WATCH YOUR SOIL TILTH

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PERMANENT SOD CROPS
maintain good soil tilth

CORN AND SOYBEANS
grown continuously destroy it

LEGUMES AND GRASSES
help to preserve it

Circular 787

UNIVERSITY OF ILLINOIS · COLLEGE OF AGRICULTURE
EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS

DOES YOUR SOIL DRY OUT more slowly after a heavy rain than it used to? Does it stay too wet to work several days longer than it should? Is it more difficult to prepare a good seedbed than it was some years ago? Any of these conditions is a warning that the physical condition of your soil — the soil tilth — is being destroyed.

We are concerned here chiefly with the way some of our best soils are deteriorating. These are the dark-colored, fine-textured soils of the Illinois corn belt. The tilth of these soils has usually become poorer under cultivation. It is impractical to try to maintain the nearly ideal tilth of the soil as it was under native grasses, but it should not be allowed to deteriorate until it causes a reduction in crop yields.

WHAT IS GOOD SOIL LIKE?

Good soil provides enough water and air and the right temperature for plant growth. It is neither too sweet nor too sour. It provides plants with the nutrients they need for good growth. The soil's ability to provide enough water and air to the plants depends on its physical condition.

It should absorb water readily and hold it in large quantities. Soil in good tilth acts like a sponge, letting water enter and holding it over long periods of time. A 100-bushel corn crop in Illinois may use as much as 2,000 tons of water an acre — equivalent to 18 inches of rainfall. If the crop is not to suffer, the soil must be able to store large quantities of water for plant use between rains.

It should drain quickly. This is important to root development. Healthy, vigorous plants need deep, strong root systems. If free water remains too near the soil surface for too long a time in the spring after a crop is planted, as often happens on poorly drained soil, the plants develop shallow, weak root systems, because plant roots will not penetrate waterlogged soil. Then later in the season when the soil dries out to a depth of several feet, these shallow roots cannot reach down to the moisture in the soil, with a resulting reduction in crop yields. If the soil is in good tilth, excess water that fills large soil pores during heavy rains drains away quickly.

It must be well ventilated. Productive soil needs free oxygen from

the air; desirable soil organisms need it to thrive. Without an adequate supply of oxygen, the organic matter in the soil cannot be broken down to provide nutrients for plant growth. Some plant nutrients, such as nitrogen, phosphorus, and sulfur, must be in the highest oxidized form before most plants can use them. Since 95 percent or more of the nitrogen in most soils is in the organic matter, it is very important that enough air to decompose the organic matter can get into the soil.

Where soil is poorly drained and poorly ventilated, the organic matter has little chance to decay, and plants soon show the effects of a lack of usable nitrogen. On these soils, money spent for commercial fertilizers is largely wasted, because fertilizers alone cannot make the soil open and porous.

It must be well aggregated. These corn-belt soils contain many tiny flat or plate-shaped particles, which are often so small that they cannot be seen under an ordinary microscope. When the soil is in good physical condition, these particles are *aggregated,* or organized in clusters about 1/250th of an inch or more in diameter. Air and water can move freely between them, providing the soil with the oxygen and moisture it needs for plant growth.

Such well-aggregated soil works well, absorbs water rapidly and holds large quantities of it; excess water can drain through it quickly. In other words, the soil has good tilth. But if the clusters are broken down, the tiny soil particles clog up the open spaces, and enough air and water cannot penetrate the soil.

WHAT HAS HAPPENED TO THE SOIL TILTH?

The soils we are concerned with in this circular are those that have no natural handicaps. Their subsoils drain well and they are on level to gently sloping land so that with some care erosion can be controlled.

When first put under cultivation, they were well supplied with organic matter and with food for growing crops. They could hold a lot of water, and excess water drained away quickly after tile drains had been installed to provide an outlet. Their tilth, or physical structure, was nearly ideal.

