what must occur in the root zone of the growing crop.

Unless the soil is well drained, the application of irrigation water in considerable excess over that required for the crop and for leaching can be as detrimental from the standpoint of salinity control as underirrigation.

Overirrigation increases the amount of water that the drainage system must convey; if the capacity of the system is exceeded, the water table will rise to an unsafe level. It is apparent therefore that a proper relation between irrigation, leaching, and drainage is of utmost importance in preventing soils from becoming salt affected. The amount of water applied should be sufficient to supply the crop and satisfy the leaching requirement but not enough to overload the system.

Excessive loss of irrigation water from canals constructed in permeable soil is a major cause of high water tables and salt accumulation. Seepage losses can be reduced by lining canals with cement, buried asphalt membranes, or more commonly with earth of low permeability. The maintenance of drainage systems is also important and usually involves nothing more than keeping tile lines in repair or open ditches clean and excavated to grade.

A gradual decrease in soil permeability is a common cause of declining productivity in land under irrigation. Without satisfactory soil permeability, crops cannot be kept adequately supplied with water and the leaching of salts is not accomplished. Soil treatments for the maintenance of permeability are the same as those we discussed for improving soil structure.

To meet the demand for agricultural products, it will be necessary to utilize salt-affected soils and irrigation waters of inferior quality more and more fully. Thus it can be assumed that the improvement of salt-affected soils and the management of productive soils so as to prevent the excessive accumulation of soluble salts and adsorbed sodium will grow in importance.

To protect soil from erosion and to hold as much of the rain as possible in a place where crops can use it are a big part of modern soil management.

We cannot avoid all risks of erosion when we lay a soil bare by cultivating it. Neither can we hold all the rain where it falls in humid or subhumid areas. But we need to know the risks and control them the best we can.

Erosion is slow wherever the soils are covered by trees or grass. Near Zanesville, Ohio, scarcely any loss of soil could be measured in 9 years from a woodland watershed of 2 acres. A nearby pasture lost soil during the same period at an average rate of one-tenth ton an acre a year, or about 1 inch in 1,500 years. A similar watershed cropped to a 3-year rotation of corn, wheat, and hay lost an inch of soil in the 9 years.

The rate of erosion in any storm depends on the force with which raindrops stir up soil and the amount and speed of the runoff water. Other factors affecting erosion include kind and amount of cover, kind of soil, and steepness and length of slope.

To judge the erosion hazards in a particular situation, we need to look at more than one rain and consider the pattern of rainfall for a whole year or for several years.

We need to study the location by looking uphill to see how much water is likely to cross the field and by looking downhill to see where the runoff
water and the soil it carries are likely to go.

We need to look at the cover that the cropping system provides each season, especially if a crop must be planted at a time when hard storms are likely to occur.

We need to study the whole soil profile to find out the effect of layers that lie beneath the surface.

We need to know what recent tillage practices have done to the structure of the surface soil and how much protection we can get from mulches.

Having appraised these hazards, we need to plan the cropping system and supporting conservation practices for the field to offset them.

Short-time changes other than erosion also are important in the management of soil and water. Nutrients may be depleted through leaching and removal of crops. Changes in soil structure can have great effect on the supply of water in the root zone available to plants. The nutrients can be replaced by fertilizers, but changes in soil structure are harder to correct.

Structure of surface soil affects intake of water and air. Whenever the surface layer becomes puddled by a hard rain or compacted by heavy machinery, the danger of runoff and erosion increases and the intake and storage of water decrease. Structure is likely to break down as organic matter becomes oxidized.

Tillage pans, also called plowpans or traffic pans, are formed in some soils as they are cultivated. A tillage pan is a thin, dense layer that develops just under the plow layer. It restricts root growth and can seriously reduce crop yields. Many silt loam and loam soils are subject to formation of tillage pans.

Structure of subsoil is important because we need the full capacity of a soil to furnish plant nutrients, water, and air. Many farmers have found that their soils drained well at first but needed more drainage after they had been farmed a few years and the crevices and root channels in the subsoil began to be filled.

We need good management of water for crops to get the full benefits of controlling erosion, improving fertility, and maintaining soil structure. Most soils contain either too little or too much water during at least part of each year.

Although drainage of wet lands and irrigation of arid land are major operations; they affect only part of the total cropland, probably less than one-third. Irrigation is increasing in humid areas but will continue to be limited by water shortages, high costs, and other factors.

Farmers who can reduce runoff from upland fields and who can increase the amount of water taken in and stored for use by plants during the growing season have a good chance of increasing their crop yields. Such management of water on most of our cultivated land where neither drainage nor irrigation is involved may produce greater benefits than the more spectacular measures.

A cover of vegetation is the first defense against erosion and runoff.

