PROTECTING Your SOIL

By C. A. Van Doren and L. E. Gard

Circular 667

UNIVERSITY OF ILLINOIS · COLLEGE OF AGRICULTURE
EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS
cooperation with Soil Conservation Service, U. S. Department of Agriculture
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Some of the information reported in this circular was obtained on these contour-farming plots on a 2-percent slope at Urbana. Since 1941 soil and water losses from corn, soybeans, and oats when planted on the contour have been contrasted with losses when these crops were planted up and down the slope. For results see pages 15 to 17.

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PROTECTING YOUR SOIL

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ALL THROUGH the corn belt we have a problem that grows more serious year by year — the problem of holding the topsoil of our farm lands in place. The reason the problem grows more serious is that many farmers do not realize the losses that are taking place, and hence are not making use of well-tested and practical measures to prevent them.

Outlined on these pages are the things that can be done to conserve our soils. They are measures that will benefit every farmer who applies them to his farm, and at the same time they will keep our soils productive for succeeding generations.

The suggestions made in this circular are based on work conducted cooperatively by the Illinois Agricultural Experiment Station and the U. S. Soil Conservation Service. Studies were begun at the Dixon Springs Experiment Station in southern Illinois in 1936. Work has been in progress at Urbana since 1940. Recently more studies have been established near Elwood in Will county.

FOUR BASIC FACTS ABOUT EROSION HAZARDS

Sheet Erosion Is Worse Than Gully

Two major kinds of erosion are responsible for most of the soil lost from Illinois farm land. Gully erosion, which occurs in spots where the flow of water is concentrated, is probably the more spectacular. Nobody viewing the ragged cuts that are all too frequent in Illinois farm fields can mistake that erosion has been at work.

Sheet erosion, however, while not always so quickly noticed as gully erosion, is actually more destructive (Fig. 1). Instead of gouging out the soil in one limited area, as gullies do, sheet erosion carries away a thin layer of soil from unprotected fields each time it rains. Gradually light grayish areas appear in places where the topsoil has been removed and the subsoil exposed. This subsoil may later be washed over onto areas where topsoil does remain, burying the good soil. This process, because it covers much larger areas than gully erosion does, removes several times as much soil. But because the change is so gradual, the

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Sheet erosion has robbed the slope in background of its surface soil. Now unproductive subsoil is being carried from the eroded slope and deposited over the productive soil in the foreground. (Fig. 1)

good soil often slips away before the farmer even knows what is happening. *The soil must be protected from both kinds of erosion, or it will eventually be destroyed.*

**Protection Must Be Adjusted to Extremes of Rainfall**

Illinois, like the rest of the corn belt, is blessed with rainfall that provides the soil moisture necessary for big crop yields. This same rainfall, however, is responsible for the destruction of unprotected

A raindrop falls toward the soil *(below)*, hitting with a force and explosive action that scatters soil and water particles *(right).*

*(Fig. 2)*
Monthly rainfall for 1944 and 1945 and normal monthly precipitation at Dixon Springs Experiment Station. Heaviest precipitation at Dixon Springs since 1938 was in 1945; lightest was in 1944. (Fig. 3)

farm land through the beating action of raindrops and heavy runoff (Fig. 2). As every farmer knows, heavy, beating rains do much more damage, as a rule, than slow, gentle rains.

Some years, of course, rainfall is much heavier than others; and there is also a wide variation from month to month. The highest yearly rainfall at Dixon Springs since 1938 was in 1945, when 71.78 inches were recorded. The lowest yearly rainfall was 30.67 inches in 1944. Monthly rainfall for these years, as well as the normal monthly precipitation, is shown in Fig. 3.

In dry years, such as 1944 in southern Illinois, erosion is normally low. Runoff and erosion are, of course, much greater in wet years. The erosion in rainy seasons would probably be still higher if it were not for the fact that tillage operations are less frequent than in normal years.

Soil losses in wet years don't have to be high, however. If the soil is properly protected, even a cloudburst will result in only mild damage (page 10). Since nobody can foretell how many or how heavy rains there will be during a year, the best defense against serious damage from erosion is a sound conservation program on every farm.
Some Soils Suffer More Than Others

As already mentioned, rain has to act upon soil in two ways to remove it from the land. First, the force of the raindrops has to break off soil particles small enough to be moved by water. Then, the runoff has to be great enough and swift enough to carry away the particles.

