SOIL MANAGEMENT

by

L. B. Streeter

upon graduation from the

KANSAS STATE AGRICULTURAL COLLEGE

1907.

SOIL MANAGEMENT

I. Introduction

II. Laying out fields

III Crop Rotation:

- a. General discussion
- b. To maintain fertility
- c. To avoid certain injurious insects and fungus diseases

IV. Tillage:

- a. Definition
- b. Relation to fertility
- c. Seed bed preparation
- d. Physical condition
- e. Moisture conservation
- f. To kill weeds

V. Fertilizers:

- a. Commercial
- b. Barnyard manure
- c. Green manure crops

VI. To prevent wasting of soil:

- a. By washing
- b. By blowing

VII. Conclusions.

SOIL MANAGEMENT

°!°

For the last fifty years the farmers of Kansas have been continually taking crops from the soil with little thought of returning anything to it. Likewise, little attention has been given to the rotation of crops and proper methods of tillage. Usually the only object in cultivation has been to kill weeds and consequently, many years, the yields have been smaller than they would have been if the field had had the proper treatment. Planting a field continuously to the same crop for twenty-five years or more has often largely exhausted certain forms of plant food that are essential to the growth and developement of that crop. This practice up to the present time has been yielding fairly good crops for the reason thtt the soil was new and rich in the necessary plant food elements. At present, however the older lands are becomming so exhausted that something must be done to stop this terrible drain upon the fertility of the soil.

The average farm in Kansas may be made to produce perhaps half as much more than it is now producing by the application of the best methods of soil management. The great question that confronts the farmer of today is how to build up and maintain the soil fertility, how to conserve the moisture, and how to prevent the soil from blowing and washing.

First we will consider the laying out of the fields. This is really more important than it may seem at first thought for if one is going to carry out a definite system of crop rotation it is very necessary that the fields should be nearly equal in size. The reason for this is that if crops are regularly rotated on fields of equal size, the area sown to each crop each year will be nearly constant. Thus the farmer can keep the same amount of live-stock from year to year. Where possible, the fields should be made rectangular in form and preferably with the long way running east and west. The object in this is that the drill marks and furrows running east and west will hold more snow in the winter and and the crops will shade the ground better in the summer. Of course there are cases where it would be better to have the longer dimensions of the field extend north and south, as for instance on an east or west slope. Then also the natural divisions must be taken into account. In rather rough sections it is the custom to let ravines, etc. form the boundries. This is alright to a certain extent where it is impossible to cross them, but if a little care is taken to put in small dams, many of the draws may be filled and the field made more regular in form and surface. There should be a drive-way running through the middle of the farm or nearly through the middle, in such a way that any of the fields can be reached without driving over other crops.

1794

Crop rotation has been carried on to some extent for a great many years in European countries but not in a very systematic way. It has been proven beyond doubt that a systematic rotation is very important in maintaining the fertility of the soil. A few strong points in favor of crop rotation are: 1st. It distributes the work throughout the entire year thus enabling the farmer to employ steady workmen. 2nd. There is not as likely to be a failure of several different crops as there is of a single crop. 3rd. The yields are increased.

In making out a plan of rotation it is important that we take into account the different influences and conditions that tend to modify it. The most important of these are climate, kind of soil, the state of the land with respect to weeds and insect pests, the kind of farming to be followed, and the demand and market value of crops. For instance it would be utterly useless to introduce into a rotation plan, a crop that is unadapted to that locality and climate or to produce a crop that there was no demand for. Prof. TenEyck gives the following as the requirements of a practical and scientific rotation for the greatest profit:

a. "Grasses and perennial legumes
b. Pasture with addition of manure
c. one or two years previous to breaking
c. Intertilled crops
d. Small grain crops with green manuring crops planted in the stubble after harvest.

The object of the perennial legume is for the addition of nitrogen to the soil. On the roots of these plants are nodules which contain nitrogen gathering bacteria. These bacteria have the power of taking nitrogen from the air and converting it into a form of nitrate which can be readily used by other plants. A second advantage of this crop is that it is deep rooted and thus much of its plant food is brought up from the subsoil.

Deep and shallow rooted crops should be alternated. This practice allows for a partial rest of the land during the alternate change, as the same portion of the soil is not drawn upon in the same degree by the deep and shallow rooted crop.

