S
501
D16

LIBRARY OF CONGRESS.

Chap. 5501 Copyright No.

Shelf D16

UNITED STATES OF AMERICA.

SCIENCE
AND ART
OF

FARMING.

THE SOIL,

ITS ORIGIN, COMPOSITION, EXHAUSTION
AND IMPROVEMENT,

14
9323

BY

Prof. J. W. Damon, Ph. D.

ADVANCE PRINT,
CHETOPRA.

*Entered according to Act of Congress,
in the year 1895,
by Prof. J. W. Damon, Ph. D.,
in the office of the Librarian of Congress,
Washington, D. C.*

Chelapa
Kam

5501
D/6

SCIENCE AND ART OF FARMING.

BY PROF. J. W. DAMON.

Introductory.

We have a few reasons for publishing the "Science and Art of Farming." The greatest reason the author has for publishing the following work is the fact that his new discoveries and observations have been thoroughly tested by the practical farmers of several western states and proved beyond all doubt that they are of such a nature that all classes of farmers can practice the scientific rules which will revolutionize farming in all parts of our country.

My discoveries are of such simple character that all classes of farmers can practice some of the ideas if not all, on account of the fact that they do not involve the expenditure of very much money. Nearly all scientific recommendations for the farm are so expensive that the poor farmer cannot afford to put them into practice. I confess we have excellent treatises on Agriculture and Horticulture as far as theory alone is concerned, and a Horace Greeley, when backed by thousands of dollars a year, can fuss and sink the same in theoretical experiments; but for all the Greeleys, and for all of our present instructions, we are compelled to confess that our country is rapidly becoming worn out, and that as yet there has been no provision made that will attract capital, restore the virgin soil, make it a pleasure and a profit, as well as practical, which will meet all the requirements of the case.

The following pages will lay out definite plans, reveal a definite art, which will invite capital, keep the boys at home and show how to make poor farms rich and rich farms richer.

So perfectly ignorant are farmers of the laws of nature that they allow nearly all the best of elements to evaporate or float down stream. The author has given the science of farming careful study and practical research for over twenty years, therefore the reader will find here a record of observations and experiments which are the result of long years of painstaking study and experiment. By careful observation the author has classified all vegetable growths into four comprehensive classes.

The first class will be named Soil Creators.

The second class will be named Soil Destroyers.

The third class will be named Semi-Soil Creators.

The fourth class will be named Semi-Soil Destroyers.

All vegetable growth is continually adding to the alluvium soil or extracting the elements from the soil, therefore the Science and Art of Farming is a definite and original work as far as the above four classified divisions of the vegetable kingdom are concerned.

In conclusion, if the farmers of this nation will buy the following work and practice the instructions herein contained we will guarantee that farming can be made profitable and farms often produce twice as much by following the instruction herein given.

There seems to be a rapidly growing disposition among the better class of progressive farmers to know more of the whys and wherefores of their calling. They want to know more about the nature of the soil which they cultivate and its adaptability to raise certain crops than ever before in the history of modern agriculture. It is this desire on the part of many an ambitious farmer which has stimulated the author to complete his observations and experiments and publish the following work. The author's work has extended over a period of twenty years. During this time he has requested many a farmer to put to the severest test the principles of the "Science and Art of Farming." The fact that the tests or experiments having in every case proven that my new observations are of the greatest utility and can be practiced in all countries on the globe, has done much to hasten the preparation of this work.

I insert one certificate or testimony from Dr. Cutler of Warrensburg, Mo., who has taken more pains to experiment for the author than any other person:

WARRENSBURG, MO., SEPT. 1, 1891.

TO EVERY FARMER OF THIS NATION, GREETING:—

I am personally acquainted with Prof. J. W. Damon, who has succeeded in reducing farming to a definite science. At my request several years ago he

called at my place and gave me a prescription for my farm which was then worn out by continual cropping. His single prescription has doubled the price of my farm, has increased the corn crop 40 bushels per acre and doubled the yield of wheat. What he has done for me he can do for every farmer in this nation, for he has the education which divides all tree growth, all vegetable growth and all crop growth into two comprehensive classes. These classes are named Soil Destroyers, Soil Creators. He has the manuscript ready for a text book for the farm home. I give him and his forth coming book the highest praise and personal recommendation,

S. P. CUTLER.

The highest ambition of my life is to be useful to my fellow man; therefore the publication of this book.

Yours Earnestly,

J. W. DAMON.

An Explanation.

SECTION I.

1st, What this work does not contain — The present work will not contain much more than fifty pages and for that reason all will understand that only a very few facts can be stated. The only reason why an exhaustive work on farming cannot be produced at present is the question of money.

Therefore this work does not contain many questions arising from the science of Botany which has to do with how plants grow, &c.

Although the science of chemistry will be used the work is not a special effort on agricultural chemistry. Although something will be said about winds and weather, rainfall, &c., the work is not a treatise on meteorology.

The following pages will not contain a special effort to instruct the farmer on how to raise and care for the horse, the cow, the sheep, &c., for such works are numerous and many of them need but little improvement. Farm fencing, farm buildings, the employment of farm hands, &c., together with thousands of ideas which the author has in mind and part in manuscript will not be published in this little work. The work will contain, for the most part, the origin of soil, the chemical composition of soil, how soil is exhausted and how it can be rapidly improved.

Origin and Formation of Soils.

SECTION II.

2nd. All soils come originally from rocks. There was a time when the first mountain range lifted its mammoth head above the first primeval ocean.

There was a time when the rocks, the flowing lava of the same commenced to be decomposed by the chemical action of the elements of the atmosphere and water. This process continued to work rock into soil unto the present time; and will continue the process, until the end of time. All clay soils, all sandy soils and all gravelly soils came from rock strata of the earth's crust.

Changes of Temperature.

3rd, All kinds of rocks are made up of crystals which differ from each other as much as the chemical elements in the same differ from each other. The heat from the internal fire and the tendency to ever cool from without furnishes the idea of temperature. Crystals not only contract and expand differently under the same temperature but also under different temperatures. On this subject Prof. Kedzie says: "These crystals would not only expand and contract unequally under the change of the temperature, but each crystal would expand or contract unequally in different directions, so that, in these changes they would tend to split off from each other, and into small fragments."

"Water in the rocks frequently becomes a most powerful force. In freezing water expands fully one fifteenth its bulk, and these forces of expansion are so great that nothing known is strong enough to resist it. Hence along the base of cliffs and mountains, there are always found great piles of rock fragments, split off from the rocks above by the force of frost. In the same manner, this force acts upon the surface of the rock itself, crumbling it into dust. If a piece of limestone, for example, be wet with water, and exposed to a hard frost over night, its surface will be found the next morning, upon examination, to be covered with a minute coating of mud, from the particles split off by the frost. The heaving action of the frost in the winter and spring still further crumbles the rock fragments of the soil."

Moving Water.

4th, "Water in motion is one of the most powerful forces known in converting rocks into soils. By the heat of the sun's rays, water from the ocean, from the smaller bodies of water, and from the earth itself, is converted into an invisible vapor, which rises into the upper regions of the air, where it floats and becomes visible as clouds. These upper regions are much cooler than the lower air, and, hence, these clouds are constantly depositing their moisture in the form of rain and snow. Mountains by their effect on the currents of the air, act as condensers of vapor, and the water gathers rapidly upon them into rills and rivulets, these uniting form

mountain torrents, until finally we have the great rivers flowing back to the seas.

Through its whole course, this moving water exerts an immense wearing power upon the rock bed beneath. At every point small particles of solid rock are worn away, the little rills cutting their way almost imperceptibly, while the mountain torrents rush down with great power, tearing away great rocks in their course. Every particle thus removed and those which fall into the current from the rocks above add to the wearing power of the water.

The delta of the Mississippi covers over 12,000 square miles, and the amount of silt yearly carried down by this river would make a bed of soil one mile square and 268 feet deep. By the continual wearing away of the rocky uplands, and their conversion into fine earth, the continent is becoming slowly lowered in height, and its spreadout material is extending into the sea. But the wearing action of water does not cease when it has reached the ocean. The ocean's waves, currents and tides are ever wearing away the rocks along the coast. This, of course, tends to straighten coast lines, by wearing away the headlands, and filling up the bays and inlets. Great oceanic currents, like the Gulf stream, doubtless accomplish much of this wearing action, although their effects can not be easily seen or understood."

We might speak at length of moving ice, and the many glacial periods; but space forbids.

Weathering Action of Water and Air.

5th, "*Air in Motion*." — The air itself, by its mere force of motion and its carrying power, is a great agent in the reduction of rocks to soil.

* * * * *

6th, SOLUTION. — We have already studied the conversion of rocks into soil by the mechanical effects of water; that is the action of water *in main*. But water produces other effects of equal importance by its power of *solution*. Even pure water will dissolve many of the elements in small quantities; and its solvent power is greatly increased when rocks are reduced to powder, as the amount of exposed surface is then much larger. But *pure* water is something unknown in nature. Water always contains other matters in solution by which its action upon the rocks is greatly increased. The most important of these matters contained in all natural waters is *Carbonic Acid*; it is obtained either from the air or from the decaying organic matter in the soil.

Water will ordinarily absorb an amount of Carbonic acid equal to its

own bulk; but under low temperatures and under great pressure, it will take up much more. Water when charged with Carbonic acid, is called *Carbonated Water*, and has a very marked solvent power upon many minerals, especially, on other carbonates, such as limestones, &c. Hence, the waters of all limestone regions are called *hard*, from the quantity of lime they contain. Carbonated water also acts upon other minerals much more powerfully than pure water. Its action is well shown in waters of mineral wells which frequently come from great depth and contain a great variety of mineral matter in solution. We know that these matters are largely held dissolved by the Carbonic acid contained in the water, because, when it is allowed to stand for some time exposed to air, the free Carbonic acid escapes, and much of the mineral water settles to the bottom, as a thick sediment.

Next in importance of the materials found in much natural water, and which greatly increases its destructive effects upon the rocks, are the *alkalies*—*ammonia*, from the air, and potash and soda from certain minerals of the soil.

Water which contains the slightest trace of these alkalies has even a stronger power of dissolving minerals than Carbonated water. Thus all natural waters are constantly exerting their destructive power upon all exposed rocks, rapidly hastening their conversion into soil.

Though this solvent effect may, in any one case, seem to be very slight, yet when we remember the immense extent to which it has operated through numberless ages, we can easily understand the great results it has accomplished.

Water also operates upon some minerals in another manner, by uniting directly with them, and forming what are called hydrates. In their condition they are softer and more bulky, and hence, more easily reduced to soil. Many minerals are so composed that they are directly acted on, both by water and by the oxygen of the air, and are thus rapidly reduced to powder.

Action of Plant Life.

7th, PLANT LIFE, Ever since its appearance up the earth, has exerted a very important influence in the change of barren rocks into fertile soil.

We may study this action of plants under two heads: 1st. The effects produced by living plants themselves. 2d. The action of decaying vegetable matter.

8th, EFFECTS OF LIVING PLANTS. — “We may suppose that ever since their appearance upon the earth, plants have produced the same effects upon the earth's rocks, as we find them producing to day. This effect is nicely shown in the first growth of vegetation upon volcanic rocks. When *lava* flows in a melted condition down the side of a volcano, it cools into a

hard, barren, rock surface. For a long time, no plants can live upon it, except little microscopic plants, invisible to the naked eye, which receive Carbonic acid and ammonia directly from the air. After many years, the weathering action of the air will gather a very thin film of true soil on the hard surface of the lava, and slightly higher order of plants will begin to appear, mosses, &c., which, as they die, will increase by their remains the layer of soil. And so with such generation of plants, this change will proceed, until finally, the sterile rock will become a bed of fruitful soil capable of supporting large trees and of growing farm crops.

But in this process of soil forming, the plants have not acted simply by contributing their remains to the gathered soil, but with their tiny rootlets, they have attacked the solid rock itself, and assisted powerfully in its destruction.

This action of living plants upon the rocks may be owing, first to the moisture which all growing vegetation gathers and holds beneath it, and which is a great aid in the formation of soil; and, *second* to the action of the roots themselves. These are well known to have the power of attacking the rock fragments, dissolving and removing minute portions. Slabs of limestone are frequently found under the soil, with their surfaces covered with a network of minute grooves or channels, each being a bed of a rootlet, which has eaten its way into the rock.

Experiments have been made, by taking pieces of polished stone, such as marble, dolomite, &c., and placing them in vessels under sand, and sowing seeds of grain above. The rootlets of the growing plants were seen to descend and spread over the stone below; and the latter when examined at the close of the season, were found with their surfaces softened and roughened, plainly reduced by the action of the rootlets. * * * *

* * This effect of living plants is, in many cases, probably owing to certain organic acids which the roots contain, by means of which they are able to dissolve and remove a minute portion of the minerals-with which they come in contact. When these minerals are partly powdered, as in the soil the effects of the plant's roots are, of course, greatly increased with the increased amount of surface exposed.

Though the matter, thus removed, may seem very small in the case of any one plant, yet if we consider the effect of the whole mass of plant growth which covers the earth, we see that living plants are a force of great importance in the conversion of rock into soil.

9th, ACTION OF DECAYING VEGETABLE MATTER. — "The action of plants on the rocks does not cease with their life. When a plant dies, the process of decay begins, and, if exposed to the air for a sufficient time, nothing will be left but the ash or the mineral matter which it contains. But it is very rarely that plant decay takes place in this manner. The dead remains generally gather under the growing plants in a slowly increasing layer, and thus shut off from the free supply of air, the decay goes on very slowly, until this mass of vegetable matter becomes a black or brown compound, called humus.

The *mold* under forest trees, and *swamp muck*, or *peat*, are good examples of *humus*; but it exists in nearly every soil. This humus assists in the destruction of rocks, and the production of soil for the following reasons. 1st, Because, in its decaying state, it is constantly absorbing moisture, and keeping all bodies around it damp. 2d, Its slow decay is constantly producing Carbonic acid, which is absorbed by the water of the soil, and thus acts powerfully upon the rock fragments below. 3d, Certain organic acids are also produced in decay, which act upon the rocks even more rapidly than does Carbonic acid. 4th, Finally, with the complete decay of this humus, the mineral matter, which existed in the plants which formed it, is itself added to the earth from which it was taken."

10th, "All these forces which we have now studied, have together converted the sterile rocks of the earth's crust into fruitful soil; and when we consider that they have been at work for almost countless ages through the various periods of the earth's history we see they are abundantly sufficient to account for the layer of soil, which everywhere covers the earth's rock strata.

Nor is this process of soil forming yet completed. All of these forces are now in operation in different states of activity, and fertile soil is continually forming all around us, thus maintaining the earth's producing power."

11th, Now we are ready to learn something definite from the above considerations of surface soil.

A perfect soil adapted to grow all kinds of crops contains the following mineral elements: Lime, phosphorus, sulphur in small quantities, salt in small quantities, sodium, potassium, magnesium, iron and silicon. Now if the reader can train his mind to think of soil as he thinks of the above compound then this definite conception will assist you to grasp other great truths which will soon be considered.

Soil also contains two fertilizing elements, derived from the atmosphere, namely, Carbonic acid and ammonia.

Surface soil is always charged, at least several inches in depth, with the oxygen and nitrogen gasses of the atmosphere. Soil is charged with the gasses of water namely, oxygen and hydrogen.

Surface soil is composed of at least nine minerals and six gasses.