It takes a harder rain to detach particles from some soils than from others. And the particles of different soil types vary also in the amount and speed of runoff needed to carry them off. The ease with which the soil on your farm can be broken into particles and carried away by water is an important factor in determining the erosion hazard on your farm.

The particles of a sandy soil are easily separated and broken down by the force of raindrops. On the other hand, the actual amount of soil lost may be small, as the sand grain is so heavy that it is not easily carried away by flowing water. The damage, however, is usually more serious than commonly supposed. The clay or fine particles in the sandy soil are the ones most easily carried away, and they contain most of the nutrients needed by the plants. The soil eroded from a sandy field is therefore likely to contain more nitrogen, phosphorus, potassium, and other plant-food elements than the soil left on the field.

On a silt loam, a harder rain is required to separate the particles than on a sandy soil. The separated silt particles will, however, be carried away more easily by water than sand particles. The soil eroded from the silt loam field will contain more plant-food elements than the rest of the field but the difference will not be as great as on sandy soils.

On a soil with a clay or clay loam texture, the particles are glued together more strongly than those of a sandy soil or a silt loam. It takes a hard storm to separate the clay particles, although the storm does not necessarily have to last long. Since the particles are easily carried away, losses may be larger than expected from short, beating rains. The eroded material is likely to be similar in nutrient content to the surface crust left on the field.

Soil drainage is closely related to the ease with which the detached particles are carried away. On soils which drain easily, a good deal of the rainfall will move down through the profile instead of running off the field and carrying away the soil particles. Soils which have a high percentage of sand usually drain more rapidly than those that are predominantly silt loam or clay.

Because of the high runoff and the smallness of the soil particles, clay soils are usually the most erosive. Ordinarily sandy soils suffer
Protecting Your Soil

the least amount of actual soil loss. However, since the particles carried from sandy soil usually contain more nutrients than the rest of the field, sandy soils may suffer the greatest reduction in yields.

A soil's natural tendency to erode may of course be modified by tillage, treatment, cropping, and other management practices. A soil naturally resistant to erosion may erode seriously as a result of poor farming practices, while on the other hand good practices will reduce the hazard on naturally erosive soils.

Small Differences in Slope Make a Big Difference in Damage

The steepness, length, and shape of a slope help to determine the amount of erosion. Of these three characteristics, steepness is the most important.

Effects of both steepness and length of field on soil loss are shown by results of an experiment at Dixon Springs. Soil losses were obtained from duplicate plots 35, 70, 140, and 210 feet long on both 5- and 9-percent slopes. The plots were farmed to a three-year rotation of corn, winter wheat (lespedeza), and lespedeza for an eight-year period, 1939-1946.

The losses from these plots are shown in Table 1. For every crop and every length of plot losses were greater on the 9-percent slope than on the 5-percent slope, with the biggest differences occurring on the corn plots. From these data it has been estimated that doubling the percent slope would increase average soil losses about $2\frac{1}{2}$ times.

Table 1. — Soil Losses per Acre per Year on Plots of Different Length and Slope in Rotation of Corn, Wheat, and Lespedeza

(Dixon Springs Experiment Station, Pope County, 1939-1946)

<table>
<thead>
<tr>
<th>Crop and time it was on the land</th>
<th>Plot 35 feet long</th>
<th>Plot 70 feet long</th>
<th>Plot 140 feet long</th>
<th>Plot 210 feet long</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Losses where land sloped 5 percent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>tons</strong></td>
<td><strong>tons</strong></td>
<td><strong>tons</strong></td>
<td><strong>tons</strong></td>
<td></td>
</tr>
<tr>
<td>Corn, 5 months</td>
<td>4.0</td>
<td>5.6</td>
<td>6.6</td>
<td>4.8</td>
</tr>
<tr>
<td>Winter wheat, 7 months</td>
<td>5.6</td>
<td>9.7</td>
<td>13.5</td>
<td>10.7</td>
</tr>
<tr>
<td>Lespedeza, 24 months</td>
<td>4.9</td>
<td>5.8</td>
<td>5.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Average per year</td>
<td>4.8</td>
<td>7.0</td>
<td>8.6</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Losses where land sloped 9 percent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>tons</strong></td>
<td><strong>tons</strong></td>
<td><strong>tons</strong></td>
<td><strong>tons</strong></td>
<td></td>
</tr>
<tr>
<td>Corn, 5 months</td>
<td>9.8</td>
<td>13.5</td>
<td>15.7</td>
<td>17.8</td>
</tr>
<tr>
<td>Winter wheat, 7 months</td>
<td>7.3</td>
<td>10.3</td>
<td>14.1</td>
<td>14.6</td>
</tr>
<tr>
<td>Lespedeza, 24 months</td>
<td>5.3</td>
<td>6.1</td>
<td>6.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Average per year</td>
<td>7.5</td>
<td>10.0</td>
<td>12.1</td>
<td>12.7</td>
</tr>
</tbody>
</table>
In general, soil losses on each slope increased with the length of plot. The only significant exception occurred when the length of plot was increased from 140 to 210 feet on the 5-percent slope. This exception was due to the shape of the slope, since there was a reduction in steepness at the base of the longer plot.

