

The Control of Soil Erosion in New York

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This publication contains:

Summary.....	3
Factors influencing soil losses in New York.....	7
Rainfall.....	7
Slope of land.....	8
The soil.....	10
Land cover, or cropping system.....	11
Protecting soils from washing.....	12
Fertilization.....	12
Winter cover crops.....	12
Good soil management.....	14
Contour strip-cropping.....	16
Arrangement of crops.....	19
Width of strips.....	22
Laying out strips.....	24
Contour farming.....	26
Waterways in grass.....	28
Diversion channels.....	29
Terraces.....	31
Control of gullies.....	31
Vegetation.....	32
Brush.....	33
Other dams.....	34
Contour furrows in pastures.....	35
Holding fruit soils against washing.....	35
Contour planting.....	36
Terracing peach orchards.....	36
Contour planting of grapes.....	37
Holding soils against blowing.....	39
Muck.....	39
Sandy soils.....	41

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SUMMARY

Good soil management and soil-erosion control go hand in hand. It is unwise to apply fertilizer, lime, manure, and to sow seed only to have them washed away because of lack of erosion control.

The steeper cropped lands should be occupied most of the time by soil-protecting crops, such as small grains and the pasture and hay grasses and legumes.

The leveler land is the best place to grow such soil-exposing crops as corn, potatoes, and beans.

On nearly all slopes, plowing, harrowing, seeding, and cultivating should be on the contour.

On long slopes particularly, soil-protecting crops in contour strips alternated with soil-exposing crops help greatly to prevent soil erosion. In many places channels are needed to carry water from the slopes.

Steep, eroded, or easily erodible land should be in forest.

Gullies should be checked as soon as possible after formation. Filling them with straw or brush or planting grasses and legumes, vines, shrubs, and trees in them is helpful. In many places, particularly in pastures, shallow channels are used to carry water away from gullies and to give vegetation an opportunity to become established.

Windbreaks and cover crops hold muck and sand from blowing.

THE CONTROL OF SOIL EROSION IN NEW YORK

A. F. GUSTAFSON

BEFORE the white man came to the area that is now New York State the land was covered almost entirely with forests. Such forests constituted one of nature's best means of protecting sloping lands. The fallen leaves and twigs absorbed much water, and, by covering the soil, protected it from the beating action of raindrops. This cover and the underbrush, together with the fibrous roots of the trees and the open, absorptive condition of the soil, prevented loss by washing or *soil erosion*. More than half of the farm land in this State has undergone or is subject to fairly severe erosion, and much of the remainder suffers some loss if not well protected.

It has been between seventy-five and one hundred years since man cut the timber on the hilly lands of the State and placed the soil under cultivation. During the first few years of cropping, the undecayed rootlets, twigs, and leaves prevented serious loss of soil. Through continuous cropping, however, nature's protection has decayed and disappeared.

Plowing, planting, and cultivation usually have been parallel to roads and fences in fairly straight lines without regard to slope (figure 1). On even moderate slopes rainwater collects between the rows of cultivated crops and in furrows or other depressions. The longer the slope the more water collects, and the steeper the slope the faster the water flows. As the speed of the current increases, larger and larger soil particles are carried in the water and larger pebbles and stones are rolled or pushed along by the water.

As the slopes were cropped year after year, heavy dashing rains carried away some of the surface soil. The topsoil to a depth of 6 or 8 inches, or a little more, is the soil from which crops obtain much of their plant food. Consequently, topsoil is invaluable and should be protected. Runoff water collects in depressions left by various implements, particularly cultivators. A single shower sometimes makes a rill or gully several inches in width and a few inches deep. On fairly steep slopes it is not uncommon to find a gully 4 inches wide and 3 inches deep between rows of corn, beans, or potatoes, following a single heavy shower. With rows 36 inches apart, such a shower

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FIGURE 1. EROSION, TOMPKINS COUNTY

This long, gentle slope had been plowed in preparation for seeding wheat. Much good soil was lost from this field. A grassed waterway would have prevented much loss of topsoil.

removes the equivalent of $\frac{1}{2}$ inch of soil from the whole area. The next cultivation or plowing fills these little gullies, and for the time they are forgotten. As this goes on year after year it is clear that but eighteen or twenty such showers can remove the entire topsoil. Since most fields are in grain or grass much of the time and since dashing rains do not occur every year while the soil is bare, it may take from forty to sixty years for the removal of the plow soil. Even that is too rapid a loss.

Not months or years but many centuries are required for the development of the productive topsoil even from partially weathered soil materials. Of course, if the land is plowed to a depth of 6 or 7 inches each time after erosion, the subsoil is mixed with the surface soil that is left. This prolongs the time required for the removal of all of the original surface soil. This mixing is inevitable and helps to maintain a fair degree of productivity. Yields, however, soon drop below those produced before topsoil was lost. As a result the steeper lands in time are abandoned.

During the summer of 1934 the writer observed numerous gently sloping fields in southern New York that had not been cropped for years. Even on gentle slopes the original surface soil was almost gone and the tight gray subsoil was at or near the surface. Usually such fields were not seeded the last year they were cropped. The result was a few grass plants along with goldenrod and other weeds. Such cover affords little protection from erosion, and the fields have little value for many years to come unless steps are taken soon to check further erosion.

What becomes of the soil material washed from cultivated fields? The coarser material is deposited at the base of steep slopes. Sometimes it fills stream channels and causes them to overflow. Subsequent rains spread sand, gravel, and stones over perfectly good valley soils. Such covering greatly reduces their productive power. The clearing of stream channels with a power shovel is a familiar sight in the hill sections of the State. The finer soil material is carried far down the larger streams to be deposited on their flood plains or in lakes or the ocean. This valuable silt and clay never finds its way back to the fields whence it came. Uncontrolled soil erosion, therefore, not only reduces the productivity of sloping upland and eventually ruins it but covers valuable bottom lands with stones, gravel, and sand of little present-day value (figure 2).

FACTORS INFLUENCING SOIL LOSSES IN NEW YORK

Loss of soil may be attributed to several factors. Four of these are: (1) the amount and type of rainfall, (2) the slope of the land, (3) the soil itself, and (4) the land cover, or cropping system, and the direction of tillage and seeding operations.

Rainfall

Usually rainfall in New York is fairly well distributed; and, on the whole, the growing-season rainfall is ample for good yields of crops.

