

"Thesis"

"Best Methods
of Improving Soils"

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Outline
Introduction
1 Historical
2 Machinery
Methods
Tillage
Drainage
Leguminous Crops
Rotation
Cover Crops
Manures

When our fore-fathers landed here, they found a soil rich in organic matter and all kinds of plant food ready to respond to any kind 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.

When settlers came to Kansas the valleys were covered with dense growths of grass, together with large quantities of rushes and mould which had accumulated for years, and when the old-fashioned breaking plow first turned a furrow the ground was ^{found} black and deep and filled with those soluble elements which make the difference between a fertile and impoverished soil.

Under such conditions it was natural to heed very little rotation or any other method of natural or artificial improvements so common

and necessary today.

Long ago during the Roman Consulate
Pliny advanced the idea, that to keep
soil enriched was a necessary practice
and to that end recommended leguminous
crops.

A few centuries ago, Gethro Pull
in his "Horse Hoeing Husbandry", 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
as a matter of fact the method of
finer 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 father"
and impoverish the sons.

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 improvement in lighter draught and greater effectiveness in pulverizing and stirring the surface.

This tendency has been accompanied with machines of lighter draught, and capable of doing much more work in a given time and the farmer of today has a dozen implements that can save 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 one 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 crops, 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 insoluble form.

This gave rise to many new practices in agriculture and in the way of improved implements.

First ground was plowed more deeply to give the roots more room to spread and collect their food, and at the same time, preventing aeration by finely pulverizing 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 & leaching.

The attempts to secure these results brought out new ideas or theory, which has worked out satisfactorily in practice; that is the "Dust Mulch" blanket,

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

Fall plowing was inaugurated largely for this purpose.

Frozing and thawing alternately broke down the insoluble chemical compounds from their fastnesses and left them in such forms, that future crops need not fear starvation. Clods and lumps were crushed, and the tough clayey subsoil was mellowed, the whole effect being to deepen and loose the

root area, and fill it with those constituents upon which success at farming depends, or to fill it with a mass of wealth 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 this weathering action, and air and sunlight during the winter.

It was easy to see the rougher the surface was left the greater the action would be, and many recommended well ridged furrows in fall plowing to secure this end.

This is done perhaps at a loss of soil moisture but more snow is retained, and blowing largely prevented.

To secure maximum crops something more than abundance of available plant food is necessary and that is, from fifteen to twenty per cent. of moisture in the first foot of surface.

To retain this during month which is a common word throughout ^{most of} Kansas taxes the ingenuity of our best farmers, but as no

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" has come 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 while the crop is growing keeping the surface well fined for a depth of two inches, so that capilarity is broken up at the surface; much moisture is prevented from escaping.

After every shower, it would be well to run hastily over the field with some implement and repulverize the soil, for a rain renews the connection between capilarity and the air.

Such implements as Cambell's Sub-Surface Packer, harrows, discs, borradocs, cultivators etc. all come into duty here.

The question of inter cultivation and more especially late cultivation after crops are ordinarily laid by, is for each

farmer to determine for himself, as are many of the problems of tillage for local conditions after requirements for cheap yet maximum crops.

At the Kansas State Experiment Station numerous cultivations, were of no practical value, and the extra crop yields did not compensate for extra labor, although at Cornell late winter tillage and a continuance of the disk mulch after corn had tasseled gave much better returns.

A few years ago, many farmers thought that at last ~~an~~ implement had been invented that would make the storing of water a comparatively simple problem and hundreds of sub-soilers were put on the market to supply the demand.

They were borned from the idea that by loosening up the ground eight or ten inches deeper than ordinarily plowed, it would allow the water from rains to percolate down into the sub-soil thus draining the surface and

this greater abundance of root area in the moist soil little used before; but after a thorough trial by many good farmers, these ploughs have been laid aside, as in a vast majority of cases no evidence of greater fertility from their use was manifest.