A soil protected by the right kind and amount of sod or forest litter is not likely to erode, no matter how hard or how long it rains. A soil so protected readily absorbs the rainfall. Its good structure permits the water to move freely through it, and heavy runoff seldom occurs unless rock or impervious layers near the surface block the downward movement of water.

Occasionally there are exceptions. Concentrated water may start a gully, or a cloudburst can saturate an entire slope and unleash a landslide. Long rains may overrun the water-storage in the soil and cause streams to rise.

The protection cultivated crops give is intermediate between none at all, as on a newly plowed field, and the nearly complete protection of thick sod or forest litter.

Some hay crops are almost as good as pasture sod. Others, like alfalfa and sweetclover, can allow much washing if the spaces between plants are not filled in with grasses or mulched by
dead stems and leaves. Small grains offer only partial protection, and that only after they have made considerable growth. Intertilled crops are little better than bare fallow unless the rows are on the contour. Crops that must be dug, like potatoes and peanuts, leave the soil ready for erosion by the next hard rain.

To judge the risk of erosion in a cropping system, we need to know the chances of erosive rains whenever the soil is cultivated or cover is thin. In a 4-year rotation of corn, grain, and 2 years of hay, the soil is plowed twice and is cultivated two or three times after the corn is planted. The risk of erosion-producing rains at those times is high in most corn-growing areas.

As many farmers know, a rotation of fallow, wheat, and kaifir leaves soil exposed to erosion for most of a year and also part of the spring in which kaifir is planted. A rotation of wheat 1 year and alfalfa mixed with bromegrass for 3 years gives protection most of the time and allows both crops to be planted when the risk of erosion is low.

Much can be done to reduce erosion by matching the crops grown to the erosion hazards of each field. Certain crops also can be used to keep or to restore fertility and good structure.

Green manure crops, which return large amounts of organic matter to the soil, are needed in humid and subhumid areas to keep good tilth in the topsoil. In drier farming areas, crops that leave heavy mulches on the surface may serve better.

Deep-rooted legumes, such as sweetclover, improve subsoil structure. We need legumes in cropping systems on many soils to keep the subsoils porous enough so that water, roots, and air can get through them.

**Tillage methods**, as well as the crops grown, affect soil conditions and therefore runoff and erosion.

Corn, cotton, and soybeans for many years have been considered the most soil-depleting crops. Much of the damage resulted from overtillage in preparing seedbeds, controlling weeds, and attempting to get more nitrogen from decomposing residues.

New cultural practices and tillage implements now available will overcome some of the hazards of clean tillage. Agronomists are studying mulch tillage, rough seedbeds, sod seedbeds, and many other practices to determine their effects on crop yields, erosion, and control of weeds and crop diseases.

Ten years of study in the Southeast showed that mulch tillage permitted less runoff and erosion and resulted in higher corn yields than clean tillage.

Rough seedbeds prepared with a field cultivator in the Midwest lost about half as much soil as plowed fields.

Contour listing of corn in western Iowa reduced water losses about 50 percent and soil losses 73 percent from those where the crop was surface planted on the contour.

Minimum tillage that keeps crop residues on or near the soil surface, used with nitrogen fertilizers and living mulches, has proved successful in many places. More research is needed to adapt these methods to all sections.

A farmer usually can choose different combinations of soil-saving and water-saving practices to use with the crops he wants to grow.

The land capability classification is a useful guide in matching conservation practices with the cropping system or type of cover on each field.

On a soil of a certain capability, for example, the cover needs to be hay or pasture two-thirds of the time if no extra practices (such as stripcropping or terracing) are used to support the protection given by the rotation. If the field is stripcropped, hay or pasture is needed half the time. Sod is needed only one-third of the time if it is terraced.

This is only one example of the many choices that can be made. In general, whenever sloping soil is to be cultivated and exposed to erosive rains, the protection offered by sod or close-growing crops in the rotation needs to be supported by practices that will
slow the runoff water and thus reduce the soil it can carry.

The most important of these supporting practices for cropland are waterways, contour tillage, stripcropping, terracing, and diversion terraces.

**Waterways** (as used in soil and water conservation work) are natural or manmade depressions on sloping land. Waterways can carry specified amounts of water without erosion and serve as outlets for terraces, diversions, and contour rows. They are needed often as passageways for water that enters a farm from other land.

Waterways are the most important single item in the control of runoff water from cultivated land. If they fail, all other parts of the system may fail.

The best locations for waterways usually are the natural drainageways of the landscape. Natural depressions require a minimum of shaping to be able to carry the expected runoff. Soil and moisture are favorable for good growth of protective vegetation. The topography usually allows free discharge of water into natural drainages from terraces, diversions, and rows.