**WHAT WE CAN DO TO CONTROL EROSION**

*Start With Good Soil Treatment*

The first step toward erosion control is to apply limestone and fertilizer as needed. As the productivity of each acre on the farm is increased fewer acres have to be tilled for cash income or feed. This means that fields needing protection against erosion can be kept in grass and legumes more of the time.

The more you build up the productivity of the fields in grass and legumes, the greater will be the protection against erosion. If a soil is rich in organic matter and produces good cover and high yields, it will not erode nearly so fast as soils that are low in organic matter and productivity. A luxuriant plant cover protects the soil from beating rains and flowing water. Organic matter helps the soil to soak up more water so that less runs off the field. The roots of the plants also help to hold the water in the soil (page 20).

Even cultivated crops will cause less erosion if they are grown on productive soils. At the Elizabethtown soil experiment field in southern Illinois, a plot treated with manure, limestone, and phosphate.

Soil profiles showing the difference in amount of erosion occurring on treated and untreated plots during a 17-year period. Both plots were on a 10-percent slope at the Elizabethtown soil experiment field. Profile on left is from untreated plot, that on right from plot treated with manure, limestone, and phosphate. (Fig. 4)
phate lost 11 inches less soil during 17 years of rotation farming (1918-1934) than a plot which received no treatment (Fig. 4). Both plots were on a 10-percent slope but were farmed on the contour for only 5 of the 17 years (1930-1934).

Fortunately many of the low-yielding soils in southern Illinois respond magnificently to soil treatment. In fact, the relative increase in net income resulting from soil treatment is greater in southern Illinois than on the more productive soils of northern Illinois.

The story of yield increases resulting from soil treatment is told in a number of other Illinois publications. Of particular importance is Bulletin 516, "Effects of Soil Treatment on Soil Productivity."

**Work Out Protective Rotations**

The crops that you use on your land probably affect erosion more than any other factor that you can control. The best crops for reducing runoff and preventing soil loss are deep-rooted grasses and legumes. Because they help hold the soil particles together, they protect the soil while they are growing and also reduce the danger of erosion when cultivated crops follow in the rotation.

One of a series of plots at Dixon Springs that have been farmed to a rotation of corn, winter wheat (lespedeza), and lespedeza since 1939. In foreground is equipment for measuring runoff and erosion losses. (Fig. 5)
Table 2. — Losses of Soil and Water From Pastures and From Crops in Rotation, Dixon Springs Experiment Station, 1939-1946
(Plots 70 feet long with 9-percent slope)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Period</th>
<th>Soil losses per acre</th>
<th>Run-off of rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>months</td>
<td>tons</td>
<td>percent</td>
</tr>
<tr>
<td>Corn</td>
<td>5</td>
<td>13.5</td>
<td>27.6</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>7</td>
<td>10.3</td>
<td>23.5</td>
</tr>
<tr>
<td>Lespedeza First 12</td>
<td>5.7</td>
<td>.4</td>
<td>13.0</td>
</tr>
<tr>
<td>Lespedeza Second 12</td>
<td>12</td>
<td>.1</td>
<td>8.5</td>
</tr>
<tr>
<td>Pasture</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Pasture was treated, seeded to mixture of grasses and legumes, and moderately grazed. Bluegrass and lespedeza predominated in the stand.

At the Dixon Springs Experiment Station soil losses from well-established meadow or pasture averaged only 0.1 ton an acre a year (Table 2). Lespedeza held the soil nearly as well during the third year of a rotation of corn, winter wheat (lespedeza), and lespedeza. But since it is a shallow- rather than a deep-rooted legume, it did little to prevent losses from corn and wheat which followed it in the rotation. Even though these crops were planted on the contour, the average 12-month losses from them were nearly 24 tons an acre.