Subsoiling has proven to be a failure at this station.

In some localities, however the subsoiler has done good work and has been profitable, more especially on bottom soil. In some cases it acts as a good drainer.

Drainage

There is comparatively little difficulty in getting rid of water in Kansas as compared with its retention, more especially in the western section.

The dashing rains, as soon as the surface is wet a few inches, run down the corn rows and each little trench carries its portion to form a turbulent little stream hurrying away the already too scarce soluble plant food, and often good sized trenches are washed in the bare surface.

at the same time leaving the sub-soil practically dry.

Pile drainage is a benefit for boggy or swampy soil, such as we find on some of the wide level river bottoms.

Where a soil needs draining, nothing will help or prove so beneficial as tile draining, but for the most part it is too expensive to make it a profitable practice. It checks soil wash and as the water trickles down through the surface much of the plant food is held in the particles of soil and water drained off through tile has been found to contain a smaller portion of nitrate than surface water.

Pile drainage is especially good on a heavy clay soil where the water stands in pools and stagnates.

Leguminous Crops

In soil improvement, tillage perhaps occupies the first place, with leguminous crops as a close second.

For two thousand years they have been in use in agriculture, and the eminent Roman Cato makes

mention of alfalfa before the Christian Era

Alfalfa was not introduced into the United States until some twenty five years ago.

At present it ranks first for soil improvement, ^{partly raised} although Clover is extensively grown in a few eastern counties and nearly all eastern states.

Alfalfa is by nature a deep rooter, and fastens itself to the soil with great tenacity.

The Rothamsted experiments in England show that alfalfa and all leguminous plants are nitrogen fixers and gatherers and here in lies their chief merit.

They have the power of taking nitrogen from the soil air and fixing it in the soil for future crops in addition to using much of it themselves.

It has been proven without doubt that a good crop of alfalfa or Clover can be grown and harvested and more nitrogen in the form of nitrates be left than was present prior to growing the crops.

Since nitrogen is one of the most essential elements, and 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 is to be added or preserved in any soil and this can best be accomplished by growing alfalfa, peas, beans, clover, etc.; alfalfa being the best of these in most part of Kansas.

It has been found that these crops, excepting soy beans, form what are known as tubercles or nodules upon their roots, varying in size from a pin head to a pea. These are found thickly clustered upon the fine fibrous roots in the surface soil.

New light was thrown upon agricultural science when these were found to be caused by minute organisms or bacteria which thrive best in warm moist soils, and had power to take up free nitrogen from the air and store it in their bodies in such a way that the plant could dissolve it ^{there} after their death, as nitrates or nitrogen compounds.

Kansas soil on an average contains sufficient phosphoric acid for hundreds of crops and potash is in yet greater abundance, but nitrogen is an element sadly lacking in much of the farm land which have been in cultivation over ten years.

The question which confronts every Kansas farmer is how to supply this nitrogen, and no doubt many farmers have a poor soil, what they call a poor soil, when nitrogen is the only element lacking to make it produce abundantly.

Fertilizer in form of nitrates and phosphates are too expensive to use in Kansas soil, and there ^{is no} 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 in the crop

14
four to six years after they are plowed
up.

Alfalfa is a better drainer and
brings up more food material from
the subsoil than clover, and is a
much more luxuriant grower and
better drought resister at the same
time being happily adapted to all
but the very driest portions of the
state.

In this crop then we find one of our
best soil renewers and Kansas
farmers should avail themselves
of it.

The merit of Soy Beans as nitrogen
gatherers is not so marked as that
of alfalfa or clover, from the fact that
they have lately been introduced into
our state, and the tubercle producing
bacteria have not yet found lodgment
in our soils, although at this institution
artificial inoculation has proved
successful; and in time, no doubt
the tubercles will be found upon the
soy bean roots as upon other native
legumes.

They will then offer a most excellent means of supplying nitrogen.