Manmade channels near field boundaries or fence lines can be made to work, but they are never so satisfactory as the natural locations.

Waterways need to be large enough to carry the runoff from the watersheds they serve without overflowing during heavy storms. Usually this means designing them to carry the runoff from the heaviest rainfall to be expected once in 10 years.

The waterway needs to be shaped and smoothed to remove irregularities that would cause turbulence in flowing water. If the site is in a natural depression, this usually can be done with ordinary farm equipment. If there is a small wash or gully down the center of the depression, it should be plowed in and the soil compacted by repeated trips over the filled area with a tractor.

The shape of the waterway should keep water from concentrating to a great depth at any point. A dished, or parabolic, shape is best. A V-shape is satisfactory if the sides of the V are laid back so that the top width is at least 10 times the depth.

It is desirable to establish a dense vegetative cover as soon as possible. Since the waterway will carry rather heavy flows at times, the seeding and fertilizing rates normally used for pasture are not sufficient. A good rule is to double these rates—or more—when seeding a waterway. In sodding, the sod pieces should be closely spaced and should be well fertilized.

Grasses that form a dense turf are best for waterway protection. Where they are not adapted, bunch grasses like the bluestems and gramas, or lespedeza sericea and many other plants do a satisfactory job if the depth of flow is kept shallow and the slope is not steep. Kudzu is good in places where it is adapted. If kudzu is used, the size of the waterway must allow for the bulky growth of the plant. Reed canarygrass is good in wet places.

**Contour Tillage** is one of the simpler practices for reducing soil and water losses. It is effective and inexpensive in the right places. Its effectiveness depends on the ridges, made by tillage implements, to retard the flow of water. Contour cultivation alone protects the soil on the flatter slopes during the less intense storms but is of little benefit at times when the rains are intense.

Contour tillage is most effective on 2- to 8-percent slopes not more than 300 feet long. Here the practice reduces soil loss to about half that with tillage up and down the hill. On slopes greater than 8 percent, the ridges retard the flow less, and soil loss is reduced only 20 to 40 percent.

On a 7-percent slope near Guthrie, Okla., contour tillage reduced losses of soil about 50 percent and losses of water 12 percent (as compared to farming up-and-down the hill) on land planted to cotton with wheat as a winter cover. In Missouri, on a soil having a rather tight subsoil, contouring rel-
duced soil losses 52 percent and runoff 20 percent on land planted to corn.

Contouring alone is not sufficient protection for soils that are severely eroded or have hard clay subsoils, for the excess runoff may break through the rows. Other practices such as terracing are needed when those conditions exist.

Contouring can increase yields of row crops as much as 50 percent; increases of 5 to 10 percent are common. The effect is greatest in years when rainfall is scant during the growing season.

To be able to plow and plant on the contour, a farmer needs one or more key contour lines marked on each field. These are level lines across the slope to be followed in tillage operations.

On short, uniform slopes, one key contour line about halfway down the hill is enough. If the slope is long or irregular, several lines are necessary. It is important to have enough lines to guide farming operations, taking into consideration a convenient width of land for plowing or planting.

Anyone with a little experience and a helper can stake out the key contour lines, using an inexpensive hand level.

First, determine which part of your helper’s body is level with your eyes (e.g., hair, face, or shoulder) when you are standing together on level ground. Then, when you sight through the hand level and see the crosshair against this part of his body, you are both standing at the same elevation.

Next, decide where the first key contour should be. Set a stake at any point on the proposed line. Stand at this stake while your helper walks about 100 feet (or not so far on sharp curves) around the slope as nearly on the level as he can. When he stops, sight through the hand level and signal for him to move up or down the hill as necessary until the crosshair again strikes the part of his body previously determined. When you signal that he is on the level with you, he drives a stake.

Move to the new stake while your helper moves on, and repeat the process. When you have crossed the field in this manner, you will have a line of stakes all on the same level. The line can now be marked with a plow.

When the entire field is contoured and planted to a single crop, odd-
shaped areas may cause some difficulty in plowing. The sketch shows how to avoid turning on loose plowed ground. Use each contour line as a backfurrow and plow around areas 1 and 2. Plow area 3 next until the remaining land is just wide enough to turn the tractor. Then plow the turnstrip (4).

In stripcropping, close-sown crops alternating with strips of other crops slow down the flow of water.

Stripcropping combined with contour tillage is more effective than contouring alone. On experimental areas in Missouri, Ohio, and Wisconsin, contour stripcropping (compared to up-and-down farming) reduced soil losses about three-fourths on slopes that were less than 12 percent and one-half on steeper slopes.

There are three types of stripcropping: Contour stripcropping, field stripcropping, and buffer stripcropping. The type to use depends on the kind of soil, the crops grown, and the topography.

