then no more send our savings to Russia, to Hungary, to America, but will make our way through life by our strong elbows and with German courage and shall keep off our adversaries.

The goal aimed at, of satisfying the hungry, and of preventing numerous maladies by restoring the natural condition for wholesome plant growth, seems to me one of the highest and most noble. Even six cwt. of prepared stone dust to the Prussian morgen (one fourth hectare, or about 10 cwt. to the acre) will give sufficient nourishment for a satisfactory crop, if this amount is supplied each year. If more is used, the yield may be so much the more increased.

I conclude these remarks, which were introduced with a motto that adorned the exhibit in Leipzig of the produce yielded by stone dust, by reproducing also the second rhyme which had been introduced there, and which, like the motto, has a conscientious adherent of mineral manure for its author:

"Art we love, but never can endure
To see the artificial in manure."

CONTRIBUTIONS

FROM

HENSEL'S

FOLLOWERS

STONE MEAL

by Herm. Fischer, M.D.
Westend, Charlottenburg
From No. 1 of Pomologische Monatschefte, 1892.
Edited by Fredrich Lucas, Director of the Pomological Institute in Reutlingen

Not only those who like to eat fruit and vegetables, but much more, those who raise fruits and vegetables rejoice in the abundant and savory produce of our gardens. To maintain this produce and, if possible, to increase it is the endeavor of rational horticulture. This end is striven for through careful cultivation, and more especially by abundant manuring, especially with nitrogenous compounds. It says this end is striven for, but it is not always reached. The long-continued labors of a well-known investigator, Julius Hensel, have opened new prospects for agriculture, fruit raising and horticulture. They show, in fact how we can "turn stones into bread."

Hensel's book, "Das Leben", has lately appeared in a second edition. Every thinking reader will find a high enjoyment in the study of this book. For our present consideration I recommend especially Chapter XXX, p.476, "Agriculture and Forestry". Lately a little work, by the same author, has appeared on "Mineral Manure the Natural Way of Solving the Social Question", published by the author at Hermsdorf unterm Kynast, Silesia. The first part of the pamphlet is devoted to the defensive, for like all pioneers our author meets with violent opposition from the or-

thodox teachers of agriculture, who cures and periwigs have come into a great state of agitation.

After his defense the author passes to his theme proper. Earth, air, water and sunlight must cooperate to produce a fruitful growth. We entrust our seeds to the earth. What is earth? The earth or soil is disintegrated primitive rock (gneiss, granite, porphyry).

The soil of our fields is continually being increased by the disintegration of primitive rocks, and from this there grow up grasses, herbs, shrubs and trees; without mineral constituents no plant can grow. Now, when in level plains the upper layer of the soil through long cultivation has become exhausted of certain necessary mineral constituents, new rocky material must be provided, from which nothing has as yet been grown, which, therefore, still contains all its strength; this is not only the most natural, but also the simplest and at the same time the cheapest way to increase and maintain the yield of our fields.

This is not mere theory, thought out in the study; but experience and success have demonstrated it. With Hensel there is no more need for experiments, but merely of demonstration. A firm in the Rheuish- Palatinate has produced a variety of fertilizers, according to his directions, out of pulverized rocks, such as are most suitable for the various plants. I will here only mention fertilizers for vineyards, meadows and potato fields. Hundreds of advocates affirm the favorable results of these fertilizers. The rest shall be read in the pamphlet itself.

Since the spring of 1890 I have used Stone Meal manure in my garden, situated on our well-known sandy soil, and am extraordinarily well

pleased with the result. I have picked from a row of raspberry bushes about twenty-three yards long fifty quarts of the most delicious fruit, some of over one inch in length and three-fourths of an inch in diameter. The shoots this year, which will bear next year, are as thick as a finger, some as thick as a thumb, and up to eight feet high. The young fruit trees planted about three years ago are bearing very well, and what is well to notice, they are set abundantly with buds for blossoming next year. What is especially surprising is that I have found no worms at all, neither in my raspberries nor my early pears and apples. The winter apples also have so far not shown a single worm-eaten fruit.

My vegetables I sowed in furrows, covering first with mineral manure and leveling the furrow with earth. The plants I took out to transplant have a mass of roots such as I have never seen even in a manure bed. They, therefore, were easily transplanted; none withered. I will not mention my asparagus because the variety used of itself brings big shoots. I have cut asparagus weighing six to nine ounces; they were a foot long and their circumference at the middle of their length was four and one half inches; the taste of this asparagus is excellent.

I would especially point to the quality, the most delicious savor of fruits, etc. grown with this manure, in contradistinction to those grown with stable manure; this is also shown in the pamphlet mentioned above. With all these advantages, mineral manure is even cheaper than all other artificial manures. **"We need no artificial manure if we supply that which we annually draw from the soil in the form of fruits, etc., by means of fresh, unexhausted**

pulverized granite, gneiss or porphyry as the genuine strengthening and primitive fertilizer, mixed with gypsum and lime.

The fallacy of the supposition hitherto held that all cultivated plants must have especially nitrogenous food in order that they may prosper, becomes more and more apparent. By experiments it has been indubitably proved, and Hensel always asserted, that plants, and especially the leafy leguminous fodder plants (clover, vetches, etc.) can take up and elaborate nitrogen through their leaves out of the air, just as the carbonic acid taken up from the air is worked up into hydrocarbons under the operation of light. All we need, therefore, is to furnish the soil with the necessary mineral constituents. Mineral manure is the most profitable, most lasting and, what is not to be overlooked, and entirely odorless fertilizer.

If I shall have succeeded in calling the attention of the reader to the glorious effects of this manure, the object of these lines are attained. When the use of this manure is then followed by surprising results the beautiful fruits will, in the most literal sense, be my reward.

STONE FERTILIZING

by Dr. Emil Schlegal, Physician in Tubingen
From the Wegweiser zur Gesundheit
September 15, 1891

This is a subject that does not immediately concern the **Wegweiser zur Gesundheit,** but which nevertheless, on account of its far extended importance may have the greatest effect on the well-being and wealth of our people. The chemist, Julius Hensel, of whom we have several times before this spoken in earlier numbers of the **Wegweiser,** and who is known to its readers by his genial book, "Das Leben", has lately published another work which deserves particular mention. He therein sets forth that the loss of soil in mineral substances (lime, magnesium, etc.) is not supplied by animal offal, though this produces a strong forcing of the plants, which makes the leaves and the products weakly and injurious, as this is said to have developed in the irrigated fields at Berlin, where the bones and muscles of the animals fed on their produce are suffering and also the milk is not satisfactory for sucklings.

In a still higher degree these injurious forcing substances are found in artificial manures and especially in Chilean nitrate, causing rapid, surprisingly luxuriant growth; but when the fruit or the seeds develop, there is a manifest falling off. Now, since every year millions of dollars are transferred from the pockets of the farmers into those of manufacturers of artificial manures, and of speculators and stockholders, this amounts to an impoverishment of the soil by parasites.

Bread from **Stones**

The true cure of an exhausted soil consists, according to Hensel, in supplying it with comminuted rocks, especially granite, gneiss, porphyry and lime. Thereby the plants receive again what they naturally demand. The Wegweiser would here remark that the best proof of these views given on a great scale is thousands of years old, i.e., the fertility of Egypt. The mud of the Nile consists almost exclusively of finely comminuted rocks, with very, very few organic nitrogenous constituents. But the flooded districts owe their unexampled fertility to just this precipitated stone dust. Hensel writes at the end of his book:

"Almost every field contains stones which have only been acted upon in part by the dissolving moisture of the soil, and which therefore show a more or less rounded form. These stones, as they injure the spade or plow, are usually removed to the sides of the fields and there heaped up, and are then sold at a cheap rate for use on the highways. The farmer who acts thus sells his birthright, so to say, for less than a pottage of lentils, for he removes the source of fertility from his fields. If such stones are heated in the stove or on the hearth for half an hour and then thrown into water they become so friable that they may be broken into small pieces by the hands and may easily be pulverized with a hammer. It is to be wished that these developments of Hensel should find a wide diffusion."

Letter to Mr. Schmitt

Oranienburg
August 17, 1893

Highly Honored Sir:

I have just returned from my long tour for the stone dust, having been away five weeks, and I herewith give you a brief report, so that you may also enjoy the victory which stone dust has gained wherever it has been really put to a practical test.

I have already written to you of the eminent, happy effects of stone dust on the estate of Count Chamare. I have been able to see its good effects also in Upper Silesia, and have established there two more stations for the future, where normal trials will be made. I saw exceedingly significant results from stone dust on the field of Chief Bailiff Donner at Culmsee in West Prussia, i.e., excellent wheat, showed after barley and oats, with only five cwt. of stone dust to the acre; also splendid rye in fourth succession on five cwt. of stone dust, and sugar beets following sugar beets on merely six and a half cwt. to the acre, which promise a very good yield. Here it was found that the fields needed above all a good supply of lime, and this lime was the best support to the happy effects of the stone meal demanded a simultaneous application of lime of sixteen to thirty cwt. per acre.

So great a quantity will not be used in one year. For the Stone Meal made according to Hensel's directions contains as much lime and magnesium as the average crops call for.

The cultivation of sugar beets can be doubled by stone meal. This accomplishment would surely be a great result from stone meal. Also in West

Prussia I have established an experimental station for the proper use of stone meal on a large estate near Braunsberg, belonging to a Herr von Bestroff. This gentleman called on me for this purpose also before this in Oranienburg.

I hope that this, my first tour in behalf of Stone Meal, has not been in vain, and I intend, God willing, to repeat these tours annually, so as to benefit our great and important cause with all my strength. I am quite confident that stone dust combined in the proper way with lime will by its practical success carry off the victory.

I shall do my best to carry out the stone-meal experiments on the estate of Count Chamare in the most conscientious manner, and hope that God's blessing may rest on this my labor, which I perform gladly for my country.

Otto Schoenfeld
Director of the Agricultural
and Forestry School

Letter By Mr. K. Utermohlen, Teacher in Leinde, to the Pomologieal Society "Heimgarten" in Bluelach

By means of the Stone Meal manure of Hensel we shall soon surpass all similar undertakings (cooperative Pomologieal Association). If the tree has a sufficiency of this primitive substance under its roots it is not only fruitful, but no more sensitive to frost and diseases. Nor will it be infested as much by insects, as it will be healthy, having a pure sap. With the usual treatment with manure rich in nitrogen the trees are satiated to repletion, and then it is with them as with men. Their fibers are relaxed, their sap is checked, diseases develop, lice and other vermin infest them, and then we have to sprinkle them with mixtures, cut out wounds, put on wax and pitch, etc. By well preparing the soil with this manure, we prevent all these troubles from the start, and the trees become strong and hardened. It is just as when parents bring up healthy children with solid food. They then have none of these troubles and cares encountered by parents who treat their children perversely.