Soil losses from three individual rains are shown in Fig. 6. In even the heaviest rain, soil losses from pasture were only 0.3 ton an acre, as compared with 13.4 tons for land in wheat.

Soil losses resulting from three individual rains on fields in different crops. Good pasture holds soil losses at a minimum. (T/A = tons an acre.) (Fig. 6)
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A protective rotation will include grasses and legumes often enough to control soil erosion and to maintain the organic matter in the soil. On nearly level, fertile soils, meadow may be needed in the rotation only one out of every four years. On less fertile soils or on more sloping land, it may be necessary to grow meadow four years out of six, and to reduce the acreage of corn and soybeans.

Soil losses resulting from several possible rotations on a few Illinois soils are shown in Table 3. The effectiveness of each rotation was calculated from data obtained throughout the country. A rotation should be used on a certain soil type only if the losses from that rotation appear below the heavy black line. If the soil losses are above the heavy line they are too high for safe farming on the land, and the rotation should not be used.

Table 3.—Estimated Annual Soil Losses¹ for Selected Soils² and Rotations on Typical 200-foot Contoured Slopes³ in Illinois

<table>
<thead>
<tr>
<th>Rotation⁴</th>
<th>Clinton 8% slope</th>
<th>Saybrook (Rolling phase) 7% slope</th>
<th>Catlin Tama 5% slope</th>
<th>Elliott 4% slope</th>
<th>Swygert 5% slope</th>
<th>Grantsburg Ava 5% slope</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tons</td>
<td>tons</td>
<td>tons</td>
<td>tons</td>
<td>tons</td>
<td>tons</td>
</tr>
<tr>
<td>C-C-G-M-M</td>
<td>15.8</td>
<td>9.0</td>
<td>5.5</td>
<td>4.4</td>
<td>6.6</td>
<td>8.3</td>
</tr>
<tr>
<td>C-C-G-M</td>
<td>12.6</td>
<td>7.2</td>
<td>4.4</td>
<td>3.5</td>
<td>5.3</td>
<td>6.6</td>
</tr>
<tr>
<td>C-C-G-M-M</td>
<td>10.0</td>
<td>4.5</td>
<td>4.1</td>
<td>2.5</td>
<td>2.0</td>
<td>3.3</td>
</tr>
<tr>
<td>C-G-M</td>
<td>10.1</td>
<td>2.5</td>
<td>1.5</td>
<td>1.2</td>
<td>1.9</td>
<td>2.3</td>
</tr>
<tr>
<td>C-G-M-M-M</td>
<td>4.4</td>
<td>1.5</td>
<td>1.5</td>
<td>1.2</td>
<td>1.9</td>
<td>2.3</td>
</tr>
<tr>
<td>C-G-M-M-M-M</td>
<td>2.9</td>
<td>1.6</td>
<td>1.0</td>
<td>0.8</td>
<td>1.2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

¹ Losses below heavy line are small enough to permit use of rotation indicated. ² Calculations are based on expected losses from fields where over 8 inches of surface soil remains. Losses would of course be greater where there is less surface soil. ³ Catlin and Tama soils are found in central and northwestern Illinois; Elliott and Swygert, in northeastern Illinois; Clinton in the western part of the state; Grantsburg or Ava in southern Illinois; and Saybrook in central and northern Illinois. ⁴ Slope percentages represent the drop in elevation for each 100-foot horizontal length of slope. For each soil, a percentage was selected which would be representative of large acreages of the soil type. Soil losses would be less on gentler slopes and greater on steeper slopes. ⁵ C = corn; G = small grain; M = meadow or pasture.

Cover crops reduce erosion. Cover crops protect the soil from erosion between the time that one cultivated crop is harvested and the next one is planted. They also enrich the soil by adding organic matter and crop residues. Some farmers plant rye, sweet clover, or a similar crop in corn at the time of last cultivation or later. Crops used as cover are usually not harvested but they can be grazed. They are generally plowed under in the spring before the next crop is planted.
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Corn stover broken down on surface in the fall of the year is an effective erosion-controlling cover during the winter and spring. (Fig. 7)

Leave crop residues on the surface. If a cover crop has not been seeded, diskling down cornstalks in the fall will reduce erosion (Fig. 7). At Urbana on fields where stalks were removed, soil losses were about 16 times as great as on land where the stalks were broken down (Fig. 8). Residues from such crops as soybeans, small grains, and clover seed should be left on the land whenever possible. Cornstalks or other residues should never be burned.