Grassed waterways are essential in a stripcropped field wherever excess runoff water accumulates.

Contour stripcropping is adapted to well-drained cultivated soils on sloping land where rainfall causes erosion. This type of stripcropping is effective on 2- to 12-percent slopes that are not longer than 400 feet.

Where both erosion and wetness are problems, strips can be laid out with a grade of 1 to 2 percent to lead the water into grassed waterways.

Steepness of slope, kind of soil, the usual amount and intensity of rainfall, and the size of the farm equipment are factors to consider in determining the width of the strips. In many localities, strips are made 100 feet wide on slopes of less than 6 percent, 80 feet on slopes of 6 to 10 percent, and 50 feet on slopes of 11 to 16 percent.

When the system is laid out so that both the upper and lower edges of the strips are on the true contour, all strips are irregular in width, as shown in the sketch below.

Strips are narrow where the slope is steep and wide where it is gentle. As a result, some rows in uneven-width strips do not go all the way through the field. Since these short, or point, rows occur on the more gentle slopes where the soil is usually best, most farmers prefer to plant these areas to the regular crops in rotation, despite the difficulty of cultivating them. Others, however, prefer to plant them to perennial hay crops or to close-growing annual crops to eliminate the point rows.

Another common method is to lay out two or more even-width strips from one key contour line, as shown at the top of page 296. When the topography of the field changes, a new contour line should be laid out as a guide for addi-
tional strips of even width. This results in an irregular correction strip between the two sets of even-width strips.

A third method provides for even-width strips alternating with irregular strips. From the first contour line, an even-width strip is measured. A second contour line is staked two strip widths above or below the first, and an even-width strip is measured from it. This process is repeated until the entire field has been laid out.

If the fields are large—160 acres or more—contour maps are helpful in laying out the system. Uniform-width strips separated by irregular-width strips can be located on the map in relation to the contour lines. Minor variations can often be made so that a minimum of land is devoted to the irregular strips. These irregular strips often are planted to perennial grasses.

Field stripcropping is used when slopes are so irregular that contour strips would be hard to till. Field strips are uniform in width and are laid out across the general slope instead of on the true contour. This method is less effective than contour stripcropping in reducing soil and water losses. A good crop rotation and cultural treatments are necessary therefore to provide the major protection to the soil.

Buffer stripcropping consists of narrow protective strips alternating with wide cultivated strips.

The location of the protective strips is determined largely by the width and arrangement of adjoining strips to be cropped in the rotation and by the location of steep, severely eroded areas on slopes. Buffer strips usually occupy
the correction areas on sloping land. They are seeded to perennial grasses and legumes. This type of stripcropping is not so effective as contour stripcropping but will serve as a temporary measure until a more adequate system is established.

Some extra precautions are necessary in farming the stripcropped fields. For ease in handling farm equipment, we need to have two types of crops in each group of strips: A row crop may alternate with a sod crop or a grain crop with a sod crop.

Plowing should be varied to prevent ridges at the edges and deep dead-furrows in the centers of strips. Two-way plows are often used to prevent formation of ridges and dead furrows.

When planting uniform-width strips, the farmer can start at the top or bottom edge and continue across the entire strip. If the strips are irregular in width, many farmers prefer to plant the row crops from both sides. Then the greatest number of rows are on the contour, and all the point rows are in the center of the strip.

**Terracing** has long been used to protect cultivated land against erosion and to make best use of available water.

We now usually use the word “terrace” to mean a ridge, or a combination of ridge and channel, built across the slope on a controlled grade or on the level, depending on its purpose.

Terraces intercept the flow of water down the slope before it attains enough velocity to damage the land. Graded terraces lead this water off the field at nonerosive velocities. Level terraces hold back the water until it can soak into the soil.

Not all soils and slopes can be terraced successfully. It is nearly impossible to maintain terraces on deep sands. The cost of construction and the difficulty of maintenance make them unsatisfactory on stony soils and on shallow soils over rock or over tough, heavy subsoil.

Terraces are impractical on mounded fields or fields where direction or steepness of slope changes every 100 feet or so. A tillable row pattern cannot be worked out on them.

The difficulties of constructing, cultivating, and maintaining terraces increases with the steepness of slope. Satisfactory waterways are also harder to establish on the steeper slopes. For slopes of more than 8 to 12 percent (even less for some of the tighter soils), we might better consider land uses or cropping systems that will give adequate protection without terraces.

The first problem to be solved in terracing a field is how to dispose of the water that cannot be taken into the soil. If graded terraces are used, or if the ends of level terraces cannot be blocked, a waterway must be provided. Level terraces with ends blocked present no problem of water disposal.