For the past two years I have been making various experiments with stone-meal manure, and indeed with the different kinds. From my experience with it, I have come to the firm conviction that we used no other manure at all but this. I wish I could speak with angels' tongues to make clear to you its great importance for our cause. It would carry me too far to speak of all the various

experiments. A radical reform in this direction will have to be made. If we give the trees when they are first planted some of this manure before their roots, with good irrigation, they will be trace as strong and vigorous as without it. We do not need any stable manure to loosen the ground, that is best effected by diligent hoeing and digging. Where this should prove insufficient we call in peat moss to our aid, and this can be gotten cheap here. That is what I did with my heavy garden soil, and then with the help of Stone Meal I have raised the finest vegetables, though the garden has seen no stable manure for eight years. And then how pleasant and cleanly is this mineral manure when compared with the smell of solid and liquid stable manure. Then we should consider its great cheapness. Much can be done with 1 cwt. If we had always to use stable manure we would have to give out great sums every year, and even then we could not get a sufficient quantity.

But there must be manure, for "from nothing nothing comes", as the saying is. In this respect the mineral manure is our best help. We cannot in this matter give any consideration to the authorities in horticulture, as they are in error with respect to the nutrition of plants. I refer especially to their silly theories about nitrogen. Who brings to the strong oaks of one hundred years growing on rocky soil, or to the other lively children of mother earth, out of free nature, liquid or solid manure or sewage? They grow and flourish and revel in their healthy growth just because they are spared all these. So will be with our fruit trees when we shall nourish them in a natural manner. It is not a mere secondary question, but a most fundamental one, which is here

involved. The question is whether we shall in the treatment of our little trees follow the perverted and worn out routine of the wisdom of the professors of our state with their theories of albumen or whether we will follow the path of nature. We have chosen for ourselves and our mode of living the latter course. It is then surely proper to do the same with respect to our plantations.

If I only has a photographic apparatus I should like to send you a picture of some of our standard trees and some of our half standard to which I have especially applied this manure. Such a multitude of the finest russets! It would hardly be thought possible in a small tree of four years. And then you should see how this little fellow has increased in thickness! His coat has almost become too narrow for him. The apples hang twice as thick as in other years, and their flavor can hardly be recognized; their aroma is really refreshing. The same I have perceived this year in our cherries and raspberries. When I come to see you I shall bring a whole selection of apples for trial.

I well manured a bed of several square yards of ground and planted it with cucumbers. After gathering this summer a whole basket full I thought I had a remarkably good crop; but no the bed is just as full again, although I have picked some from time to time. The same is the case with the beans and onions which I have noticed particularly, as we can only plant flat-rooted vegetables between the trees.

We cannot sufficiently express our satisfaction that **we have in this manner not only found a substitute for, but something far better than stable manure.**

The STONE MEAL of DR. HENSEL

before the Committee on Fertilizers of the German Agricultural Society

From Dr. F. Schaper, in Nauen, in the "Osthavollaendishes Kreisblatt"

Most of the members evidently knew nothing about the mineral manure through the abuse of the well-known Professor Wagner, in Darmstadt. It is a sad state of affairs, but it is true, that these institutions, founded for the use of agriculture, cannot act freely, but have to regard quite different groups of interest, i.e., those of the manufacturers of manure. That their interests and those of the farmers are directly opposed to each other is manifest from this that the farmers desire cheap fertilizers but the manufacturers of manure desire to keep them as high as possible in order that they may make the more money. Now the agricultural experiment stations receive part of their support from the manufacturers of manures, as they are paid for their control analyses, experiments, etc. In order that they may not lose these contributions, these institutions must avoid whatever runs counter to the interests of their employers. It is often even stipulated in the contracts between the manufacturers of fertilizers and the agricultural experiment stations that they should obligate themselves to protect these factories of artificial manures from unfair competition.

But who is to decide who and what belongs to "unfair competition?" The manufacturer will be

apt to consider every one as an "unfair competitor" who threatens to diminish his profits, and he will therefore insist, and a certain plausibility cannot be denied to their demands, that the agricultural stations according to their contract should in every case work for them. This enables us to explain the silence or the open hostility of the agricultural experiment stations toward Stone Meal fertilizer. No intelligent man will on this account consider this hostility of importance or take too serious view of it.

The opposition should even be of use to the cause, since no truth valuable in itself can be injured by the exercise of a criticism ever so sharp, if this is done in a scientific manner. But such an objective criticism has not been exercised on Hensel's theory, but certain directors of experiment stations, instead of combating it in a scientific manner, have descended to gross abuse and have, therefore, been judicially punished.

Mr. Shulz-Lupitz, the chairman of the Committee on Fertilizers, objects to Mr. Hensel in the season of February 14 of this year (1893), that he is conducting his cause against acknowledged men of science in a rough manner, and that this could not be rebuked sufficiently - a peculiar objection as coming from a man who, as far as the direction of the proceedings and the form of the resolution offered by him and finally accepted go to show, has only a slight regard for the whitewashed politeness of Europe. Mr. Hensel was not the attacking party, but quite a different set of people, the close friends of Mr. Shulz-Lupitz, and the aim of the proceedings was evidently to get them out of the scrape into which their own precipitation had brought them.

The well-known professor, Dr. Wagner, in Darmstadt, director of the agricultural experiment station there, in his edict in the year 1889, has called the mineral manure a gross swindle and denied it any value. This edict had been published in Zimmer's factory in Mannheim in innumerable pamphlets and in journals as a supplement. Thus it came that in far extended agricultural circles which only heard of mineral manure through journals of Wagnerian tendency, Mr. Hensel was accounted as a charlatan. When a man like Mr. Hensel who thinks he has discovered something useful for agriculture is thus shamefully reviled, and in the end deals with his assailants in a somewhat doughty fashion, who will account him reprehensible? Nor Mr. Shulz-Lupitz, in the proceedings, continues this kind of polemics against Mr. Hensel.

The resolution passed declares in its first part: "Hensel's Stone Meal is from the standpoint of practical and scientific knowledge to be designated as a worthless fertilizing agent". Just the contrary is the truth. From the standpoint of practical experience the Stone Meal has shown itself a valuable fertilizer; surely enough, the men who had some practical experience with the manure were not acknowledged by these gentlemen of the fertilizer division but they were presented by some learned men of this assembly conscious of the infallible book learning, as men who could easily be cheated, and who now also cheat others, thus as cheating and cheated.

These learned gentlemen seem to forget that in practical life a grain of common sense outweighs a hundred weight of book learning.

In the second part of its resolution the fertilizer division rebukes the "impertinent bearing"

of the "so-called chemist", Hensel, with indignation and "expresses" to Professor Wagner, in Darmstadt, the thanks of the practical agriculturists for his appropriate designation of the Stone Meal of Hensel. This latter gentleman has called it as above mentioned, a gross swindle. The fertilizer division has cautiously avoided using this expression. For this expression has caused the punishment of two editors who had copied the Wagnerian production and its author. Professor Wagner has escaped a probable judicial condemnation only by the fact that the complaint owing to an oversight fell under the statute of limitation.

We who are convinced of the value of Hensel's method of improving the soil look trustingly into the future, with the courageous and intelligent champions.

I would, therefore, request all who have had any practical experience with Stone Meal to publish their experiences for the good of the cause and of their fellowmen, and not to leave the field to the sole occupancy of the opponents. The word of the single man easily dies away, the multitude only make the full chorus, especially in our democratic times, and this chorus alone can hush the short-sighted insolence and the self-interests which oppose the new discovery.

ABOUT STONE MEAL MANURE

(Land und Hauswirthschafliche-Rundschau, No. 11, 1893)

A short time ago we published an article on the experiments with the new Stone Meal fertilizer; we also gave space to an objective presentation as to the causes which make Stone Meal suitable for a manure. The new fertilizer and its discoverer have suffered severe infestations. It may, therefore, interest our readers to see a report from our neighborhood as to some trials made of it. We have received the following:

Some time ago a burgomaster of the neighborhood called our attention to the splendid stand of grain manured with Stone Meal on the "Steinheimer Hof", on the estates of the Grand Duke of Luxembourg. A company of gentlemen who take an earnest interest in this matter (chemist Dr. Ebel, teacher Eeisenkopf, and the landed proprietor, Loeillot de Mars, from Wiesbaden; Director Spiethoff, editor of the Pioneer, from Berlin; Mr. Forke, of Eltville and Dr. Dietrich and Dr. Brockhues, from Oberwallauf) in a Whitsuntide excursion verified these statements beyond all expectations.

In spite of the great drouth, the rye on 18 1/2 acres of ground had stout stalks and long thick ears, and the tenant, Mr. Heil, told us that little more than 5 cwt. to the acre, together with 1000 cwt. had been used. Just as luxuriant with dark green stalks and leaves stood the oats, 1 1/2 acres, right by the highway. This piece of ground had not had any stable manure for many years,

and had only received 20 cwt. of Stone Meal with an addition of 6 cwt. of iron slag. The comparison with the neighboring fields which had been well cultivated, but differently manured, was very much in favor of the manuring with Stone Meal.

Just as striking as was the success of Mr. Forke, with his rye, oats and clover, it was on his fruit trees and grape vines. We would only mention that a clover field of which one half has been manured with stable manure and the other half with Stone Meal showed a dense growth of clover on the latter half, while the former half showed many weeds but hardly any clover. A cherry tree and a tree with Gravenstine apples, which for many years has yielded no fruit worth speaking of, this year, after having been well supplied with Stone Meal, was covered over and over with fruit.

A neighboring farmer told him, on seeing his fine oats, Here we can see clearly how your manure acts; it could not stand better if you had put on 60 cartloads of stable manure per acre, which would have cost $125.00 to $150.00 per acre.

The condition of the grape vines after repeated manuring with Stone Meal was on comparison with other grape vines found to be excellent, but we shall return to particulars, as with the rye and oats, at the time of harvest. We invite the farmers of the neighborhood to make their comparisons and to convince themselves of the solid results of manuring with Stone Meal. This possesses the quality of **vigorously nourishing the plants and making them strong to resist frosts and drought.** The above-mentioned gentlemen will bear record as to whether Hensel is really the "false prophet" that he has been represented to be.

To Director Spiethoff this investigating committee, in which he took part, was the more wished for, as the **Pioneer** has first called addition to the scientist Hensel, and has also been the first to communicate last year the astonishing results in the Agricultural School of Oranienburg.

What help can be given to the HARD-PRESSED FARMERS

(Badischer Volksbote, July 1, 1893)

Our land is not only being more heavily encumbered with mortgages every year, but is also losing some of its good qualities and fertility, and as the debt increases the value decreases.

We can improve the soil and can make it fertile by using Stone Meal as a fertilizer, as is shown by the experience of many practical farmers. In the "Neues Manaheimer Volksblatt", M. A. Heilig publishes the following declaration:

"The Landwirthshaftliche Blaetter", by Councillar Nessler in Karlsruhe rejected a few months ago Hensel's method of mineral manuring. Whoever wants to convince himself how Hensel's method acts in practice is invited to inspect my two and one-half acres of barley near the Isolating Hospital. Despite the unusual drought, the barley has attained an unusual height, and stands much fresher than the barley in other fields. After the harvest I shall have the yield determined before witnesses to see the difference also in the respect."