Not all of these soils are in bad condition now, but on many

farms the desirable tilth of the original soils has been largely destroyed. The crumbs of soil particles have been broken apart and the tiny particles now fit so closely together that enough air for good plant growth cannot get into the soil. Water enters the soil slowly, and it cannot drain away fast enough after heavy rains or a long wet spell.

This is happening because of over-all poor soil management. Some of the reasons why the tilth is being destroyed are explained here in more detail.

The soil has been worked more than necessary. Working a soil breaks down the crumbs or clusters of soil particles. Crops like corn and soybeans need cultivation during the growing season, as well as preparation of a seedbed every year. This repeated working of the soil gradually destroys its tilth.

Many farmers work the soil too fine when they prepare seedbeds, destroying the soil structure and leaving a dust layer on the surface. When it is soaked up by rain, this dust layer forms a dense, compact mass that will not absorb air or water readily.

Much damage is done when the soils are too wet. The damage done in a single operation like plowing on soil that is too wet, may make it difficult to prepare a seedbed for several years. The soil crumbs are broken down, and when the soil dries out, the particles are packed together into tight, hard clods. When this happens, water can no longer move into and through the soil.

Tramping by livestock is also bad, particularly on stalk and stubble ground. A cow may sink 8 inches or more into wet soil, leaving at the bottom of each track a compressed ball of mud that dries into a hard clod. This is hard on the cow as well as on the soil.

Heavy machines like tractors, combines, and corn pickers squeeze the life out of wet soils. Although it is a temptation to get into the fields in the spring before the soil is really dry enough to work, the damage that can be done by heavy machinery on wet soil should be avoided in so far as possible.

Our soils have been left without a protective cover too much of the time. In addition to being bare every year while the seedbed is being prepared and while the young crop is making its early growth, corn, small-grain, and soybean land is often unprotected during the winter. After the crops are harvested, the fields usually lie idle until

the next spring, which means the soil is subject to loss of plant nutrients by leaching and loss of soil by erosion.

The soils also suffer much damage from the force of falling raindrops. The pounding breaks down the soil crumbs, splashing fine clay and silt particles and even the coarser particles of sand a foot or more into the air.

On sloping land the particles are washed away, and even on level land, they may be moved several feet. These particles fill the soil pores near the surface, forming a seal that prevents water and air from passing into the soil. With each succeeding storm, the crumbs are further broken down and the seal is made tighter.

Supply of active organic matter has not been maintained. Organic matter is the life of the soil. In Illinois climate it is always associated with good soil tilth. The soils with which we are concerned in this circular have a relatively high content of organic matter. However, unless fresh organic matter is added regularly, that which is in the soil becomes relatively inactive. It decays slowly and does not release plant nutrients, especially nitrogen, as fast as needed. It is not as effective a soil conditioner as organic matter that is undergoing active decay.

Corn and soybeans have been grown too much of the time. Where corn and soybeans have occupied the land year after year, soil tilth has deteriorated. The soils have maintained better physical condition where crop rotations including grasses and legumes have been followed. It appears that the corn-belt soil will have better tilth if a sod crop is included in the rotation.

Whether or not desirable soil tilth can be maintained on land growing corn and beans every year remains to be seen. Certainly it cannot be done unless the usual soil-management practices are drastically improved.

WHAT CAN BE DONE TO MAINTAIN SOIL TILTH?

Do not work the soil more than necessary. Recent investigations indicate that under some conditions corn yields are not reduced by cutting down on the amount of tillage. This may be true on your farm. Legumes and grasses in the crop rotation give the soil a rest from being worked and help its physical condition. They are more effective if left as a "standover" crop than if used as a catch crop.

Keep off wet soils as much as possible. Many who have had a hard time preparing a good seedbed have realized how much damage has been done in the past by working the soil too wet, yet some will do it again. If you can keep heavy machinery and livestock off wet soils, and keep from working the soils before they are dry enough, you will be able to prevent much damage.