STOVER MULCH

205 LB.
PER ACRE

NO MULCH

3225 LB.
PER ACRE

14 %

SOIL LOSS

WATER LOSS

SOIL LOSS

WATER LOSS

82 %

Soil and water losses from unmulched plots and from plots on which cornstalks were broken down on the surface, at Urbana. Losses resulted from a rain of 1.75 inches lasting one hour. (Fig. 8)
Avoid fall-plowing. Plowing in the fall leads to excessive erosion. It is particularly important to avoid this practice on slopes steeper than 4 percent and on soils with impermeable subsoils. Examples of such soils are Elliott, Swygert, and Clarence silt loams in northeastern Illinois.

Treat Pastures and Graze Them Moderately

As already mentioned (page 8), proper treatment of pasture land can do a great deal to reduce erosion and increase productivity. This treatment needs to be combined with moderate grazing. Severe grazing can undo much of the good accomplished by treating the soil.

The value of both treatment and moderate grazing is shown by results at Dixon Springs. Only about half as much water ran off from treated pasture that was moderately grazed as from treated pasture that was severely grazed (Figs. 9 and 10). Untreated plots, regardless of severity of grazing, lost over twice as much of the rainfall in runoff as the treated, moderately grazed plots. The value of the moisture con-

![Diagram]

Annual soil loss and runoff from treated and untreated pasture plots under different grazing managements, Dixon Springs, 1938-1947.
These two pasture plots at the Dixon Springs Experiment Station were both treated with limestone and phosphate. Plot on left was moderately grazed; that on right intensively grazed. Part of the equipment for measuring runoff and soil loss appears in foreground. (Fig. 10)

served by good soil treatment and moderate grazing is reflected in increased yields of forage (Table 4).

On overgrazed pastures the concentrated flow of runoff in low areas can cause deep gullies. This is especially true if the soil is low in

Table 4.—Annual Water Loss, Yields, and Sheep Production on Treated and Untreated Pastures, Severely and Moderately Grazed
(Dixon Springs Experiment Station, 1938-1947)

<table>
<thead>
<tr>
<th>Item measured</th>
<th>Treated plots</th>
<th>Untreated plots</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Severely grazed</td>
<td>Moderately grazed</td>
</tr>
<tr>
<td>Water losses (inches)</td>
<td>6.8</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>(pounds per acre)</td>
<td></td>
</tr>
<tr>
<td>Desirable forage²</td>
<td>2 507</td>
<td>3 448</td>
</tr>
<tr>
<td>Weeds²</td>
<td>1 111</td>
<td>942</td>
</tr>
<tr>
<td>Sheep gains</td>
<td>49</td>
<td>185</td>
</tr>
</tbody>
</table>

¹ Treated plots received limestone and phosphate according to needs indicated by soil tests.
² Data for 1947 are not included.
Protecting Your Soil

productivity. Sheet erosion losses on pasture land, however, are usually not severe. In most parts of Illinois poor pastures, even overgrazed pastures, may have enough weed growth to prevent serious erosion of this kind.

For information about specific soil treatments, seeding mixtures, etc., consult your Farm Adviser or write to the Illinois Agricultural Experiment Station. Circular 647, “Pastures for Illinois,” contains information of practical value to farmers in all areas of Illinois.

Plow and Cultivate on the Contour

When properly practiced, contour farming will reduce the rate and amount of runoff, reduce soil losses, and increase yields. (Contour farming is farming land across the slope, with tillage operations and rows running at right angles to the direction of the water flow.)

The danger of erosion is greatest during the preparation of the seedbed and the early part of the growing season. On experimental plots at Urbana 64 percent of the yearly soil losses and 53 percent of the water losses over a 9-year period occurred during June. The soil is finely pulverized in June as a result of seedbed preparation and cultivation, and rainfall is normally heavy.

Two contour cultivations will prevent much of the damage that would normally occur. The ridging at the crop rows resulting from contour cultivations will reduce runoff and help to develop storage capacity. Using furrow openers or shallow listers on the corn planter will give additional protection against erosion on most permeable soils (Fig. 12).

Contoured soybeans have been more effective than contoured corn in reducing soil losses (Fig. 13). This is because soybean plants are spaced more closely in the row than corn plants. The close spacing of plants reduces runoff rates, causing soil to be deposited next to the rows instead of washing from the field. However, four years’ data at Urbana indicate that in May or June of the year after corn and soybeans have been grown, losses from fields that had been in soybeans may be greater than from the fields previously in corn.