When practical experiments show such results the farmer ought to give up his old prejudices and try himself to see whether the new method of manuring is not better than the old. That the scientists and professors ignore the new source of fertilizing need not astonish us. On the contrary, "the professors are opposed to it, therefore it is good" may soon become a proverb, for hitherto the professors have always opposed everything good at its first appearance. We think Hensel's

method of manuring will likely make agriculture again profitable, and we shall recommend it even if all should oppose us on this account. When at some future date, not too far removed, the German farmer and through him the German people shall enjoy the blessings of this improvement of the soil we shall yet receive thanks that we helped to prepare the path for this new good during its hard times.

"THE RHEINISCHER COURIER"

by L. Forke, Wiesbaden, June 6, 1893

We have received the following communication: In No. 152 of your valued journal, among the Agricultural Communications), is a short, but favorable, notice from the Fertilizer Division of the German Agricultural Society concerning Stone Meal. With respect to this, permit me to invite you and everyone interested to examine the fields and vineyards of my friend Franz Brodtmann here, as also the rye fields of Mr. Heil, the tenant farmer at Hof-Steinheim, on the estates of the Grand Duke of Luxembourg, which had been manured with this material according to my directions, and they will be convinced that contrary to these views, Stone Meal is a most important fertilizer of the very best quality, which when rightly used yields the best results.

THE REINISCHER COURIER

by L. Forke, June 29, 1893

Communication No. 175 of your morning edition of June 26 contains an attack on Stone Meal as a manure, and an exaltation of the present method of manuring with potassium., nitrogen and phosphoric acid. I was for many years an adherent of this latter method, but I have become convinced by experience and practical trials that these artificial manures serve indeed to **force the growth** and may be used with effect for several years, but that they do not restore to the soil what we withdraw from it in cultivation. Therefore the state of our soil unavoidly deteriorates from year to year, and at last refuses its service. Nobody can stand partridges every day, but he can his daily bread, and so it is with all plants, which not only need potassium, nitrogen and phosphoric acid for their nourishment, but in addition soda, lime, magnesium, sulphuric acid, silicic acid, chlorine, iron, fluorine, carbonic acid etc. All these elements are found in many rocks in greater or smaller quantities, and Hensel cannot be sufficiently thanked that he has pointed out to us farmers these inexhaustible supplies.

When we return Stone Meal to the soil we restore to it all that was in the soil from the beginning; and that our early ancestors did well with the original material is manifest, as stable manure has only been used for about two hundred years, and so-called artificial manure

only about fifty years. Of course we cannot force matters with Stone Meal; but if it is brought on the fields in autumn and plowed under we may count on success as may clearly be seen here and as I have already stated in No. 155 of your much valued paper. With all esteem for science, we farmers cannot be contented with simply finding out how much potash, nitrogen and phosphoric acid the artificial fertilizer contain and how much every per cent thereof costs. We must rather strive to raise good crops on our fields with slight expense, without at the same time causing our soil to deteriorate by a one-sided system of fertilizing, and this is certainly done when we only apply potassium, nitrogen and phosphoric acid.

THE "NEUS MANNHEIMER VOLKSBLATT"

July 19, 1893

That the much-abused Stone Meal cannot be without its excellent points the results in the fields best show. Mr. Kircher here has raised on various fields manured with this material barley and wheat, which must absolutely convince even the most skeptical of the usefulness of this manure. First, not only are the stalks considerably higher and stronger than those from fields manured with other material, but the ears are on the average one-third longer and the grains considerably more perfect. (Mr. Kircher has left in the editorial room of the "N.M.V." several wheat ears and barley ears from his fields to show the difference, also some from neighboring fields which have not been manured with Hensel's fertilizer. Whoever is interested in this matter, and every farmer should be so, may inspect the ears in our office.)

IRON SLAG

(Koelnische Volksveitung, April, 1893)

The supplement of the **Thueringer Landboten** brings a noteworthy article by the practical farmer, A. Armstadt, under the heading, "The Future of Iron Slag". The author first notes that iron slag has risen to be the most generally used fertilizer containing phosphoric acid only in consequence of an immense amount of advertising, but now it seems to be about to lose much of its reputation. Even the German Agricultural Society will earnestly declare against it in its next publication. "I myself, says A. Armstadt, "have never been enabled to feel any enthusiasm for iron slag in consequence of my experiments with it, and I have frequently on various occasions declared this, and it is a satisfaction to me that numerous reports are now appearing which confirm my observations. First of all, the fact that people come to doubt the theory of a gradual enrichment of the soil, thereby will cause it to lose credit. Men of science, as is well known, gave out the notion that the soil must gradually be enriched with phosphoric acid in order that rich crops may be raised. Iron slag was said to be the most suitable for this purpose, not only because the phosphoric acid in it is cheapest, but also because phosphoric acid in this form would in time become more soluble. But most farmers have waited probably in vain for the after effects. I myself have never found any after effects. According to the latest experiments, it is not only probable but pretty well established that every enrichment of the soil with phosphoric acid in

mineral form is a waste, for it passes into a form difficult of solution, so that it cannot any longer be taken up by plants. Professor Liebscher (Goettingen) even found that with a manuring of 100 cwt. of iron slag to three-fifth of an acre no after effects developed, though he waited for it for seven years.

"NEUS MANNHEIMER VOLKSBLATT"

by Dr. E. Schlegel (Physician), August 3, 1893

With a few potted plants or a small piece of garden anyone can make a trial of the value or worthlessness of Hensel's teachings, and no more paper need to be wasted in their justification. An increasing number of farmers are experimenting successfully with the new fertilizer and it will gradually but surely supersede the old. The old manures supplied plants with too much **forcing** material and too much phosphoric acid, a substance which surely causes plant-lice, caterpillars, snails and the like. The Stone Meal improves the nutrition of the plants without forcing them, so that while their growth is slower, their leaves have a lesser amount of water, the fruits and stalks a greater amount of lime and are more wholesome and nourishing.

As the fruits mature the phosphorus passes mostly into the seeds and the silica into the leaves and stalks. When agriculture hitherto built its theory of manuring on the ashy constituents of the seeds with their high contents of phosphorus, it did not consider that the whole growing plant before the separating process ripening requires quite different proportions of admixture than what may be derived from seeds alone. A comparison of Hensel's views on this domain with the questions of human nutrition rises very naturally.

Bread from Stones

Exhausted men also are favored with allowing them to eat heartily of the convenient meat, with eggs and milk, all nutriments fully prepared for assimilation. The consequence is an excitation and irritation of the whole organism, bad digestion, increased waterly contents of the body perspiration, thirst, exhaustion from slight exertions, debility.

A strong manuring with predominantly animal offal is for plants planted in a soil deficient in certain minerals what a predominantly animal diet is for men. If we look at men who live in the country almost altogether on food difficult of assimilation, of bread, vegetables and fruit, we observe a far more quiet bodily activity, little perspiration, little thirst, great and continuous muscular power.

It is similar with plants when we offer them again the original nutriments, direct them to the appropriation of mineral constituents and give them organic manures or nitrogen only in small quantities and as a secondary matter. In both cases the results will be more normal, freer from parasites (diseases). If we notice in agriculture journals the enormous expenditures for advertising artificial manures it may be known what a gain these factories yield, and the mind grows sad at the wealth withdrawn from German farmers, who even without this are so hard-pressed.

WIESBADENER GENERAL ANZEIGER

July 8, 1893

For diminishing the distress as to fodder, we do not need as the troubled farmer is advised in another journal to use artificial manure; superphosphate and Chilean nitrate or superphosphate of nitrogen of potassium for the meadows; superphosphate of nitre with acid phosphate or phosphate of lime for the cloverfields; fresh stable manure and liquid manure. Chilean nitrate, superphosphate of potassium or superphosphates of nitre for Indian corn for the horses, etc. The pen and compositors object to the twenty-fold repetition of the wonderful compounded fertilizers. We recommend for the meadows ashes of every kind, and for the root fields, street manure.

For five years I have been using Stone Meal manure in my garden and fields. The results always have been satisfactory in every respect, for the soil becomes better every year by using this manure. Especially this year during the extraordinary drought, the excellent effects of Stone Meal fully manifested themselves. The flower as well as the different vegetables developed so magnificently that everyone who passed my garden stopped and admired the great growth, especially of the kohlrabi. In the cabbage which I planted at the beginning of April in my cow pasture, the rich crop is the more astonishing as it was not watered during the whole of its growth. This field has received for five years only Stone Meal manure (no solid or liquid stable manure).

Bread from Stones

Alongside of the cabbage field is the potato patch and it shows a most luxuriant growth despite the abnormal drought. The above experience has brought me to the firm conviction that this fertilizer not only improves and augments the cultivated soil, but also keeps it moist and therefore prevents the rapid drying up of plants during the drought.

Bernh. Wettengel
Horticulturist and Truck Farmer
July 1, 1893

For two years I have used Stone Meal manure with the greatest success, and especially this year, despite the extraoridnary drought. The results have been magnificient; the barley showed a much larger yield of grain than ever before; the potatoes were very fine and to our astonishment remained untouched by the heavy frosts, though others that had received stable manure suffered very severly. I was very much pleased with the effects on oats and clover. Quite astonishing also is the dark green, full leaved appearance of the sugar beets, notwithstanding the great continuous drought. With the fruit trees, where I especially applied the new fertilizer, I have fully learned how extraordinary it acts. I would therefore urgently recommend every farmer to adopt the new method.

Peter Heilman
Agriculturist, Moersch, near Frankenstal
June 30, 1893

Meeting of Farmers and Friends of Agriculture Assembled on June 25, 1893

In order to determine the results of the new method of fertilizing, farmers and friends of agriculture assembled on June 25, 1893, early in the morning at 7 o'clock sharp, for a common inspection of the fields where Hensel's Stone Meal was used. Nearly all taking part in the inspection were practical farmers, who are entirely familiar with the local relations and quality of the fields. The result of the inspection may well be called astonishing.

Though the summer has been abnormally dry, all the barley inspected distinguished by its dark green appearance when compared with other fields not fertilized with Stone Meal. The ears compared with the others contained more rows. In a number of them we counted forty grains extraordinarily fine and well developed. The same conditions existed with the rye. The potato fields showed a surprisingly luxuriant stand. We must especially mention the full dark green appearance of the sugar beets, which encourages us to look forward to a full development of the roots. With the cabbage the rich crop is the most surprising as it has not been watered during the whole period of its growth.

STONE MEAL FERTILIZATION from Viewpoint of Agricultural Chemistry

The Cause of the Decadence of Agriculture

The yield of the ground is steadily decreasing. Everywhere is distress. Our fields do not yield sufficiently abundant crops to compete with the cheap lands of the Far West. To change this condition is the object of this book.

It is now 400 years since the second half of the world was discovered, but the whole earth is only now discovered, so far as the knowledge is concerned, of how the inexhaustible treasures may be utilized which are at our disposal in the nourishing forces of the rocks of the mountains. Instead of working this colossal mine men have bought the material for restoring the fertility of the exhausted soil in the form of medicine, i.e., chemical fertilizers.

For the past fifty years a dogma has crept into agriculture which calls itself "The Law of the Minimum", namely:

That one of the substances which the plant requires and which is contained in the minimum quantity in your fields, you must furnish to it in the form of a fertilizer.