An area covered with a dense sod of permanent grasses is a safe place on which to spill the water from terraces. A good pasture next to the field provides a ready-made solution to the problem if the terraces can be run onto it. If no such area exists, one must be developed or a waterway must be established. If the terraces will bring more water to the location than had been coming there before, the vegetation needs to be established before the terraces are built.

* Level terraces are used mainly in areas where the average annual rainfall is less than 30 inches. If the soil is able to take in water at a rate of at least one-half inch an hour, the ends of the terraces may be blocked, and the runoff from all but the most intense rains can be made to enter the soil. If the rate is much less than that, the ends are left open or only partially blocked. Otherwise, the impounded water may damage small grain by causing uneven ripening or difficulty in harvesting. For row crops, such as grain sorghum, slower water intake is not always objectionable.

Where the average annual rainfall exceeds 30 inches, it is generally best to give terraces grade or fall to allow the surplus water to drain from the
field. The grade must be gentle enough that the water will flow at low speed. It should not exceed 3 inches per 100 feet on soils that are easily eroded. On others it may be as much as 6 inches or more per 100 feet.

The spacing of terraces usually varies, inversely with steepness of the field slope—that is, as the steepness increases, the distance between terraces decreases.

Two basic spacing formulas are used: In the Northern States, \( V. I. = \frac{S}{3} + 2 \); in the Southern States, \( V. I. = \frac{S}{4} + 2 \). \( V. I. \) stands for vertical interval in feet, and \( S \) for slope of the land in feet per 100 feet. The vertical interval is converted to horizontal distance by multiplying by \( \frac{100}{S} \).

The way the soil is managed is about as important as steepness of slope in determining the correct spacing of terraces. If good soil-management practices are used, the spacing indicated by the formulas can be increased as much as 50 percent or more on some of the deep, permeable soils. If little attention is given to soil management, the spacing should be narrowed.

The more nearly two terraces parallel each other, the easier it is to farm the space between them. Irregular spaces mean that some rows do not run the full length of the terraces, so that equipment has to be turned in the planted part of the field when row crops are grown, and fields of odd shapes have to be drilled and harvested when drilled crops are grown.

Irregularities in the space between two terraces result from changes in land slope along the terrace line, the extension of terraces across natural depressions, or the grading of terraces so they drain across ridges or hogbacks. These irregularities can be reduced by grading the terraces to drain each way from all ridges and to discharge into the first depression reached. On
some fields this may call for several waterways, and on first thought the farmer may object to them. Experience has proved, however, that the inconvenience of raising tillage tools to cross waterways is less bothersome than farming the additional short rows that result when terraces are built across them.

The sketches on the preceding page illustrate the advantages of using the waterways in natural locations.

The inconvenience of farming terraces can be reduced by using parallel terraces. Actually, it is seldom possible to have all terraces in a field parallel, but the ideal can be approached by care in laying out the system according to the following suggestions:

First, locate all ridges and depressions in the field. All terraces will be graded to drain from the ridges toward the natural depressions.

Next, stake a key terrace on the grade recommended for the soil; adjust the staked line to ease sharp curves as much as possible. All stakes moved in making the adjustment must be rechecked with the level to be sure that the grade from ridge to depression is continuous and not excessive.

Stake a trial line above or below the key terrace and parallel to it. That is done by having one man walk along the line of the key terrace carrying one end of a tape. A second man, holding the tape at a point marking the proper distance between terraces, keeps pace with the first man, setting stakes to mark the trial line. This line is then checked with the instrument. The location is accepted if the grade is not excessive or does not reverse anywhere along the line. Repeat the procedure for each new line.

When the grade of the new line becomes excessive or reverses, lay out a new key terrace a distance of two or more terrace intervals from the last acceptable line.

This gives two sets of terraces, all those in each set being parallel to each other. The only short rows will be in the small adjustment area between the two sets of terraces. Some fields may require several sets of parallel terraces.

A comparison of the bottom sketch with the other two illustrates the advantages of this system.

Two requirements govern the dimensions of the individual terrace.

First, the terrace must be large enough (either in ridge size or channel capacity) that it will seldom be overtopped. The usual recommendation is that a terrace be built to carry the runoff resulting from the heaviest rain normally expected to occur on an average of once in 10 years.

Second, the terrace should be shaped so that mechanized farming equipment can be used without undue difficulty.

Two sketches show dimensions generally recommended for the two types of terraces most commonly used.

Adequate terraces can be constructed with almost any type of equipment that will move soil.

Effective Cross Sectional Area of
Channel 8 to 16 Square Feet
Each side of terrace should be wide enough to allow at least one trip with widest piece of equipment that must be used on it. Minimum not less than 7'.

Channel-type Terrace
Generally used in humid and sub-humid areas where removal of excess water is the problem. Usually given a grade.