According to the above facts in reference to soil, the Nile valley of Egypt has a perfect surface soil. In north Africa rain falls abundantly on the several mountain ranges, thence it gathers into the several branches of the Nile, thence again, into the Nile proper; and in the great annual overflow, it fertilizes the whole valley, because it has brought down all of the nine minerals, in solution, and also in fine attenuated atoms, so that these several minerals are ready now to be taken up by the roots and root-lets of the farm crops.

The elements from the air, from the water, and the nine minerals make, by nature's own process, a perfect soil in Egypt. We should be greatly interested in this lesson for wherever man can assist nature and

bring together the same number of elements he has a perfect surface soil.

Undoubtedly the Nile valley has produced more of the great farm crops than any other valley on the surface of the earth. Organic chemistry is the only science which can explain why this valley is so fertile. It must be on account of the fact that all the mineral elements necessary to grow a perfect crop are contained in its soil. Commit to memory the above facts then we are ready to classify surface soil and learn how to improve the same.

Classification of Soils.

SECTION III.

12th, **THE SOILS.**—The action of the rain fall, and the action of the atmosphere, and also the action of water and moving ice, as already described, have placed many a compound of minerals on or near the surface of the earth which we call soil.

When you examine soils of many sections you will find an infinite variety.

Soils may be classified as clayey gravel, or gravelly clay, also as sandy clay or clayey sand; also as clayey loam or loamy clay, the soils are also called heavy, light, rich, poor, &c.

This variety seems rather lengthy; but soils can for all of the above variety be classified. Soils may be known by their formation, by their composition, by their physical properties and by their position.

First by their Formation.

13th, **SEDENTARY SOILS.** — When rocks do not get moved away from where the laws of nature made them but do get decomposed into soils such soils are called sedentary. Nearly all the high hills of Kansas are composed of sedentary or stationary soils.

14th, **TRANSPORTED SOILS.** — Says William K. Kedzie, "Transported soils are those which have been carried into a considerable distance from the rock layers from which they were formed. They are of three kinds, *drift*, *alluvial* and *colluvial* soils."

15th, **DRIFT SOILS.** — "These have been formed by the actions of glaciers and were brought down during the glacial epoch."

16th, **ALLUVIAL SOILS.** — "Are those which have been formed by the action of running water, generally over the valleys, or *bottoms* of streams."

17th, **COLLUVIAL SOILS.** — "These may consist of either drift or alluvial matter; but they always contain a quantity of sharp angular rock fragments, showing either that they have not been transported far, or else, that they are a mixture of sedentary soils with drift alluvium."

Soils May be Known by their Composition.

"The great mass of soils may, from their composition, be divided into seven classes which from a scientific point of view, are neither distinct nor clearly defined; but which answer the purpose of a practical application."

By this classification, then, we have gravelly, sandy, clayey, loamy and calcareous soils, marl and peat.

18th, GRAVELLY SOILS:—"Are those containing an abundance of small stones or gravel. The value of a gravelly soil depends not only on the general size or coarseness of the pebbles, but also upon the nature of the mineral which composes them. A pure, coarse, quartz gravel would be almost utterly barren and useless. But when the gravel pebbles contain other minerals, such as feldspar or limestone, we may have produced a soil of great fertility."

19th, "SANDY SOILS:—A soil to be called sandy must consist of at least ninety per cent sand, and sandy soil may be rich or poor, according to the kind of mineral contained in the sand."

20th, "CLAYEY SOILS — are those consisting mostly of fine adhesive matter, generally clay. These soils are heavy and sticky when wet. Pure clays are poor soils. Their various colors, yellow, red, brown, etc., are owing to the oxide of iron which they contain. Many soils are called clayey which contain no clay at all."

21st, "Loamy Soils embrace all grades of soil between clay and sand. Loams makes the greater portion of our more valuable farming lands."

22nd, CALCAREOUS OR LIME SOILS—"Are those of which the carbonate of lime forms a large proportion. They are known from the fact that when any acid, such as vinegar is poured over them, they bubble violently from the escape of carbonic acid gas. Many Kansas soils contain enough lime to be properly called calcareous soils. When mixed with other materials, these soils are called calcareous sands, clays, or loams, according to the nature of the material."

23rd, Marls are mixtures, in about equal parts of finely divided clay and carbonate of lime. *Shell* marl is nearly pure carbonate of lime.

24th, Peat is partially decayed vegetable matter, produced by the slow decay of plants under water.

Soils are Classified by their Physical Properties.

Again soils may be divided into *heavy* and *light* soils; but, as these words are not here used in their ordinary sense, this division requires

some explanation. By heavy soils are meant, not those which have weight, but those which are so compacted in their structure that they strongly resist the movement of the plow through them, and hence are hard and heavy to cultivate. And on the other hand, by light soils are meant those which are so light and porous in their texture that they can be lightly and easily cultivated.

Soils are Known by their Position.

25th. **SURFACE SOIL:**—"By the surface soil is meant that portion ordinarily stirred by the plow, and penetrated by the rain and roots of crops."

26th. **SUB SOIL:**—"By the sub soil is meant that soil layer immediately beneath the surface or active soil."

27th. **HARD PAN:**—"This is the hard compact layer wholly beneath the subsoil." In the condition of hardpan, the soil is really returning to the condition of rock.

The Farm Soils of Kansas.

SECTION IV.

28th. Says the above author, Professor Kedzie, "The general surface of Kansas is a rolling prairie; but it is an undoubted fact that the prairie surface is slowly decreasing, while the timbered areas are slowly increasing in extent. The farm soils of Kansas, while in many respects similar to those of the surrounding states, yet present some distinct and peculiar features. The soil of this region was probably, in part at least, of drift origin, but this has since been very greatly changed in its character by the action of water, so that little of its true drift nature remains. As we have already learned, the boulders or hardheads of the glacial drift are only found in comparatively small numbers, scattered over the northeastern part of the state."

29th. **BLUFF SOIL:**—"The soil of the bluff formation occupies the eastern portion of the state along the Missouri river, and is very marked and peculiar in its nature. It is the early accumulation of the Missouri river."

30th. **LOW BOTTOM:**—"We have in Kansas many rivers and considerable low bottom lands, which are very rich, and in some cases many feet deep. When these are protected from overflow they will form some of the richest farms in the state. This soil has all the mineral matter necessary for the growth of a crop, and is also rich in organic matter. This soil has the capacity to resist the injurious effects of drought."

31st. **SECOND BOTTOM:**—"The soil of this class include the large areas of farming lands extending along the next terrace above the low bottoms. They were formed in the same manner as the latter, but at an earlier

period, when the rivers covered a much broader and deeper bed than at present. The second bottom soils make up the greater part of the best farm lands of our state."

32d. **HIGH PRAIRIE:**— This class of soils includes the high rolling uplands of our state covering much of its central and western portions. These soils are the result of the decomposition of the rocks where each variety of soil is found. Nearly all high prairie soil is of local origin.

These soils have their origin in the reduction of the rocks of carboniferous and cretaceous formation of the state. Generally it will be found, in any locality, that the upland soil has, as the basis of its composition, the same materials as the rock strata of the neighborhood. The comparison of these local soils with the rock strata from which they have been derived, will always be found a very interesting study.

33d. **SPECIAL CHARACTERISTICS OF KANSAS SOILS:**— The soils of Kansas, in general, are well known as among the most fertile and productive in the United States, and are specially remarkable for two reasons:

1st. Their power to resist drought.

2d. Their great fertility under continued and exhaustive cropping.

Relations of Soils to Crops.

SECTION. V.

34th, The common farmer knows but little about the relation of the soil and subsoil to the growing crops.

All crops get their mineral matters from the surface soil and from the subsoil.

If the farmer knew how many minerals were contained in his growing crops he would know that they were in the soil if his crop grew well from year to year.

To illustrate this fact. If a farmer has grown wheat on the same piece of land, say, for ten years and has had a good average crop he can conclude that this soil is rich in whatever mineral matter is required to grow a crop.

The following are the definite agricultural minerals in all farm crops the world over.

1. Calcium, the metallic base of Lime.	7. Phosphate of Magnesia.
2. Carbonate of Lime.	8. Chloride of Sodium.
3. Phosphate of Lime.	9. Sulphate of Soda.
4. Fluoride of Calcium.	10. Carbonate of Soda.
5. Phosphate of Soda.	11. Peroxide of Iron.
6. Phosphate of Potash.	12. Silica, or Sand.

All of the above twelve mineral compounds may be comprehended in the following condensed statement. 1st. The Carbonates, or Lime elements. 2d. The Phosphates. 3d. The Sulphates. 4th. The Alkalies, potash, soda. 5th. Magnesia 6th. Iron. 7th. Silica. 8th. Traces of Sulphur.

The most condensed statement of the agricultural minerals includes the above eight minerals. The most extended statement includes the above twelve minerals.

The above minerals are *soil in fact*, for they pass from the soil to the composition of plants. A growing crop of wheat feasts upon all of the above minerals.

There are two more valuable elements in the surface soil which are placed there by the decomposition of vegetable matter, namely Carbonic acid gas, and ammonia.

The latter gas, ammonia, is transformed into the nitrates of potash and soda.

The most comprehensive conception of surface soils takes in also, the gases of the atmosphere, oxygen and nitrogen, also the gases of water, oxygen and hydrogen.

Soil when charged with six gases and twelve minerals gives as a result eighteen essential elements or a perfect surface soil.

Soil then is composed of the following elements:

1. Oxygen from air.	9. Phosphate of Lime.
2. Nitrogen.	10. Fluoride of Calcium.
3. Carbonic acid, unites with Lime in the Soil.	11. Phosphate of Soda.
4. Ammonia, unites with Potash and Soda in the Soil.	12. Phosphate of Potash.
5. Hydrogen.	13. Phosphate of Magnesia.
6. Oxygen from water.	14. Chloride of Sodium.
7. Calcium of Lime.	15. Sulphate of Soda.
8. Carbonate of Lime.	16. Carbonate of Soda.
	17. Peroxide of Iron.
	18. Silica or Sand.

The most perfect expression of the above elements are to be found in Egypt, or in the silt of the Nile valley.

The rain falls upon the mountains and water brings down all the above combinations of minerals. Therefore the Nile valley is and always will be perfect.

Now if all valley soils were perfect all a farmer would have to learn would be all other branches of agricultural science and let the soil take care of itself. But all valleys and all lands are not so rich in all the above matters, therefore the soil will form a very interesting study in its relation to growing crops.

The relation of soil to crops, is the relation of supply to the demand. The crops when growing demand all the above elements and the soil when perfect yields them up to the powers of organic growth.

35th, Soils may be considered fertile when in any climate they will produce a full crop.

Soils are not fertile in Kansas when they will not grow from year to year a full or average crop.

Soils are fertile in Kansas if a full crop of cereals can be grown upon them, for all of the cereals require a perfect soil or nearly perfect for their growth.

Crops can be largely increased by increasing the gases which all crops rest upon which are Carbonic acid gas, and ammonia. In fact there are classes of trees and plants which live direct upon Carbonic acid, and ammonia from the atmosphere and add these gases to the soil where such crops are plowed under. We are now ready to study the subject of soil exhaustion.

SECTION VI.

36th. **WORN-OUT SOILS.** — Says Prof. Kedzie on this subject: "It is well known that when a heavy crop is grown for years in succession upon a piece of land, without the use of fertilizers, the yield will each year become less and less, until finally it will be so small as hardly to return to the farmer the seed itself.

Such experience is not uncommon where corn and wheat are grown for a period of years without fertilizers. Other crops which are more exhausting in their effect upon the soil, produce these results more completely even than the grain crops."

Tobacco and cotton are great soil destroyers. There are thousands of acres in the south which have been worn out and thrown out on account of continued cropping and the corresponding lack of fertility.

"If we would seek an explanation of these effects, it is plain that we must look for them in the plant food taken from the soil. This we know to be of two kinds, first the mineral food, or what we call the plants *ash*, second, its nitrogenous and carboniferous plant food, furnished largely by the decaying organic matter of the soil. Of these two classes of plant food, the latter is more rapidly exhausted by the continuous growth of the same crop, but the plant's mineral food is also exhausted by it.

These facts are well shown in an estimate made by Prof. Johnson, upon the hay crop, as follows: "A hay crop probably carries off more mineral matter than any other known, thus one crop of hay, of two and one half tons, will remove 400 pounds of mineral matter from each acre of the soil. When we compare this with the whole weight of the soil, about 4,000,000 pounds to the acre, to the depth of twelve inches, the quantity seems very small. But when we remember, that out of *one hundred* parts of the soil, not more than *one* part gives food directly to the plant we see that the number of hay crops which a soil can produce is by no means unlimited.

The same might be shown of the other staple crops of the farm. We can, therefore, readily understand, how, by continued cropping for long periods of years, without the return of any equivalent in the form of fertilizers, we may easily reduce the producing power of our farms to a very low point."

37th, **THEORETICAL EXHAUSTION.** — "Taking these well known facts as a basis, many writers have attempted to prove, that a system of farming which does not return to the soil, in the form of fertilizers, whatever is taken

from it in the form of crops, would finally produce such an exhaustion of the soil that it would sustain no plant growth whatever. But such absolute exhaustion is impossible, and exists only in the imagination. A soil, once fertile, could never be reduced to utter barrenness simply by cropping.

38th, PRACTICAL EXHAUSTION. — While complete exhaustion of the soil, so that it will sustain no plant life, is impossible, yet it is very easy to bring about a *practical* exhaustion, by careless culture. This is the case when the cost of cropping is greater than the value of the crop grown. Hence no soil can be called productive which does not produce a crop whose value is more than sufficient to cover the time, labor, and money consumed in raising it. Whenever the value of the crop is too small to cover this expense, the soil is practically exhausted, and further cultivation of it is unprofitable."

From this it will be seen that soils can be exhausted. I have spent much money and time in the study of soil exhaustion, and I find that all soils in all climates as a rule can easily be restored to its first fertility by the proper rotation of crops. Soils become exhausted when the farm crops cannot get available plant food. Plant food is consumed rapidly by all crops which depend upon the gaseous elements in the soil instead of taking them from the atmosphere. A farm might be exhausted for the growth of cereals, and at the same time be the fertile home of the clover, and all leguminous plants.

I have observed that there are two classes of crops on all farms in all parts of the world.

The first class I shall call *Soil Destroyers*. The second class I shall call *Soil Creators*. Now all soil destroyers have and always will be destructive of all available mineral matter and especially of the carbonates and nitrates of the surface soil.

39th, First Class Farming. In the next chapter the author will treat of the nature of those plants which destroy surface soil and will also treat of the nature of those plants or crops which produce surface soil. Therefore we desire all students of the "Science and Art of Farming" to learn the nature of the above two great divisions of plant growth, and plant his farm with soil creators, and plow them under, then follow the next year by planting a soil destroyer, such as any of the cereals, and destroy from the soils what the previous crop has made available. It is not only true that every crop on all farms and in all countries are either soil creators or soil destroyers, but it is also true that all weeds are actually gathering elements which benefit the soil, or they are engaged in extracting the vegetable gases already accumulated. Therefore all weeds as well as all farm crops are soil producers or soil destroyers. We need only to know these general facts, then we can improve our farms as fast as we can plow soil creators under.

It is also true that every tree which grows in all this broad world is either a surface soil producer or a surface soil destroyer. As we have passed over the *origin*, the composition and the exhaustion of surface soil, we now invite our readers to the next and the most interesting observations in reference to the improvement of our farms.