This false precept owes its reception solely to the defective method of chemical investigation which prevailed fifty years ago.

As there was found a considerable quantity of phosphoric acid and of potash in the ashes of all

seeds, and as these do not exist in the air and must therefore be furnished by the soil, it was very natural that the inquiry was started, how much of these substances necessary for the raising of plants is still at hand in the soil?

While the soil was then investigated and was treated with muriatic acid, in order that the substances contained might be dissolved, there was found only inconsiderable quantities of potash and of phosphoric acid in this solution, because the alkalies in the soil which are combined with silicic acid are as little dissolved by muriatic acid as, e.g., powdered glass. In order to be able to define the amount of potash, it is necessary first to drive out the silicic acid by the use of fluoric acid after having converted it into volatile fluoride of silicum; this method was not used by the former agricultural chemists. As a consequence thereof they overlooked the presence of potash, as also did they fail to notice the phosphoric acid which is combined with alumina and iron in the silicates, because when the iron was precipitated from the solution the whole of the alumina and phosphoric acid was precipitated with it; the further examination of the fluid solution therefore gave a negative result with respect to phosphoric acid, and this is also the case at this day if we work according to the old method.

The teachers of agriculture therefore announced:

"Of potash and of phosphoric acid, these most important nutriments of plants, there is only a minimum left in the soil; therefore we must first of all supply potash and phosphoric acid to our fields."

To these two substances nitrogen was also added. Nitrogen in the form of vegetable albumen

is on the average contained in such quantities in plants that its weight frequently exceeds that of the fixed constituents of the ashes. The following may serve to explain this: The affinity of the earthy substances (lime, magnesium and oxide of iron) and of the fixed alkalies with respect to hydrocarbons is quite limited; its sphere of operation is limited to eighteen molecules of hydrocarbons, as may be seen in the soaps, which consist of combinations of potassium or soda with oleic acid or with stearic acid. Of like affinity with these earths and the fixed alkalies is the volatile alkali Ammonia N.H.H.H. this explains why when there are not sufficient earths carried up by the juice to complete the upbuilding of plants in their stalks and leaves, their place is filled by ammonia, which, as before said, is formed from the nitrogen and watery vapor of the air. The wood in the trunk of trees contains no nitrogen at all, but the leaves of trees contain a quantity of nitrogen; the parenchyma of the leaves condenses it from the air because the sphere of action of the earths, which extends even into the veins of the leaves, does not reach to parenchyma.

Now, in view of the great quantity of nitrogen found in the produce of the fields and of which agriculturists presuppose that it is derived from the roots of plants from the earth, they came to the same result as with respect to potash and phosphoric acid, i.e., they found only a vanishing "minimum" of it in the soil, and therefore they concluded: "Our crops have already consumed all the potash, all the phosphoric acid, and all the nitrogen; these substances are, therefore, in "minimum" proportions in the soil. If we are not to miserably starve we must bring this minimum

in abundance to our fields in the form of manures."

The result is that the use of superphosphates, sulphate of ammonia, guano and Chilean nitrate has enormously increased, but agriculture has entered into the sign of cancer (retrogression), for it may easily be seen that if the cost of fertilizers amounts to more than the harvest, the farmers must emigrate.

It took a long while before the teachers of agricultural economy, having the fact pointed out to them by practical farmers who judged with clear eyes and sound reason that crops of peas and beans rich in nitrogen prosper on soil entirely devoid of nitrogen, at least granted that leguminous plants derive their whole supply of nitrogen exclusively from the air, which consists of four-fifths of nitrogen. It is difficult for them to admit that other plants also do this, because their reputation and their income is mainly derived from the theory of potash, nitrogen and phosphoric acid. They explained this by asserting:

"There are **producers** of nitrogen and there are **consumers** of nitrogen."

Or if we count the 0.6 of soda, 0.4 of lime and 0.6 of magnesium equivalent with 1.65 of potash, then the **entire** quantity of potassium in the sugar beet, amounting to 3.85, would be at our disposal. This potassium we may consider as combined with carbonic acid in the ashes, while it exists in the sugar beet in combination with sugar, cellular tissue and albumen. Besides, 3.8 potassium, 1.6 of nitrogen, or in round numbers, 1.9 of ammonia, is to be taken into account as being also an unsaturated basic constituent of the beet root. From this it proximately follows: That

the 3.8 potassium cannot result from the manuring with sulphate of potassium, for else it would need the presence of 3.25 of sulphuric acid, while there is only 0.3 present, nor can the 1.9 of ammonia be due to the sulphate of ammonia, else they would call for 5.0 of sulphuric acid instead of only 0.3. If, therefore, we manure sugar beets with sulphate of potassium and sulphate of ammonia, these substances are to be regarded, as already stated, as largely wasted. As for the source of potash and the soda for the sugar beets we can only consider the feldspar, which, thanks to God, is still contained in a certain degree in the soil, while the nitrogen is furnished by the atmosphere.

A computation shows that to supply 0.3 sulphuric acid, 0.6 gypsum, combined with water, will suffice; thus if the acre of land is to furnish two cwt. of beets it would need among other things only 13 1/2 lbs. of gypsum.

As a parallel we will now consider the carrot. The ashy constituents of one kilogram (2.206 lbs.) are according to Wolf's tables as follows:

Potash	3.0	Phosphoric acid	1.1
Soda	1.7	Sulphuric acid	0.5
Lime	0.9	Silicic acid	0.2
Magnesium	0.4	Muriatic acid	0.4

A comparison with the sugar beet roots show that the carrot contains somewhat less potash and magnesium, but somewhat more soda and lime; besides this, the carrot contains about one-third more of phosphoric, sulphuric and muriatic acid. These variations seem to be caused by manuring with liquid stable manure; as to the rest we recognize that for the basic requirements

of potassium, soda, lime and magnesium in the carrots, the pulverized primary rocks of the soil are the natural source.

We find that all plants, as also all animal bodies (for these are built up from vegetable substances), after combustion, leave behind ashes which always consist of the same substances, although the proportions of admixture vary with the different kinds of plants. We always find in these ashes potash, soda, lime, magnesium, iron and manganese combined with carbonic, phosphoric, sulphuric, muriatic, fluoric and silicic acids. These ashy constituents give their form and connection to the bodies of plants and animals according to the manner indicated above.

Now, inasmuch as the plants spring from the soil, it is manifest that the enumerated earthy or ashy constituents must be furnished by the soil. And, as in the soil these substances are present in combination with silica and alumina, the origin of the soil thence becomes manifest. It has arisen from the disintegrated primary rocks, all of which contain more or less potassium, soda, lime, magnesium, manganese and iron, besides phosphoris sulphur, acids, chlorine, fluorine, silica and alumina. From such earthy material from primary rocks, which have been associated with sediments of gypsum and lime, in combination with water and the atmosphere, under the influence of the warmth and light of the sun, the plants which nourish man and beast originate.

Now, as all the enumerated earthy materials with the exception of silica and alumina enter into the crops that are taken away from the field, it is clear that they must be replaced. If we desire normal and **healthy** crops, and that men and animals living on them should find in them **all**

that is necessary for their bodily sustenance (phosphate and fluorate of lime and magnesium for the formation of bones and teeth, potassium, iron and manganese for the muscles, chloride of sodium for the serum of the blood, hydrocarbons for the nerve-fat), it will not suffice to merely restore the potassium, phosphoric acid and nitrogen. Other things are imperatively demanded.

With regard to this I shall adduce one instructive example. The proprietor of an extensive estate wrote to me that he formerly manured with ammonia, superphosphate and Chilean nitrate, and although there was a steady retrogression in the yields, yet he continued to earn something. Of late, however, when he had passed over to manuring with iron slag and Chilean nitrate, with a steady retrogression, at last neither rye, nor barley, nor oats would prosper, only, strange to say, wheat gave a tolerable yield. How could I explain this to him? To this question I gave the desired answer by pointing to the ashy constituents. The ashes of barley and oats contain five times as much sulphuric acid as wheat. The latter could still find its small requisite of sulphuric acid in the soil, but for oats, barley and rye these feeble remains did not suffice.

Now as we have seen that the primary rocks in the mountain ranges, porphyry, granite and gneiss, through the mellowing and crumbling influence of thousands of years (and nothing else is meant by "disintegration"), has produced the fertile soil which furnishes us with healthy nourishing plants, it may easily be seen that when such a soil has been almost exhausted of the elements that nourish plants through a cultivation of several hundred of years and a yearly turning

over with the plough or the spade, the original natural strength cannot be restored by it by means of medicines and single chemicals, but this can only be effected by supplying new soil out of which nothing has grown, and the strength of which is therefore intact.

To gain such new soil we need not wait a thousand years till wintry cold, snow and rain crumble the rocky material and bring it down into the valleys. We have only to put our hands to work, and from the proper rocks obtain the necessary materials to rejuvenate the old and worn-out soil and restore it again to virgin fertility.

HEALTHY AND UNHEALTHY PRODUCE

According to the chemical examination of the ashes which remain when plants are incinerated, the average result shows about as much potash and soda as lime and magnesium; silicic acid somewhat more than one- fifth of the sum of these four bases; chlorine about one-twentieth of the whole; phosphoric acid one-sixth of the whole; but sulphuric acid only one-fourth in weight of the phosphoric acid.

Now, as granite rocks contain on an average six per cent of potassium and soda, while their contents of phosphoric acid are more than one per cent, **granite by itself will readily fulfill the demands for vegetable growth,** as may be confirmed by a report to the papers received while writing this. We read:

"In Deutmansdorf, Kreis Lowenberg, in Silesia, were found on the heap of refuse from the quarries there stalks of rye with ears containing ninety to one hundred grains" (General Anzeiger fur Schlesien and Posen, October 1, 1893).

As to chlorine, this mostly reaches our cultivated plants through manuring with liquid manure containing salt, and has been proved directly injurious to the growth and quality of many plants; in this respect it is sufficient to point to the evil effects of manuring tobacco with liquid manure. Chlorine is not found in wheat, rye, barley and oats, millet and buckwheat, linseed, apples and pears, plums and gooseberries, acorns and chestnuts, nor in the wood of any forest trees. We need, therefore, not consider chlorine in fertilizing our fields.

Now, when I state that the given proportions of the ashes have yielded this average in comparing more than eighty analyses of the ashes of the various parts of plants, it need not be concluded from this that any particular plant, or the particular part of a plant, needs a quite definite proportion of ashy constituental but it is found on the contrary that the earthy constituents of the same kind of plants differ in various ways.

This explains why we find the same species of plants to flourish now on calcareous soil, now on soil formed from granite, gneiss or porphyry, as an example of which I shall only mention sheep's yarrow (achillea millefolium). This is effected in great part by the fact that potassium and soda are interchangeable, but these two alkalies may also be replaced in most plants to a considerable part by the alkaline earths, lime and magnesium; but, of course, the nutritive value of the plants and the other qualities cannot then remain the same. Potassium and soda may even be wholly lacking in a plant and they may be entirely replaced by lime and magnesium. As this fact is not as yet found in any book, I cannot refuse a challenge as to proof. I name as my witness the

royal mason, Wimmel, of Berlin, and engineer Klug, of Landshut. In company with these gentlemen I visited, on June 25th of this year (1893) the loftily situated marble quarry near Rothenzechan. In the neighborhood of this marble quarry the vegetation is always somewhat behind in time to that of the valley, and so we found the dandelions still wearing their downy crown, while in the valley, by the end of May, they have passed away.