FIGURE 2. STONES DEPOSITED IN A GOOD CORNFIELD, DELAWARE COUNTY

These stones were brought down by a prolonged rain. Corn similar to that shown occupied the area where the stones now lie. Such coarse material covers good soil and makes it almost worthless.



A large total rainfall as slow drizzles causes little loss of soil; but rapid rainfall leads to severe erosion, particularly on bare slopes. In 1936, 0.7 inch of rain fell in 5 minutes, or at a rate of more than 8 inches on hour and caused a loss of 17,000 pounds of soil an acre from bare land on the United States Soil Conservation Experiment Station near Ithaca. In contrast, a rain of 3.69 inches in 1937, the heaviest of which was at a rate of 1.2 inches an hour, during 5 minutes caused the loss of only 546 pounds of soil an acre. During the past few years rains of more than 1 inch in 10 minutes and even as much as 0.7 inch in 5 minutes have been recorded. Downpours of such intensity cause severe washing on sloping bare soils. It is during the summer when the soil is bare or not well protected that the heavier showers fall. A rain of 1.75 inches fell on land newly-plowed for wheat in Onondaga County in September 1941. The fact that New York is subject to downpour rains emphasizes the need for protecting the soil as much of the time as possible.

Slope of land

Both steepness and length of slope have an important bearing on the washing of soil.

Steepness of slope

Water flows more rapidly on steep slopes than on moderate ones.¹ Doubling the speed of running water makes it four times as effective in scouring or loosening particles. If the velocity is increased three times, the scouring ability becomes nine times greater (figure 3).

The carrying power of water, that is, the weight of the separate particles that water is capable of carrying in suspension, is increased more by increased velocity than is the scouring power of running water. Doubling the velocity of a stream increases its carrying power 64 times; trebling the velocity increases carrying power to the almost unbelievable extent of 729 times. For example, a stream that can carry soil particles that weigh not more than 1/100,000 of an ounce can by doubling its velocity carry particles that weigh 64/100,000 of an ounce. Although this carrying power sounds incredible, it explains how large stones (figure 2) are brought down steep slopes. Rounded stones may be rolled along the bed of a stream while flat ones are shoved along, or, in places, picked up and carried momentarily. Only this enormous increase in carrying power can explain the choking of so many stream channels, which must be cleared periodically to prevent damage to bottom lands, roads, or buildings.

¹Slope is expressed in percentage. A vertical drop of 10 feet in 100 feet of horizontal distance is called a *slope of 10 per cent*. A drop of 25 feet, therefore, is a slope of 25 per cent. Levels are needed to determine the per cent of slope. The tripod, the hand level, or a simple arrangement of a carpenter's level such as that shown in figure 3, may be used.

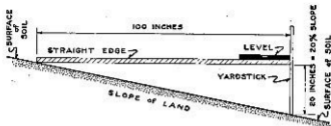


FIGURE 3. A SIMPLE WAY TO DETERMINE PERCENTAGE OF SLOPE

At the Arnot Experiment Station of the Soil Conservation Service a slope of 18 per cent lost nearly twice as much soil as one of a little less than 9 per cent. Similar differences may be expected over the State.

Length of slope

Short, relatively slight slopes ordinarily do not wash badly because little water accumulates on them. With the same degree of slope, however, erosion may be pronounced on slopes of 20 rods in length and severe on

FIGURE 4. EROSION IN POTATOES, MONROE COUNTY

Note the gullying in the potatoes and the deposition of stones, sand, and gravel in the foreground. Damage was even greater on the right slope of this drainage.





FIGURE 5. GULLYING AND SHEET WASHING ON DUNKIRK SOIL,
SENECA COUNTY

This slope is very gentle. Even so, considerable soil was lost during a heavy rain. Maintaining this waterway in grass would prevent further erosion in it.

slopes of 80 rods (1320 feet) or more in length on which considerable water accumulates during thawing of snow or in heavy rains (figures 4 and 5).

In experiments in New York, a medium-length slope (72.6 feet) lost 8000 pounds of soil an acre a year. Under similar conditions a longer slope (145 feet) lost one-half more soil. These slopes are both short compared with those on many farms in the State. From these losses on narrow strips it is clear that heavy losses must be expected on slopes a few hundred to several thousand feet in length.

These facts show how essential it is to decrease the velocity of water running over the surface, especially over bare land. With decreased velocity, not only is the carrying power reduced but the quantity of water absorbed by the soil is increased so there is less runoff to carry away valuable soil.

The soil

The soil itself has a marked influence on the ease with which runoff water can loosen and carry away soil particles.

Size of soil particles

The size of the soil particles affects the rapidity of absorption of rainfall. A coarse, sandy or gravelly soil may absorb rain as fast as it falls. Thus there is no runoff and no erosion. A heavy soil, such as fine silt or

clay, on the other hand, has such small openings between the particles that water is absorbed slowly and much may flow off over the surface. On such soils, there is danger of serious erosion unless the surface is well protected.

Tilth, or porosity

Absorption may be increased by maintaining good tilth, that is, keeping the surface of the soil loose and porous so that it can take up and hold rainwater. This increased absorption by reducing runoff decreases erosion and supplies water for crops.

Depth to the subsoil

The depth of surface material has a bearing on absorption and runoff. This is particularly true if the subsoil absorbs water slowly. In rainy periods a shallow surface soil above a tight layer soon takes up all the water it can hold, and additional rain must run off. This usually causes erosion.

Stones

Removing the stones permits rapid runoff, and leaving the stones holds the water longer on the soil so that more of it is absorbed. In many fields the larger stones must be removed to cultivate crops satisfactorily, but the medium-sized ones may well be left on the land.

Land cover, or cropping system

The cover of the land largely controls the loss of soil by erosion. Virgin forest holds the soil but food and feed crops also are needed. Next to trees and shrubs, grasses afford the best protection. Grasses may be widely used in the cropping system to excellent advantage, as is shown in table 1. The small loss of soil and water from the fertilized meadow was notable. Similarly, the loss from good pasture was slight. The loss of soil was rather heavy from corn and from fallow soil. The rotation was relatively effective in holding both soil and water.

