"Thesis"

"Best Methods of Improving Soils"

By

Henry Wm Rogler
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When our forefathers landed here, they found a soil rich in organic matter and all kinds of plant food ready to respond to any forms of cultivation. They made little or no attempt to retain the natural wealth of the soil, and the phrase "inexhaustible fertility" was a common one.

Little did they think that soil improvement would become a question of paramount importance to coming generations. Where settlers came to Kansas, the valleys were covered with dense growth of grass, together with large quantities of hitch tillage mould which had accumulated for years, and where the old-fashioned ploughing fused with trees to form the ground was black and deep and filled with those soluble elements which make the difference between a fertile and a impoverished soil.

Under such conditions it was natural to heed very little rotation or any other method of natural or artificial improvements.
and necessary today.

Long ago during the Roman consular days, the idea that to keep soil enriched was a necessary practice and that it recommended leguminous crops.

A few centuries ago, Gaius Plinius, in his "Hortus Horreum Rusticum," said that fertility depended upon the tilth of the soil. It was thought that plants could take up the fine particles of soil and dissolve them, so while they are a matter of fact, the methods of fine tilth did improve the soil. Yet the theory was at fault.

However, this gave the idea of a better pulverized soil. A new impetus which has continued and has been of untold benefit since. About the same time, lime and salt began to be used as fertilizers. Lime was found to be beneficial but salt was said to enrich the latter and impoverish the corn.
Machinery

Coming down the centuries we find improved farm machinery keeping pace with other industries. The plow is a typical implement in this respect, showing gradual improvements in lighter draught and greater effectiveness in plowing and turning the surface. This tendency has been accompanied with machines of lighter draught, and capable of doing much more work in a given time. The farmer of today has a dozen implements that can do farming a pleasure to me, a few years ago.

Tillage

As the readily soluble plant food is diminished by succeeding crops, it becomes necessary to replenish it by lime or several of the many methods that present themselves, and the one which naturally suggests itself as the cheapest, quickest and most efficient is soil culture or tillage.
Numerous experiments prove that ordinary soil contains enough of three important elements—phosphorus, nitrogen and potash—for ten to twenty centuries of maximum crop, and when it was found that the growing of one continuous crop soon brought diminishing returns means were sought to make available for plants the great mass of plant food found in an invisible form.

This gave rise to many new practices in agriculture and in the way of simple implements—this grass was placed more deeply to give the roots more room to spread and collect their food, and at the same time preserving moisture by fire, fertilizing and checking evaporation or breaking connection of capillarity with the subsoil.

While doing this another object was also attained, namely, giving the soil an increased capacity to retain moisture not only to hold it better.
but also to hold more of it, and prevent too extensive washing or leaching.

The attempts to secure these results brought out a new idea or theory, which has worked out satisfactorily in practice, that is the “Dent Naik” blanket.

Frost and weathering have long been known to be the best agents in the disintegrating and breaking up of inorganic materials found in the soil in such great abundance, and it consequently became necessary that the agriculturist should shape his soil that this process would be aided.

Fall plowing was inaugurated largely for this purpose.

Frequent and thorough alternately broke down the inorganic chemical compounds from their hardness and left them in such form, that future crops need not fear starvation. Clods and lumps were crushed, and the tough, clayey subsoil was mollified, the whole affected to deepen and lose the
not area, and fill it with those constituents upon which success at farming depends, or to fill it with manure and make it a store house from which future crops could draw their living.

The next question was how could the most surface be exposed to the weathering action of air and sunlight during the winter.

It was easy to see the rougher the surface was left the greater action would be, and many recommend well ridges seventeen feet plowing to secure this end.

Practically perhaps at 4 tons of soil moisture and more snow contained, and lowing largely prevented. Precipitation maximum against. Using more than abundant of available plant food necessary, and that is from fifteen to twenty percent of moisture in the first foot of surface.

Precipitation during drought, which is a common word throughout Kansas as taxes the ingenuity of our best farmers, but does so
usual in agricultural matters which are left to the farmers to settle. A partial solution at least has been found and no doubt the Dust Mulch doctrine is to stay.

It has been found that by plowing deep in the fall to make a reservoir for the surplus moisture and in the succeeding seasons work the bedsoil of the ground keeping the surface well fine for a depth of two inches so that capability is broken up at the surface; much moisture is present. Sometimes after every shower, it would be well to run hastily over the fields with some implement and to pulverize the soil, for a rain renewing the connection between capability and the air.

Such implements as Campbell's Sub-Surface Fanner, harrows, discs, plowbars, cultivators et cetera are important on this book.

The question of inter-cultivation and more especially late cultivation after crops are extensively laid by for each
farmer to determine for himself.

As are many of the problems of tillage for local conditions alter requirements for cheap yet maximum crops.

At the Kansas State Experiment Station, numerous cultivations were of no practical value, and the Delta crop yields did not compensate for labor costs, although at Cornell certain tillage and a continuance of the disk plow after corn had turned gave much better returns.