Contouring increases yields. Corn yields on a 2-percent slope at Urbana during the period 1941-1949 were 2.3 bushels an acre greater on contoured than on non-contoured plots; oat yields were 2.0 bushels an acre greater; and soybean yields, 1.4 bushels greater. Contoured soybeans outyielded non-contoured soybeans by 1.6 bushels an acre in 18 tests on 2- to 5-percent slopes in 1943. In tests on nine farms in
1945 yields from contoured corn were 6.2 bushels an acre greater than from non-contoured. Contoured soybeans on five fields in 1945 out-yielded non-contoured soybeans by 3.8 bushels an acre.

**Contouring alone is not enough on long slopes.** Observations indicate that terracing should be combined with contouring on 2-percent slopes longer than 400 feet. On most 3-to-6-percent slopes the limit in length of contour farming alone is 300 feet; while on slopes above 6 percent the slope length should not exceed 200 feet. On 3-to-6-percent slopes between 300 and 400 feet long, and on slopes above 6 percent that are 200 to 400 feet in length, either strip cropping or

Runoff after a heavy rain causes erosion between non-contoured soybean rows. (Fig. 11)

The furrow channels on this contoured corn plot trap the rain water, thereby reducing runoff. The plot is on a 2-percent slope at Urbana. (Fig. 12)
Annual soil losses from different crops planted on the contour and planted up and down the slope. Contouring made the most difference on the soybean plots — less than one-fourth as much soil was lost from the contoured soybeans as from the non-contoured beans. (Fig. 13)

terracing may usually be used. Terraces should always be used on slopes longer than 400 feet. On some slowly permeable soils or on land being intensely cropped, the above lengths should be reduced.

Strip Crop to Help Hold the Soil

Contour strip cropping is the practice of alternating bands of non-cultivated grasses or legumes with bands of intertilled crops or small grains. The strips are placed on the contour. Width of strips may vary from 100 feet on 2-percent slopes to as narrow as 50 feet on 18-percent slopes. The dense erosion-controlling cover provided by meadow slows down the rate of runoff and thus causes soil from the tilled areas to be deposited in untilled areas instead of being carried off the land.

Strip cropping is more effective than contouring alone in saving soil, but is less effective than terracing. On slopes that are over 400
feet long, if less than 12 percent in steepness, terracing should be combined with strip cropping. Slopes steeper than 12 percent and longer than 300 feet should be put down in permanent pasture or meadow.

**Build Terraces to Intercept Runoff**

Terraces or diversions break up a long slope into a series of short ones, thereby slowing down the runoff and reducing soil losses. Only a fraction as much soil is carried from terraced fields as from unterraced fields. Permanent terraces on long slopes are therefore an important part of every sound conservation system. Terraces should be built on all slopes longer than 400 feet and steeper than 2 percent, and they are also necessary or desirable on many shorter slopes (pages 16 and 17).

Despite the importance of terraces in a conservation program, some farmers have been reluctant to try them because in the past there have been some difficulties connected with building and maintaining terraces. The most frequent criticisms of terraces have been that: (1) point rows present a problem; (2) outlets are difficult to establish and maintain; (3) terraces overtop, scour, or fill with soil; (4) modern machinery is hard to operate on terraced fields; and (5) stands are poor in channels. These difficulties, however, can be overcome.

Many of the problems have been the result of building terraces without proper consideration of how they will fit into an over-all

A group of central Illinois farmers watch demonstration of how a terrace should be built. Terraces are valuable in removing runoff safely. Before they are built, however, outlets should be well established. (Fig. 14)
conservation program for the entire farm. Trouble has often resulted because the farm operator was not trained to farm terraced fields and, in many cases, had not established adequate outlets.

During recent years terrace design and establishment have been considerably improved because more thought has been given to developing good water disposal systems. Outlets should be constructed and have a good cover of vegetation on them before terraces are built. It is a good investment to spend money for liberal soil treatment and even for filling in eroded spots with topsoil when outlets are being constructed.

Overtopping and breaking of terrace lines can be avoided. On some soils where fills are necessary, a close-growing crop such as grain or meadow should be grown during the first year to reduce runoff while allowing the system to mature and settle. The land should be worked carefully. Careless tillage operations encourage excessive erosion, causing soil to be stranded in the channel in spots where the grade is slightly reduced, and thus resulting in overtopping.