We found such dandelions there growing immediately on the marble rock, where this had water flowing over it, and the flowerstalks reached the height of about a foot and a half. There was not, indeed, any great wealth of leaves, and the thick and high flowerstalks themselves could be broken like glass into pieces, which I did not weary in repeating before the eyes of my companions.

Now, this Silesian marble is a very white dolomite, consisting, therefore, of carbonate of lime and carbonate of magnesium; but it must also surely contain besides this some phosphate and sulphate of lime, besides a tract of carbonate of protoxide of iron, the presence of which is demonstrated in the moist clefts of the marble by a brown oxidation.

This extreme example convinces us that the alkaline earths (lime and magnesium) may really replace the alkalies (potassium and soda) in the building up of plants, and this also furnishes us with the explanation why the iron slag, as a preeminently calcareous fertilizer unmistakably causes an increase of crops on fields which are deficient in lime. The same result might, indeed, have been reached more cheaply by directly spreading the lime on them. But there is another

"but" in the matter, for in harvests it is not merely the quantity but much more the quality which has to be considered.

Even if the striking example cited makes it manifest that lime may in great part replace the alkalies in the building up of plants, giving them the same form, and, indeed, making them of imposing size, nevertheless the quality and the internal worth of the products of the soil is considerably influenced by the difference in its basic constituents. I, therefore, mentioned, not unintentionally, that the flower stalks of the dandelion grown on marble could be broken like glass into separate pieces, while on the contrary, dandelion stalks, growing on soil containing potassium may be bent into rings and formed into chains, as is frequently done by children. Potassium makes pliable and soft, lime makes hard and brittle. Flax is a very good example of this.

Silesian linen made of the flax growing on our granite soil rich in potassium is celebrated for its suppleness, softness and durability, while the Spanish and French linen produced on calcareous soils is hard, of little strength of fiber and of small value. What avails it then that the Spanish flax exceeds the Silesian by twice its length?

As with textile plants so with plants serving for nourishment and for fodder. It is manifest that where calcareous plants have not the same nutritive value as those in which alkalies and earth are harmoniously associated that the former are not as healthy as the latter. With reference to this, Dr. Stamm, who practiced in Zurich (where, in 1884, I saw a whole mountain of lime dug away), states that he nowhere saw so many examples of ossification of the arteries as on the Swiss soil so rich in lime; the fact that the

drinking water is correspondingly rich in lime may contribute to it. The strong bony frame of the Swiss strikes everyone, even those travelers who visit Switzerland for only a short trip. This was an essential reason why Winkelried in 1368 at Sempach could with his strong-boned arms hold a whole dozen of lances of the knights, and 1400 Swiss could win the victory over 6000 Austrians who were fed on meat, wine and flour, and this despite of their 4000 horsemen in armor.

How much influence nutrition exercises on temperament and breed may be seen from the breeders of fine horses. As Professor Marossy communicated to me, Englishmen import the oats for their race horses from Hungary. Why? Because the granite of the Carpathian Mountains is rich in potassium, but contains but little lime. Potassium makes supple, but lime makes tough and awkward. The counterpart of the world-renowned Hungarian saddle horses and carriage horses is found in the strong-boned Norman breed horse which derives its peculiarities from the French chalky soil, and could not be so easily replaced as draught horses before the heavy stone wagons, the baggage wagons and the brewer's wagons with their heavy loads of beer barrels.

And is it possible that the human race should be uninfluenced by its nutrition? Let us make some comparisons. Wine contains almost only phosphate of potassium, for the calcareous ingredients are precipitated during the fermentation as tartar. Hence the Frence **esprit,** the Austrian good nature, the artistic inspiration of the wine-drinking Italians. But like a stone wall in the battle stands the Pommeranian potato-eating grenadiers. In the ashes remaining from

potatoes we find the following proportions: 44 potassium, 4 soda, 64 lime, 33 magnesium, 16 phosphoric acid and 13 sulphuric acid. Sulphur is indispensable in the formation of normal bile and of tendons. Also hair and wool require much sulphur, about 5 per cent of their weight.

After some such hints as to nutrition it cannot be indifferent what kind of crops we raise for our nourishment and with what substances our fields are fertilized. It cannot be all sufficient that great quantities are harvested, but the great quantity must also be of **good quality.** It is indisputable that by merely fertilizing with marl, i.e., with carbonate of lime, such a large yield may be gained as to make a man inclined to always content himself with marl, but with such a one-sided fertilization slowly but surely evil effects of various kinds will develop; these have given rise to the axiom of experience: "Manuring with lime makes rich fathers but poor sons."

Despite such experience, however, after a certain time, when those who experienced the damage have passed away, manuring with lime always again becomes a fashion. So even now, the harvests after manuring with lime are so favorable that there are those who expect their salvation from fertilizing with lime. Not long ago the German Agricultural Society granted a prize to a paper on "Fertilizing with Lime." But such prizes do not prove anything. Also a paper on Chilean nitrate as a fertilizer received a prize. But how has this substance, so poisonous for plants and animals, fallen into disgrace!

Lime, indeed, is not directly injurious to plant growth, but everything has its measure and its limits. Lime can only produce wholesome cereals,

vegetables and forage when there is at the same time a sufficiency of potassium and soda.

"Too much of a thing is good for nothing!" In this connection I have to add a few things more. In the same way as lime and magnesium can replace potassium and soda in the structure of plants so all these four constituents can in great part be replaced by basic **ammonia,** without any resultant appreciable change in the **form** of the plants, except that this appears strikingly luxuriant and rich in leaves, as the milfoil on and near the mounds of cemeteries.

Such a substitution of ammonia for the alkalies and the alkaline earths corresponds in some degree to the relation between potassium-alum and ammonia-alum, which are so similar in form that they cannot be distinguished without a chemical examination. In an analogous manner the muriate of ammonia has quite a similar taste to the muriate of soda, and the sulphate of ammonia almost the same bitter taste as sulphate of soda (Glauber's salt) and sulphate of magnesium (Epsom salts), but the **effects** of these salts vary considerably.

A particularly interesting example of the fact that the appearance of plants in which ammonia has largely taken the place of the fixed alkalies and earths is found in tobacco leaves. Only specialists can at once recognize their quality at a glance; the great majority only perceive the difference when the leaves, made into cigars, are lighted. Then the one kind, grown on the Virginia soil, rich in magnesium and lime, gives us light, loose ashes and a fine aroma, while the product of vierraden (Prussia), manured with stable dung and liquid manure, in which ammonia takes the

place of lime and magnesium, "coals" and diffuses unpleasant odor.

It is quite similar with plants raised for nourishment or for fodder. The inability of offering resistance, as seen in the "lodgine" of grain after manuring with dung and liquid manure, after a long rain, and, in accordance with this, the grain also which is harvested from such a field has no firmness; it becomes soft in grinding, smearing the mill-stones, so that no grain raised with stable manure can be ground without mixing it with Western or California grain, and it has always a lesser value. So the barley raised with stable manure produces a malt which the brewer refuses to buy, as it would spoil his beer.

Now, as these ammoniacal plants lack the internal firmness and the ability of offering resistance, so also they cannot be healthy for animals when used as fodder, for the animal bodies have no consistence without earths. But these earths are subject to elimination owing to respiration. The ashy constituents of the blood corpuscles, which are oxidized by respiration, i.e., sulphate and phosphate of lime, magnesium and iron, are eliminated from the organism with the secretions of the kidneys, as also the bases present in the flesh of the muscles, i.e., potassium and soda; for the muscular substance also is oxidized through the oxygen of the arterial blood.

Now, as the earthy or ashy constituents, which are specifically necessary for the albumen of the blood, as well as for the flesh of the muscles and for the renewal of the bones (for all parts of the body are subject to this mutation of substance), are not replaced by the substances in the fodder, it is an unavoidable sequence that a relaxation and loosening of the tissues, brittle-

ness of the bones and every kind of disturbance of health should take place with our cattle. I shall only adduce one single very instructive example in proof of this out of my neighborhood.

The hotel keeper in Carlstal, near Schreiberhau, in the Riesengebirge, kept twelve beeves. The manure from the cattle he conveyed to a swampy meadow, which up to that time had only produced sour grasses; but after the stable manure was applied, it yielded so luxurious a growth of grass that he used the abundance to feed his twelve oxen and cows. It was not long however, before the cattle became decrepid and ten of them died. The cause of this was the fodder grown from stable manure, in which ammonia supplied the place of the fixed alkalies, potassium, soda, lime and magnesium. The other two beeves were quickly sold, for they suffered from lickerishness; i.e., they refused their food and gnawed instead the cribs and other wood in the stable. For all wood contains about three per cent earthy substance, and the cattle craved these earthy substances in order to gain firm flesh and bones. The two oxen recovered when their new owner gave them a different fodder.

This same reason serves to explain other cases lately observed. It has been found that some kinds of pork do not bear pickling. While salt and nitrate of potassium insure the keeping of pickles meat, the meat of certain hogs when lying in brine very soon passes into putrefaction, but into a decomposition different from the usual kind. The process that takes place is like what is called the "cheesy degeneration", which chemically means that the connective and muscular tissue decompose into peptones (leucin and tyrosin) as during digestion.

To explain this phenomenon we must consider the cheesy degeneration of the lung-tissue in consumptives. In their blood there is also always a deficit in lime and sulphur, which are absolutely necessary in the formation of red blood corpuscles.

Now, on inquiring why this port when pickled underwent such a peculiar change, it was found that the animals had been fattened with Fray Bentos Meat Powder. But the lean meat contains as its chief ashy constituent only phosphate of potassium with almost imperceptible traces of lime and sulphur. Lime, indeed, is not found in the meat, but in the bones, which are devoured by the tiger and the dog, but not by man. Therefore we have to gain the calcareous supply for our blood, our bones and our teeth from calcareous corn and from vegetables rich in lime. As our present fine flour, freed from bran, is furnished us almost entirely devoid of sulphur and lime, we need not wonder at the great number of modern maladies.

Bow when hogs are fed with Fray Benton Meat Powder, devoid of lime, in place of vegetable food, they cannot acquire a strong bony frame, and in consequence we need not wonder at the flaccidity, sponiness and easy putrefaction of the meat of such animals. If they had not been slaughtered in good time these helpless animals would have succumbed to some hog disease.

From this we may draw our conclusions with respect to human health. Many a one considers a meat diet to be a godsend, but is plagued on that account with rheumatism, asthma and corpulency, to cure which he is ordered to drink some mineral waters which contain lime, magnesium and sulphate of soda.

To return to agriculture and the feeding of cattle. Nitrogenous foods are supposed to be strength-givers; this is a theoretical error full of fatal consequences for agriculture. We never have had as many cattle plagues as we have had such artificial fertilizers and "strong" foods have been in vogue.