TABLE 1. EFFECT OF CROPS ON LOSSES OF SOIL AND WATER, AVERAGE 1935 TO 1941, ARNOT STATION
(Rainfall 21.2 inches; Bath flaggy silt loam; slope 20 per cent)

Plot	Crop and treatment	Losses over 7 years	
		Water	Soil
A 8.....	None cultivated	<i>Inches</i> 3.74	<i>Pounds an acre</i> 20,266
A 5.....	Continuous corn, 200 pounds 5-10-5	1.75	6,178
A 12.....	Rotation: Corn, oats, clover; 6 tons manure on corn	0.46	537
A 9.....	Meadow, fertilized	0.18	21

Potatoes planted on the contour and ridged do not suffer serious losses of either soil or water. Even contour-planted potato land loses both soil and water after the crop is harvested and during the following spring before the soil is prepared and seeded to the small grain that usually follows in a short rotation (figure 6). Rye should be used as a cover crop wherever possible.

Land planted to corn is subject to some loss of soil during winter and spring, but ordinarily less than land planted to potatoes under New York conditions. In 1937 the rainfall from May through October was 31.3 inches, or about one-half greater than the average for this period. Fertilized corn lost 6522 pounds of fine soil to the acre in comparison with a loss of 9562 pounds from third-year unfertilized corn. Fertilizing corn reduced the loss of soil one-third. Corn that was grown after clover lost a little less than 1000 pounds of topsoil to the acre. And the use of 6 tons of manure an acre on the clover sod reduced the loss of soil to 728 pounds an acre. This relatively small loss occurred during a season of unusually heavy summer rainfall which generally produces severe erosion.

PROTECTING SOILS FROM WASHING

ALTHOUGH for many years farmers have employed measures to control the washing of soils, some important step has been overlooked and heavy losses have resulted.

Fertilization

Fertilization itself does not control erosion, but it does help by producing thrifty plants and by increasing yields. Moreover, the thriftier plants protect the soil against the beating action of raindrops and produce more roots to hold the soil together. Furthermore, if the crop is fed and the resulting manure and the crop residues are returned to the soil, the tilth is eventually improved. The following measures are inexpensive and may easily be put into effect on many sloping farms.

Winter cover crops

Even on extremely gentle slopes much erosion occurs in late winter and early spring following corn, cabbage, potatoes, buckwheat, and truck crops. The seed for a cover crop must be inexpensive and easily obtained. Also, the crop must be capable of making good growth in this State during the times it competes least with the main crop. Rye and oats meet these specifications. Wheat and winter and spring barley also serve this purpose but the seed costs more than that of rye or oats. Domestic rye grass sown in July or August deserves extensive trial in New York.



FIGURE 6. GULLYING IN POTATOS, STEUBEN COUNTY

Note that the rows slope toward this gully. The rows delivered water to the depression in which this gully started. The large number of flat stones indicates that much of the fine surface soil has been lost. Continued loss of fine soil makes this land unsuited for potatoes and lowers its value for other crops.

FIGURE 7. COVER CROP OF RYE

This rye was broadcast by hand on September 15 and was photographed late in October. Although some vegetation had not been harvested, the soil was fairly well covered with healthy rye plants. The following spring the rye protected the soil.



Rye may be drilled after silage corn has been harvested, after the earlier varieties of late potatoes have been dug, or after vegetables in home gardens.

Although covering the seed is desirable, in some seasons sowing broadcast is successful. In gardens, the harvesting of late vegetables covers the seed enough. The stand of rye sown in cabbage (figure 7), beets, or parsnips is somewhat spotted as would be expected. Broadcast seeding affords better protection than does drilling. If drilled, the cover crop should always be seeded on the contour.

Cover crops take up and use available plant food, some of which would be lost if no crop were sown. Moreover, normal growth of cover crops protects the soil somewhat from alternate thawing and freezing in early spring. During thawing the soil is wet and soft and consequently easily churned into suspension by the beating action of raindrops. Much fine soil is lost in this way at that time of year. Also, the cover crop actually holds back runoff water and thereby reduces its speed and consequently the loss of valuable topsoil, organic matter, and plant food.

Under current (1944) shortages of feed grains, somewhat lighter rates of seeding than usual may be used. Best protection for the soil is obtained, however, if considerably more seed to the acre is used for winter cover than is usually sown for grain production.

Oats and spring barley may be used if growth the following spring is not desired. On Long Island, spring barley and rye are sown together and rye alone is used extensively. On Long Island and upstate as well, winter cover crops help to reduce spring erosion and should be sown on much of the land that otherwise lies bare during the spring thaw.

Good soil management

Maintenance of productivity is essential in any erosion-control plan and definitely supplements and supports other erosion-control measures. Good management requires that organic matter be returned to the soil. This is accomplished by plowing under crop residues and farm and green manures. Moreover, adding an abundance of phosphorus and lime as needed to grow clover, alfalfa, and other crops, aids in the production of organic matter and increases the yield of crops. Also, the production of such close-growing, soil-protecting crops as meadow mixtures, including legumes, and of the small grains prevents exposing the soil.

On sloping lands, growing protecting crops in rotation with clean-cultivated, soil-exposing crops, such as corn, potatoes, beans, cabbage, and other vegetables, is usually advisable. On gentle slopes of moderate length, the maintenance of high organic content and high productivity, especially

if tillage operations are carried out on the contour, may be enough. On moderate to steep slopes, however, much lime, fertilizer, and organic matter may be washed away if such inexpensive erosion-control measures as contour tillage and seeding, contour strip cropping, grassed waterways, and cover crops are not employed. On more steeply sloping lands, any one method seldom succeeds fully without the others.

On fairly steep slopes, particularly if the soil is shallow, the return of the soil to forest is good land use. Even the more moderate slopes that are not needed for pasture or meadow also may well be reforested.

Moderate to steep slopes may be used for the production of forage. Pastures and meadows lose plant food in the forage removed from them. Most of these lands were not rich in the virgin state and have since been depleted by cropping and washing. Thin stands of grass are the rule. The application of phosphorus, and lime if needed for alfalfa and clovers, is essential for the production of satisfactory yields and a good cover. A thick sward is needed to protect the soil against the beating action of heavy rains that cause runoff and loss of soil (figure 8). Moreover, the use of lime and phosphorus is highly beneficial to the livestock that grazes these treated pastures or eats the hay that is grown on such fertilized meadows. Light, frequent applications of manure are highly stimulating to crop plants on

FIGURE 8. ALFALFA AND GRASS HOLD SOIL AGAINST EROSION, STEUBEN COUNTY

This alfalfa-grass mixture was ten years old when photographed. The slope is 18 per cent. The rainfall was 2 inches in 20 minutes (unofficial). The entire slope above was planted to potatoes and oats that had made little growth. The alfalfa and grass protected the soil against erosion.



depleted soils, and the manure itself affords some protection to the soil. On the rougher lands, the productivity of meadow or pasture should be maintained as long as it is economical and then the land should be reseeded quickly.