A few years ago, many farmers thought that at last some implement had been invented that would make the cutting of water a comparatively simple problem and hundreds of subscription were put on the market to supply the demand.

They were born from the idea that by tending up the ground eight or ten inches deeper than ordinarily places it would allow the water from rains to penetrate down into the sub-
soil thus draining the surface and
This greater abundance of isolated millimeter soil has been largely due, as in a vast majority of cases, to the evidence of greater fertility from their use and utilization. Subsoiling has proven to be a failure at this station.

In some localities, however, the subsoiler has done good work and has been profitable, especially in cotton. In some cases, it acts as a good drainer.

**Drainage**

There is comparatively little difficulty in getting rid of water in Kansas compared with its retention, more especially in the western section. The clodhopping rains, as soon as the surface is a few inches run down the corn rows and reach little trenches passing it portion to form a turbulent little stream, hurrying away the already loosened soluble plant food. The after good rains reach the prairie surface.
at the same time leaving the subsoil practically dry.

Tile drainage is a benefit for boggy or swampy soils, such as the fine ooze in the wide level rice bottoms. Where soil needs draining, nothing will help so much as tile drainage, but for the most part it is too expensive to make it a profitable practice. It keeps soil moist and as the water trickles down through the surface, much of the plant food is held by the particles of clay and water drains off through the tile. It has been found to contain a smaller portion of nitrates than surface water.

Tile drainage is especially good for heavy clay soil where the water may pool and stagnate.

**Leguminous Crops**

In soil improvement, tillage perhaps occupies the first place, with leguminous crops a close second. For two thousand years they have been in use in agriculture, and it is impossible to say just how much they increase the richness of the soil.
mention of alfalfa before its establishment in the United States until some twenty-five years ago.
At present it ranks first for soil improvement, although clover is extensively grown in a few eastern counties. Almost all eastern states grow alfalfa by nature as a leguminous plant. It fixes the nitrogen of the air and gathers ammonia. It is therefore chief among plants.
They have the power of taking nitrogen from the soil. Thus, it is the soil for future crops in addition to being much of it themselves.
It has been proven without doubt that a good crop of alfalfa or clover can legumin and produce more nitrogen in the form of nitrate left than was present prior to growing the crops.
Since nitrogen, one of the most essential elements, is in fact absolutely necessary for plant growth, at the same time being very soluble and easily washed from the soil, it becomes evident that it must be added or preserved in any soil and this can best be accomplished by growing alfalfa, pearl beans, clover, etc., whose roots, being the best of their kind in most parts of Kansas, it had been found that these crops, especially legumes, form a nodules upon their roots carrying nitrogen from the air, that is, from the free nitrogen in the air and store it in their tissues in such a way that the plants could dissolve it and add it to their food in such a way that the plant could dissolve it and add it to their food in such a way that the plant could dissolve it and add it to their food in such a way that the plant could dissolve it and add it to their food.
Kansas soil on an average contains sufficient phosphoric acid for hundreds of crops and should yield great abundance, but nitrogen is an element badly lacking in much of the farm land which have been in cultivation over twenty years. The question which confronts every Kansas farmer is how to supply this nitrogen, and some doubt may linger in many farmers' minds if the soil is poor, while the farmers believe that most of their farms have a poor soil, with the result that by the increase in control as the element lacking to make it produce abundantly. Potassium and even of nitrate and phosphate are both expensive to use in Kansas soil and the necessity for it. We have in our leguminous crops, plants which will produce abundantly, the first hay and at the same time increase the nitrogen content of the soil and prepare the way for better crops to follow. The effects of alfalfa and red clover are distinctly noticeable on the crops.
Four to six years after they are planted
alfalfa is a better drain and
brings up more food material from
the subsoil than clover, and
much more luxuriant growth and
better, drier, resist at the same
time being rapidly adapted to all
but the very dryest portions of the
state.

In this crop there is one of our
soil improvers and Kansas
farmers should avail themselves
of it.

The merit of soybeans as a
legume which matures at the
time of alfalfa sowing, from the fact that
they have lately been introduced into
this state, and the tubercle producing
bacteria have not yet found lodgment
in our soil, although at the Institute
artificial inoculation has proved
successful, and it is quite probable
that this will be found upon the
soybean root and upon other native
legumes.
They will then offer a most excellent means of supplying nitrogen.

The shallow cultivation necessary to grow them can early spring of falling
before planting into the cool, rich, welled conditions for full seeding of wheat
after the crop harvested without further labor.

As soybeans are quite vulnerable to drought, the prospects of their becoming
a facility crop of importance is good
and they will do their part towards
making more plant food available,
and in some important additives
for the soil.

**Rotation**

While writing soil improvement
it is evident that the subject would
be incomplete without mention
of rotation and its relation to soil
fertility.

The key arrange almost any more
rotation but some have advantage
derover others. And, as rule, long rotations
are much better than short ones.
Corn, oats, and wheat is a good rotation with cereals alone, but after the rotation that is used, they acquire a good chance such a rotation leaves the ground in
fine mechanical condition.