The theorists in nutrition who demand that man should have so much hydrocarbons, so much fat and so much albumen have evidently little conception of the close relationship in which these substances stand to one another, by which the one may pass into the other, e.g., the hydrocarbon sugar, through the adjunction of earths and ammonia, becomes albumen. But albumen easily undergoes a change into fat, as may be seen in cheese, and also from the manner in which the meat of ham passes into fat. The same transformation takes place in nutriments containing hydrocarbons, e.g., the malt sugar of beer drinkers and the starch of grasses. Many an ox accumulates a few hundred pounds of tallow and yet is not fed with fat or butter, but with grass, hay and grain.

The so-called "strong" food of cattle, therefore, amounts to nothing and ought rather to be called poison food. The truly strong food for cattle consists of mountain herbs rich in earth, when these besides alkalies also contain lime and magnesium. Just think of the dairy cows of the Swiss Alps and of the cattle in Holstein that derive their strength from the grass of the marshes which are not fertilized with stable manure, but which are preserved in their lasting fertility by manure, but which are preserved in their lasting fertility by the neighboring rocky highlands, which continually enables the rain to wash down

the soluble rocky material which enriches the meadows.

As a counterpart to the pork raised from Fray Bentos Meat Powder I will mention here an example from my own observations. Here (on the Kynast) I kept two sheep. I once saw them eating lime from the wall of the stable, as chickens do when they need lime for their egg shells. From this I concluded that the grasses growing on my soil, in which there is little lime, did not supply them with sufficient sustenance for their bones. I, therefore, mixed some whiting with their cooked roots and this craving for lime ceased. When I at last sold the animals to the butcher he was so much pleased at their solid meat that he desired to bespeak immediately some sheep for the next year.

Chemistry teaches us that the characteristic nature of the albumen rich in ammonia consists in the easy interchangeableness of their atomic groups; but just on this account muscular fiber and connective tissue can be built up from the albumen of the blood, but every case has two sides. The case with which the constituents of albumen can be shifted also favors their children decomposition. Need I mention here the savory smell of fresh-laid eggs and the smell of rotten ones? Intelligent people have long since perceived that feeding with albumen does not do all that theorists claim. It does not pay for its expenses.

The chemical "strong" food for the soil in the shape of Chilean nitrate, which contains nitrogen, and which has been awarded the premium over all its competitors, has proven a miserable failure; but the theorists are indefatigable. They now advocate chemical "strong"

food for cattle, and there are many people who put this latest theory into disastrous practice.

All of us have to bear the evil consequences of this. Does not stable- feeding cohere with this "strong" feeding and this forced fattening? And does not the stable air so poor in oxygen cause the muttain of cattle? And does not the mortality of our children spring from the cow-milk poor in earths? That in consequence of fertilizing with stable manure, crops poor in earths are produced is indubitable after what has been stated above. From these nutriments poor in earths again follows a host of ills - nervous debility, nervous sufferings, decomposition of lymph and serum, which are continually becoming more prevalent. Among these diseases are anemia, chlorosis, scrofula, swelling of the lymphatic glands, cutaneous diseases, asthma, catarrhal states, nervousness, epilepsy, gout, rheumatism, corpulency, dropsy, consumption, diabetes, etc., as I have demonstrated anatomically and physiologically in a manner easily comprehended in the book "Makrobiotik", or "Our Diseases and Our Remedies". Fertilizing with stone meal will in the near future give us normal and healthy crops and fodder.

WHAT SHALL WE DO WITH STABLE MANURE?

So long as attention was not called to the fact that new earth from pulverized primitive rock, together with the carbonate and the sulphate of lime (limestone and gypsum), forms the best and most natural fertilizer for an exhausted soil, men directed their attention to that part of the food which cattle do not assimilate, but excrete, for manure. So men came pretty generally to the position that we must bring dung to an exhausted

field, else nothing can grow. Now in order to get manure we must raise cattle; for these stables and attendants are necessary, and a considerable area of land must be devoted to provide the necessary fodder. Now since it is said that without manure nothing can grow, manure must be used to make fodder grow on which cattle feed in order to produce manure for more fodder.

In such a circle of life where does the advantage of keeping cattle come in? The raising of cattle only pays in mountainous regions, where the fructifying dew transforms the stones into herbs, or in the marshes irrigated by canals, for here the subsoil is naturally moist, and without water nothing can grow. In marshy regions the raiser of cattle can put his hand in his pockets and look on while the ox "eats money into his pocket"; and elsewhere the ox rather eats money out of the owner's pockets than into them.

But anyways, the production of milk, butter, cheese and wool, as well as the necessity of having horses for driving, makes the raising of cattle and horses a factor that must be taken into consideration.

Now, as all cattle produces manure, solid and liquid, the question arises: "What shall we do with it?"

The fact that stable manure undoubtedly promotes the growth of plants gives to it a certain value. This value does not depend upon the nitrogen but on the earthy or ashy constituents which it contains, and on the combinations of hydrocarbons, i.e., these carbonate hydrocarbons do not need to be first produced by the sun, but may be utilized by a simple change of grouping and may be compared to ready- made building stone that may at once be built into the plants

with the result that their growth may take place in the cool springtime more quickly than where the warm sun must do the whole work of drawing the carbon out of the carbonate rocks in conjunction with water. Still this advantage will no more be considered so decisive because the same result, yea, a result almost four times as great according to my experience, may be attained by a judicious mixture of rocks in a finely powdered state. This stone meal is dry while manure is moist, and for that reason the former is worth at least four times as much because more condensed, while in addition thereto the earthy constituents have mostly been eliminated out of the latter by passing through the animal or human body, and the stone meal mixture contains these in abundance. But of course not all earthy constituents have been taken out of the dung, for of some a superabundance may have been provided, part of which is still contained therein.

Such manure, therefore, is by no means without value; as animal bodies contain about four-fifth water so there are also considerable quantities of water contained in crops. Dry hay, e.g., will in the kiln still lose 15 per cent of water; and green fodder and vegetables contain a full three-fourth of four-fifths of water; in some root crops the water amounts even to nine-tenths. Considering its properties of water, stable manure is not to be valued so highly, because only an equal weight of crops can be procured therefore. Still even this is sufficient to keep us from rejecting it. Only it should be deprived of the injurious qualities clinging to it owing to its excessive quantity of nitrogen. As far as the liquid manure is concerned, indeed, little damage is done, for despite those erudite in manures, the

simple farmer spreads the liquid manure over the fields, where the ammonia is oxidized into nitrogen and water. Before this process is completed, at least before the ammonia has been very much diluted, as on the irrigated fields, nothing will grow from it. The most important point lies in this, that it is not the nitrogen which is combined organically with hydrocarbons as in leucine, tyrosin and hippurate of lime, which is the most injurious factor of the dung, but the carbonate of ammonia, which is formed from the urea of the liquid manure. Free ammonia is a poison to plants.

Ammonia is not only poisonous for plant roots, but is also poisonous for animals, producing paralysis, even when diluted in the blood to a mere trace. In this respect I shall report a case from actual life respecting stable manure; wherever a similar state prevails a lesson may be drawn from what I report.

In certain cavalry barracks was a rule that in summer the bedding from the horse stables should be spread in the morning on the open place before the stables to dry, and then be used again in the evening. In the stables of these barracks a remarkable mortality of horses developed, and what was the cause? The liquid manure in the straw became more or less concentrated and carbonate of ammonia in excessive quantity was thence generated, because urea in a moist state is transformed into this substance.

Urea (CO_2HHN) plus water (H_2O forms Carboniate of Ammonia (COO_2HHHN)

Such ammoniacal vapors are indeed perceptible in every horse stable, but in those military stables this evil was extreme. In stepping near the cribs, the rising ammonia vapors irritating

the mouth and nostrils, caused catarrh, and the eyes would gather tears. Now the heads of the horses were bent down over the cribs, and they continually inhaled concentrated fumes of ammonia. This acted in a paralyzing manner on the nervus vagus and its branches in the respiratory organs and in the abdominal system. The horses were seized with fever, stopped eating and died. The veterinary physician did not recognize the carbonate of ammonia as the real cause of the appalling number of cases of disease and death, but according to his dictum the stables were infected with **bacilli.** A thorough disinfection with carbolic acid was therefore ordered. For this purpose, of course, the bedding also with its "bacilli" was ordered out and the learned veterinary physician gained a brilliant scientific victory, for after throwing out and burning the bedding and white washing the walls the mortality ceased for the time being.

In my book "Das Leben", I have recommended the transformation of the carbonate of ammonia, which comes from the liquid manure into odorless sulphate of ammonia and carbonate of lime by strewing the stables with gypsum. Therefore the solid and the liquid manure are freed from their injurious qualities, which are manifested wherever the manure is heaped up a foot deep before it is removed and fresh bedding substituted for it. Those who have hitherto given no heed to the warning fumes of carbonate of ammonia and its evil consequences may continue to consult the veterinarians how to put a stop to the prevalence of cattle disease.

We have already shown how the carbonate of ammonia may be rendered harmless. Now, in order to largely increase the value of the manure,

the primitive rocks containing potassium and soda, reduced to powder, should be scattered over the fields before the manure is applied. Thereby the nitrogenous hydrocarbons of the solid and the liquid stable manure are prevented from entering into a decomposing fermentation, which give rise to unwholesome ammoniacal products of decomposition, which in part, through capillary action, rise into the plants without being transformed into vegetable substance, such plants when cooked manifest an ill odor, as may be seen in vegetables raised on fields irrigated with sewerage. Of late even roses are said to be cultivated on such irrigated field near Berlin, but the home of the Bulgarian rose, that yields the attar of roses, lies at the foot of the Balkan mountains, which consist of granite, gneiss and porphyry; i.e., the rose demands a soil of disintegrated primary rocks, or with us it demands as a fertilizer pulverized rocks. All roses fertilized with sewerage are infested with leaflice. Whoever undertakes rose culture on such fields need not expect success.

In order to lay down once more the value of stable manure, and of excrementous matter in general, it is demonstrable that nitrogenous ammonia is **injurious.** What is effective consists of the combustible hydrocarbons, which are ready building material, and further of the earthy or ashy constituents to which the hydrocarbons cling; for the hydrocarbons by themselves are rather injurious than useful in the growth of plants. This may be seen when we pour petroleum on the soil of potted plants, but hydrocarbons combined with bases of soluble in water advance the formation of leaves. I summarize then as follows:

1. Nitrogen in the form of carbonate of ammonia is directly injurious to the growth of plants.

2. Nitrogen is unnecessary as a fertilizer for the growth of plants if the soil contains a sufficiency of fixed basic substances (alkalies and alkaline earths). The proof of this is afforded by the fruitful calcareous soil in the Jura, which is not manured with nitrogen, so also the illimitable pasture grounds in America, as also the vegetation of our German mountains. **If plants find at their disposal for their growth a sufficiency of fixed bases, they receive an ample supply of the complementary nitrogen from the air, four-fifths of which consists of nitrogen.**

3. The nitrogen of the solid and the liquid manure may be used in the construction of plants, but in order to produce crops useful to health it is necessary to add to it a sufficient quantity of alkalies and alkaline earths in the form of stone meal as a counterpoise. By so doing we not only preserve but especially amend the nature of stable manure.