The author guarantees that if farmers will follow the instructions in the following sections, farms can be kept in first class conditions.

How to Improve the Surface Soil.

Surface Soil Producers or Creators.

Leguminous or Pod-Bearing Plants.

SECTION VII.

40th, ALFALFA —is the greatest soil producer which has come under my observation. I have never found out how long it will live in its native home. It has been known to grow down into the subsoil to the depth of 30 feet.

Alfalfa has the power to not only go down among the various subsoils and clays to a great depth but it has the power to throw out the acids and transform inorganic soil to organic soil. It has the power also to gather the Carbonic acid, and ammonia from the atmosphere. Therefore Alfalfa is a perfect surface soil producer.

Alfalfa should always be planted in a warm and a friable soil, above a sandy or gravelly subsoil. The farmer can safely plant Alfalfa on all bottom lands which resist the long Kansas drought. It flourishes on subsoil moisture, even better than when irrigated.

There are thousands of acres in Kansas and other states where there is not only a gravelly subsoil but a plenty of water within 16 to 20 feet from the surface. I advise the farmers to examine the soil and subsoil thoroughly before planting this crop, then if all the conditions of success are present, make the trial effort of a few acres. Be sure and leave this crop on the ground several years. Then break the ground up deeply and plant potatoes and all root growing crops, then follow with corn or small grain.

The result will be that you can gather more than twice as much of all crops by the means of this clover soil.

For full and particular instruction on this valuable plant I refer you to "Report of the Kansas State Board of Agriculture, for the month of November, 1894." Address F. D. Coburn, Sec., Topeka, Kansas.

CHEMICAL ANALYSIS OF ALFALFA IN 100 PARTS.

1. Water, - - - - -	74.00	6. Lime, - - - - -	.85
2. Nitrogen, - - - - -	.72	7. Magnesia, - - - - -	.09
3. Ashes, - - - - -	1.92	8. Phosphoric Acid, - - -	.16
4. Potash, - - - - -	.45	9. Sulphur, - - - - -	.11
5. Soda, - - - - -	.03	10. Silica, - - - - -	.18
		11. Chlorine, - - - - -	.06.

If the farmer purchased the above minerals in as great a quantity as the Alfalfa leaves them in every acre it will cost at least one hundred and fifty dollars per acre, at present prices. Alfalfa benefits the soil at that rate every five years.

41st, RED CLOVER:— This plant has fertilized more acres of land, probably, than any other. . The leading farmers of all nations have utilized this plant more or less for the purpose of improving the soil. It is here classified as a perfect surface soil producer, for it, like the Alfalfa, gathers carbonic acid and ammonia from the atmosphere, and it gathers eight minerals from the sub-soils. I have observed the fact that it will grow from eight to sixteen feet deep in the sub-soil. RED CLOVER has the power to throw out acids from its roots and decompose rocks. Therefore when red clover is grown and the crop plowed under there is a gain of both mineral and gaseous matter, amounting to enough to supply the soil with enough fertility for four or five cereals crops.

CHEMICAL ANALYSIS OF RED CLOVER PLANTS IN 100 PARTS.

1. Water, - - - -	80.00	6. Lime, - - - -	.48
2. Nitrogen, - - - -	.48	7. Magnesia, - - - -	.15
3. Ashes, - - - -	1.37	8. Phosphoric Acid, - - - -	.13
4. Potash, - - - -	.44	9. Sulphur, - - - -	.04
5. Soda, - - - -	.03	10. Silica, - - - -	.04
11. Chlorine, - - - -	.05		

Red clover will grow two years, it is therefore a biennial plant. When you plant it for a fertilizer it should be plowed under the second season at the end of the growth of the second crop. *Red clover* will not grow in a rich barn yard, but finds its home in all worn out land where the agricultural minerals are abundant.

About nine years ago Dr. Cutler requested me to call at his home at Warrensburg, Mo., and prescribe a remedy for a part of his farm which was badly worn out. I saw at a glance when I arrived on the poor land that it was the home of the red clover. I advised the planting and the utilizing this plant for the purpose of producing perfect soil. The doctor has accomplished wonders with red clover for his farm, and all other farms in that section of Missouri can be improved by this plant.

There are several theories about how the pod-growing plants get the gases from the atmosphere, which will not be discussed here, for all the farmer wants to know is the fact that red clover will produce when properly handled, a perfect surface soil. Do not let your clover beds remain more than two years, for all plants die at the second year, and if the ground is not charged with seed your clover meadow fails. But remember that you should as a rule plant clover for its fertilizing value, and get this value out of the soil as quickly as possible, for in this way only would you be reducing farming to a definite science. To enable the farmer to build up soil, then to destroy it again, and get the value in grain or animals, where at any time he can change either for money is the object to be accomplish-

ed. Nitrogen at once, being the most costly element, among all elements, which go to make up soil and at the same time the element to disappear first from the soil, therefore if clover will gather it from the atmosphere it should be planted and utilized wherever it can be grown.

42d, THE CASTOR BEAN: — This plant, like the clovers, is a soil producer. In its native home near the equator it will grow several years and become quite a tree before it dies.

Castor beans are grown in Kansas as a regular farm crop, therefore the soil can be improved by them and not miss a crop. The best plan is to plant only one fourth of your plowed ground into castor beans, then another fourth until your farm has been covered. If you have a farm where clover will not flourish, then fertilize with castors.

I have no space here to tell how to plant and cultivate, for this work is not for that purpose. It is an easy matter to learn how to plant and raise a crop. It is hard to learn how to make your farms grow rich and richer every year, and not pay out any extra money and not miss a crop. To teach the farmer how to double the productive power of his farm is the mission of this work. Therefore if any Kansas farmer has several children large enough to gather castor beans, and are not old enough to follow the plow, he should put out just enough castors to keep the children busy during the harvest season. It is not only a fact that the castor bean gathers up the eight sub-soil minerals and also gathers carbon and ammonia from the atmosphere, and is a help to the soil because it does this perfect work. but if it is plowed under before the frost kills the leaves it will be valuable as a fertilizer during the whole time it is decomposing in the soil, for it continues to employ the same gases, carbonic acid and ammonia from the atmosphere, by the process of decomposition, until the last cell is transformed into soil. I desire all to plow soil producing plants under while in a green state, for by so doing you take advantage of one more element, that element is *iron*. The green color of all plants is owing to this element.

Iron has the strongest affinity for oxygen, carbonic acid and ammonia of all the agricultural minerals. When a green crop is frost bitten the iron immediately rusts or turns to peroxide of iron. When the iron is plowed under in an organic and liquid condition, the elements of the air have to pass down through the earth where the *iron* unites with oxygen and forms new compounds, and is made ready to go again into the living crop. The ground by this process is finely pulverised. All the farmers who have plowed under green crops can remember how mellow the soil gets. Now it is the *iron* in a green state which helps to pulverise the soil. In fact this agent is of more worth than the farmer can imagine, for no amount of harrowing can do the work of the silent elements of nature. In fact farming is the greatest science on earth and no one but the learned chemist can take all of the advantages of the definite elements of the natural economy and use them to the greatest advantage. But all farmers when they read the instructions in this work can practice, and, in fact, secure to themselves the benefits, as much as the wisest chemist. I have assisted several farm-

ers in doubling their cereal crops by planting them according to my advice after castor beans

Several mortgages have disappeared by means of this practice. Farmers who do not want to gather the beans can sow them broadcast and plow under when the plant has its growth. This would give a chance to plow early in the fall. Twenty acres plowed under this way, the first year, can be cultivated the next year in corn and will bring more than enough corn to pay for the experiment. I mean by this that the corn crop will be more than two crops otherwise would amount to. When a farm is all improved this way a second experiment brings astonishing results.

43d, ALL KINDS OF PEAS are soil producers. To improve soil rapidly where clover will not grow, perhaps *stock peas* are the best. Farmers can plant an acre each year for seed and thresh them when they thresh other grain and after one year always have on hand an abundance of seed. Then a part of the ground can be devoted to the improvement process by means of the *pea crop*. This crop should be planted soon after you plant corn, planting about two and one half bushels per acre, then plow under just before the seed ripens. This crop gets carbonic acid gas and ammonia from the atmosphere, and also has the power, not only to go down from 6 to 10 feet in the sub-soil, but has the power to throw out the acids and decompose rock material.

The whole southern country can be improved by this one plan. There are hundreds of thousands of acres in the south which can be made first class fertile soil by the use of the stock pea. Cotton and tobacco are soil destroyers and rapidly destroy the available plant food of the soil. The stock pea by being plowed under at the proper time not only restores soil, but under the best of circumstances brings together all the essential elements for a perfect alluvial soil. This single prescription if carried into practice would double the productive power of all upland farms of the south which are in a state of practical exhaustion of plant food.

44th, BUCK WHEAT: — This plant, while not endowed with all the powers of the clover plant, nevertheless has some very excellent qualities which enable it to improve the soil, when properly managed. A great many farmers will plant a crop of *buck wheat* and reap the crop and then complain that the crop is hard on the land. But to get the best results buck wheat should be plowed under when the seeds are in a soft state. Farmers who keep bees in this western country would do well to improve their land by plowing this crop under for this reason while it is maturing a crop, it would furnish a supply of nectar for the bees.

Buck wheat has more carbon, in the form of starch in it than any other cereal and it gets this element as well as its nitrogenous element from the atmosphere, therefore when plowed under it is a great benefit to the soil, not only, because of its accumulated carbon and nitrogen but because, while in the process of decomposing, the carbonic acid and ammonia from the atmosphere are continually being added to the soil. The above facts taken into consideration prepare one to use buck wheat free-

ly as a soil producer. I know several farmers in the state of Missouri who have improved their farm with buck wheat and fed their bees at the same time.

45th, **THE SUNFLOWER:** — From the fact that this plant, as well as clover, the peas and castor beans, gathers carbonic acid and ammonia from the atmosphere and on account of this fact it can be utilized for a soil producer. But the sunflower would have to be plowed under when it is but half grown, because when grown it is too tall and the stalks too stubborn to be handled by the plow.

There is one reason why the sunflower is not so useful as the other varieties mentioned for the purpose of improving the soil, and that is the fact that it extracts so much soda from the soil that if the crop is removed instead of being plowed under there is a great loss of this element to the soil. But the plant can be grown and plowed under when it gets about four feet high with the best of results.

46th, **PLOWING UNDER GREEN CROPS:** — All green crops improve the ground when plowed under. Many farmers burn up all the vegetable matter from their fields, and in this way lose the very gases needed for the growing crops. Many times farmers neglect to plow under crops of weeds while they are in a green state. The benefit of plowing under a crop of weeds in the fall instead of burning off the same the next spring can hardly be estimated unless we know what crop is to follow. If a good crop of rag-weeds are plowed under in September, and plowed under deeply, and the ground planted to corn in the spring probably the yield of corn will be increased at least one fourth. In all the western states where wheat grows well it would pay the farmers to raise rye and have plenty of seed on hand at all times, the seed could be scattered broadcast over all the corn fields of the west, which will not be plowed until spring, then plow under just before the planting of spring crops, it would quickly decompose, during the early summer, and furnish an abundant supply of organic matter to the growing crop. All clayey farms can be kept up in this way, for rye seems to be adapted to extract the mineral matter from clayey soils.

This rye pasture which this plant would afford would be good all winter for all kinds of stock, and especially for the milch cows, and at the same time can be plowed under in a green state and makes a good substitute for clover. Remember that when one crop dies and returns to soil it prepares food for the life of another, for the same elements which assist in decomposing one crop are also the same elements which assist and enter into the life of another crop.

47th, **THE WALNUT TREE AS A SOIL PRODUCER.** — I was told when a boy to observe that a walnut tree always grows on good ground, and that it would not grow on bad land. I was advised never to buy a farm unless walnuts were growing upon it. The walnut was considered a test whether a farm was good or bad. Its presence was considered as evidence that the farm was rich in soil qualities. Its absence was considered as evidence that the soil was not so good. The above advice could not be farther from

the truth and facts in the case, for the walnut tree is a perfect soil creator. it gathers its gases, carbonic acid and ammonia from the atmosphere, and also gathers its eight minerals from the sub-soil. It does not run its roots where the farmer runs his plow, but runs them down deeply into the earth. It spreads its roots from the central root only enough to brace the tree well against storms.

The mission of the root seems to be one continual search after mineral matter. The roots ask for no alluvial soil whatever, for they are endowed with power to throw out a combination of acids which transforms geological rock into the organic ash for vegetable growth.

The walnut tree gathers all the elements from the atmosphere and all the minerals from the sub-soil which compells me to name it as a first class soil creator.

It brings together fourteen different combinations of soil. It is, as a soil producer, what it does. No wonder the farmer frequently thinks that the walnut grows on good ground, for a walnut could not remain long on any land without making it very rich in all the elements of a perfect soil. Several years ago, in northwest Missouri, I was walking along a high bluff. I observed a huge walnut tree which in growing had displaced two large limestone rocks. One rock was lying yet against the roots of this particular tree, the other one had been tilted down the bluff by the growth of the same tree.

I commenced from that hour to study the relation of the walnut tree to the creation of surface soil. I went back and read the history of this one tree. I estimated how old it was, also tried to form some estimate of its yearly value as a soil producer. This particular tree instead of growing, as some farmers think only in good ground, had grown up and flourished between two limestone rocks.

I observed also how quickly the stems and leaves of this tree return to the soil. This tree should be planted as a border tree all around your farms. This tree if it was growing all around the farms of the United States, would produce enough leaves and fruit to fertilize the surface of our whole country. Every farmer in the west should immediately prepare one acre of ground and plant a walnut grove on the same. The best way to do this is as follows: "Prepare ground just as you would if you were going to plant wheat. Mark out as for corn in rows both ways. Then take a large pointed iron and make holes about four inches deep and place one walnut with hull on in each hole. It will take about 4,800 nuts for one acre. When that acre is in a walnut grove one year old, it is worth one hundred dollars at the least calculation.

The grove can be thinned out three times and then leave a huge forest of walnut trees sixteen feet apart both ways. The value in lumber finally can be only estimated when placed on the market. But it is not only true that the farmer's boy who plants a walnut tree is doing something to grow good lumber, but this tree while growing helps to purify the atmosphere. By gathering in carbonic acid and ammonia, it enriches the soil wherever

its foliage is decomposed. In conclusion as most men plant trees why not plant a walnut tree and do something for the future generations, if not for yourself. Therefore plant the walnut at least all around your farm and trim it high, for when trimmed high it will let in under it light, air and moisture, or all the conditions and elements of plant growth and the farmer can raise a good crop even under the tree. Therefore I repeat plant the walnut, for a surface soil producer, for lumber and for an atmospheric purifier.

48th, **THE BUTTERNUT** — behaves above ground as a soil producer of the first class, but its roots differ from the walnut, for they draw much of the vegetable gases from the surface of the soil. Therefore it belongs to the third class of trees and plants in this work and will be classified as a semi-soil creator.

By taking the walnut tree as a criterion all the readers of this pamphlet can study all trees which behave as this tree does. Whenever you find a tree which does in all cases what this walnut does class it as a soil creator. Whenever you find a tree which grows and behaves as the butternut classify it as a semi-soil creator.

When we come to treat of trees which destroy soil we will call attention to many which will be classed as soil destroyers. We desire to discuss thoroughly the question of how to improve the soil, for most any one can destroy it when it has been well improved.