A terrace channel will not scour or gully if constructed with the proper grade. A qualified man should be secured to lay out a terrace system.

More flexible machinery than that in general use today is no doubt desirable for tilling, planting, and harvesting on the terrace. However, even with present equipment most operations can be performed with very little loss of time and with increased yields.

More information about terraces is given in Circular 513, "Save the Soil with Contour Farming and Terracing."

**Prevent Gullies With Grass Waterways**

Grass waterways are grassed channels which help to remove runoff from sloping land (Fig. 15). On contoured and strip-cropped fields, waterways are established in natural drainageways. On terraced fields, outlets may be either natural drainageways or constructed channels. They are often located next to a field border.

The main purpose of a grass waterway is to keep gullies from forming. Cultivated drainageways quickly develop into gullies. "Plowing in" these gullies each year to permit crossing and farming with field tools is certain to make the gullies too deep to cross. Not only are land values reduced where gullies are allowed to develop, but production costs are increased.

Detailed instructions for constructing, seeding, and maintaining grass waterways are given in Illinois Circular 593, "Grass or Gullies."
Grass waterways in this corn field help in the safe removal of runoff. If grass waterways are not established in natural drainageways, gullies soon dig into the soil, each year becoming deeper and wider. As the gullies grow, land values go down and production costs go up. (Fig. 15)

Give Water a Chance to Get Into and Through the Soil

Improving drainage helps to control erosion. The more rainfall that can move through the soil into tile or underground storage, the less there is to run off and carry away the detached soil particles. Ideal drainage calls for free water to be removed from the upper 21 inches of soil in 48 hours, although this rate of drawdown cannot be accomplished on some soils that naturally drain poorly.

Drainage is closely related to other soil characteristics. For example, a waterlogged soil is poorly supplied with oxygen, and plants need oxygen to grow. They can get some oxygen from the water but not enough. A soil that permits free movement of water has many open air spaces which supply oxygen for plant roots.

Although crop roots may have a hard time getting started on waterlogged soils, they will, once they are established, help to improve drainage on most soils. Before the development of grass and legume roots, poorly drained soil at Dixon Springs absorbed only 2.07 inches of water in 24 hours and was wet only to a depth of 11 inches (Fig. 16). After a good root system was developed (mostly redtop, with other grass and some legumes), the soil absorbed 6.68 inches in 6 hours and was wet to a depth of 30 inches.

Tile improves drainage on many soils, though not on all. “Principal Soil Association Areas of Illinois,” put out by the Department of Agronomy, University of Illinois, gives some information on effectiveness of tile in draining certain soils. Before installing an elaborate and
PLANNING A CONSERVATION PROGRAM
FOR YOUR FARM

In developing a conservation program, you are faced with many decisions. One of the most important is the problem of choosing a rotation that will fit the conditions on your farm.

As already pointed out (page 11), suitable rotations vary with soil type and slope. And they also vary with the mechanical measures such as contouring, strip cropping, and terracing, that are adopted. For example, terraces might make it safe to use a rotation that would otherwise result in much loss of soil.

The Agricultural Experiment Stations and Soil Conservation Service have conducted enough experiments under a variety of field con-
Table 5. — Maximum Length and Steepness of Slope on Which Various Rotations and Practices Can Be Used Safely on Selected Typical Soils in Four Areas in Illinois