WILL FERTILIZING WITH STONE MEAL PAY?

Some people say: "With such nonsense as Hensel's Stone Meal, I shall never have anything to do; noting can grow from it." "Useless dirt". This is the cry of men who have no chemical knowledge, yet two hundred farmers in the Palatinate testified before court that fertilizing with Stone Meal showed far better effects than those from the artificial manures used hitherto.

"What do you say to this?", asked the judge of the young man who declared the Stone Meal a swindle (being himself a dealer in artificial

manures). "I don't say anything to it; the people deceive themselves", replied the young man, who was fined for a too libelous tongue.

Since then persons who traffic in artificial manures are good enough to allow: "We will not deny that Hensel's Stone Meal may have a certain effect, but this is far too slow and too small; for the silicate bases are almost quite insoluble and it will have to disintegrate for many years." These people also are deficient in chemical knowledge.

The silicates have indeed little solubility in water and hydrochloric acid, but they do not resist water and the forces of the sun.

Of course, in speaking of the solubility of silicic acid, we must not compare this with the solubility of common salt or sugar, lime would sooner do for comparison, for of this one part dissolves in 800 parts of water. Silicic acid is somewhat less soluble, for little more than one-half of a grain is dissolved in 1000 grains of water. All hot springs contain silicic acid in solution together with other substances from the primitive rocks.

Men who say that silicates of bases are insoluble are contradicted by the trees of the forest as well as by every single straw. Oak leaves, on combustion, leave 4 2/3 per cent of ashes, and of these fully one- third consists of silicic acid. How can this come into the leaves unless the ascending sap conveyed it in solution?

The accumulation of the silicic acid in the leaves is the result of the evaporation of the water which conveyed it.

From the forest tree to the straw! In the ashes of the straw of winter wheat, two-thirds consist of silicic acid. In the bread of the barley the proportion is still greater. This yields nearly 12 per cent of ashes, and 8 1/2 of this consists of silicic acid.

Still more striking is the solubility of silicic acid in the stems and leaves of plants which grow in water or in wet soil. Reeds, on combustion, leave 3 1/3 per cent of ashes, more than two-thirds of which is silicic acid.

Sedge or reed-grass yields 6 per cent of ashes, of which one third is silicic acid. That sedge is at the same time rich in potassium proves in the most striking manner that it needs only irrigation to make silicate of potassium available for plant growth. Shave-grass (horse-tail) leaves 20 per cent of ashes, half of which consists of silicic acid. From this it may be seen that only in those parts of plants which rise above the water, so that evaporation can take place, silicic acid is accumulated. But in the water itself this very solubility of silicic acid stands in the way of its accumulation. The best proof of this we find in seaweed. This leaves behind it a greater proportion of ashes than most plants, namely, up to 14 2/3 per cent, but only one-fiftieth of this is silicic acid. The remainder mainly consists of sulphate of muriate of potassium, soda, lime and magnesium; these the seaweed concentrates and combines with its cellular tissue, for sea water has not 14 2.3 per cent, but only about 4 per cent of saline constituents.

This is sufficient to prove that with respect to vegetation silicic acid and silicates are not insoluble; on the contrary, they enter, like all other saline combinations, into the most intimate combination with glycolic acid, C O O C H H, which is interamolecularly present in the cellulose of plants, so also with the ammonia of chlorophyll, so that the silicates cohere with the plants grow-

ing from them as an organic whole. We may easily convince ourselves of this by tearing a weed out by its roots. Then it is seen that the root-fibers of most of the plants are everywhere entwined around little stone which, dangling, still cleave to them and can only be torn away from them by violence and by tearing off some of the fibers.

So the objection as to the insolubility of silicic acid is invalid, both theoretically and practically.

In reality we cannot find a root, a stem, a leaf or a fruit which does not contain silicic acid. This fact must be known to every teacher of agriculture. How then can these teachers deny the solubility of silicic acid in vegetation, as many of them who advocate artificial fertilizers do?

The men interested in artificial manures, who thought that they had attended to the funeral of Stone Meal as a fertilizer have learned nothing from history, or have at least forgotten that every new truth has first to be killed and buried before it can celebrate its resurrection. Besides I do not stand as isolated as these people suppose, for I have the light of truth and of knowledge on my side -

He who sights for truth and right
E'en alone, has strength and might.

I can also call to my aid a whole army of men who understand something of chemistry and of scientific farming, and of their number, at this day, where science is making such giant strides and hundreds of well edited agricultural papers are ready to supply the interests of the farmer, are daily on the increase.

What is lacking at present is that the manufacture of Stone Meal should be undertaken

by men of scientific attainments who at the same time have sterling honesty, so as to make it certain that farmers will actually receive what is promised and what has proved itself so useful hitherto. I have received innumerable requests from farmers who asked for this mineral manure, but I had to answer them that with my advanced years I could not actively engage in this manufacture. The whole subject is of such immense importance for the common welfare that it is my wish to see this work placed into hands that are thoroughly reliable. I but point the way for the benefit of the human race.

The practical point to settle is how far fertilizing with Stone Meal pays, what yield it will afford, thus whether it will be profitable for the farmer to use it. I shall therefore treat this subject as exhaustively as possible and give an exact account of the results obtained.

It must here be premised that the fineness of the fineness of the stamping or grinding and the most complete intermixture of the constituent parts are of the greatest importance for securing the greatest benefit of stone-meal fertilizing. A manufactured article of this kind has recently been submitted to me which showed in a sieve of moderate fineness three-fourths of the weight in coarse residuum. But as the solubility of Stone Meal, and thus its efficiency, increases in proportion with its fineness, the greatest possible circumspection is required in grinding it. The finer the stone dust the more energetically can the dissolving moisture of the soil and the oxygen and nitrogen of the air act upon it. A grain of stone dust of moderate fineness may be reduced in a mortar of agate perhaps into twenty little particles, and then every little particle may be

rendered accessible to the water and the air, and can, therefore, be used as plant food.

Thence it follows that one single load of the very finest Stone Meal will do as much as twenty loads of a coarser product, so that by reducing to the finest dust the cost for freight and carriage and the use of horse and cart would amount to only one-twentieth. Therefore we can afford to pay unhesitantly a higher price for the finest Stone Meal that has passed through a sieve than for an article that may be not so much a fine powder but rather a kind of coarse sand.

The average contents of ash in cereals is about three per cent. Thence, from three pounds of pure vegetable ashes we could raise a hundred pounds of crops. Now, as Stone Meal properly made contains an abundance of plant food in assimilable form, it may be calculated to produce four cwt. of cereals, or that an annual use of six cwt. to the acre will produce twenty-four cwt. of grain. On this basis every farmer can calculate whether it will pay. But in reality the harvest will be far greater, because even without the Stone Meal most fields still possess some supply of mineral nutriment for plants which will become effective in addition thereto.

Such being the case, we need not consider the fact that not all the Stone Meal is used up completely in the first year, but yields nourishment to plants even in the first year, but shown by experiments. That no mistake would be made by using double the quantity on an acre, or twelve cwt. instead of six, is manifest, for the prospects of a still greater yield would thereby be improved, but in applying twelve cwt. an abundance would be supplied; even five or six times that quantity would be far from causing an injury to the soil,

but we cannot force by excessive quantities of Stone Meal a correspondingly higher yield of crops for the reason that within a definite area only a definite quantity of sunlight can display its activity, and on this factor the growth of the crop mainly depends. There is, therefore, no use in passing beyond a certain quantity of mineral manure; it could only come into use in subsequent years, and it appears to be more practical to supply the amount needed each year.

I will now present in summary form the quintessence of the significance of this natural fertilizer.

1. The point to be gained is not only a greater quantity of produce, but also a better quality. Sugar beets gain thereby more sugar, this, according to experiments made, may amount to 75 per cent more than hitherto. Potatoes and cereals show a greater proportion of starch. Oil crops (as poppies, rape, etc.) show more seed-vessels and a corresponding increase in oil. Pulse, such as beans, peas, etc., yields more lecithin (oil containing phosphate of ammonia as the chemical base of nerve-substance). Fruits and all vegetables receive a more delicate flavor. (The vegetables in my garden have become famous with our neighbors and our guests, so that they ask, "How do you manage that?") Meadows furnish grass and hay of more nutritive value. Vines form stronger shoots, giving sweeter grapes and are not touched by insects and fungus diseases.

2. The soil is steadily built up and improved by this natural fertilizer, as it is progressively "normalized", i.e., shows gathered together potassium, soda, lime, magnesium, fluorine, and phosphoric and sulphuric acid, etc., in the most favorable combination. There is hardly one cul-

tivated field which by nature is normal at the present time. Either lime prevails or we have a clayey soil, which through its excess of clay, refuses to let the rain water pass, and by its toughness obstructs the access of the atmospheric nitrogen and of the carbonic acid; or we have a mere sandy soil (quartz), or again the soil has humus in excess, like the moor-land soil. This latter is characterized by a predominance of lime and magnesium on the one side, while sulphuric bases are two or three times in excess of phosphoric bases, as is shown by the analysis of the ashes of peat.

3. The value of the new fertilizer with respect to the whole-someness of nutritive plants and fodder depends in great part on the careful and intimate comixture of its several constituents, so that with every little particle of dust of potassium and soda, the other nutritive elements required to cooperate in the harmonious construction of plants are at their disposal in the proximate vicinity. As a contrast to this, in a one-sided fertilizing with lime it may happen that the plant contents itself with the lime, so that the other constituents of the soil are not drawn into cooperation for the growth of the produce, because they are not within the nearest proximity of the root fibers. This is, of course, of great importance to the quality and the nutritive value of the plants.

4. For raising nutritive plants and fodder which may afford wholesome nourishment I deem it of the greatest importance that no substances should be used which lead to ammoniacal decomposition. By such additions we may indeed produce a luxuriant, excessive growth that blinds the eyes, and in which the abundant formation of

leaves by means of nitrogen forms the chief part but no healthy growth is effected thereby. From this point of view I would also depreciate the use of so-called fish guano. Everyone knows how quickly fish pass over into putrefaction; there is formed at the same time a considerable quantity of poropytamin (C_3 H_6, NH_3) which is an ammoniacal base. The manure manufactured in Sweden from fish guano and powdered feldspar does not, therefore, merit the esteem that it claims.

A CHAPTER FOR CHEMISTS

The Chemical Process in the Growth of Plants Which are the Basis of our Nutrition

The sum and substance of the growth of plants consists in creating out of burnt substances through the electrically decomposing forces of the sun material which may again be burned.

To take an example: A stearine candle, consisting of hydrocarbons (C H H), in a twenty-four old aggregation, is consumed by means of the oxygen of the air into carbonic acid or carbon dioxide (C O O) and water (H H O) and these same products of combustion may through the vegetative processes in plants be again wholly or partially changed back into hydrocarbons. This is effected by separating from the carbonic acid dissolved in rain water or combined with the moisture in the soil, water and together with this oxidized water (peroxide of hydrogen). In this way there arises from two molecules of carbonic acid and two of water, first of all oxalic acid (C_2 H_2 O_4) and peroxide of Hydrogen (O H H O).