49th, **FALLOWING FOR SOIL IMPROVEMENT.**—The practice of fallowing ground all through Roman and English history can now be explained on scientific principles. The explanation is this, that plowing land loosens it up and makes it capable of letting in the air, accounts for the reason why fallowing is good for the land. If any farmer will set one acre aside and plow it say four times during the season, and plow a little deeper every time, he can then plant a corn crop and estimate how much value this plan is worth as a process of soil production.

50th, **AN EXPERIENCE OF AN OHIO FARMER.** — A farmer in Ohio once left out a field and did not work it for a term of years because its fertility was practically exhausted. During the time it was in this condition, a windstorm came and blew off from his barn the double door, and carried it out into the above described field. The door happened to alight on a very poor part of this field, and laid there several years, but finally the Ohio farmer concluded the field ought again to be cultivated. So he plowed it one fall and planted it to corn the next spring. This farmer observed that the ground where the barn door lay was very rich, so he planted just as many hills as this square of land would contain and in the fall this barn door plat had yielded corn at the rate of 80 bushels per acre while the balance had hardly yielded 25 bushels per acre. Now the farmer was puzzled to know how so much fertility could come from a barn door. He reasoned that it did not come from the door itself for he burned a part of it in another place in the field. He finally concluded that it was shading the ground that made it so rich. He did not reason that shade is a

condition and not an element. He did however become so elated over shade as an element of fertility that he published a book of 50 pages illustrating his argument. This sold rapidly for a while and finally was the cause of the farmers holding, in that section a county convention for the purpose of discussing the merits of the book. To my surprise one of the learned professors of the State University endorsed the idea that shade was an element of fertility and made a lengthy speech on the subject. He explained that this idea of shade was why clover was so beneficial to the soil. He explained that it was shade that made old fence rows so rich in soil elements. The farmer was not only mistaken as well as the professor, but it furnished an illustration that no farmer or no professor has yet reduced farming to a definite science. While neither the farmer nor the professor could tell how the soil was made rich by a barn door, nevertheless the fact remained to be explained by some one who knew that shade was a condition and not an element.

Now for an explanation which will be final and also an addition to the natural sciences. This particular soil had all the mineral matter necessary for a corn crop, but it did not have the elements of carbon and nitrogen. The barn door retained moisture under it at all times, therefore the carbonic acid from the atmosphere, at all times in spring and summer and early fall, at all times, except when the ground was frozen, was continually uniting with the elements of water and the mineral matter of the soil and in this way the soil was built up as far as carbonic acid, water, the carbonate of lime and phosphate of lime could build up soil. Now there is another explanation of how the nitrate of potassa and the nitrate of soda was formed in the soil, under this barn door. The only scientific explanation is this, that under all similar conditions a chemical microbe is produced which eats ammonia and transforms the same into the forms of nitrate of potash and soda.

Remember then the fact that whenever ground is shaded by a board, a side walk, a log, a fence row or mulched with straw, hay or leaves the same chemical process is going on. Under all these conditions nature's first effort is exerted in producing surface soil. If the clay or worn out soil put in any of the above conditions has in its composition all of the agricultural minerals, then a perfect alluvial deposit of all the combinations are made. This barn door then simply assisted nature or furnished nature with conditions which enabled her to do for the soil what is done by the clover plant or any of the soil creators.

The soil under the door chemically speaking would be identical with clover soil. This is the place to speak more fully of this chemical microbe or nitrogen microbe. It has been observed that this little animal is always present where clover is growing. It has been thought that the nitrates found in the clover plant as well as in the soil is owing to his presence. I do believe that much of the nitrates of the soil in clover fields is owing to his presence, but I do not believe the clover plant has to depend upon him for its supply of that element. This chemical microbe is always present

where barn yard manure is spread: in fact it is necessary for him to be there, for all the ammonia would escape into the air if he was not there to transform it into a solid. Now the reason why he is always present in a clover field is because the clover stools die the second year and furnish this little microbe with nitrogenous food which he eats and precipitates salt-peter. The plant is rapidly decomposed by this chemical microbe and by his work the nitrates of potash and soda, the two most costly elements, are furnished. While clover is decomposing he gets his nitrogen easily, while he works under manure piles he gets his food easily, yes, rapidly, but under our Ohio farmer's barn door, during the five or six years in which time it lay on the field, he got ammonia from every drop of soft water that fell, and as 25 or 30 feet fell, he had enough to add his wonderful deposit of niter to the soil. In this way we account for the corn growing on this particular piece of land.

51st. MULCHING LAND TO INCREASE ITS FERTILITY. — The practice of mulching plants and shrubs and also trees is as old as the history of nations. In this paragraph we will not discuss mulching as a protection to growing crops, trees or shrubs, for this well is known. Let us see if mulching does more than hoarding moisture in the soil. If the facts laid down in paragraph 50 are true, and we cannot doubt them, then it follows that wherever mulch lies on the ground carbonic acid and ammonia, from the atmosphere, are continually collecting under all forms of mulch. The NITER MICROBE is at work under every square yard of mulching. Science knows of no way in which the albuminoids and nitrogenous elements of all vegetable matter can return to the dust of the ground except by agency of this chemical animal.

The practical benefit of mulching is now apparent. Now it is a fact that thousands of old straw stacks are lying out on Kansas farms, which are of no practical benefit whatever. I recommend then, early fall plowing for all ground which will be devoted to oats or corn, or garden crops, in the spring. Harrow all fall plowing just as you would for wheat crop, then apply to harrowed land one foot of straw mulching or even four inches deep in mulch will do. In the spring, burn off your straw if you have to use the land that soon, otherwise leave during the whole of the next season and then raise a crop and notice the results.

Wherever this is practiced I venture to say that all will be convinced that the atmospheric gases help much to enrich the soil. Now I want about one thousand farmers to experiment on one acre of ground and carry out the following prescription:

Prepare and plant one acre of corn in ordinary way, mulch the acre about six inches deep with straw and pull up weeds, but do not cultivate and notice the results. If you cannot experiment on one acre take less. After melons and all similar crops are planted and the surface well tilled straw mulch might be laid on and this would help the growing crop and also put the *niter* animal to work, then in the fall or spring burn off,

plow under the ashes and plant corn. There are many ways to employ this niter animal and secure his valuable services.

52d, It is taken for granted that all farmers know the value of farm manures. When the author of this work was a practical farmer's boy—reading what Horace Greeley knew about farming, he was accustomed to haul out all barn yard manure as fast as it accumulated, which was about one ton per day in the winter season. I had three sleds at three different stables which would be loaded once in three days. I would hitch a team to each twice per week and scatter broadcast on timothy sod. Timothy would double its yield by this treatment. I have found out since that timothy is a soil destroyer. Now as timothy is being sown on Kansas farms, hasten to do likewise, fertilize it with animal manure. Sow timothy near farm buildings for the above reasons.

Surface Soil Destroyers.

SECTION VIII.

53d. INDIAN CORN. — This cereal holds the leading place among the grains produced in the United States. It is supposed to be a native of America. It thrives over a wide range of climate and in a great variety of soils. A high temperature is required for its full development, but small varieties are grown as high as 47 north latitude.

Corn loves moisture, light, heat and a deep rich loam. The stalks of corn are cylindrical in form, covered with a silicious substance, and filled with a fibrous pith. The leaves are long and flat, the largest ones being near the center of the plant. The flower is in two portions, the staminate at the top of the stalk in the form of a tassel, which bears large quantities of pollen, and the pistilate on the side of the stalk between the tassel and the ground, which is called the silk. While there is but one species of corn, there is an immense number of varieties. The different varieties of corn vary greatly in size, yield and time of ripening. These qualities are modified by climate and soil, and are due largely to the environment of the plant. There are northern varieties which ripen in ninety days. There are southern varieties which ripen in one hundred and fifty days. The plant has, in a remarkable degree, the power of adapting itself to its surroundings. The plant will adapt itself to all kinds of soil and climate. Succeeding best in a rich warm loam, it will yet grow in any land, from gravel to peat, which is not barren of minerals or extremely wet. The yield is always determined, by soil, by climate, by variety and by cultivation.

Now from the above facts we class corn as a surface soil destroyer. We do this because it thrives best on soil well charged with carbonic acid and nitrate of soda and nitrate of potash. Corn does not extract as much *niter* from the soil as a wheat crop, but extracts more phosphoric acid and phosphate of potash. Corn as a soil destroyer should always follow a soil

creator. Corn should follow clover, beans, peas, the castor beans, buckwheat, timber ground and all kinds of sod ground. While the ears are being formed it gathers carbonic acid from the atmosphere, and carbonate of lime and carbonate of soda from the soil. Corn will always be the king of the cereals. In this western country if the stalks were plowed under deeply in October the stalks and leaves would return during the process of decomposition enough fertility to keep the ground in first class condition. It destroys the ground faster where stalks and ears are both removed. By planting corn after one of the surface soil creators, the crop is placed under the best of circumstances to grow a full crop.

54th, WHEAT. — This cereal is a surface soil destroyer when we take the straw and grain off of the ground. Wheat gets a part of its carbonic acid from the soil and part from the atmosphere, therefore, it thrives best in a strong alluvial soil, as far as it is dependant on the soil for this element. It is dependant also upon the soil for its supply of nitrate of potash and soda

Every bushel of wheat draws from the soil nearly one and three quarters of a pound of nitrogen or nitrate of potash and soda, therefore, the necessity of plowing under a soil creator such as mentioned in the preceding chapter, for all the above named soil producers leave a plenty of nitrate of potash and soda in the soil.

Wheat develops its roots in two directions, the tap root grows downward generally three to four feet. Its mission seems to be after mineral matter only, while the lateral roots spread out into the first six inches of the surface soil and gather up the nitrate of potash and soda. Wheat seems to do best when the ground has been made rich with alluvial soil. It does not require a deep soil, for experiments demonstrate that shallow plowing soon after old crop is taken off, then harrow after several rains, drill moderately deep, brings a good crop.

The tap root loves a permanent soil to grow in. The surface roots grow well in a loam, therefore comply with the above suggestions and the best results will follow, as far as conditions can be controlled. By planting this crop as above described twice as much wheat can be obtained. Health in the growing plant can be obtained only by complying with the above directions, then the crop will thrive, and out live the chinch bug, rust and all other diseases. In all central and southern states farmers should buy the modern sub-soil plow, and sub-soil as deep as three horses can do the work and move with ease. Where a good crop of soil producers is plowed under, the sub-soiled ventilated, there wheat will grow because not only is every chemical element there but sub-soil moisture will continue to rise during the last stages of crop growth.

Soil with the above conditions present will also stand more wet weather as well as more drouth than the land in old conditions. Every farmer should study his soil in reference to the above elements and conditions and conform his farm management to the same, as soon as he can.

55th, OATS. — This cereal can be grown on a great variety of soils. This grain does not seem to demand so much organic matter to be present in the surface soil as other grains, as wheat, barley and rye; but it thrives best when corn and wheat have taken part of the gases out of the surface soil. There are a great many varieties, some adapted to the northern countries and others to the southern countries which will not be discussed here. The oat is considered a soil destroyer, because when land is sown with oats and the crop removed the land is not so fertile or will not produce so much year after year as it does when sown on fresh new land. The oat develops a tap root down into the earth in length equal to the stem growth above ground. This tap root with its branches are after its mineral elements. It has a numerous amount of fine lateral roots which canvas the surface soil and gather in not only mineral matter but the gases, carbonic acid and ammonia. Therefore the oat is a soil destroyer. It should follow the soil producer. In the southern states oats ought to follow a crop which has been planted as soil producer and has been plowed under in a green state. But the southern farmer frequently plants his oats on the poorest land on the farm. In Iowa or any northern state oats can follow the corn crop. In nearly all states fall plowed ground is best for an early crop. Oats thrive the best in the northern climates; they grow early in spring under a low temperature, therefore in all southern states this crop should be planted early. In the south the stock pea should be planted and the same plowed under for the purpose of producing a perfect soil for oats.

56th, RYE. — This cereal is like wheat, corn and oats a soil *destroyer*, for it does not get all of its carbonic acid and ammonia from the atmosphere, but from the surface soil. Rye does not take from the soil so much of the nitrates of potash and soda, not so much of the phosphoric acid, as the corn or wheat crop, therefore it will frequently grow one or two years longer on ground where wheat will not grow a paying crop. This cereal should be sown on hundreds of thousands of acres of corn land in the northern states for fall and spring pasture, and also as a crop to be plowed under in the spring season after it has grown six inches high, for a soil producer. When the rye can be sown just before the laying by of the corn it will get a fine start for fall pasture, then with the stalks it furnishes a good winter pasture, and both stalks and rye increase the vegetable base of soil. The roots of rye like wheat and oats and corn act under ground as a soil destroyer. Rye therefore grows best in a rich mineral loam, although it will do well on poorer soils. It is practically a soil destroyer, and should when planted for the yield in seed be planted on good rich sandy loam.

57th, BARLEY. — This cereal is a soil destroyer as much so as the above cereals, but differs from them all in some respects. It enjoys the northern climate and the sea shore climate better than the warm internal climates. It extracts large quantities of minerals from the sub-soils and is very fond of carbonates and nitrates of the surface soil, therefore it should follow a soil producing crop. Plant a soil producing crop, plow the same under, then plant the barley crop in the spring. The best of results should follow.

Barley is a strong food for man and beast because of its muscle feeders and nerve feeders.

58th, **THE ROOT GROWING CROPS.** — *Beets, Carrots, Parsnips, Turnips, Radishes, Onions* and all similar root crops are soil destroyers. These root crops thrive well only on the best alluvial soil. New bottom land is the best. Barn yard manure at the rate of 80 to 100 tons per acre should be put on the ground for root crops and plowed under say in the spring then sow buckwheat, and when it is in the milk state, plow the same under, then plant the root crop the following spring. All of the above crops will do still better if the sub-soil plow follows. I mean by sub-soiling the ventilation of the sub-soil and do not mean in any case the throwing of the sub-soil on the surface, for that is not following the laws of nature, but a plain violation of the same. But letting in the air into the sub-soil is following the laws of nature and therefore beneficial. For further instruction on the subject of how to plant, grow and cultivate the above root crops I refer you to D. M. Ferry's seed catalogue, which is issued annually and has all needed instructions, after you read this work and build up the soil by the instructions herein given.

59th, The cabbage, lettuce, celery and leeks plants are all soil destroyers, therefore plant on the richest of soils.

60th, Melons, cucumbers, squash and pumpkins are all surface soil destroyers and should be treated as such. Cultivate as the best works on the subject direct you as I have no room here, but to treat of their relation to the soil.

61st, **TOBACCO.** — This plant grown on ground rich and alluvial extracts the gaseous elements so fast that the ground soon becomes poor for this crop, therefore tobacco is a radical soil destroyer. To quickly restore the tobacco fields of the south which are now worn out, the southern farmer should plow under several pea crops. This soil producing crop canvasses so many square yards of sub-soil that the ground is soon filled with the proper elements and conditions to raise large crops of tobacco.

62d, **COTTON** — Like tobacco is a radical soil destroyer when we take off the seed, the lint and frequently burn the stalks. The cotton roots gather both the agricultural minerals and the nitrates and carbonates; or the gaseous matter, in large quantities. The southern pea should be used as a soil producer, then a bale per acre can be obtained on the hill land.