Contour strips may be plowed for reseeding. The roots of the grasses should hold the soil against erosion fairly well through the period required for growing one clean-cultivated crop and a small-grain crop in which a meadow mixture may be seeded. Under favorable conditions, particularly if the clean-tilled crop is not needed, small grain and the meadow mixture may be sown on a well-worked-down sod. It should be possible to reseed such soils with little or no erosion.

On somewhat less steeply sloping and less erodible land, a long rotation may be practiced in which grasses and legumes for hay and pasture occupy the land for periods of from three to ten years. The longer-term meadows and pastures can be kept productive by applications of manure, lime, and phosphorus.

On many farms the homestead is in the valley, with varying acreages of good bottom land and sometimes gently sloping adjacent upland. In these situations clean-tilled crops may be grown in short rotations or continuously on the valley soils. Of course, liberal manuring and fertilization are essential for maintaining high yields. If high yields are obtained on bottom lands, the better part of the erodible hill land may be left in semi-permanent meadow and in pasture.

If cash crops, silage, and hay must be grown on moderately sloping lands, a shorter rotation, such as one of four years, is suitable. Such a rotation properly fertilized on moderately productive land that has not suffered heavy loss of topsoil should produce good average yields. Under these conditions and on the more productive lands that have a high proportion of moderate to steep slopes, contour strip-cropping is good practice.

Contour strip-cropping

The production of close-growing, or soil-protecting, and clean-tilled, or soil-exposing, crops in alternate contour strips is known as *strip-cropping*. This practice has been carried on for nearly a quarter of a century by one farmer in Steuben County. On three other farms, strip-cropping has been carried on for several years previous to 1934 (figures 9 and 10).

Strip-cropping is an older practice in Pennsylvania, Ohio, West Virginia, and Minnesota than in New York. In Pennsylvania it was begun by the farmers themselves, as they had no land for cultivated crops that was not moderately to rather steeply sloping. Because of bad surface washing and gullying, they found that something must be done to protect these sloping lands. The beginners in each locality placed the strips at right angles to



FIGURE 9. A QUARTER CENTURY OF CONTOUR STRIP CROPPING ON LEFT; ORDINARY CULTURE ON RIGHT

The hedgerow running up the hill in the middle of the scene separates two farms. Note the absence of gullies on the contour strip-cropped farm at the left, and the presence of gullies on the farm at the right. This is shown to better advantage in the cover illustration. The landscape is continued on the back cover of this bulletin.

the natural direction of the gullies. From one farm so laid out north of Jersey Shore, Pennsylvania, the practice has spread so that nearly all of the cropped land over an area of 100 square miles is now farmed in strips that are close to the contour. Since each farmer did it on his own initiative

FIGURE 10. OLD STRIP-CROPPING, STEUBEN COUNTY

This long steep slope of deep Webster soil has been strip-cropped by its owner for a number of years. These strips are relatively narrow and close to the contour. They have prevented gullying across the strips in recent years.





FIGURE 11. OLD STRIP-CROPPING, CENTRAL PENNSYLVANIA

This farm has been strip-cropped for at least twenty-five years, according to the present owner. The strips are of uniform width so that not all rows are on the level. For this reason some washing takes place.

and according to his own plan, the strips in some areas, unfortunately, were not strictly on the contour. As a consequence crop rows had slopes where the water from heavy rains caused some washing. On the whole, however, this early strip-cropping has helped greatly to check soil erosion. Gullying is rarely found on these farms.

On one farm near Danville, Pennsylvania, the contour strips were laid with a level in 1885 and have been farmed in level strips ever since. In an inspection of these strips the writer found no gullies, although gullies were

FIGURE 12. OLD STRIP-CROPPING, SOUTHWESTERN PENNSYLVANIA

This strip-cropping in Washington County was begun soon after 1900 and has been followed as shown ever since. The strip with corn checks runs all the way around this hill.



plainly evident on the same slope on the same soil on the adjoining farm. The corn rows were definitely on the level or contour. A fair degree of prosperity is evident on these hilly lands that have been strip-cropped over a period of years (figure 11).

In Washington County, Pennsylvania, most of the cultivated land in two areas is being strip-cropped. One is north and the other south of the city of Washington, Pennsylvania. Many of these strips are close to the contour and help greatly to hold the soil in place (figure 12).

Near Wheeling, West Virginia, and near Saint Clairsville, Ohio, are two areas where much of the cultivated land has been strip-cropped for 30 or 40 years or longer.

Strip-cropping in Minnesota² was started by a Swiss farmer who brought the idea from the homeland. Farmers have practiced strip-cropping of their own free will throughout a generation, and in places longer, because it is a practicable system of reducing loss of soil by erosion and of increasing yields on their lands.

In New York, strip-cropping as a means of reducing erosion has been used generally by the Soil Conservation Service and in the Soil Conservation districts in the State. Farmers have noted the washing that resulted from crop rows that were off the contour. It is they who have insisted on a layout that keeps the rows on the level. Loss of water and, consequently, loss of soil are thus lessened and larger yields are produced.

Arrangement of crops

Long slopes are common in New York (figure 10). Even though such slopes are moderate, large quantities of water collect during heavy rains, with the result that the unprotected slopes are badly washed. In areas of productive soils, moderately intensive cultivation is the rule. Cropping slopes in contour strips helps to conserve the soil while growing soil-exposing crops. It is desirable to alternate clover with cultivated crops on part of the farm and on other fields to alternate timothy with grain. This arrangement has the advantage of keeping a crop all on one field or series of strips in any one season. It lessens the distance from one area of potatoes, for example, to another, and thus reduces the time lost in moving machinery and working crew from one field to another (figures 13 and 14).

An example of this arrangement is the following:

²Effect of erosion on long-time strip cropping in Bush Valley, Minnesota. By I. J. Nygard and L. E. Bullard. *Soil Conservation*, Vol. 4, No. 10, p. 239-241. 1939. (U. S. Agr. Dept., Soil Conservation Service.)