The peroxide of hydrogen passes into the atmosphere decomposed into watery vapor and oxygen, while oxalic acid arising from the first product of the reduction of carbonic acid caused by the action of the sun is found combined with lime in all vegetable cells. Formerly this first process of growth (for oxalic acid arises from the secretion of two atoms of hydrogen to two molecules of carbonic acid) was not at all understood. It is hardly four years ago that I heard a teacher of agricultural economy say: "Lime has no

value in the growth of plants. It is rather injurious than beneficial. The plant knows not at all what to do with the lime. In order to rid itself more easily of it, it takes it up as oxalate of lime in the cells."

Oxalic acid derives its name from the fact that chemists first discovered it in wood-sorrel (oxalis) in the form of a combination of oxalic acid with lime. From the oxalic acid there proceeds in a continual reduction sugar, the material of plant cells and starch.

The sugar that has been produced from a symmetrical grouping of two molecules of hydrocarbons, two of carbonic acid and two of water, and which therefore is not yet a complete product of reduction, produces with the separation of carbonic acid and of water, through a heaped up grouping together of hydrocarbons, which remain yet combined with a molecule of formic acid, C 0 O H H, (this second product of production or rather production of addition to carbonic acid) then the vegetable oils (olive oil, almond oil, poppy oil, rapeseed oil, linseed oil, etc.)

Furthermore, from sugar, which is exhibited in all young plants during their sprouting, after receiving watery vapor and nitrogen from the air, and indeed, after again separating peroxide of hydrogen, while ammonia arises, there are formed N_2 H_{12} O_6 N H_6 H_2 O_6, the numerous kinds of vegetable albumen.

The simplest kind of vegetable albumen is found in asparagus, in the juice of asparagus, a combination of ammonia with malic acid, which is a step towards the formation of sugar or rather a product of splitting off of sugar.

This asparagin is found not only in asparagus, but to select an example which may be

demonstrated also in the young roots of thistles (which are weeded out from asparagus beds) and which taste very much like raw asparagus, and it is also found in the sprouts of very many other plants.

As the simplest of all kinds of vegetable albumen, asparagus is the best exemplification of the fact that in albumen intromolecular gelatine sugar is contained.

Of the latter, however, it is ascertained that on account of its contents of carbonic acid it can condense into an organic whole with itself basic substances (potash, soda, magnesium, oxide of iron and oxide of manganese), and owing to its basic ammoniacal substratum, it also condenses acids, and accordingly also at the same time both bases and acids (e.g., sulphate of magnesium, phosphate of limes, the silicates of potash and of soda, fluorate of lime), besides manganese and oxide of iron, and there arise indeed on account of the contents of the hydrocarbon in the form of gelatine sugar from insoluble substances soluble combinations after the analogy of the insoluble sulphate of baryta and the ethyl sulphate of baryta, which is soluble in water.

And so we may comprehend how from earthy elements in combination with sugar and nitrogen there can arise in endless modifications the most numerous varieties of vegetable albumen, according as the soil furnished various substances.

In this the electrolytic force of the sun plays the part of the architect. As in the galvanic bath, the atoms of the reduced metals apply themselves into a connected covering without a gap, so the solar forces cement together the reduced elements of the hydrocarbons with phosphates, sulphates, muriates, fluorates, silicates and

carbonates of lime, potash, soda, magnesium and of the oxides of manganese and iron, uniting them together into the edifices which, as grasses, herbs, bushes and trees, refresh our eyes with their leaves and flowers, while their fruits serve to nourish men as well as the animal world.

But it is to be noticed that the above-mentioned processes only take place under the supposition that the carbonic acid, which lays the foundation out of which the hydrocarbons arise, find basic substances (potash, soda, lime, magnesium, etc.) with which they may condense themselves into firm combinations. Therefore the firm earth is the absolute condition for all vegetable growth. There is no vegetation in the air alone, nor must water be lacking, for its hydrogen, being combustible in itself, renders the groups of hydrocarbons combustible.

Now, as the process of our life represents nothing else than a continual combustion of our bodily substance by means of the oxygen respired, with the condition that to replace the substance consumed during the day by oxidation, during the night new combustible material must be supplied; by the contents rich in lymphatic vessels to the numerous nerve sheaths as the oil of life, and to the renewing blood new albuminous substance. Our life could not continue if we should not renew so much of the bodily material as is chemically consumed by the oxidizing respiration by means of the periodic supply of food. Every disturbance in the regular supply of food has the most manifest effects on the state of the soil. The inexorable demand for new material in place of the bodily stance which is breathed away makes even men, who by nature are kindly, angry and regardless of others when their food is

kept back. And so cause and effect join themselves into a mischievous chain.

As the means for procuring food consists in by far the greater number of callings in coined money, and this is only given as a reward for work done, the question arises: What can the man do who has no opportunity and chance to find paying work? He will and must eat. If we can assist everyone in getting a supply of food and mainspring for lying, deceit, stealing and numerous crimes vanishes.

Food is supplied to us in the first place by the immediate produce of the ground, and only in the second place by the fat, flesh and blood of domestic animals produced from grasses and herbs.

Now, as it is a primary chemical condition that earthy material, air, water and solar forces must be present in order that plants may grow, it is the all-mother Earth which, surrounded by water and earth and fructified by sunshine, nourishes men and animals through the crops produced; and at the same time it clothes animals, as their skin causes the hair to sprout forth, which contains sulphur and silica, and the hair by isolating keeps the bodily warmth and the bodily electricity.

Man, whose producing spirit desires occupation and to whom it is granted the wonderful mechanism of the fingers, has the advantage that he can weave his garments according to the season, either of flax and cotton or of the wool of sheep and the hair of goats, and can protect himself from the wind, the weather and the cold by using the wood from the forest to build his house and to warm it.

Food, clothing and shelter are the fundamental requirements to which everyone born has a

claim, and these can also be acquired by everyone who has sound limbs. In the muscles of our arms we possess the fairy charm which can say, "Table be set!", for labor always finds its reward. Of course, if people are foolish enough to leave the places where the muscles of their arms are in demand and paid for, if they leave the source of all earthly riches, agriculture, and go where their arms have no value, because many others that are unemployed are waiting for employment, then distress, lack of food, of clothing and shelter must give him the occasion to consider and turn back, returning to a life in the country, which is continually becoming more deprived of its inhabitants.

Every work brings its reward. Work is necessary for our bodily and mental well-being. By cooperation it confirms us in the consciousness of a common humanity, for in social life we see in every fellow man an image of ourselves and this calls for mutual regard, charity, kindliness, mutual assistance. How different with the man who is not working. His thoughts turn to laying nets and setting traps in which to catch his unsuspecting fellow men.

Further, when the knowledge will have spread more and more that the essential work of man consists in allowing the sun to work for him, in order that food, raiment and wood may grow up from the earth, water and air, then many foolish outbirths of idle brains will lose their soil and foundation.

There are, indeed, in these times some bad calculators who say: We will work less and get more money. These do not consider that the more money is in circulation, so much more money must be paid for the materials of food, if these

remain the same in quantity, and this change will be of indefinite limits. The real remedy can only consist in producing more food. The more grain is raised, the less money will be required to buy it. Here must apply our lever. What infatuations when men attack one another in order to compel the supply of sufficient food? That can only be furnished by the earth. "Does a cornfield grow in my palm?" God has created us rich enough in supplying us with an understanding. If we use this, brother need not over-reach brother, but we can in serene tranquillity of soul win the little that we need day by day from our all-mother Earth.

STONE MEAL AS A TOBACCO FERTILIZER

Of late years the general attention of tobacco growers centered in the query, "What is the best manure for obtaining a good tobacco?" For it stands to reason that, if for a number of years tobacco is grown on the same fields, in the course of time the soil must be rendered bare of the constituents entering into the remarkable quantity of ash which tobacco contains. There is no other product of the soil which gives as much ashes as does tobacco, for the best dried leaves will yield 14 to 27 per cent, while, for example, dried ash of birch leaves only yield 4 3/4 per cent, and most other plants contain still less, dried pine needles only 1 1/4 per cent. In the ash of most plants yielding 2 per cent or more silex predominates, and birch ashes contain over one-third, while the ash of barley and oats consists one- half of silex. It is, however, quite different with tobacco ash, which contains only one-twentieth part of silex, the rest being lime, magnesium, potash, soda, phosphoric and sulphuric acid. There is no fixed rule in the proportion of these substances, but lime and potash always predominate in about the proportion of five to four parts.

German tobacco yields less ash than Virginia leaf, only about 14 per cent, and consists of about five parts of lime, four of potash, one of magnesium, one-half of soda, two-thirds of phosphoric acid, four-fifths of sulphuric acid and four-fifths of silex and one part of muriatic acid.

The less of sulphuric and muriatic acid tobacco contains the freer will it burn and the whiter its ashes will be. The best tobacco is raised with

nothing but wood ashes for manure, and be it noted that the ashes of oak, beech, birch, pine and fir contain not a trace of muriatic acid and but one-fiftieth per cent of sulphuric acid. We are forced, therefore, to the inevitable conclusion that the comparatively high percentage of sulphuric and muriatic acid which the ash of German tobacco yields and which makes its present quality so poor is owing to the persistent use of stable manure, and it is plainly of the utmost importance to do without that altogether.

The question now arises what shall be used in its stead. Our answer is that inasmuch as forest trees are grown on rocky soil which contains potash, soda, lime and magnesium in combination with silica alumina and phosphoric acid, we must, instead of burning the expensive trees for the purpose of obtaining their ashes for tobacco manure, go back to the original substances out of which the trees were created, and these are suitable minerals found in rocks. This is as plain a proposition as the egg of Columbus.

With regard to Virginia tobacco a study of the topographical features of the tobacco lands will be in order. The best soil for the purpose is found where the debris of the Alleghenies and their foothills, the blue mountains, has been washed down into the plain. These mountains contain gneis, granite, syenite, sepentin and horn blend slate. Hornblend is silica combined with lime, magnesium and iron. These lime and magnesium silicates are of far more importance for the production of a fine tobacco which will burn freely, making a white and firm ash, than the potash which is found in all primitive rocks, although potash is necessary for the production of elastic leaf cells so much appreciated in good tobacco.

But it is a great mistake to lay undue stress on an overabundance of potash. Neither the Strassfurt potash salts nor powdered iron slag will produce good tobacco. For the potash contained in tobacco is not combined therein with sulphuric and muriatic acid, but enters into direct combination with cell material, and it is eliminated out of silicated potash and soda by the action of the carbonic acid of the air or of the soil. A healthy and fine quality of tobacco can therefore only be grown by the use of a liberal supply of a mineral mixture which yields in appropriate proportions silicate of potash and soda together with carbonate of lime and magnesium and a small proportion of phosphoric acid, such as was present originally in the virgin soil of the tobacco lands of Virginia.

In accordance with these principles suitable mixtures of the several kinds of rocks have been prepared in the form of a very fine powder for the production of fine tobacco, and it is at present being used with great success in the Palatinate in Germany.