63d, **WEEDS.** — The author cannot speak of weeds in particular for it would take more than the space in this pamphlet to do the subject justice.

A few general observations will suffice. All weeds which thrive well in rich ground and will hardly grow in poor ground can be classified as soil destroyers. There are many weeds which thrive well on worn out land. The farmer can classify them as soil producers. Plow all weeds under in a green state if possible, then the chemical influence during the process of decomposition is worth more than the weeds themselves are in fertilizing the soil.

64th, **OSAGE HEDGE SHRUB.** — This shrub or low growing tree is one of the greatest soil destroyers in all this western country. This shrub grows a very durable piece of timber, which makes good posts. It has a slick upper surface on its leaves. It has long lateral roots which grow far out into the surface soil. The farmer ought to look at these roots carefully and observe the different layers of rappings around the roots which seem to furnish them with an abundant power to pull out all organic gases as well as the mineral matter from the soil. While this shrub has served its purposes as a fence, a wind break, and again as fence posts, no more should be planted, for they are so destructive to the sixteen elements of a perfect soil.

The easiest way to get rid of the roots is by the use of a dense shade. Chop down about as many rods of hedge as you can handily cover deeply with old straw. Cover the roots two feet deep or even more and four feet wide, with old straw and leave the straw about two years, then burn it off. The breaking plow can then be used and run nearly up to the old fence row. In a few years more the stump roots, and in this easy way the roots can be finally disposed of.

65th, **THE APPLE TREE.** — This tree cultivated as it is in all of the western states for the fruit it bears has not yet been by any author, analyzed as a soil destroyer. But it will take out of the surface soil just the same elements which the soil producers place in the surface soil. Therefore it is a soil destroyer. The orchard should therefore be planted on ground that will yield a good corn crop, and not on the highest and poorest ground on the farm. There are in the state of Kansas over 6,000,000 bearing trees or trees which should bear. There are about 5,000,000 apple trees in the state not old enough to bear. The usual way is to plant corn among the trees until they begin to bear apples, then the orchard is seeded down to grass which frequently is like the corn crop a soil destroyer. The farmer then expects his orchard to bear fruit from a barren soil. But in Kansas the drouth lasting two months is even more severe on the tree and the fruit than a barren soil. I have observed many a Kansas orchard which has been planted on a hill with the soil destroyed by corn, then seeded down with weeds and whatever grass happens to take and grow on the land. This land being destitute of vegetable loam gets very dry and hard in the summer and is the very worst condition an orchard could be in. This is fruit culture as it exists but not as it should be. Now the proper way to cultivate a young orchard is as follows: 1st.—Plant an orchard on the best corn ground and cultivate with corn the first two years, then follow with crops which are soil producers for several years. 2d.—Seed down if possible with clover, if not sow stock peas in June and let them shade the ground and ventilate the soil and sub-soil and gather carbonic acid and ammonia from the atmosphere, and in this way furnish an abundant fertility for a perfect growth of tree and fruit. 3d.—When pea crop is ripe turn in the hogs, for the hog will thrive on the stock pea, and eat up the imperfect fruit and tramp leaves and stalks into the soil. This process can be

continued until the ground is rich enough to be seeded in blue grass. In this way alone can the soil furnish the proper combination of elements for the lateral roots and fibrous rootlets which soon canvass the whole surface of the ground.

There are a great many hard pan sub-soils which should be broken up by the use of dynamite, for it spends its explosive force by circulation and is adapted, when placed just below where you want to set a tree, to ventilate the sub-soil and let the air and water have a chance to assist the roots in finding the necessary elements of mineral fertility.

66th, **THE PLUM TREE.** — This tree like the apple is a surface soil destroyer, therefore the earth should be in as good condition as the best corn land. Plums are generally grafted on peach roots which are very destructive to the surface soil; therefore plant on good ground and keep the land fertile with soil producing crops.

67th, **THE PEACH.** — This species with all of its varieties is endowed with the power to absorb the elements of perfect soil. Peach trees are generally allowed to stand much too long. This tree grows quick, spends its force and in ten years ought to be grubbed out. A new orchard of peach trees should be planted every few years. Keep the ground fertile as recommended in paragraph 64.

68th, **RASPBERRY VINES.** — This shrub is a soil destroyer and should have as good ground as the farm can afford. I have seen farmers plant this shrub on the poorest land on the farm, then expect a perfect crop but are generally disappointed. Plant on good ground, mulch in winter and by this means carbonic acid and ammonia will accumulate in the soil. The plants should be grubbed out in about five years and the ground used for some other purpose. The ground should be planted with a soil producing crop and rest one year if raspberry shrubs are to be planted the second time on the same land.

69th, **BLACKBERRIES.** — This vine is a semi-soil destroyer. This vine is a soil destroyer only as far as the roots behave under the surface, for its leaves gather much carbonic acid from the atmosphere, and are supposed to gather ammonia also. This vine then is a semi-soil destroyer. Plant the blackberries in good fertile soil. Mulch in winter, leave straw on to rot between rows after the first year, for this is necessary to keep down weeds, hold moisture and furnish fertility for the roots.

70th, **STRAWBERRIES.** — This plant is a soil destroyer and should not be planted on land unless it will bear a good crop of corn. About 60 tons of barn yard manure plowed under and exhausted by a garden crop furnishes a good base in Kansas for a strawberry bed. If large acres are going to be planted then castor beans or peas should be used as a fallow crop. After one crop is plowed under, say in August, then sow rye, plow this crop under in April and follow the plow with a sub-soiler leaving the sub-soil where it belongs, would furnish the conditions for the best results for the strawberries.

The old straw stack could be spread on an acre and let it remain two years, then burn and prepare the land as above and the best results can be expected.

71st, THE IRISH POTATO.—This is one of the most important of cultivated plants. Millions of bushels are annually raised for food. Its relation to the soil is important, it is a strong surface soil destroyer. One hundred tons of coarse barn yard manure is just enough for one acre if the same is plowed under and the ground fallowed one season. The ground should be plowed several times while the fallow process is doing the work necessary to prepare the soil for perfect results the next season.

The greatest fault the American farmer has is his eager desire to do so much in so short length of time. Do not try to do everything in one season. Build up the soil then reap the harvest. Any one desiring to raise potatoes should first learn how to fertilize the ground as described in the different paragraphs of this work, then read some special work on potato culture. All this "Science and Art of Farming" knows about the potato has to do with its relation to the soil. It is a soil destroyer, therefore build up the soil, then destroy the same by the potato crop.

72d, THE SWEET POTATO.—This root vine differs in some respects from the Irish potatoes. The sweet potato is a semi-soil destroyer for it gets only a part of its gaseous matter from the earth. The millions of little stomachs in the leaves gather carbonic acid and ammonia from the atmosphere, and on this account is a semi-soil destroyer. The sweet potato is a native of some southern climate, and gathers more carbonic acid from the air and transforms the same into starch than the Irish potato. It also grows better in the southern states than in the northern states, while the Irish potato grows best under low temperature and in the northern states.

73d, Blue grass, timothy grass, orchard grass, red top grass and all similar grasses are semi-soil destroyers, and good rich ground should be prepared for their growth. Prepare the ground by planting the soil creators, follow with grass as soil destroyers. Much more might be said here but space forbids.

74th, THE GRAPE VINE.—This vine is a first class soil destroyer. The roots go down after mineral matter and also canvass the surface soil after the gases, carbonic acid and ammonia. In all countries where clover grows plant the grape on clover soil. Where it will not grow plant after some other soil producing crop. For further information read the many excellent works on grape culture. The great question is in keeping the soil in good condition and not in the culture. I saw an old vineyard once in north-western Missouri which had quit bearing grapes because all alluvial matter had been taken up by the fibrous rootlets. And the rootlets themselves had been killed by the cultivator. I thought that here was an excellent chance to put to test the facts and laws of the "Science and Art of Farming." I requested the farmer to sow clover on his ten acres of old vineyard land, let the clover come and decay of its own accord, which he did. The

result is easily guessed. The clover grew and rotted about four crops. It transformed the yellow barren clay into a fertile primitive soil. The crop for several years was immense.

Volumes might be written on the above subject but space forbids. When four crops of clover have come and rotted on the ground, then the greatest benefit comes when the niter microbe has transformed the nitrogenous elements of the clover into the soil elements of nitrate of potash and nitrate of soda. These elements are so costly that no vinyardist can afford to purchase them. Should this pamphlet fall into the hands of some grape grower, the advantage to be taken by the above information cannot be calculated.

Water Precipitation on the Western Farm.

SECTION IX.

75th, The United States depends for rain not on the Pacific ocean, but on the Gulf of Mexico. There can be but little doubt that, but for the high range of the Rocky mountains in Central America, the greater part of the western states would be an arid waste.

These mountains are so high as to present an effectual barrier to the passage of the trade-winds which blow over the Gulf of Mexico. They are, on this account, turned northward, and spread themselves over the states, especially over the low basin of the Mississippi. These winds being characterized by the great heat, and loaded with moisture from the warm waters of the Gulf of Mexico, tend to disturb the statical equilibrium of the atmosphere. When they have blown for sometime, vast accumulations of moisture take place, the equilibrium is destroyed, and a great storm arises in consequence, sweeping eastward over the states, and in many cases crossing the Atlantic and descending with violence on western Europe.

In all of our western states, the southerly winds preceding the storm give place to the dry north west winds, which rapidly clear the sky and bring brilliant, bracing weather in their train. It is a fact that the south winds from the Gulf of Mexico spread the moisture over the states and the north west wind disengages this moisture from them by coming in below them, because of their greater density, and thrusting them into the high regions of the atmosphere. If this be the case, as the phenomena indicate, then the heaviest rain falls will be in the valleys, and the least on the higher grounds—a mode of distribution quite different from that prevalent in Europe. This explains why the greatest rain fall occurs annually in the state of Florida, for the rain record in several places in that state is as follows: Pensacola, 57 inches; Fort Brooke, 55 inches; Fort Pierce, 63 inches

of rain falls annually. The rain fall in the Gulf states averages over 50 in. annually. The low bottoms of the Mississippi are blessed with an annual rain fall of nearly 60 inches.

The amount of rain fall diminishes as we get away from the great father of waters. Now we will lay down a few facts and draw a few conclusions. First, all moisture which falls on the American farm comes as a rule from the Gulf of Mexico. Second, the trade winds blow from all points on the Gulf towards the Rocky mountain range. Third, the great ice cap peaks draw towards themselves a great amount of warm moist atmosphere and serve as condensers and cloud formers. Fourth, warm moist currents pass over western farms and do not stop until they reach the Rocky mountains unless compelled to do so by the cooler temperature of lower currents coming from the Rockies toward the Gulf. Fifth, Radiation is so great in July and August that the moist currents going toward the Rocky mountains are raised much higher than they are earlier in the season or later in the fall; therefore the moist currents are too high up in the mid summer months and the temperature of the same is too great to be available for cloud formation. Sixth, the cooler currents are warmed by heat radiating from the prairie farms of the west as they return from the Rocky mountains toward the Gulf, therefore the moisture which would otherwise be precipitated now passes over this otherwise grand agricultural country in the form of white clouds, and these clouds turn dark in the great valley and shed their rain drops where they are least needed. Now from the above facts there are two things which the farmers of the west can do to increase the local rain fall. The farmers can plant at least five acres of timber on each farm which will not only be growing good timber for the future generations, but will hold moisture under such groves and yield up the same in June, July and August, when such moisture is so much needed to check the effects of the sun's rays and assist in forming local clouds which will in turn furnish local showers.

Groves can retain moisture under their dense shades until the high temperature of mid summer compels it to ascend into the atmosphere; therefore groves can assist in yielding up moisture at the season when such local moisture is much needed to increase the local precipitation or rain fall. The natural sciences suggest that this yielding up of moisture explains all the good the groves of the west can do to increase the local rain fall. If there were five acres of timber on every half section in all of the western states, then the combined influence would no doubt be great. There ought to be at least ten miles of solid timber planted on the south line of the state of Kansas to check the hot winds of the south, and also charge the same with moisture. Then at least five miles in width should be devoted to the same timber culture every hundred miles as you go north until you reach the British possessions. The time may come when the general government might set out timber on such a large scale, individuals never will. So the best thing we can now do is to deal with the practical. We can plant groves as individuals. This we are doing and should do until at least one

twentieth of all farms should be in valuable timber culture. There is one more suggestion the author can bring before his readers, which would be of great benefit to every farm and at the same time a great benefit to assist nature and her laws governing the amount of rain fall.

The author would suggest that the farmers organize in every school house in the western country and assist each other in placing a large water stoppage of at least five acres on every large farm in all of this western country. Suppose there was a five acre lake of water on every half section of land in all this western country, the benefit to the atmosphere in June, July and August cannot be estimated. I will enumerate some of the benefits. First, such bodies of water would furnish a good supply of water for stock and if the ponds did cover five acres of land the water would purify itself by the action of the water in motion. In the second place this large surface of water would yield up a large amount of moisture in June, July and August, when it would do good to the growing crops in return showers. If there were such bodies of water on every half section and such groves as above described the author believes that even in droughty Kansas the local shower would be the rule in the summer months and not the exception. I rejoice also that many other naturalists view this subject as I do. This lake of water on every farm would furnish a home for fish of several kinds, and in this way furnish food for the table. Fish furnish much more food for the muscles and brains than the common food from the farm, therefore, what an advantage it would be for the farmer to eat more fish and less pork.

The farmer generally feeds his cows and hogs more brain food than they need and gives his children an excess of the kinds of food which produce fat.

The Foundation Principles of "The Science and Art of Farming."

SECTION X.

76th, It will be interesting to all classes of readers to fully realize that the scientific observations and instructions given in the foregoing sections can be demonstrated to be true and conclusive by the science of organic chemistry. Organic chemistry has to do with the surface soil or alluvium, the various classes of vegetation, the animal economy and the human constitution. Organic chemistry finds a certain number of elements in the human body, and also a very differentiating proportion. If the philosopher should enquire how these elements get into the human body, the answer would be as follows:

These elements of the human body are transferred from the outside world and become a part of the human constitution by eating, by drinking and by breathing; therefore, there are no more elements in the human body than there are in the air, water and the food supply as above stated.

Now the philosopher asks one more question, namely, where does the food supply or growing crops get their constitutional elements. The answer is forthcoming, the growing crops get their elements from the air, from water and from the surface soil. Therefore, the final logical conclusion is this, there are no more and no less elements in the soil than there are in the growing crops or the human constitution, for both come from the soil. Soil has been considered by the unphilosophical and unlearned to be anything and any elements which happens to be on the face of the earth. But a definite conception of agricultural soil includes only those elements which the growing crops gather from the surface soil, plus the element of air and water. Therefore the final conclusion is that the organic elements of organic soil, organic farm crops, and organic animal bodies, are the same in number; but present an endless variety of combinations and differentiated proportions. The human body in its growth gathers together only fourteen different elements. But it has seventeen combinations of the fourteen elements. When the human body dies and returns to the ground it produces a perfect surface soil, which is comprehended in eighteen elements obtained from the fourteen by the process of decomposition.

The author observed the above facts about sixteen years ago, and the facts have laid for him a foundation for a new science, namely the "Science and Art of Farming." Therefore a few chemical statements will illustrate the above argument. Chemical analysis of the human constitution when alive and weighing one hundred and fifty four pounds. In one hundred parts can be stated as follows, from Dr. Bellows' chemical tables.

The Human Body Analyzed.