ARRANGEMENT OF CROPS ON TWO SERIES OF STRIPS IN A DIVIDED FOUR-YEAR ROTATION

Strip	First year	Second year	Third year	Fourth year
<i>First field or series of strips</i>				
1.....	Potatoes	Oats	Clover	Timothy
2.....	Clover	Timothy	Potatoes	Oats
3.....	Potatoes	Oats	Clover	Timothy
4.....	Clover	Timothy	Potatoes	Oats
5.....	Potatoes	Oats	Clover	Timothy
6.....	Clover	Timothy	Potatoes	Oats
7.....	Potatoes	Oats	Clover	Timothy
8.....	Clover	Timothy	Potatoes	Oats
<i>Second series</i>				
9.....	Oats	Clover	Timothy	Potatoes
10.....	Timothy	Potatoes	Oats	Clover
11.....	Oats	Clover	Timothy	Potatoes
12.....	Timothy	Potatoes	Oats	Clover
13.....	Oats	Clover	Timothy	Potatoes
14.....	Timothy	Potatoes	Oats	Clover
15.....	Oats	Clover	Timothy	Potatoes
16.....	Timothy	Potatoes	Oats	Clover

An arrangement such as this can be followed on an even number of strips in either series.

On a small farm that has a limited number of strips, the following arrangement is desirable:

ARRANGEMENT OF CROPS ON STRIPS IN A SINGLE SERIES OF A FOUR-YEAR ROTATION

Strip	First year	Second year	Third year	Fourth year
1.....	Potatoes*	Oats	Clover	Timothy
2.....	Timothy	Potatoes	Oats	Clover
3.....	Oats	Clover	Timothy	Potatoes
4.....	Clover	Timothy	Potatoes	Oats
5.....	Potatoes	Oats	Clover	Timothy
6.....	Timothy	Potatoes	Oats	Clover
7.....	Oats	Clover	Timothy	Potatoes
8.....	Clover	Timothy	Potatoes	Oats

*The potato represents clean-tilled, soil-exposing crops in general.

This arrangement may give somewhat better control of losses of water and soil than the arrangement given above. On slopes of less than 10 per cent on well-drained soils, a rotation of three years may be desirable, especially if only a small acreage of the farm is well adapted for a special crop, such as cabbage or potatoes. In a rotation of three years, the acreage of cabbage or potatoes is one-third larger than in a rotation of four years. The following arrangement is feasible and may be repeated on all the strips:

ARRANGEMENT OF CROPS IN A THREE-YEAR ROTATION

Strip	First year	Second year	Third year
1.....	Potatoes	Oats	Clover
2.....	Oats	Clover	Potatoes
3.....	Clover	Potatoes	Oats
4.....	Potatoes	Oats	Clover
5.....	Oats	Clover	Potatoes
6.....	Clover	Potatoes	Oats

A serious objection to this rotation is that oats and potatoes are adjacent to each other every year.

Corn, cabbage, beans, or other cultivated crops may occupy the same place as potatoes in any or all of these crop arrangements. Soil and water from cultivated strips are caught and held by the grass, clover, and grain below. These close-growing, soil-protecting crops check the runoff and reduce its carrying power.

In less heavily cropped areas, the grass may be cut for hay 2 additional years, thus making a rotation of 5 years. On steep or badly eroded land this rotation is better than one of 3 or 4 years. Obviously, only one-fifth of the land is in a soil-exposing crop, such as corn or potatoes, at any one time and four-fifths of the land is in grain and hay, or soil-protecting crops. Except on long, steep slopes or with heavy showers, erosion should seldom be serious if this rotation is practiced and contours are followed.

Wherever a 5-year, feed-crop rotation is desired, the following arrangement of crops on the strips provides excellent protection against erosion. It is best to use 5, 10, or 15 strips, or some multiple of 5 for this rotation, to have the same acreage of each crop every year.

ARRANGEMENT OF CROPS IN A 5-YEAR, FEED-CROP ROTATION

Strip	First year	Second year	Third year	Fourth year	Fifth year
1	Corn*	Oats	Clover	I timothy**†	II timothy**†
2	Clover	I timothy †	II timothy†	Corn	Oats
3	II timothy†	Corn	Oats	Clover	I timothy†
4	Oats	Clover	I timothy†	II timothy	Corn
5	I timothy†	II timothy†	Corn	Oats	Clover
6	Corn	Oats	Clover	I timothy†	II timothy†
7	Clover	I timothy	II timothy†	Corn	Oats
8	II timothy†	Corn	Oats	Clover	I timothy†
9	Oats	Clover	I timothy†	II timothy†	Corn
10	I timothy†	II timothy	Corn	Oats	Clover

*Corn or other soil-exposing, cultivated crop.

†I Timothy = first-year timothy; II Timothy = second-year timothy.

Seldom, if ever, may two soil-exposing crops be grown with safety under these less favorable soil and slope conditions.

Under more favorable slope and soil conditions, however, a 5-year cash-crop rotation with two years of exposing crops might be used to advantage in place of a 3-year rotation, particularly in western New York. A rotation

of corn, beans, wheat, and two years of alfalfa may be grown safely with the following arrangement of crops:

ARRANGEMENT OF CROPS IN A 5-YEAR, FIELD-CROP ROTATION

Strips	First year	Second year	Third year	Fourth year	Fifth year
1	Corn*	Beans	Wheat	1 alfalfa	11 alfalfa†
2	1 alfalfa†	11 alfalfa†	Corn	Beans	Wheat
3	Wheat	1 alfalfa†	11 alfalfa†	Corn	Beans
4	Beans	Wheat	1 alfalfa†	11 alfalfa†	Corn
5	11 alfalfa†	Corn	Beans	Wheat	1 alfalfa†

*A vegetable or other desired cultivated crop may occupy the same place as corn.
 †1 alfalfa = first-year alfalfa; 11 alfalfa = second-year alfalfa.