The typical shape and dimensions of channel-type terrace.

Total Width of Ridge 14 to 30 or More Feet Depending Upon Size of Farming Equipment To Be Used on Terrace

Height of Ridge Above Natural Ground 10 to 18 Inches Depending Upon Slope of Field and Length of Terrace.

Ridge-type Terrace
Generally used in low rainfall areas to impound water until it can be absorbed by the soil. Usually level.

The typical shape and dimensions of ridge-type terrace.

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CONSTRUCTION PROCEDURE

A. Scarify, chisel, rip, or plow a 20-foot strip \(8\) or \(10\) inches deep on channel excavation area. This step must not be omitted. Loose soil is required to build an adequate terrace section in two trips as shown.

B. Method of placing earth in cross section of terrace is shown above, figures 1 and 2.

C. Sequence of construction down the terrace is shown at right, figures 2 through 6.

D. Back slope of terrace must be built while bulldozer is moving forward down length of terrace, as shown at right in figure 7. A motor patrol grader can be used to widen the back slope if the bulldozer operator is not skilled in keeping a smooth path of forward travel.

E. Resulting terrace, figure 8 at right, averages 15.6 square feet in ridge, \(20\) to \(22\) feet in base width, and 14 square feet excavation in channel.

F. In easy moving soils a gap equal to half the width of the dozer blade may be left between trips (1 and 2) and 3, and the same gap left between 3 and 5. This results in faster construction.

STAGGERED CUT METHOD

Method of progressing down length of terrace

STRAIGHT CUT METHOD

All additional trips are a repetition of trips 5 and 6.

BACK SLOPING

Cutting down, widening, and smoothing the lower slope of the terrace ridge.

FINAL CROSS SECTION
Four sketches show construction methods applicable to some types of equipment.

Keeping the terraces built up to their original size is important. This requires attention to maintenance every year. The job consists of removing silt bars that may have formed above the terrace; inspecting terrace ends to see that they are fully open (if they are supposed to be open) or properly closed (if that is the plan); building up low sections in the terrace ridge; and plowing to maintain adequate size of ridge or channel.

Having terraces on a field often calls for changes in farming operations. The problem is simple where most of the terraces are parallel. If that is impossible, one of the systems shown in the sketches on the next page will be helpful.

A DIVERSION TERRACE (also called diversion ditch) is like a field terrace in shape. The main difference is that it is designed to handle larger flows of water. Diversion terraces usually are considerably larger than field terraces.
Final Round

Rounds should be spaced so that width of plowed area below terrace is \( \frac{1}{3} \) more than width of plowed area above terrace. This calls for overlapping the rounds above the terrace.

A method of maintaining channel-type terraces with disk plow. This method tends to clean out the channel and move the soil up onto the ridge. This method is not recommended for continuous use. It may be used occasionally in rotation with a motor grader.

![Diagram of rounds]

First Round

Second Step

Area between this point and lower edge of next terrace is plowed as separate land.

Third Step

A method of maintaining channel-type terraces with moldboard plow. By starting with a back furrow at the terrace ridge, as shown in step 1, and ending with a dead furrow in the channel (step 3), the farmer can keep the terrace at the desired capacity.

![Diagram of rounds]

NOTE: If terrace should become peaked, start back furrow on back slope, one plow width from top of ridge.

![Diagram of rounds]

Some of the important uses of diversion terraces or ditches are to protect fields from hillside runoff; divert water from a gully to assist in controlling it; increase or decrease the amount of runoff water entering a farm pond; divert water from points of concentration to other nearby areas where it can be spread and used; protect terrace systems from runoff that originates outside the terraced area; break up the concentration of water on long, gentle slopes; and intercept and divert shallow, or perched, subsurface water that would interfere with farming operations and plant growth.

Because diversions are used to intercept the runoff from drainage areas of a few acres up to several hundred acres, each must be designed to fit the site. The grade and dimensions should be determined by a technician.

The need for adequately protected waterways and outlet areas is just as important for diversions as for field terraces. Special structures of concrete or other permanent materials often are required to protect the outlet ends of diversions that intercept the runoff from large drainage areas.

**ONE OF THE GOALS IN CONSERVATION FARMING** is to keep soil losses down to something like the natural rate in the undisturbed landscape. It is often impossible and impractical to use farming systems that will completely prevent all soil losses.

But the farmer and the conservationist need to be aware of the rate of loss their practices permit and to plan to keep erosion within allowable limits.

This section presents a method of estimating soil loss as a guide to conservation planning in the Corn Belt. The principles could be used in other sections where experimental data are available to give reliable values for the various factors involved.