ELEMENTS.	LBS.	OZ.	GR.
Oxygen, a gas in quantity sufficient to occupy a space equal to 750 cubic ft.	111.	0.	0.
Hydrogen, a gas occupying 3000 cu. ft.	14.	0.	0.
Carbon, - - - - -	21.	0.	0.
Phosphorus, - - - - -	1.	12.	190.
Nitrogen, - - - - -	3.	8.	0.
Calcium, the metallic base of lime, -	2.	0.	0.
Fluorine, found in the bones, -	0.	2.	0.
Sulphur, - - - - -	0.	2.	210.
Chlorine, - - - - -	0.	2.	47.
Sodium, - - - - -	0.	2.	116.
Iron, which gives color to the blood.	0.	0.	100.
Potassium, - - - - -	0.	0.	290.
Magnesium, - - - - -	0.	0.	12.
Silicon, - - - - -	0.	0.	2.

THE ELEMENTS OF A BODY WEIGHING 154 POUNDS.

Now suppose the same living body dies and is not buried but returns to the soil elements from which it originally came, what will we have? The following statement will show:

1. Oxygen.
2. Hydrogen.
3. Carbonic acid gas.
4. Ammonia.
5. Nitrogen, unites with potassium and soda.
6. Carbon.
7. Calcium, metallic base of lime.
8. Carbonate of lime.
9. Phosphate of lime.
10. Floride of calcium.
11. Phosphate of soda.
12. Phosphate of potash.
13. Phosphate of magnesia.
14. Chloride of sodium.
15. Sulphate of soda.
16. Carbonate of soda.
17. Peroxide of iron.
18. Silica.

(TOTAL ELEMENTS IN NUMBER 18.)

Therefore a human body when it returns to the soil produces all the above combinations and adds them to the soil. Therefore the above elements only belong to a perfect agricultural soil.

The grandest discovery in agricultural history is the fact that when the crops which are called soil producers or creators in the foregoing sections are plowed under and decompose and return to the soil, *they produce the above 18 elements, and therefore produce perfect surface soil in every case where the agricultural minerals are present in the soil.* It is also true that the above minerals are in nearly all clay sub-soils. It is also true that the soil producers, throw out certain acids from their rootlets and unlock the above minerals in abundance, and also grow much deeper than soil destroyers, and on this account bring all clay soils as above described to chemical perfection when plowed under. There are soil creators and soil destroyers in all farm crops of all countries. Therefore the scientific instructions herein given can be practiced in all climates and countries on the globe. Now if there are *soil creators and soil destroyers* on all farms the world over, then all farmers can learn to classify the same and in theory and in practice reduce farming to a definite science.

MISCELLANEOUS INFORMATION.

Feeding Value of the Cereals and Other Crops by Chemical Analysis.

SECTION XI.

77th, Chemical analysis of the cereals and other articles of food, in 100 parts:

ARTICLES.		Food for Muscles.		Food for Fat.		Food for Nerves.		Water.		Waste.
Wheat,	- -	14.6	-	66.4	-	1.6	-	14.0	-	3.4.
Barley,	- -	12.8	-	52.1	-	4.2	-	14.0	-	16.9.
Oats,	- -	17.0	-	50.8	-	3.0	-	13.6	-	15.6.
North'n Corn,	-	12.3	-	67.5	-	1.1	-	14.0	-	5.1.
South'n Corn,	-	34.6	-	39.2	-	4.1	-	14.0	-	8.1.
Buckwheat,	-	8.6	-	53.0	-	1.8	-	14.2	-	22.4.
Rye,	- -	6.5	-	75.2	-	0.5	-	13.5	-	4.3.
Peas,	- -	23.4	-	41.0	-	2.5	-	14.1	-	19.0.
Beans,	- -	24.0	-	40.0	-	3.5	-	14.8	-	17.7.
Irish Potat's,	-	1.4	-	15.8	-	0.9	-	74.8	-	7.1.
Sweet "	-	1.5	-	21.8	-	2.9	-	67.5	-	6.3.

I consider wheat the king of all cereals. It can be eaten by man and beast in all climates and in all seasons of the year with the best of results. Why will men take 100 pounds of wheat and separate sixty-six pounds of starch, which is devoted to keep up the heat and fat of the animal economy, and utilize this in the form of bread and at the same time reject the fourteen pounds of nitrogen which is utilized in the animal economy to feed the muscles. Think of the tons of bran and shorts which are annually lost to the human family and fed to stock. Yet we boast of living in the nineteenth century or scientific age. Wheat then being a perfect food for the animal kingdom should be fed as it grows with all the elements and in the same proportion as furnished by the laws of nature. There has been much said of late about the feeding value of wheat. By a reference to the above table wheat when compared with northern corn has this difference. Wheat has two pounds more muscle food in every 100 pounds than northern corn

Wheat has one pound less food for fat in every 100 pounds than northern corn. Therefore for growing muscles wheat is best, for putting on fat corn is best. For both growth and fat wheat is best. For water, wheat and corn are alike. Waste material in the above table is the woody fiber in fact; but in the animal economy when eaten it is used to keep up the action of the digestive organs. Therefore as wheat has two pounds less of waste it is not so good as corn to keep up the action of the bowels.

Now the reader can take wheat in the above table and by comparison can bring every other article in comparison with it and in this way become acquainted with the relative value of the different articles of the food supply. When wheat is fed to fatten cattle it should be fed without being threshed. The bundles should be taken and laid in the regular feed troughs, then take a cleaver and cut off the butts and leave the heads only in the trough. Have plenty of hogs to follow and the best results will be obtained. In this way the threshing bill is excepted, and that much is gained. Then in this way the steer eats also much more chaff which is a strong food, and therefore another gain. This also furnishes all of the conditions of health.

The same might be said of oats. As a general rule oats should be fed in the bundle for health and the best results. Oats excels wheat in muscular food and also in brain and nerve food. Oats therefore is adapted to be fed to young and growing stock. Oats can be fed to calves, commencing when they are two months old and increase the oats for two months as you lessen the quantity of milk, then the calf will never know when it is weaned. Then feed oats to the young calves all winter and in the spring they will be one-third larger than when managed in the old way. If you look over the above table you cannot find anything better to feed the young colt at weaning time than oats, for organic chemistry as well as human experience demonstrates that the horse feels his oats. The colt will eat them eagerly and in this way the mother will not long be missed.

Now suppose you had forty young hogs, which would weigh fifty pounds each, what should you feed them to make them grow the fastest? Southern corn would be the greatest for muscular growth. But oats will do almost as well as Southern corn and keep the health of the shoats much better than corn. I requested a large dealer in hogs to invest in oats when they could be purchased for 20 cents or less, and feed to all classes of hogs while he was bunching them and getting ready to ship. This particular farmer tried the experiment with the best results. I met this man afterwards on the railroad and inquired of him how oats served as an all-round food for hogs. He said that he had so much faith in oats as the proper food for hogs that he had enlarged his feed yards and divided his hogs into three classes. The first class were young pigs, which he fed oats soaked twenty-four hours before feeding. The second and older class he fed oats twice a day and soaked corn once per day. The third class he fed oats and shelled corn dry and let them drink pure water from the well. This last class he called his shippers. This man said he would not take

several thousand dollars for the information and suggestions which I had given him. By observing the above chemical tables it will be seen that rye has 75 per cent for heat and fat. Now for fattening any animal quickly rye is the cereal. Soaked rye will fatten hogs faster than any other grain. The above suggestions are sufficient to assist every farmer to commence a study and a practice in the feeding value of the cereals. I was raised in Lorain county, Ohio, where everybody was in the cheese making business. The question came up how can we raise the calf and furnish the milk to the cheese factory at the same time. Or how can we raise a calf on whey? There were many answers to the question, I had the honor of solving the problem. First, I found out the chemical analysis of whey which was as follows: Muscle-feeders, none; food for fat, 4.6; food for nerves, 0.7; water 94.7; waste none. I answered at once you cannot raise a calf on whey; but you can starve it to death very easily, for ninety-four pounds in every hundred is water. Calves cannot live on water. The next thing to do was to study the nature of the calf, which I did.

The next idea was the following experiment: I took a calf 10 days old and taught him to eat a compound of bran, shorts and meal, one-third each in a dry state. This was a grand success. In less than ten days the calf was eating this compound in a dry state and doing well; eating about one quart per day. Experience soon taught me to keep bran, shorts and corn meal on the farm by the ton in quantity. Then I would serve twenty calves as follows—I would give them all the warm whey they needed in the morning only as it came fresh from the factory. Then at noonday I would give them all the bran, shorts and meal mixed needed for a day's rations. This together with good shady pasture and black river water furnished all the elements and met all the conditions to make the calves thrive. This experiment was so successful that it has spread over three counties. The above experiment of feeding the above compound to calves and continuing the same through the winter and also late in the spring did much to make farming a success. This experiment alone made several thousand dollars difference in results. All cattle should be ready for the beef market by the time they are two years old. Cattle and hogs for the meat market should be fattened as they grow and be matured as quickly as possible. This saves using up so much food to keep them warm so long for fat only accumulates after the system is warmed up. Quick growth, quick sales and small profits or willingness to accept the markets as they come bring the best results. I would not speak so advisedly here if I had not been the most successful farmer's boy, and by being such helped to accumulate \$35,000 on the farm. It was this early intense education and successful practice which has led me on to master every phenomena on the farm.

I see I have room in this pamphlet to give a further chemical analysis of many articles on the farm. Therefore I will make the following quotation from Dr. Bellows' chemical tables. I make the following quotation because it was from the same tables I have made all my successful experiments:—

ARTICLES.	Food for Muscle.	Food for Fat.	Food for Nerves.	Water.	Waste.
Buckwheat,	- 8.6	- 53.0	- 1.8	- 14.2	22.4.
Rice,	- 5.1	- 82.0	- 0.5	- 9.0	3.4.
Parsnips,	- 2.1	- 14.5	- 1.0	- 79.4	3.0.
Turnips,	- 1.2	- 4.0	- 0.5	- 90.4	3.9.
Carrots,	- 1.1	- 12.2	- 1.0	- 82.5	3.2.
Cabbage,	- 1.2	- 6.2	- 0.8	- 91.3	0.5.
Cauliflower,	- 3.6	- 4.6	- 1.0	- 90.0	0.8.
Cucumber,	- 0.1	- 1.7	- 0.5	- 97.1	0.6.
Milk of cow,	- 5.0	- 8.0	- 1.0	- 86.	
Human milk,	- 3.0	- 7.0	- 0.5	- 89.5	
Veal,	- 17.7	- 14.3	- 2.3	- 65.7	
Beef,	- 19.0	- 14.0	- 2.0	- 65.0	
Lamb,	- 19.6	- 14.3	- 2.2	- 63.9	
Mutton,	- 21.0	- 14.0	- 2.0	- 63.0	
Pork,	- 17.5	- 16.0	- 2.2	- 64.3	
Chicken,	- 21.6	- 1.9	- 2.8	- 73.7	
Oyster,	- 12.6	-	- 0.2	- 87.2	
Salmon,	- 20.0	- 1.0	- 6.0	- 75.0	
Eggs, white,	- 13.0	-	- 2.8	- 84.2	
Eggs, yolk,	- 16.9	- 29.8	- 2.0	- 51.3	
Butter,	-	- 100.0	-	-	
Cheese,	- 30.8	- 28.0	- 4.7	- 36.5	

Miscellaneous Subject Continued.

SECTION XII.

78th. The American Hog.—The rearing of swine is one of the most important branches of industry. So immense has hog raising become, that there are at the least calculation about 5,000,000 now nearly ready for the market and the sales of this year's supply will aggregate about \$50,000,000. The annual sales of swine bring more money to farmers than any other class of live stock. Anything beneficial to this vast industry is on account of its greatness, beneficial to the whole nation. Our government has spent hundreds of thousands of dollars to find out what is the cause and cure of hog cholera. The national congress appropriated \$100,000 at one time to find out the cause and remedy of the dire malady. From all of the facts and observations brought together by past research I have come to the conclusion that there is no such a disease as hog cholera; I have also come to the conclusion that the hog has nearly as many diseases as the human family, and cause of diseases and cure are the same.

I have seen shoats die with chills and fever; i e, as far as I could judge—but the farmers declare that the hogs die with the cholera. Now when hogs group together and shake for several hours every other day they are actually having a spell of chills and the fever follows, and finally blood poison caused death; for the hog has but little constitutional power to throw off disease. Again, I have seen hogs have fever for 28 days—some of them live and some die. I inquire of the farmer in this case and as before he says his hogs are dying with the hog cholera. Again I have seen hogs apparently in good health and fattening well but all at once appetite fails and some morning they are found dead in their bed, but in the best of flesh, or it seems that the diseases have not caused them to lose one pound of flesh. Now as a philosopher I am puzzled to know how young hogs chilling, older hogs having a run of fever for 30 days, and others dying in a few hours without a bit of fever, can all be said to die with one disease or hog cholera. It is all nonsense, the hog does not die with the hog cholera, but with all sorts of disease.

The hog dies with chills and fever. The hog dies with typhoid fever. The hog dies with heart disease caused by blood poison.

The young pigs die with measles frequently in great numbers. The hog dies with lung diseases.

Now I have observed that nearly all of the above diseases can be traced to one cause more than any other cause—carbonic acid gas in the atmosphere and ammonia in the atmosphere cause nearly all the diseases the hog has. These gases are abundant in the atmosphere where he sleeps. These gases combine with other elements and form a vegetable growth on the tongue, throat and stomach. This causes a very morbid condition and the hog commences to lose his appetite. These vegetable plants on the tongue, throat and stomach decompose and turn into animalcules or microbes which are the cause of all the fevers the hog is subject to. There are many kinds of plants, many kinds of microbes, and finally many fevers and various diseases. I do not pretend to be infallible in the above observations and conclusions. I simply am telling my experience as a chemist and a naturalist. Having studied the nature of carbonic acid and ammonia in their relation to many other elements has caused me to come to the conclusions as above stated. After I came to the conclusion that carbonic acid and ammonia were the cause of most of all the diseases the hog is subject to, then it became a comparatively easy matter to prescribe remedies. The first remedy is to keep the hog in as good clean quarters as you can. Keep the hog from bedding in the horse manure heap. Keep the hog from bedding under buildings, for under all buildings there is several hundred times as much carbonic acid gas, as there is twenty feet higher in the atmosphere, and the same is true of ammonia. Keep the hog nested in as good a place as you can plan for him. Change his bed once per week. Strong soap-suds make a good bath for the hog, and he enjoys it; for it keeps his hide in the best condition. Now when in spite of all you can do he gets into a morbid condition the only remedy I know which will kill the

morbid plants on the tongue, throat and stomach is charcoal. Charcoal placed where the hogs can get it will soon be eaten, for the hog seems to be his own doctor. At least, if you put in his pen a thousand remedies for his coated tongue he probably will pass them all by; but you put a barrel of charcoal in a pen where several hogs are fattening and chop a hole in the bottom of the barrel so that the hog can get at it and in time it will all be eaten. In damp days they will eat more than they will in bright days. Therefore I believe that hogs should have this simple remedy at their command at all times. I have prescribed this remedy in several severe cases with the best results.