<table>
<thead>
<tr>
<th>Rotation and practice</th>
<th>Western Illinois (Clinton silt loam)</th>
<th>Northeastern Illinois (Elliott silt loam)</th>
<th>Central Illinois (Saybrook, Flanagan)</th>
<th>Southern Illinois (Ava, Grantsburg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum length or percent of slope on typical soils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-C-G-M</td>
<td>Contouring alone on—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2% slope</td>
<td>300 ft.</td>
<td>400 ft.</td>
<td>400 ft.</td>
<td>400 ft.</td>
</tr>
<tr>
<td>4% slope</td>
<td>150 ft.</td>
<td>400 ft.</td>
<td>125 ft.</td>
<td>225 ft.</td>
</tr>
<tr>
<td>Terracing</td>
<td>5 perct.</td>
<td>9 perct.</td>
<td>125 ft.</td>
<td></td>
</tr>
<tr>
<td>C-G-M</td>
<td>Contouring alone on—</td>
<td></td>
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<tr>
<td>2% slope</td>
<td>400 ft.</td>
<td>400 ft.</td>
<td>400 ft.</td>
<td>400 ft.</td>
</tr>
<tr>
<td>4% slope</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
</tr>
<tr>
<td>6% slope</td>
<td>125 ft.</td>
<td>150 ft.</td>
<td>225 ft.</td>
<td>125 ft.</td>
</tr>
<tr>
<td>8% slope</td>
<td>9 perct.</td>
<td>8 perct.</td>
<td>12 perct.</td>
<td>8 perct.</td>
</tr>
<tr>
<td>Terracing</td>
<td>400 ft.</td>
<td>300 ft.</td>
<td>150 ft.</td>
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<tr>
<td>C-G-M-M</td>
<td>Contouring alone on—</td>
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<td>400 ft.</td>
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<tr>
<td>4% slope</td>
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<td>300 ft.</td>
<td>300 ft.</td>
<td></td>
</tr>
<tr>
<td>6% slope</td>
<td>150 ft.</td>
<td>150 ft.</td>
<td>200 ft.</td>
<td>125 ft.</td>
</tr>
<tr>
<td>8% slope</td>
<td>9 perct.</td>
<td>8 perct.</td>
<td>12 perct.</td>
<td>5 perct.</td>
</tr>
<tr>
<td>10% slope</td>
<td>275 ft.</td>
<td>300 ft.</td>
<td>350 ft.</td>
<td>175 ft.</td>
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<td>12 perct.</td>
<td>8 perct.</td>
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<tr>
<td>C-G-M-M-M-M</td>
<td>Contouring alone on—</td>
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<td>150 ft.</td>
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<tr>
<td>15% slope</td>
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<td>250 ft.</td>
<td></td>
</tr>
<tr>
<td>Terracing</td>
<td>12 perct.</td>
<td>12 perct.</td>
<td>12 perct.</td>
<td>8 perct.</td>
</tr>
</tbody>
</table>

1 Recommendations would be similar for soils related to the selected types in each area.
2 C = corn; G = small grain; M = meadow or pasture.
3 Estimates apply only to areas where more than 8 inches of surface soil is present. Lengths recommended would be less on eroded soils.

Conditions to justify making recommendations for a number of soil types. Some of these recommendations have already been given in Table 3 (page 11). In this table only one slope is given for each soil type, the slopes are all assumed to be 200 feet long, and contouring is the only mechanical measure assumed.
More variable conditions are taken into account in Table 5. Different soil types, slope percentages, slope lengths, and mechanical measures are considered for each of several rotations. If you have one of the soils listed in the table, you may find that you can use several possible combinations of rotations and mechanical practices.

For example, let us assume that you have a 250-foot long, 4-percent slope on Elliott silt loam with at least 8 inches of topsoil. If you wanted to use a rotation of corn, corn, grain, and meadow you would need terraces to keep soil losses at a safe level. On this soil type and with this rotation, 150 feet is the maximum length of slope on which contouring alone can be safely used. Terraces, however, may be used on slopes up to 5 percent. Any of the other rotations would be satisfactory with contouring alone. With a rotation of corn, grain, meadow (two years), or of corn, grain, meadow (four years), strip cropping would give added protection against erosion. If erosion has already been at work and there is less than 8 inches of topsoil, then the maximum slope lengths for the different practices and rotations would have to be reduced.

Your Farm Adviser can give you more information on how you can develop a good conservation program for your particular farm. He can also tell you how to get in touch with the officers of your Soil Conservation district. Soil Conservation districts have been established in most Illinois counties, and they have personnel who can help farmers apply research findings to their individual problems.

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The authors are indebted to several staff members of the Illinois Agricultural Experiment Station and the Soil Conservation Service for their assistance in the preparation of this circular—especially R. S. Stauffer, who assisted in the contour-farming investigations, and A. A. Klingebiel, who helped to prepare Tables 2 and 5.
To control erosion
on your farm . . .

Treat the soil. Luxuriant plant cover and rich organic matter help to hold the soil in place.

Use rotations that include grasses and legumes. Grow these crops often enough to keep soil losses at a safe, low level.

Manage your crops in a way that will reduce erosion. Good management includes diskimg down stalks in the fall and moderate grazing of grain and pasture.

Farm on the contour. This practice not only helps to hold the soil, but also increases yields.

Combine strip cropping or terracing with contouring on slopes too long or too steep for contouring alone.

Provide grass waterways and outlets to remove runoff.

Improve soil drainage. Install tile systems where they are needed, and establish good root systems.

These steps are essential for continued, profitable farming on your land.