Crops differ as to the kind, amount, and also as to the time of taking their food. Some feed during the spring months while others take the bulk of their food later in the summer. There is no particular set time or place for the application of manure but is usually quite convenient to apply it to the pasture, meadow, or alfalfa field the year befor the sod is broken. If applied at this time it will cause a very rank growth of hay. In case the rotation plan does not contain a sod-forming crop it may be applied to the stubble of some of the grain crops.

The intertilled crop is usually grown because it is usually a money producing crop, and also to eradicate weeds. By

changing the crop from time to time certain injurious insects and fungus diseases do not have time to become fully established. There are so many of these pests that the average farmer cannot be expected to know the life history of each but he should know enough about them so that he may adopt methods that will be distructive to the insects and diseases which prey upon his crops. The western corn root worm deposits its eggs late in the summer about the roots of the corn. The following spring the eggs hatch and the larvae attack the roots of the corn. It can be readily seen that because of this habit, the insect may be readily destroyed by changing this field to some other crop.

Care must be taken in breaking up sod that sufficient time elapses before the next crop is sown to starve or drive out the insects that have been at work on the grass crop. If the sod is broken during the summer and plowed the next spring, the danger will be greatly reduced. But even in this case it may be well to crop the first season with some other crop than corn.

The following are a few rotation plans:

a. Four year plan:

Wheat two years (followed by legumes) , corn two years.

b. Six year plan:

Grass and clover three years, corn two years, wheat or oats one year.

c. Eight year plan:

Alfalfa four years, (plus manure) corn two years,

wheat two years.

d. Sixteen year plan:

Alfalfa four years, (plus manure) corn two years, wheat 2 years, meadow two years, pasture two years, (plus manure) corn two years, [redacted], wheat two years.

The term tillage has been applied to the different methods of working the soil in order to secure the conditions needful for the best growth of cultivated crops. The objects of tillage are numerous. Some of the more important are; to prepare the seed-bed, to improve the physical condition of the soil, to conserve soil moisture, to aerate the soil and to kill weeds.

First we will consider the relation that tillage bears to soil fertility. In nature the crops die and decay returning to the soil nearly all the plant food which they have taken from it, but with cultivated crops much of the plant food is removed and taken away from the soil and it is a wise provision that tillage tends to enrich the soil.

In the strictest sense of the word there is no plant food added. The plant food of the soil is simply made more available for plant use. This is brought about by tillage in the greater exposure of the soil to the action of the air, water, heat, and cold. It brings together different forms of soil particles and this increases the likelihood of chemical changes. It also aerates the soil, which causes the vegetation to decay more quickly, forming humus and carbonic acid. The carbonic acid in turn is mixed with

soil water and greatly increases its dissolving capacity. The aeration of the soil is also favorable to the growth of nitrogen fixing bacteria thus the soil is made richer in nitrogen.

In preparing a seed bed take in account first the crop to be sown. Crops having small seeds such as the grasses and alfalfa, require a much more carefully prepared seed-bed than do those crops having larger seeds. In preparing for sowing alfalfa or grass seed, the plan should be formed at least a year before so that the land may be seeded to such crops as will leave the soil in good physical condition asd which will not exhaust its moisture and plant food supply.

If the seed is to be sown in the fall, the ground should be plowed deep the preceding fall and left unharrowed until the following spring when it may be harrowed down well and planted to some spring grain as oats or speltz. The object in leaving the field unharrowed during the winter is to allow the newly upturned soil to weather and anso catch more snow. After the spring crop is removed the ground should be again plowed. This time it should not be plowed as deep as before as there is danger of not getting it packed down sufficiently to give good connection with the subsoil and thus the moisture supply would be diminished. The field should be harrowed immediately after plowing and after each hard rain uhtil it is well pulverized and firmed. The sub-surface packer is one of the best implements for firming

the soil especially if there has been a rather heavy growth of stubble turned under. The seed bed is now ready providing there is sufficient moisture.

The manner of sowing varies with the locality and the climate. In a moist climate it may be all right to sow broadcast and harrow in, but as a rule if the climate is likely to be a little dry it is advisable to sow with a press drill. By this means the seed is all in at an even depth with the soil pressed firmly about it so that it will not dry out. In preparing a seed bed for small grains it is much the same as for grasses, except that they do not require the soil so well pulverized nor quite so firm.