The first question to be answered is: What is “allowable soil loss”—that is, how much soil can be removed annually per acre, on the average, without damaging the land or causing excessive

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**ONE OF THE GOALS IN CONSERVATION FARMING** is to keep soil losses down to something like the natural rate in the undisturbed landscape. It is often impossible and impractical to use farming systems that will completely prevent all soil losses.

But the farmer and the conservationist need to be aware of the rate of loss their practices permit and to plan to keep erosion within allowable limits.

This section presents a method of estimating soil loss as a guide to conservation planning in the Corn Belt. The principles could be used in other sections where experimental data are available to give reliable values for the various factors involved.

The first question to be answered is: What is “allowable soil loss”—that is, how much soil can be removed annually per acre, on the average, without damaging the land or causing excessive
Four methods of planting row crops on terraced land.

silting on lower lying fields or in streams and reservoirs?

More effective erosion-control practices are needed on shallow soils than on deep ones on similar slopes. Conservation practices for cropland in the Corn Belt should keep average annual soil losses below 4 to 5 tons an acre on deep soils and 2 to 3 tons an acre on shallow ones. Soil washing, gully formation, and silting are not excessive at those rates.
Harvest row crops in reverse of the way the field was planted. The illustrations below show how to harvest corn where the turnland was planted between the terraces.

**Step 1**
- Pick out turnland first

**Step 2**
- Pick "shorter" rows on wide portion of turnland

**Step 3**
- Pick corn land between turnland and second terrace ridge

**Step 4**
- Pick all corn above turnland to field boundary.

Harvesting corn on terraced land.

An "allowable soil loss" within these broad limits has been assigned for each important soil in the Midwestern and Northeastern States to serve as a goal for judging the adequacy of erosion-control practices.

Soil conservation experiment stations since 1929 have been studying the factors that influence the amount of soil and water lost during rainstorms. The principal ones are the amount, intensity, and distribution of the rain; length and steepness of slope; kind of soil; kind and amount of plant cover; and the tillage and conservation practices used.

With the exception of the rainfall, all of these factors can be influenced to some extent by what the land operator does. It is important therefore that he consider all factors when he develops a conservation plan for his farm.

Usually once each year a rain will fall faster and in such amount that the soil will be unable to absorb it. Usually a few hard rains cause most of the erosion during a year. At Arnot, N. Y., 21 rainstorms out of 177 caused 65 percent of the erosion from 1935 to 1943. At La Crosse, Wis., four storms a year from 1940 to 1943 caused 95 percent of the total soil loss and 84 percent of the runoff from cornland.

Length of slope is an important factor affecting the rate of erosion. Length is measured as the distance from a ridge or crest where runoff can begin to the point where water enters a channel that cannot be filled and altered by the tillage operations or to a definite change in steepness where water is checked and deposition of eroded soil begins. Usually the length of slope, so considered, is less than the distance from the top to the bottom of the hill.

The longer the slope, the more soil and water are lost when cultivated. If the length of slope is doubled, the soil loss generally is increased about 1.5 times. Terraces and diversions help control erosion by reducing the length of slope over which runoff water has a chance to pick up speed and erosive power.

Steepness of slope is another factor that affects the speed of runoff water and amount of erosion. As the slope gets steeper, the water flows faster and carries more soil with it. If the percentage of slope is doubled, soil losses are increased 2.5 times. This means that soil losses on a 16-percent slope are 2.5 times those on an 8-percent slope, other things being equal.

Relative erodibility of soils vary widely. One field may lose 10 tons of soil an acre while another loses 15 tons under the same conditions. These differences in erodibility are due largely to the ability of the soil to absorb water and the tendency of the soil particles to stick together.

To reflect the comparative rates at which different soils will erode, soil scientists have assigned erodibility factors based on measurements at conservation experiment stations. A factor of 1.0 is given to deep Prairie soils such as Marshall, Parr, and Tama. Other soils, such as those developed
On land that slopes less than about 6% terraces are built wide enough to let you cross them with machinery at almost any angle you choose. Thus you can cut such fields by going 'round and 'round them just as you always do. On steeper slopes, where terraces can't be built wide, it is probably better to harvest the grain with the terraces. The three drawings below showing a windrower in operation illustrate how this may be done.

**Step 1**
Open land on top of second terrace

**Step 2**
Cut land until terraces one and three are approached.

**Step 3**
Cut around the area left above, and including, terrace number one.

Harvesting grain on terraced land.

under a forest cover, have a factor of 1.25, meaning that they erode 25 percent faster than those having a factor of 1.0. For slowly permeable soils and some sandy soils, the factor is 1.5. Soils with tight, nearly impermeable subsoils have a factor of 1.75.