The shallow cultivation it is necessary to grow them, and early spring or fall plowing before planting puts the soil in excellent condition for fall seeding of wheat after the crop is harvested without further labor.

As soy beans are quite invulnerable to drought the prospect of their becoming a future crop of importance is good and they will do their part towards making more plant food available and in some proportion add nitrogen to the soil.

Rotation

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

We can arrange almost any number of rotations but some have advantages over others and as a rule long rotations are much better than short ones.

Corn, oats and wheat is a good rotation with cereals alone, but it has the objection that Chick leg. are given a good chance.

Such a rotation puts the ground in fine mechanical conditions.

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

Waffin corn, Corn oats, wheat and three years alfalfa set would be a most excellent rotation giving a good variety of crops and allowing a varied treatment of the soil.

A few advantages of rotation are:-

- 1st Food elements exhausted uniformly
- 2nd The ground can be given various treatments and methods of tillage desired to thoroly stir and pulverize it and bring more food into a soluble form
- 3rd It affords an opportunity to subdue noxious weeds.
- 4th The soil can be improved by use of leguminous crops.

If we grow some one crop year after year, say corn, it gives no chance to practice early fall plowing.

and stalks or shocks 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 very great diminution in the grain, if proper tillage is used, and the insoluble materials thus made available; but when it comes to keeping up the original fertility for a quarter or half century there seems to be no way except by rotation or fertility is Rotation lengthens out the process of soil exhaustion indefinitely.

Rotation is all necessary in all good farming communities.

Discussed from the thought of improvement, Leguminous crops are the only ones that add anything in the way of plant food above what they take up. For instance Corn is a crop requiring a large amount of nitrogen to make good growth, so if we grow it continuously it is this element that would fail first, the soil remaining comparatively fertile in other plant

food. By putting in a crop of alfalfa or clover, the equilibrium can be restored, or give the soil time to recover by weathering processes, its original fertility. A change to small grain mellowing up the soil and adds humus from stubble or gives chance to grow cover crops.

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

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 disking soon after harvest and harrowing after rains but if the ground is moist enough to start some such crop as soy beans, or sorghum, a good method of shading and improving the soil is afforded at the same time.

Illage for soy beans would provide a dust mulch and the growth they make would prevent considerable evaporation and protect the soil from a blistering 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 & washing to an appreciable extent; for a characteristic of soils deficient in organic material is that they blow badly.

Manures

One of the most important and oldest method of soil improvement is manuring.

Natural manures have been applied to land from time immemorial and is today a universal practice.

Much of Kansas soil being new it has not shown sufficient loss of food elements to make us feel the necessity of going to any great trouble or outlay to supply it. Hence we find manure heaps being considered by many a nuisance, and in nearly all cases where the manure is ultimately applied to the soil it has undergone the leaching process for six months previous with the barn lot or under the eaves and lost one half to three fourths its value.

Materials that would aid the growth of plants are thus lost and it will be necessary to supply them perhaps sooner than we 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 is rated all the way from nothing to fifty cents a ton. At the first price, and up to twenty cents a ton it would pay to put on a very liberal supply but when costs more than this there comes the question whether we could not supply or restore 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 manures on soils is well known and few comments are necessary.

If a heavy coating of manure is added and followed by a dry and the season following is dry a poor crop is almost sure to result as the manure holds the earth apart allowing aeration and the chemical action within the manure generates heat, causing more rapid evaporation.

If the season is wet a better crop will result 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 coating of manure is almost always accompanied by dark green foliage and a heavier and more thrifty growth and if nitrogen is too abundant increased fodder 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 is 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 ^{light} clay and black loam as a crop soil.

Soils 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 quantities of good manure as evaporation is stopped and damage checked

Fertilizers are of no practical value in farming in Kansas, yet, as cheaper methods of improving soil fertility present themselves

The scope of this thesis is necessarily limited to a discussion upon a few main principles on the bettering and improving of soils, and no attempt has been made at detail.

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