One farmer in Missouri fed over one thousand hogs with charcoal at their command at all times, and reports that he never lost a hog from the above diseases. This farmer said he had such confidence in charcoal and all other health conditions, that he bought all diseased hogs in reach of his farm and had the satisfaction of curing all cases if the disease had not reached that stage where the hog ceased to eat. I also noticed a lot of hogs feeding in a corn-field in Missouri where logs and trees had been burned. The hogs had eaten up all the charcoal they could find on the surface of the ground and at the time I saw them they had reached up on several charred trees and had removed the charcoal from them. I saw the owner of the hogs and made inquiry into the matter and asked many questions. I found the hogs ate corn, drank water and rustled for their own nest. I found that this man had the best of results, feeding his corn in this natural way, called I believe "hogging it." I conclude then that the American hog is a dandy and knows more about himself than all the masters of medicine in our nation. If the American farmer had studied the primitive hog, and his primitive habits and his primitive health, he would have put his hogs in similar conditions, and the hog cholera would be unknown. But the farmer never studies, as a rule he is very much opposed to original thought. At least I have never heard of an American farmer killing himself by hard study. I have not space here to discuss the question thoroughly. But go back to the early settlement of this country and inquire as I have and you will find that the wild hog has always eaten all the charcoal which his superior knowledge dictated. This primitive hog has always eaten the blackberry roots and has considered them as first-class blood medicine. This primitive hog has always eaten the sweet briar and many other roots for the same purpose. I do not know enough to dispute his majesty, his education or his practice.

Yea! I learn only when he is my teacher. All will readily agree that the hog is led by instinct to the proper remedies he should have to cure his diseases. In conclusion then, all the farmer has to do is to give the hog room, give the hog a shady pasture in the summer time, give him an abundance of fattening food, give him pure cold water to drink, give him a clay mud hole to wallow in, in the warm seasons of the year. Go down to his hog paradise and observe how he eats, and how he drinks and how he wallows, and how he rubs against the trees and by friction he keeps his

hide in first class trim. Take a good look at his hide and notice that he never sweats and in this respect he is like the elephant and rhinoceros. He has no pores in his skin, which explains why he never sweats. Notice he has two very large gas pores at each heel, or just under his upper pair of hoofs. These large pores are here to let out the poisonous gases. The human body has millions of pores. The hog has but eight large pores. The human body should live about 100 years. The hog in the best conditions ought to live until he is 20 years old.

The hog is easily cared for when you learn his nature. It is ten times easier to keep the whole number of hogs on the farm in good health than it is to cure one, when blood poison has about consumed the vital forces. When hogs are dying with what the farmer calls hog cholera, they are dying because the blood and whole system are so full of microbes that to undertake to cure a hog in this condition is foolishness. In fact in the last stages a cure cannot be effected. The only practical way is to so care for the hog that he never will need to be doctored for hog cholera. Charcoal will kill the plant germ growing on the tongue, throat and stomach. If it will what is the use of waiting until the hog is about to die and then pay a dollar per box for cholera medicine, and lose all diseased ones just the same?

Pay out your money for charcoal and keep the hog healthy or pay for health instead of paying for disease. I have not space here to treat of breeds and discuss how to grow and care for the hog. If my labors in publishing this little work are appreciated then a complete work on the American Hog will be forthcoming. I have the manuscript partly prepared.

Miscellaneous Subjects Continued.

SECTION XIII.

79th. Since I commenced preparing this little work on the soil I have been asked to say something on the subject of irrigation; I will now do so. There are some farmers who think that the general government or the state or some great monopoly will finally bring water in great quantities for the purpose of irrigating his farm. Some are so sanguine that they seem to think that the water and some system will soon arrive and all he will have to do will be to patiently wait. Now I will cause all reasonable minds to see that a general system of irrigation for Kansas is an impossibility. The rainfall all over our state is about thirty inches. Now one-half of this is needed to saturate the earth before planting time arrives in the spring. For irrigating purposes only fifteen inches can be hoarded up if we estimate what falls on our state. Fifteen inches all caught and returned to the ground would not be enough for irrigation purposes. For it would re-

quire at the least calculation four feet of water to take an acre of land through a long dry summer in Kansas. It would require on an average at least three feet of water for all crops to be properly irrigated in this part of the country on account of the intense radiating influence of the sun's rays. It might be thought by some that the water shed from the state of Colorado would furnish the balance of water needed. But here remember that Colorado is making arrangements to stop every square yard of water she can and irrigate her own lands. This is right and proper, for her valleys are rich in all other elements; all she needs is the water supply. Her valleys are laid out in such shape that they can be irrigated with great advantage. About four tiers of counties in the western part of the state will in time be irrigated. Then there will be incidental irrigation from subterranean water.

But a universal system cannot be practiced. The water is not here. We might remark here that the sooner you lose your faith in the modern rain-maker the less disappointed you will be in the long run. If the God of nature has so fixed the laws of nature that the wind has to blow at least seventy-two hours from the Gulf of Mexico to give the Mississippi valley states a general rainfall then all lesser characters had better shut up shop. If the rainmakers could command oceanic currents, command the forces of the Rocky mountains and could command the laws and nature of electrical currents as they arise from and return to the earth, then we could listen a moment to their logic. This they cannot do, so dismiss them from your mind. Give them a wide berth.

But suppose they can in some cases cause the moisture to change places and come from the atmosphere and return to the earth. How do we know but that the moisture in the atmosphere is much more beneficial there than to have it precipitated on the earth where it soon evaporates and returns to the atmosphere. Frequently where the rain-maker is a success his meager showers are a curse and a mockery, and not a blessing. Many a small shower in Kansas only increases the damages of the drought, for the sun's rays are so intense that the light shower scalds vegetation.

Read thoroughly on the grove and pond question in this work and depend on nature by her general laws to do the rest. Simply fall in with the facts in the case and help nature solve the problem. If we had the water and Kansas had about twenty times as many people then a system of universal irrigation would be just the thing. But we have not the labor or even a demand for more crops as a food supply, for there is a practical chronic over-production on now, because a large per cent of our people have not the ability to pay for what they could eat. The world has been blamed more by individual effort than in any other way. As individual farmers then let us give our own farms the heroic treatment suggested in this work and not depend on the general government to help us; no, not for one cent. Let us depend on self and not on the state. Let us be our own farming engineers, and not be the slaves of some irrigation monopoly or pay an extra state tax to support some great scientific philosopher who

makes it rain much more in the regions of his own idealty than on the parched farms of Kansas. Let us fill the sub-soil with vegetable roots and rootlets; let us ventilate our hard sub-soils with the sub-soil plow, in conclusion let us be heroes and not slaves. Let us master the situation, improve our own farms by our own energies and common sense. Remember that common natural sense is as uncommon in the scientific agricultural world as it is uncommon in politics and religion. What little natural common sense the young American has left, let us make the most of it.

Miscellaneous Subjects Continued.

The Fertilizing Gases of the Atmosphere.

SECTION XIV.

80th. Carbonic Acid Gas and Ammonia.—These gases are nature's great resources for fertility. While carbonic acid gas and ammonia cannot be seen at all times by the naked eye, nevertheless they are doing more to keep the surface of the earth in a fertile condition than all other natural and artificial means. Carbonic acid (CO_2) is always present in the atmosphere. Its average quantity is 4 parts in every 10,000 parts of the atmosphere. But it is in much greater quantities down next to the earth than it is above the face of the earth. No doubt you have observed in a damp day smoke from the house chimney go down to the ground, blow along some distance and finally disappear on the surface of the ground. Now the smoke is carbonic acid and that is a fair description of how it behaves in the atmosphere. Carbonic acid seems to unite with the elements or atoms of water and form surface soil compounds. Carbonic acid settles readily in water and forms black muck at the bottom of all swamps. Carbonic acid is in all exposed waters in as great a quantity as the water itself. Carbonic acid helps all vegetable fiber to decompose when the same is moist with water. Carbonic acid is entering under all vegetable matter lying on the surface of the earth. Carbonic acid always creeps under the ground rail of the fence row, and under every log; and on account of carbonic acid and the other gases the lower rail of all fences rot from the bottom up and not from the top down. All logs or wood of any kind always rot from the bottom upward and not from the top down. The farmer's fence post rots in the first two inches of the surface soil on account of car-

bonic acid gas together with the other gases of air and water. All the fat on all cattle, sheep and hogs which is shipped to the city and eaten by the human family is thrown off from the human lungs in the form of carbonic acid gas. Then this vast annual quantity floats annually in the atmosphere and is as evenly distributed over land and sea as the currents of the earth are universal in their general action.

Every pound of flesh going to the city returns to the farm. Now this fact is worth millions to the western farmer, if I can get him to cultivate the plants which I call "soil creators;" for they have the power to gather carbonic acid direct from the atmosphere in much greater proportions than the soil destroyer. Now the farmer who buys this book and plants a crop of Soil Producers can have the satisfaction that he is gathering by this means one of nature's great fertilizers from the atmosphere and in doing this he is logically returning the flesh or fat element which has been shipped to the city, back to his farm. Now what is there to hinder any man from carbonizing his farm after he understands this valuable information? The only scientific reason in this world why clover is a benefit to the soil is the fact that they gather carbonic acid gas and ammonia from the atmosphere. Just think how soon all farm operations would stop if it was not for this great fact that every pound of flesh and muscle which goes off from the farm to the city returns to the country in the form of manurial gases.

Now, the intelligent farmer can set his organic chemical traps to catch billions of atoms of fine attenuated carbonic acid every hour during the growing season. Nature is much more perfect than the unlearned suppose; for the more we know about nature's laws, the more perfection we see in her complicated workings. Now let me illustrate how carbonic acid gas goes its rounds in the conservation of nature's forces. For instance take the starch eaten annually by the human family in the form of white flour. This white flour is carbon in the form of starch. It is taken into the stomach and transformed into glucose by the action of the acids and alkalies. Now in the form of liquid sugar it is burned in the blood by coming in contact with the oxygen in the air cells of the lungs. Then carbonic acid gas is thrown off from the lungs as heat is set free and absorbed by the system. Now this carbonic acid gas from all human lungs for one year is so great that no mathematician can estimate it, for the number of the human family is not known. But this vast quantity of gas is taken up next season by the growing crops and in this way only can starch be provided again for the human family. God has prepared this world for us, not only in good shape but the only shape probably if we knew all the facts in the case. Now, it is a fact that carbonates or carbon elements in the soil are always placed there by the chemical action of carbonic acid in its relation to lime and other minerals of the soil, and its relation to the mineral elements of all vegetable bodies in the process of decomposition. It is also a fact that all the nitrates of potash and the nitrates of soda are placed in the soil by the chemical action of ammonia from the atmosphere.

It is also a fact that where ever a soil producing crop is plowed under the combined forces of carbonic acid and ammonia are exerted and both carbonates and nitrates are formed in the soil and it is a fact that when both of the above formations take place nature is manufacturing a perfect surface soil with all the elements present.

Be sure and practice the above plans and make your farms rich in the elements corresponding to flesh and muscle.

81st. *Lathyrus Silvestris Wagneri*—Flat Pea.—This plant has been experimented with in Germany and France for a number of years, and is a pronounced success. It belongs to the Vetches or Tares, and is described as an everlasting pea. One of the agricultural papers in Germany describes it as follows:

"This plant," it says, "has all the valuable traits of red clover or lucerne, without showing any of its defects (such as causing bloating in cattle when fed green carelessly, or the heaves in horses when hay is given dusty), and surpasses them in every valuable essential of a fodder plant. It will endure at least sixty or seventy years on the same spot without necessitating a new seeding. It grows on any soil free from stagnate water. Where no other forage plant will live it flourishes with undiminished vigor and exuberance, scarcely needing rain after it is once well established the second year. After that time it needs no further care except mowing and gathering.

"It produces heavy crops, averaging about 200 quintals to the hectare (four tons per acre) of cured hay. Its nutritive qualities twice exceed those of red clover or alfalfa, weight for weight; careful investigations made at several experimental stations, showing that the two latter plants contain only 10 or 12 per cent of protein or albumen, while this improved lathyrus, or everlasting pea contains from 21 to 30 per cent of these valuable nutritive substances.

"Cattle, as well as horses and hogs, eat it with avidity. The yield of milk from cows fed with it averages about 25 per cent more than when fed with any other fodder, and the quantity of cream from the same amount of milk is nearly doubled. The use of it as a hay provender is also said to afford a preventive or cure against murrain or spleen diseases."

Two years' experiments by O. Clute and F. B. Mumford, at the Michigan station, with the new fodder plant, *Lathyrus Silvestris*, or Flat Pea, prove that it germinates and reaches the surface in from seventeen to twenty-eight days. It grows slowly at first, and needs care to keep the weeds down. It makes on very poor, unimproved sandy soil, a top growth of 6 to 8 inches, and a root growth of from 12 to 15 inches, the first year. It makes, on sandy soil that has been cultivated and improved, a top growth of from 12 to 15 inches, and a root growth of from 18 inches to two feet, during the first year. Only a severe frost will kill the tops. The roots stand the winter well. Tubercles form abundantly upon the roots. One-year-old plants, transplanted in the spring to sandy soil, yield over half a ton of green forage per acre. It has not bloomed the first year, and

but very slightly the second. Cattle eat the green forage readily. The flat pea promises well for the sandy soils near the great lakes, where a perennial forage plant is needed, that will not be killed by severe frosts or by protracted droughts that will yield good forage for all farm stock, and at the same time has valuable qualities as a fertilizer.

Directions for planting the seed are given as follows:

Sow in April or May on well prepared ground in drills about one to two feet apart, seeds about two to three inches deep, about two inches apart in the drills and cover well; keep well cleaned from weeds afterwards. The plants can be transplanted either in spring or fall on any kind of soil, even on rocky ground, but not on wet lands.

To give our customers an opportunity to try this new plant we have imported a limited quantity of the seed from Germany, and will furnish as long as supply may last. Per pkt. 10c, oz. 30c, 1-4 lb., \$1; 1 lb., \$3.

82nd. Soja Beans.—These beans resemble the Cowpeas, and have been experimented with at the Agricultural College at Manhattan, which gives the following results:

Growth vigorous throughout the season, from the time the plants first appeared above ground until they were killed by frost. The plants grow erect, averaging 4 1-2 feet in height. The stock is strong and woody, and has numerous branches covered with heavy foliage. The branches and upper part of the main stem are thickly studded with clusters of pods—from two to five pods growing in a cluster, each pod containing two beans. The plants were killed by frost before the bean had matured. This plant has many valuable qualities, and deserves further trial. The bean should be sown a half bushel per acre broadcast, or planted in drills three and a half feet apart, and one and one-half feet between the plants, dropping two or three in each hill, which will require one gallon per acre. Lb. by mail 20c, 1-4 bu., \$1.25; 1 bu., \$4. I desire all farmers who can invest a little money, to try on Kansas soil the above plants. Address

F. BARTEDES & Co., Lawrence, Kansas.

83rd. "Bromus Inermis," the great forage grass of Russia, the only grass for the arid regions of the south and west.—The finest fodder grass for stock, excelling in nutritiousness and productiveness the well-known Alfalfa, and succeeds in drought-stricken districts where all other grasses fail. In many sections of this country such a grass has long been sought after, not alone by private individuals, but by the department of agriculture at Washington, D. C., which has been experimenting with this wonderful variety at its experimental stations in the arid regions. Following we publish a letter from the Experimental Grass Station at Garden City, Kansas:

Experimental Grass Station, Garden City, Kansas, says: "We have grown 'Bromus Inermis' successfully, and think it is to be the coming grass for the arid regions of the West. Sow it about the first of April, and about twenty-five pounds per acre."