In planting corn there are many who favor the level planting, but for Kansas conditions the majority favor and practice the listing method. A few points in favor of listing are as follows: Economy of time in planting, better root system, the crop stands the drought better, uses the ground to better advantage, and there is less down corn. The disadvantages of listing are as follows: The soil may wash worse and in case of wet land, or wet seasons, the corn may not do as well when listed as when planted with the surface planter.

The depth at which corn should be planted depends upon the earliness of the spring and the nature of the soil. If the spring is inclined to be cold and the soil is a heavy clay, which will hold moisture, planting an inch deep is considered deep enough, but if the soil is of a light nature

and the spring warm and rather dry, planting three or four inches deep will give better results.

The crop depends largely upon the supply of a proper amount of available moisture at the critical time when the plants are making their greatest growth. The amount of available moisture in turn, depends to a great extent, upon the maintenance of a proper physical condition of the soil. It is seldom that there is sufficient rain during the summer months to mature a crop, thus it is necessary for some of the moisture to come from beneath. One writer gives the following on the proper physical condition of the soil: "First, a soil in which the capillary action which has been broken up by the plow has been restored so that water can rise freely. A soil of sufficient compactness down to the permanent supply of water so that it will rise by capillary action. This condition cannot prevail when the seed bed is full of hard bumps nor when there is a layer of coarse manure or other vegetable matter between the furrow turned by the plow and the soil on which it rests. Hardpan, coarse gravel, and rock, directly beneath the soil are also unfavorable to this action. Second, assoil in such tilth that the tender rootlets may develop freely and fill the entire surface. This is not possible where the land is cloddy nor where it is saturated with water. Plants must have sufficient water but air is quite as necessary,

and it cannot penetrate a saturated soil. Good drainage is therefore necessary."

There are two methods of draining soils. One is by open ditches and the other is by the tile drainage system. The tile drains, though more expensive at first, are usually much more satisfactory than open ditches and are more economical in the end.

Hydroscopic water is the thin film which surrounds each soil grain. This in turn is supplied by the capillary water. The later is doubtless more available for the use of plants. Sandy soils dry out quickly for two reasons. First, the grains are large and will not hold so much moisture and secondly the spaces between the grains are so large that capillary water is not brought up. Such soils can be greatly benefited by the addition of humus. The reason that clay soils hold the moisture so well is that the grains are very small and thus there is a large surface for the water to adhere to.

The best means of conserving the soil moisture is by means of a soil mulch. This is brought about by surface cultivation. Surface cultivation breaks up the crust and puts the soil grains so far apart that the capillary water cannot escape directly into the open air. The surface soil should be stirred as soon as the ground will work well after each rain. The depth of the mulch depends to some extent, upon the nature of the soil and the time of the season, but

in general a soil mulch three inches in thickness gives very satisfactory results. The mulch is more difficult to obtain and usually has to be deeper, upon a clay soil than upon sandy soil or loam.

A weed may be defined as a plant in the wrong place. Weeds injure the crop by reducing the supply of available plant food and soil moisture, and also by shading the crop. In the past weeds have really proven a blessing, for in many instances farmers would not have cultivated their lands much if the weeds had not threatened their crop. At the present time, however, as farmers are becoming more highly educated in agricultural science, the crops are cultivated for other reasons beside that of killing the weeds.

The best time to kill weeds is when they are very small before their root systems become well established. Most weedsseeds that grow are in the first inch of soil, so that by shallow cultivation early in the season, the young weeds or sprouted seeds will be exposed to the sun and thus destroyed.

In corn the weeds quite often get a start between the time of planting and when the corn gets large enough to cultivate. This may be overcome by going over the field with a harrow or monitor before the corn comes through the ground. Another time when weeds often get a start is after the corn is laid-by. Some practice going through with a single horse cultivator, but this often does as much harm as good by cutting off the lateral corn roots. Probably

the hoe is the most effective way of combating weeds in the corn late in the season. Weeds should never be allowed to go to seed.

The term commerical fertilizer is usually applied to the crude forms of plant food which are purchased upon the market. The most important of these are substances containing one or more of the plant food elements: Nitrogen, phosphorous, and potassium. A mixed fertilizer that contains all three of these plant foods is termed a complete fertilizer. It is not advisable to buy complete fertilizers, because there are but very few soils that are deficient in all three forms of plant food. Another reason why we should not buy complete fertilizers is the uncertainty of their real composition. There are many advantages in buying the raw materials and mixing them in the proper proportions to suit the soil and crop. Often a soil is deficient in but one form of plant food and thus it would be a needless expense to apply all three forms.