Keep the soil covered as much of the time as possible. Bare soils suffer from erosion and falling raindrops. The best cover is a sod crop, but a mulch of crop residues gives a lot of protection. Cornstalks broken down flat to the ground across the slope furnish more protection than if they are left standing; it is even better to shred the stalks and distribute them evenly over the ground. Soybean straw will give some protection, although less than cornstalks, if it is distributed evenly over the land. Dumping it out of the combine in piles or windrows leaves too much of the soil without cover.

Keep adding organic matter. Utilize all crop residues instead of burning them. Take care of animal manure on farms where it is produced so that as much of its value as possible is retained and returned to the land. And use legumes and grasses — they are the best source of soil organic matter.

Do not grow corn and soybeans all the time. Where this has been done, the soil has been worked more than it should be, and soil tilth has deteriorated, even in our best soils. The soil tilth is better where rotations have been followed that include grasses and deep-rooted legumes.

On the Agronomy South Farm a study of 13 different rotations was started in 1937 on a black silty clay loam on slightly sloping land. When soil samples taken in 1952 were studied, they showed that in each set of rotations corn yields and aggregate stability were higher when clover was included in the rotation. "Standover" clover was more effective than a clover catch crop.

Lime and fertilizers are needed. The soils in which we are mainly interested here are the heavy, dark-colored, nearly level soils. These were very productive when first put under cultivation and plant nutrients were not needed. But since that time, the available nutrients in the soil have been largely used up, and fertilizers and lime are now needed to maintain productivity.

Adopt a cropping system that will help maintain good crop yields. If your soil has poor tilth, you had better include grasses and clover in your rotation. If it is in good tilth, you may be able to grow row crops for some time, but watch the soil tilth; you may need to change.

Just how effective cropping systems can be in determining yields and improving soil tilth is shown by the following results from the Ohio Agricultural Experiment Station. Remember that the higher the degree of aggregation, the higher the percentage of soil particles that cling together in crumbs or granules. In other words, the higher the degree of aggregation the better the soil tilth.

Cropping System	Degree of aggregation of the soil	Corn yield per acre
	perct.	*bu.*
Corn, oats, 2 years of alfalfa-bromegrass	54.2	67.9
Corn, oats, alfalfa	53.0	58.8
Corn, oats, sweet-clover catch crop	45.2	46.9
Corn, oats, (residues returned)	40.1	39.2
Corn (residues returned)	23.4	22.5

These are the results of a ten-year experiment. The soil is a heavy dark-colored clay on nearly level land. No fertilizers were used. In another experiment on the same kind of soil, fertilizers gave little or no increase in yields. The main problem has not been one of plant nutrients but one of keeping the soil open and porous so water can get through to the tile drains. Close spacing of the tile drains did not solve the problem. Growing grasses and deep-rooted legumes did the job.

Watch your soil tilth. Changes in soil tilth are easily recognized. If your soil is harder to work than it used to be, and if it does not take water as well, the tilth is going bad. If it stays too wet to work for a week or ten days longer in spring than similar soil nearby, the tilth is becoming poorer. Do not let it go too far. If poorer tilth is cutting down your yields, start a good soils program. If you have a potentially good soil, you can make it produce accordingly by following the recommendations in this circular. Grasses and deep-rooted legumes will help you to maintain soil tilth.

Good soil tilth is really a byproduct of good soil management. If you want to keep your soil in good physical condition, you need an effective soils program based largely on good soil-conservation. A soil-conservation plan for your farm will include:

- practices for erosion control
- drainage of wet land
- liming soils that are too sour
- maintaining an adequate supply of available plant nutrients
- a suitable cropping system

This circular is particularly concerned with practices, such as proper tillage, that are especially directed toward preserving soil tilth.

This publication was prepared by R. S. STAUFFER, Associate Professor of Soil Physics, Emeritus. *It supersedes Circular 655.*

Urbana, Illinois January, 1958

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois and the United States Department of Agriculture cooperating. LOUIS B. HOWARD, *Director.* Acts approved by Congress May 8 and June 30, 1914.

10M—1-58—64254