Conservation practices like terracing, contour strip cropping, and contouring materially reduce losses of soil and water. Each has its limitations and needs to be used in its proper place. For example, terraces are not generally constructed on steep slopes, contour strip cropping is most effective on slopes that are not more than 400 feet long, and contouring alone is most effective on 2 to 6 percent slopes that are not more than 200 feet long.

Measurements show that contouring reduces soil losses about 50 percent from those occurring with up-and-down-hill cultivation, contour strip cropping reduces losses about 75 percent and terracing even more, depending on length and steepness of the slopes involved.

Tillage and crop-management practices modify the erosion-control effectiveness of crops they are used with.

Corn, cotton, and soybeans long have been considered soil-depleting crops. Most of the damage associated with them was due to over tillage in attempting to prepare fine seedbeds, control weeds, and get more nitrogen from decomposing organic matter. Improved cultural practices and new tillage implements have helped overcome some of the hazards of clean tillage.

In the Midwest, seedbeds that were prepared with a field cultivator lost about half as much soil as plowed ones.

Contour listing in western Iowa reduced water losses about 50 percent and soil losses 73 percent from those on fields planted on the contour.

Leaving the crop residues, such as corn stalks or grain straw, on the surface of the soil will reduce soil losses as much as 50 percent.

The kind and amount of plant cover have a major influence on the rate of erosion. On cropland this varies with different crops and their sequence in the rotation. Measurements at experiment stations have shown the relative amounts of soil losses from different crops in various rotations. These are shown below in comparison to a standard 3-year rotation of row crop (R), spring grain (O), and hay (H)—that is, R–O–H has the index number of 100.

<table>
<thead>
<tr>
<th>Percentage of R–O–H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row crop, spring grain, hay (R–O–H)</td>
</tr>
<tr>
<td>Continuous row crop (R)</td>
</tr>
<tr>
<td>Row crop, spring grain catch crop (R–O&lt;sub&gt;2&lt;/sub&gt;)</td>
</tr>
<tr>
<td>Row crop, row crop, spring grain, hay, hay (R–R–O–H–H)</td>
</tr>
<tr>
<td>Row crop, winter grain, hay (R–W–H)</td>
</tr>
<tr>
<td>Row crop, spring grain, hay, hay (R–O–H–H)</td>
</tr>
<tr>
<td>Row crop, spring grain, hay, hay, hay (R–O–H–H–H)</td>
</tr>
<tr>
<td>Winter grain, spring grain, hay, hay (W–O–H–H)</td>
</tr>
</tbody>
</table>

The relative values of individual crops in different sequences have also been found.

Conservation workers in the Corn Belt and the Northeastern States have used tables of soil-loss factors reflecting these variables to evaluate conservation cropping systems. The tables serve as guides to help farmers select combinations of rotations and practices for...
Average Annual Soil Losses in Tons per Acre a Year, Using a Rotation of R-O-H Having a Soil Factor of 1.0

<table>
<thead>
<tr>
<th>Soil</th>
<th>Factor</th>
<th>Length of Slope</th>
<th>Terracing</th>
<th>Contouring</th>
<th>Stripping</th>
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<tr>
<td></td>
<td></td>
<td>200'</td>
<td>300'</td>
<td>400'</td>
<td>400'</td>
</tr>
<tr>
<td>2.0</td>
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<td>1.75</td>
<td>2.19</td>
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<tr>
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<td>1.25</td>
<td>1.75</td>
<td>2.19</td>
<td>2.7</td>
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</tbody>
</table>

The above values are based on good management. For a high management level, multiply the factors by 0.7.

The table above presents combined soil-loss factors for common rotations on soils of different erodibilities. When the basic soil losses in the first table are multiplied by these factors, the results are the estimated soil losses from corresponding slopes and practices with different rotations on different soils.

For example, to estimate the soil loss from an R-R-O-H-H rotation on a soil that has an erodibility factor of 1.25 and a 6-percent slope 300 feet long that is contoured, first find the basic soil loss figure in the first table for the slope and practice specified. It is 4.7 tons per acre. This figure multiplied by the combined soil loss factor from the second table (1.55) gives 7.3 tons an acre as the expected average annual soil loss under the conditions described.

If the allowable annual soil loss for this soil is 4 tons an acre, this rotation with contouring is not an adequate conservation system. Either a more effective rotation must be used or the land must be stripcropped or terraced to bring the expected soil loss down to the allowable figure. Other calculations with the two tables will indicate which combinations of crops and practices will do that.
SLIGHT OR NONE

MODERATE
25 to 75 percent of topsoil lost, may have some gullies.

SEVERE
More than 75 percent of topsoil lost, may have numerous or deep gullies. Includes severe geological erosion in parts of low rainfall areas.

Many small areas could not be shown at this scale.

Generalized soil erosion.