Width of strips

The width of strips needed for a fair degree of erosion control is influenced by the length and steepness of the slope, the texture of the soil, the rate of absorption of water by the soil, and the crops grown, that is, the proportion of soil-protecting to soil-exposing crops. Many long slopes are divided by farm boundaries, the upper part being on one farm and the lower on another. The width of strips to use on the lower part of the slope depends on conditions on the upper part. It is desirable to protect the lower part of slopes by diverting the water away. If this cannot be done, the vege-

FIGURE 13. SWATZER CREEK WATERSHED, STEUBEN COUNTY, BEFORE SOIL CONSERVATION WAS STARTED

Note the predominance of short rectangular fields. The heavy dashed line outlines the watershed
 PHOTOGRAPH FROM UNITED STATES SOIL CONSERVATION SERVICE



tative protection or lack of it and of the probable runoff from above must be considered. To control erosion on the lower part, it is advisable to be prepared to take care of all the water likely to come from above onto the lower part of the slope. In any system of strip-cropping, the width of strips should be such as to catch and hold in grass and small grain much of the water and soil that comes from the slope above in addition to the water that falls on the strip itself.

New York has four distinct soil conditions with respect to drainage through the soil:

Group 1. Well-drained soils represented by Bath, Lordstown, Ontario, Honeoye, Wooster, and others, and the Groton and Otisville and others with good to excessive drainage.

Group 2. Moderately drained soils represented by Mardin, Canfield, and Jangford.

Group 3. Poorly drained soils represented by Fremont, Volusia, Erie, and others.

Group 4. Lake-laid and marine soils represented by Dunkirk, Schoharie, Cazenovia, Canadea, Hudson, Vergennes, and others. These soils wash easily on very gentle slopes.

The formula summarized in table 2 is *tentatively* suggested as a general guide in determining strip-widths for New York conditions.

FIGURE 14. SWITZER CREEK WATERSHED AFTER FOUR YEARS OF SOIL CONSERVATION

The large number of long narrow fields is noticeable. These long strips are so laid out that the point of crops are planted on the contour. Practically all of the work is done on the level and erosion is markedly reduced.

PHOTOGRAPH FROM UNITED STATES SOIL CONSERVATION SERVICE



TABLE 2. PROVISIONAL APPROXIMATE STRIP-WIDTHS FOR DIFFERENT SOILS

Slope	Soil groups		
	1	2	3 and 4
	Good drainage	Medium to poor drainage	Poor or slow drainage
<i>Per cent</i>	<i>Feet</i>	<i>Feet</i>	<i>Feet</i>
5 (3 to 5 for Group 4 soils).....	125	100	75
7.....	115	90	65
10.....	100	75	50
12.....	90	65	
15.....	75	50	
17.....	65		
20.....	50		

A slope of 10 per cent was chosen as the base and 100 feet as the width of strip for soils similar to those in Group 1, 75 feet for those similar to Group 2, and 50 feet for soils similar to those in Groups 3 and 4. The width of strip is varied 5 feet for a change of 1 per cent in slope toward either "leveler" or steeper land.

On Dunkirk and other *lake-laid* soils, control measures are necessary even on a slope of *less than 5 per cent*. Cultivated crops may well be grown on or near the contour on very gentle slopes on these soils.

The matter of convenience enters into a determination of strip-widths. In Pennsylvania and Ohio, for example, strip-widths are such as to fit a desired number of rows of corn shocks. In other places widths that provide for full rounds with the potato sprayer are desirable. Some farmers will wish to base widths on the two-row corn or potato planter. The most important crop or planting or tillage implement deserves consideration in determining the strip-width. The widths given in table 2 may be regarded as the approximate maximums that are safe under average conditions. It may be desirable even in Group 1 to hold widths to 100 feet, or less, to maintain a fair degree of uniformity in acreage of strips, because uniformity in acreage of each crop each year is essential.

Laying out strips

Best protection from erosion through strip-cropping is assured only when the strips are on the contour. Various types of level are being used, such as carpenter's levels supported on standards, hand levels, and "farm levels".³

In starting the layout, it will be necessary to stake a level or contour line across the slope. This line will be the boundary between two strips, and it may be desirable to locate it at a particular point to fit the slope or layout.

³Good farm levels mounted on sturdy tripods are ordinarily available at reasonable prices, and simple hand levels cost even less. The county agricultural agents or Soil Conservation District workers have information about levels.

The procedure is as follows:

1. Drive a light stake at the beginning of the first contour line.
2. Locate the level at a point several hundred feet from the start of the contour line, in the direction in which the line is to be run and on nearly the same elevation as the stake.
3. Be sure the instrument is accurately levelled.
4. Hold the surveying rod at the first stake and note the height of the rod reading at the instrument. Since the line is level, the same height of rod will be read at all stakes until the instrument is moved. The reading may be marked on the rod with a string or rubber band for the convenience of the instrument man.
5. Set stakes about 50 to 200 feet apart along the line, the instrument man motioning the rodman up or down the slope until he reads the elevation on the rod. Distance between stakes varies with evenness or unevenness of the slope.
6. When the instrument man can no longer see the readings on the rod, he must move the instrument to a new location ahead of the last stake. After locating and releveing the instrument, he "backsights" to the rod at the last stake, noting the new reading. This reading is the new one for the instrument and can be marked on the rod in the same manner as the first one.
7. Now measure from the completed contour line a distance equal to the width of strip desired. Set a stake and lay out another contour line; lay out additional ones over the entire area in the same way. Each line is the boundary between strips and should be marked by a shallow furrow to preserve it. Very sharp curves may be smoothed somewhat, but few lines should depart much from the true contour. Old healed gullies or other depressions that make sharp bends in the contour lines are best left as grassed waterways.

If care is exercised, satisfactory lines may be laid with a hand level.

New York farmers who have farmed strips a few years prefer to keep all rows on the contour. This is accomplished by planting along the strip border on one side; then planting in the other direction along the opposite side of the strip and so on. Short, or point, rows at wide places in a strip fall in the middle of the strip (figure 15). Turning in cultivating and spraying, as for potatoes, does not injure the stand enough to cut yields materially; and excellent control of erosion is accomplished by planting and seeding in this way.