To bring the best results, rotated crops must be studied with reference to locality and needs of the soil.

Certain corn, corn oats, wheat and other grains all self seeds would be a most excellent rotation giving a good variety of crops and allowing a variety in
the treatment of the soil.

A few advantages of rotation are:

1. Pest elements are exhausted uniformly
2. The ground can be given various treatments and methods of tillage desired to thoroughly stir and pulverize it and bring more food into soluble form
3. It affords an opportunity to

4. The soil can be improved by use of leguminous crops.

5. If we grow some one crop year after year, say corn, it gives no chance to practice early fall plowing.
and stalks, which interfere with later plowing.

Soil fertility may be kept up a good while and the same crop be grown consecutively for half a score of years without significant diminution in the grain. Proper tillage is used, and the available material thus made available, but when it comes to keeping up the original fertility for a quarter of a century there seems to be no way except by rotation of fertility. Rotation prevents and allows the phases of soil exhaustion indefinitely. Rotation appears necessary in all good farming communities. Excused from the thought of impropriety, leguminous crops are the only ones that add anything in the way of plant food above what they take up. P. Poinclaire found a crop requiring a large amount of nitrogen to make good growth, so we grow it continuously in this form that would fail first, the soil remaining comparatively fertile in this plant.
food. By putting in a crop of alfalfa in close, the equilibrium can be restored, or give the soil time to recover by weathering processes to original fertility. A change of small grains mellow up the soil and adds humus from stubble or gives chance to grow cover crops.

The use of alfalfa makes a notation of long duration, loss of efficiency and it will pay every Kansas farmer to plan a rotation embracing a leguminous crop and providing for the restoring of lost organic matter.

**Cover Crops**

Another method of soil improvement that deserves recognition is by the use of cover crops. Cover crops have been little used in Kansas but they are a means of restoring cheaply organic matter to those soils which blow and wash badly.

We do not appreciate the amount of moisture lost from a stubble field during the hot dry days of summer.
and it behooves us to practice some
method to retain this moisture
if the best results are to be obtained
from fall wheat or next year's crops,
especially when rain is scant.
This could be accomplished in a
measure by drying some after
harvest and strawing after rains
but if the ground is moist enough
to allow such crop as soy
beans, sorghum, a good method
of shading and simplifying the soil
is afforded at the same time.
Plowing for soybeans would provide
a natural mulch and the growth
they make would prevent considerable
corrosion and protect the soil for
a chilling sun.
In the fall these crops could be
plowed under as a green manuring
thus adding large quantities of
organic matter and soil would thus
be prevented from blowing away
in an appreciable extent. A characteristic
of soil deficient in organic materials is that
they blow badly.
Manures

One of the most important and oldest methods of soil improvement is manuring.
Natural manure have been applied to land from time immemorial and is today a universal practice.
Much of Kansas soil being new at harvest time requires sufficient loss of food elements to make up for the necessity of going to a plowed floor. Soil to supply it, hence we find manures being considered by many a measure and in duty of care where the manure is ultimately applied to the soil it has undergone the leaching process for six months previous with the latter of winter the causes and lost one half to three fourth it value.
Materials that would aid the growth of plants are thus lost and it will be necessary to supply them perhaps sooner than I think, and that by more expensive and laborious processes than it would require now.
How much care is to be given to manure is another question for each individual farmer to settle for himself.

Manure ranges all the way from nothing to fifty cents a ton. At the first price, up to twenty cents, I would say just as a very liberal supply. But when costs more than this, there comes the question whether we can not sufficiently meet food for plants in some cheaper way. Well-rotted manure is the best becoming disintegrated and available much sooner than coarse manures. The action of manure on soils is well known and few comments are necessary.

If heavy coating of manure is added and heavy shoveling and the season following is dry as a bone except almost sure to be chalk, do the manure hold the earth apart allowing aeration and the chemical action within the manure generates heat causing rapid decomposition.
If the season were a little cooler we
would expect the first year, but the maximum effect
of the manure will be shown the second
year, after which it becomes less and less
noticeable.

A good dressing of manure is almost always
accompanied by dark green foliage and
a heavier and more thickly-grown
and its nitrogen too abundant
increased foder growth may be at
the expense of grain.

Corn can stand much heavier
manuring than small grain like
oats or wheat which lodge and fail to fill.

The soil can be made blacker and filled
with humus in which is stored up
abundance of those elements essential
to plant growth, and illustrating the
difference between a thin clay and
black loam as auspices.

Soil which are clayey, hard and have
tendencies to puddle, can be vastly
benefited and improved by a good
application of manure, making them
more friable and easily worked.
Sandy soils will not dry out as readily if they are mixed with granules of good manure as evaporation is faster and drainage checked.

Fertilizer and no practical value in farming in Kansas, yet as cheaper methods of improving soil fertility present themselves, the scope of this thesis necessarily limited to a discussion upon a few main principles in the testing and improving of soils, and no attempt has been made at detail.

Henry H. Boyler
May 48