Nitrogen is the most costly of the three forms of plant food. There are two classes of commerical sources of nitrogen. The nitrates, of which nitrate of soda is the most important, and the organic nitrogen which is the nitrogen found in certain forms of plant and animal materials, such as cotton seed meal and dried blood.

The principle sources of phosphoric acid are phosphate rock, and bones. Potash is obtained largely from wood ashes

and German potash salts. Muriate and sulphate of potash are used more than any other form in the United States.

In mixing the fertilizers, of course there comes the difficulty of knowing what the soil needs and how much. But by trying the different plant foods separately and in combinations with varying amounts on as many test plots, the fertilizer or combination of fertilizers giving the best results may be determined. Care should be taken in laying out these test plots that they are no arranged that the drainage from one will not affect any of the others. As there is but little need of commercial fertilizers in this State they will not be taken up in detail at this time.

From the very beginning of agriculture, the chief means of maintaining the fertility of the soil has been by the addition of barnyard manure. Manure, aside from being a complete fertilizer, had other values which are even greater than its value as a fertility restorer. Its value as a plant food is from two to four dollars per ton but it has been proven that the same value in commerical fertilizers will not give as good results. The greatest value of manure on some soils is the improvement of the physical condition of the soil which results by the application of manure, and allows the plant to more readily make use of the plant food that is already present in the soil. This is brought about by the addition of humus which loosens a heavy compact soil and binds together a loose, leachy one. Such soils, when manured, will retain

more moisture and are better for the plants in every way.

S. W. Fletcher, in his book on "Soils" gives the following regarding the value of manyre: "In three years' experiments King found that manured fallow ground contained eighteen tons more water, per acre in the first foot of soil than similar land unmannured, while the total gain of water in the first three feet of soil was thirty four tons." This value, together with the bacterial benefits which are not yet fully understood, places barnyard manure far above other fertilizers in value.

Manures vary in plant food value according to the animals from which they come. Average horse manure contains six per cent nitrogen, three per cent phosphoric acid, and five percent potash, and is valued at $2.25 per tone, while poultry manure contains 12% nitrogen, 9% phosphoric acid, and 6% potash, and is valued at six dollars and fifty cents per ton. The value of manure is often very much lessened by allowing it to leach and also by fermentation. The best manner of handling manure is to haul it directly to the field and spread it on the land. But of course there are seasons of the year when this is impossible. At such times it should be stored in sheltered manure pits.

Manure should not be spread on land that washes badly until just before it is plowed or cultivated . The amount of manure to be applied varied somewhat with the soil, and the crop which is to follow, but as a general rule it is better

better to give light applications (10 to 12 tons per acre), frequently, rather than heavy applications only occassionally. Every farmer who raises much live-stock should have a good manure spreader. This is practically the only way to get the manure pulverized and spread evenly. It is especially valuable in applying top dressings to meadows and alfalfalfalfields.

Green manur ing crops are those sown after some other crop for the purpose of plowing them under to enrich the soil. If the soil is lacking in nitrogen, some leguminous crop such as cowpeas, soybeans, or vetches, should be sown, but if there is no great lack of nitrogen, rye or buckwheat is especially valuable for this purpose as it is a very heavy feeder and can take up and make available forms of plant food that other crops can not. Aside from their nutritive value, these crops add humus to the soil, and thus improve its texture.

Great care should be exercised in preventing the washing of soils. Fields that are on a slope should always be plowed so that the furrows run across the slope. Dead furrows and the like should always be well filled so that the water cannot get a start. Cover crops are especially valuable for preventing washing during the fall, winter, and early spring.

Cover crops are also very helpful in preventing the soil from blowing. In sections where the soil is inclined to blow the surface soil should not be pulverized to fine-

ly. In such a locality the subsurface packer would be a very useful implement. Wind breaks may also be planted which will be of some service. If the fields are laid out in such a way that the prevailing winds blow cross-ways of the fields of grass, alfalfa, and grain, it will aid materially to prevent soil from drifting onto cultivated fields.

In conclusion it may be said that one to attain the greatest success as a soil manager must be a keen observer, an exact judge, and willing to experiment. He must make a careful study of each field and all the conditions that go to make up the largest yield with the least expenditure of plant food.

L. B. Streeter.