Preliminary economic studies in New York indicate that labor is equally as efficient on contour strips as on the old type of field layout. On many farms the rows on contour strips are considerably longer than on the pre-

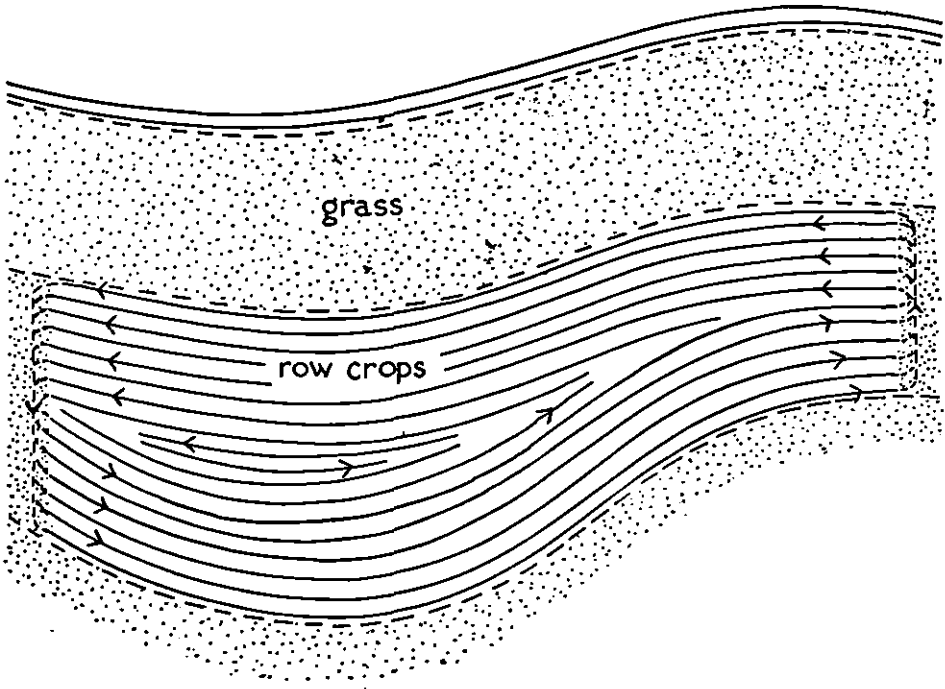


FIGURE 15. PLANTING PLAN FOR CROPS ON STRIPS

The heavy broken line represents the contour laid out as the border of strips. Because of unevennesses of the slope, the contours are not parallel and short rows are needed to fill in the wider places. By this method of planting, all rows are kept on the contour.

vious "square" fields. In a number of comparisons on moderately sloping soils it has been shown that yields are 10 per cent or more higher on contour than on uphill and downhill rows. In places, a saving in power has been noted on the contour as compared with uphill and downhill tillage.

Contour farming

On divides or on narrow fields on gentle slopes that do not receive water from other land, crops may be planted on the contour without strip-cropping. All plowing, harrowing, seeding, cultivating, and harvesting is on the contour. On a long, fairly steep slope planted to a soil-exposing crop, contour tillage alone cannot prevent erosion, yet erosion should be less than with uphill and downhill rows and tillage.

The only feasible way to move soil uphill is to throw the furrow uphill in plowing, and this should be done quite generally.

Nearly all implements leave depressions and ridges in the soil. If uphill and downhill, they serve as channels that lead to gullying (figure 16). On the contour, these ridges hold water like tiny dams until it soaks into the soil. More than 2 inches of rain has been held by potato ridges on slopes of



FIGURE 16. WASHING IN SPRING-LOOSE-BARROW FURROWS

The distance from the crest of this slope to the central foreground is about 100 feet. The slope is from 7 to 8 per cent in the center. Even so, the loss of soil has been severe. Some loss of silt may be seen in the foreground. Is it safe to "let each row or furrow take care of its own water"?

FIGURE 17. WASHING IN FARM ROAD AND IN WHEEL TRACKS

The washing in the road is from the potato rows that sloped toward the road and carried water into it. Note the gully at the right where water left the road and cut through the stubble. The pile of stumps above the fence is more than a foot deep. The gullies at the left started in wheel tracks made while hauling grain.



about 20 per cent. In dry seasons, the water so held is needed by crops. In New York potato yields on fairly steep slopes are about 10 bushels higher on contour than on uphill and downhill rows. In other States, yields are about 10 per cent higher on the contour rows than on uphill and downhill rows.

Losses of soil are generally less with contour planting than with uphill and downhill planting. Even after harvesting some depressions are left that are favorable to contour farming.

Uphill and downhill wheel tracks made in spreading manure and lime and in harvesting, especially if the soil is moist, may lead to gulying (figure 17). Hauling, therefore, should be done on the contour, particularly, on bare, moist soils.

On soils that lack good drainage, particularly with potatoes, peaches, and grapes, the rows may well be given enough slope to produce drainage. It is necessary, however, to take care of such drainage at the lower end of the rows.

Waterways in grass

Leaving waterways in grass has been practiced less in New York than in the Midwest and in the other States in the East, particularly in Penn-

FIGURE 18. GRASSED WATERWAYS

The grassed waterway on the right extends across four strips and part way across the fifth. Wide grass strips, such as these, protect depressions across strips from gulying. Old gullies may fill when managed in this way.

PHOTOGRAPH FROM UNITED STATES SOIL CONSERVATION SERVICE





FIGURE 19. GRASSED WATERWAY IN NEW YORK

Grass occupies this uphill and downhill depression, possibly an old dead furrow, where washing has taken place. Thick vegetation not only prevents further erosion but catches silt and sand which eventually fills such depressions. After they have been filled, crops may again be planted and cultivated across them.

sylvania. Even on land that is being strip-cropped, old partly-healed gullies often cross the strips. When this land is plowed from sod for an intertilled crop, such as corn, these depressions remain in grass. Such a strip of grass wide enough to carry the water that may collect in the depression will prevent erosion. The mistake, however, is often made of leaving too narrow a strip of grass and of killing too much of it during tillage operations. Sometimes gullies start on both sides of the grass because the strip is too narrow. The grass catches water and silt and actually in time fills many gullies. Wherever such grassed waterways are wide enough, they may be mowed and the grass harvested for hay (figures 18 and 19).

Diversion channels

Much water collects during long and heavy rains on long slopes. To prevent erosion on such slopes, diversion channels are built to carry the runoff to safe or protected outlets (figure 20). Each channel carries the runoff from the slope above and thus prevents the water from causing surface erosion or gulying on the lower part of the slope.

Such channels placed below every third or fourth strip help to make contour strip cropping effective. The width of strips immediately below the channels may be made somewhat greater than elsewhere and still protect the soil.

The channel is usually given a fall of 1 per cent, or 1 foot in 100 feet.