This grass is certainly the greatest boom to the arid districts ever discovered; not only is it the grass for dry sections, but it can be raised on almost all kinds of soil, and in any climate. It being a native of Russia, makes it particularly desirable for our Northwest; and it is adapted to such states as Texas, Colorado, Kansas, Montana, and in fact all that are subject to drought. Description—It originated in Russia, and is recommended on account of the manner in which it has stood on the Hungary plains, where the dry, sterile nature of the country and the long-continued droughts make so many plants succumb. This *Bromus*, however, stands well, and has been known for thirty years to stand when such robust crops as Lucerne have been destroyed. It gives a luxuriant crop, particularly on fresh sandy loam soil, and where the climate is warm. It is found that animals eat it greedily, whether in the green or in the dry state, so that it can be used as mown or saved for winter use. The seed is sown in the early spring. It is also useful in filling up gaps where Lucerne or Clover crops have failed. It will stand under favorable conditions for twelve years, and give as much food in one month as Lucerne gives in three months. Price 50 cents per pound postpaid. By express or freight, in 25 pound lots, \$10 (sufficient to sow one acre). Address

L. L. MAY & Co., St. Paul, Minn.

Glossary or Definitions of the Chemical Terms Used in this Work.

SECTION XV.

84th. Oxygen.—That elementary gaseous body which gives to air its power of supporting respiration and combustion, and which, by its union with hydrogen forms water. Its chemical affinities for other elementary substances are very powerful; with most of them it is found in combination, or may be made to combine, in more than one proportion: with several in 4, 5 or 6 proportions; and there is only one element (fluorine) with which it does not enter into any combination.

Owing to the intensity with which many of these combinations take place this gas has the power of supporting combustion in an eminent degree. Of all known substances it exerts the smallest refracting power on the rays of light. It possesses weak but decided magnetic properties, like those of iron, and like this substance, its susceptibility to magnetization is diminished or even suspended by a certain elevation of temperature. It is only slightly soluble in water: 100 cubic inches of that liquid dissolving 4.11 cubic inches of gas at 32 degrees, and only 2.99 inches at 59 degrees.

Oxygen gas is not only respirable, but is essential to the support of animal life; hence it was termed vital air by some of the older chemists. Oxygen is the most abundant and most widely distributed of all the elements. In its free state (mixed but not combined with nitrogen,) it constitutes about a fifth of the bulk and considerably more than a fifth of the weight of the atmosphere. In combination with hydrogen it forms eight-ninths of all the water on the globe; and in combination with silicon, calcium, aluminum, etc., it enters largely into all the solid constituents of the earth's crust; silica in its various forms of sand, common quartz, flint, etc.,—chalk, limestone and marble—and all varieties of clay containing about half their weight of oxygen. It is, moreover, found in the tissues and fluids of all forms of animal and vegetable life, none of which can support existence independently of this element.

85th. Hydrogen.—An elementary substance which exists as a colorless and inodorous gas. Hydrogen exists for the most part in combination with oxygen, as water. One of its most striking peculiarities is its specific gravity, it being the lightest of all known bodies. Its refractive power is greater than that of any other gas and is more than six times as great as that of atmospheric air. Hydrogen is combustible; it is capable of combining with oxygen and developing light and heat. Hydrogen then readily combines with oxygen, fluorine and chlorine.

Hydrogen and chlorine mixed together, and exposed to direct sunlight combine with explosion; in diffused daylight they gradually unite, but in the dark do not act on one another. The fact that oxygen will unite with so many other agricultural elements in the light and under a high temperature, explains why plants and trees and animals grow and mature in the light and do not develop in the dark.

86th. Carbon.—This is one of the most important elements in the natural economy. It occurs uncombined in the mineral graphite or black-lead, and also in the diamond which is pure crystalized carbon. The importance of carbon in the form of carbonic acid in the surface soil is in its tendency to unite with lime and form with oxygen the carbonate of lime, the carbonate of soda, carbonate of potassa, &c. These combinations of carbon furnish the more substantial elements of all vegetable and animal structure.

The starch of all the cereals is carbon in that form. The fat of all animals is carbon in the form of fat. Now when starch is decomposed or when fat is decomposed heat is thrown off and a gas arises which we call carbonic acid gas. This gas is taken again into the cereal kingdom and transformed into starch and all of the units of heat lost in the process of decomposition are regained and incorporated again in the vegetable kingdom. Therefore nature is perfect, while there is a continual change of all the organic elements going on at all times; there is no loss of atoms or energy.

87th. Nitrogen.—It is a colorless, tasteless, inodorous gas, which in appearance in no way differs from atmospheric air, of which it is the main

ingredient. It is characterized rather by negative than by positive properties. It is not combustible, nor is it a supporter of combustion. Its combining powers are very slight. Its agricultural value is contained in the fact that it unites with oxygen, hydrogen, chlorine and many other substances; the union is effected rarely by direct action on one another but only by the complicated workings of the elements of the natural economy. Many of the nitrogen compounds are very unstable. Nitrogen passes into the lungs with oxygen, then it returns immediately to the atmosphere associated on its return with carbonic acid gas. Now it seems that nitrogen does not combine with carbonic acid gas; but it does associate with this gas, while it does not combine. Nitrogen associated with carbonic acid gas does enter into the composition of all pod growing plants called soil creators in this work. What a wonderful phenomena to observe the fact that nitrogen associated with carbonic acid gas comes out of the animal lungs, while oxygen enters the animal's lungs and nitrogen associated with carbonic acid goes into all soil creating crops while oxygen escapes from every pore and passes into the air in a pure state.

"Nitrogen is absolutely essential to plant life and growth. It forms one of the principal and most costly elements of commercial fertilizers, and in soils long under cultivation is very likely to be deficient in quantity. Concerning the sources whence it is obtained by certain plants there has been much mystery. Experience has proved that the growth and yield of wheat and other cereals which contain only a moderate quantity of nitrogen are greatly increased by the use of nitrogenous manures, while clover, alfalfa and other leguminous crops, though using large quantities of nitrogen, do not show such marked benefit from the application of these fertilizers and thrive with the application of less than the cereals require. It has been conclusively shown also that though leguminous crops remove considerable quantities of nitrogen from the land they leave the surface soil richer in that element than it was before they were produced. Only two sources of this surplus nitrogen are possible—the sub-soil and the atmosphere. For a long period many farmers have claimed that both these sources were drawn upon, while scientists have declared that the nitrogen not furnished by the rainfall or by fertilizers, or not already existing in the soil must come only from the sub-soil. During several years past Prof. Hellriegel of Germany has been conducting a series of elaborate experiments which seem to make it absolutely certain that leguminous crops obtain much of their nitrogen from the air. Sir J. B. Lawes, who long opposed the theory that plants could use free nitrogen, has repeated the tests at his famous experimental estate, Rothamsted, England, with results as far as secured, corroborating those obtained by the German chemist. It is supposed that the nitrogen is made available for the use of crops largely through the action of microbes."

The old world chemists are mistaken about the habits of the niter microbe as far as my own observations go. I believe that all the albumenoids and nitrogenous elements of vegetable and animal substances are trans-

formed from these organic elements into the corresponding elements of nitrate of potassium and nitrate of sodium as soil elements by the agency of the Niter Microbe. I believe that all the soil creators described in this work get their nitrogen direct from the atmosphere, from the nitrogen proper and from ammonia. I believe also that the Niter Microbe can be found by the billions in all niter caves of the earth, and the only way we understand that this little animal gets nitrogen is from the free nitrogen of the atmosphere combined with ammonia which also freely circulates in the atmosphere.

88th. Lime.—This mineral substance has been used for centuries as a means of increasing the fertility of land. All crops require a certain amount, as is found by analyzing the ash which remains after combustion. This element can be supplied to farm land in the form of marl and chalk wherever they are found near enough to be handled by the farm team. About three to eight tons per acre of slacked lime is enough, placing three tons on light lands and eight tons on the richest alluvial. Remember that all soil creators throw out acids and decompose lime rock and place in the soil carbonate of lime as well as all other necessary elements. Remember that carbonate of lime in the soil attracts as much water and carbonic acid gas as its own weight, and aids in this way to control three gases, namely—oxygen, hydrogen and carbonic acid.

89th. Phosphorus.—An elementary substance of wax-like consistence easily made to burn even by the heat of the fingers or by friction. Phosphorus has a corresponding acid called phosphoric acid, this is a union of phosphorus and oxygen. This acid has much to do with operations on the farm, for this element is essential to plant and animal life. Phosphoric acid is about three parts of all the cereals, it is about four parts of the animal system. Therefore we would expect it to constitute a corresponding part of the soil. It is returned to the soil in the form of bone meal, wood ashes, fish refuse, phosphate rock, guano, etc. Phosphorus combines with oxygen and gives us phosphoric acid. Phosphorus combines with soda and gives us a phosphate of soda. Phosphorus combines with lime and gives us phosphate of lime. It also combines with hydrogen gas of water. Phosphorus should be present in all soils for it is one of the parts of plants and a part of all animals. Phosphorous occurs in combination with potassium and is called phosphate of potassa or potash. Phosphate of lime is the greatest ingredient of bones, being about 57 per cent. There is also the basic phosphate of magnesia, which is composed of three parts of magnesia; one part of oxygen, two parts phosphorus and five parts oxygen again is added. This is sufficient to suggest the value of phosphorus in relation to the "Science and Art of Farming." But to make sure that you have it in all your fields plant soil creators and plow the same under as advised. Phosphorus, oxygen and iron together with electricity are the elements of life in the soil, in the plant and in the animal body; and finally even life to the human body and physical life to the human mind or without these four elements life would become extinct in less than one minute of time. There is such a

thing as placing the conditions of life in the soil.

90th. Chlorine and Sodium.—Combine as common salt. This combination is in the blood of all animals and in the structure of all plants not as common salt, but both of these elements are combined with other elements in the structure of plants. These elements are present in all fertile soil.

91st. Ammonia.—Is an agricultural gas or a gas which unites with the mineral element potassium and forms the nitrate of potash. Ammonia is not a separate element, it is composed of one atom of water, one atom of nitrogen, four atoms of hydrogen and one atom of oxygen.

92nd. Sulphur.—This element is second only to oxygen in its affinity for other elements. Wherever oxygen unites with a mineral and forms an oxide, sulphur and oxygen will also unite and form a sulphide. This element is present in all growing crops. When crops are plowed under in a green state the sulphates are formed in abundance.

93rd. Ammonia—Is a volatile alkali. It derives its name ammonia from being obtained from salammmoniac. The atmosphere contains a minute quantity of ammonia, amounting to 210 parts in 10,000,000,000 parts of air. This is equal to one volume of ammonia in 28,000,000 volumes of air. It is present in every drop of rain water. While the above figures represent all the science of chemistry can do in estimating the amount in the atmosphere it is a fact probably that chemistry never can obtain a correct statement of the proper amount of this element in the atmosphere. It hastens to the earth in every rain shower. It is a very valuable element. It is the muscular element in the animal kingdom, it is the albuminous and nitrogenous element in the vegetable kingdom; then again where these elements have decomposed they throw off the gas which we name—Ammonia.

Remember when the farmer plants any of the Soil-Creators and plows the same under he is fertilizing his ground with this precious the element as fast as he can run the plow, when the time for plowing has arrived.

94th. Magnesia—Is the only oxide of metal magnesium. Magnesia enters into the structure of all growing crops. It attracts and hordes water and also attracts carbonic acid from the atmosphere, and with the carbonates of lime forms an important work in the growth and composition of plant life.

95th. Iron—Is so well known that it is useless to speak of the mineral element here. There are but few farmers who know much of the value of the combination of oxygen and iron and hydrogen and iron. Oxygen has a powerful affinity for iron and all the red and yellow clay soils are owing to this power and affinity. All the color of plants is owing to the relation of oxygen and iron to all the other complicated combinations in the structure of plants; therefore plow all crops under in a green state.

96th. Silicon—Is common sand and seems to be such a hard substance that it cannot be decomposed and utilized by the growing crops; but this is a great mistake. Sand is essential to all perfect soils and under the higher temperature of spring and summer the oxygen element of the at-

mosphere and the hydrogen element of water act upon sand and decompose this mineral slowly but surely and it passes into the structure of all farm crops. It is the outer gloss on all wheat, corn, rye, barley and oat straw. It is the varnished surface of all grains. It is the gloss on the hair of all animals. It is the outer varnish of the finger nails and toe nails of all animals. It is a part of the enamel of the teeth also. Therefore it is one of the valuable agricultural elements.

Now, all the above elements enter into a perfect surface soil and become the base of a perfect food supply. Then this food supply fed to the animal kingdom and to the human family passes as six gases into the atmosphere and into water and are returned to the general surface of the country. Then the eight minerals as ash are left in great quantities where animals and man live and die in great numbers or in our great consuming cities. There will soon be a perfect sewerage system in all of our great cities and all the solid and liquid offals will be floated and mixed with an abundance of water, and in this way will be used as a means of irrigation as well as perfect fertility. There will be large farms near all great cities treated this way, and market gardens when properly summer fallowed will the next season yield up their vegetable growth and grandeur, which will astonish as well as please the admiration of mankind.

CHRONOLOGICAL INDEX.

	PAGE
Introductory, - - - - -	1 to 3
Origin and Formation of Soils, - - - - -	3
Changes of Temperature, - - - - -	4
Moving Water, - - - - -	4
Weathering Action of Water and Air, - - - - -	5
Action of Plant Life, - - - - -	6
Classification of Soils, - - - - -	9 to 12
Relation of Soils to Crops, - - - - -	12
Worn out Soils, - - - - -	14-15
How to Improve the Surface Soil, - - - - -	16 to 24
Surface Soil Destroyers, - - - - -	25 to 32
Water Precipitation on the Western Farm, - - - - -	32 to 34
The Foundation Principles of the Science and Art of Farming, - - - - -	34-35
The Human Body Analyzed, - - - - -	35
Feeding Value of Cereals and Other Crops by Chemical Analysis, - - - - -	37 to 40
The American Hog, - - - - -	40 to 41
Irrigation, - - - - -	43 to 44
The Fertilizing Gases of the Atmosphere, - - - - -	45 to 46
Flat Pea, - - - - -	47
Soja Beans, - - - - -	48
Bromus Inermis, - - - - -	48
Glossary or Definitions of the Chemical Terms Used in this Work, - - - - -	49 to 54

Words of Commendation.

HACKBERRY TOWNSHIP, DEC. 13TH, 1894.

In consideration of our appreciation of the very interesting and valuable lecture delivered at the Bishop school house last evening by J. W. Damon of Chetopa, Labette county, Kansas, on The Science and Art of Farming, a unanimous vote of thanks was bestowed upon the Professor and a committee was appointed which passed the following resolutions:

1st. Resolved, That our experience and observation confirm his illustrated lecture on the origin, composition, exhaustion and improvement of the surface soil.

2nd. Resolved, That he treated of the complicated working of the elements and laws of nature in such a plain manner that the lecture was not only appreciated but understood by every farmer present.

E. W. HOPKINS, Chairman of Committee.

Rev. J. W. Damon of Chetopa was in the city Tuesday on his way from Labette where, on last Monday night, he delivered one of his inimitable lectures on agriculture. Every farmer in Labette county should hear this lecture, as it is money in their pocket.—Labette County Times-Statesman, Dec. 6, 1894.

LIBRARY OF CONGRESS

00025863045