FIGURE 20. A DIVERSION OF THE NICHOLS TERRACE TYPE

This diversion terrace channel catches the runoff water from twelve acres on the gentle slope of poorly drained land at the right. The man at the left stands on the top of the embankment, the man in the bottom of the channel which is about 18 inches deep. Instead of going down over the steeper slope of well-drained soil at the left the water is carried around the hill and delivered onto a good pasture where it does not wash. The slope below can be worked earlier in the spring than formerly.

A filter strip 30 feet wide above the channel, the channel, and the embankment are seeded to long-lived, legume-grass mixtures. The filter strip catches soil, sand, and gravel and thus keeps the channel from becoming clogged. The vegetation protects the channel and embankment from erosion and should be cut and removed for hay twice a year. All of this grass requires fertilization to maintain an erosion-resistant cover. Each spring and after heavy rains channels should be cleared of stones, gravel, or other obstructions so that they may serve their full purpose.

Diversion channels not only carry off rain water, but aid in the drainage of moderate- to slow-draining soils. If properly placed, these channels drain many troublesome wet, springy spots in sloping fields. Slopes protected by diversion channels may be tilled, seeded, and harvested sooner than otherwise. In wet seasons these channels prove a highly profitable investment.

The outlet

A safe, suitable place for the disposal of water is the *first* consideration in the location and construction of diversion channels. If none can be found or developed inexpensively, it is wise to keep the water spread out instead of concentrated in a channel. An ample area of trees or brush, a fertilized permanent pasture, or a long-term meadow with a stiff, erosion-resistant sward usually serves this purpose. These *safe* outlet areas must be fully developed before the channels are completed and the water is turned onto them.

In so far as possible, vegetation should be used to protect the outlet end of channels, partly because of expense. Sometimes, however, concrete, masonry, or stone ripraps are needed to let the water down safely from channels to disposal areas.

To operate correctly, the fall in a channel must be uniformly accurate (1 per cent). High spots are dams and low places are ponds. Either may cause a break, and costly repairs will be needed. Channels should be laid out, and their construction supervised and the settled channel and embankment checked, by a person trained and experienced in the operation of an accurate level.

The shape of a suitable channel is shown in figure 20. The side slopes of the channel and embankment are gentle and may easily be crossed by ordinary farm implements.

Power graders and crawler or track-type tractors are used in the construction of the larger channels. Smaller channels may be made with small-bladed, horse-drawn graders, and very small ones may even be made with plows.

Terraces

Although terraces serve the same general purpose (removal of water), they differ from diversion channels. Terrace channels have a very gentle slope because the entire terrace is cropped with the rest of the field. The grade, must be so gentle as not to permit erosion when clean-tilled crops are being grown. Land with slopes up to 10 per cent may be terraced successfully. Some improved terracing implements have been demonstrated and others are being developed. Terracing is practiced for intensive production of high acre-value crops both on Long Island and upstate.

According to the Conservation Needs Survey⁴ about one-fourth million acres in New York would benefit from terracing.

The methods and precautions stated for construction and maintenance of diversion channels apply with equal force to terraces.

CONTROL OF GULLIES

AS ALREADY stated, gullies form wherever water is allowed to concentrate on slopes that are not protected by vegetation, but there is little gully-ing on contour strip-cropped land. Under many conditions a first step in the control of gullies is to break down the steep sides and thus to reduce the steepness of the slopes.

⁴From unpublished data (1943) by I. B. Stafford, State Conservationist, Soil Conservation Service.

Vegetation

The control of gullies by vegetation is highly desirable because the degree of control improves with additional growth. Small gullies may be filled by plowing them in and seeding them to grain with adapted grasses and legumes. A liberal application of manure and superphosphate, and also lime if needed, aids in the formation of a sward that is resistant to erosion. Once established, grass in the waterway is left undisturbed when the field is plowed again (figure 19). Such grassed waterways have been used in Illinois for more than forty years and for a long time in Pennsylvania and in other States, including New York. The grassed area should be of ample width to carry all of the water. The grass, may be harvested for hay as usual.

In many places it is desirable to divert the water from the gully for a time to permit the grass to become well established. This may be done by plowing one or more furrows or making a diversion channel above the head of the gully, depending on the amount of water in the gully. These diversion furrows may be allowed enough slope for water to flow away slowly, but not enough to permit cutting or erosion in the bottom. Moreover, these diversion channels should be long enough to carry the water far enough to each side so that it does not find its way back into the gully. Sod dams or burlap bags filled with sod are sometimes used in small gullies, particularly at their heads or at small waterfalls.

In larger gullies, or in areas not in active cultivation, shrubs may be used. The bush honeysuckle grows wild in many hedgerows in southern New York. This and other native, wild shrubs are exceptionally useful. The coralberry produces runners that take root and grow new plants. These plants grow well under unfavorable soil conditions and consequently are useful in gullies and on banks of raw subsoil.

Vines are of much service in difficult places. The Virginia creeper is of some value. The climbing honeysuckle,⁵ however, is much better (figure 21) because it roots from the vines or runners and thus spreads over a bare ditch or other bank. It is capable of growth under unfavorable conditions and affords complete protection. Its leaves stay on and remain green in winter, which is a marked advantage in that the leaves protect the soil under them from the beating action of raindrops.

Black-locust seedlings may be planted to advantage on steep, raw, subsoil banks where they make excellent growth. Being a legume, black locust makes better growth in these situations than does a non-legume.

Slips or cuttings of various species of willow, cottonwood, elderberry, philadelphus, or mock orange, and others may be used. The basket willow is particularly useful. Slips are cut in the spring when dormant and pushed

⁵(*Lonicera japonica halliana*)



FIGURE 21. CLIMBING HONEYSUCKLE ON A ROAD BANK

The climbing honeysuckle grows well even under unfavorable conditions and, as seen here, covers and protects bare banks. It can be used to advantage on gully and stream banks as well as on cuts made for roads.

into the soil along the banks or in the bottom of gullies. The slips grow and make a complete mat of roots and, when once established, prevent further washing. Moreover, the vegetation slows the current and causes the deposition of silt and sand, and thus eventually fills the gullies. Where trees are not wanted, the basket willow, which grows as a tall shrub, is exceptionally useful. Straw or coarse manure might be scattered over the surface of the gully after it is seeded to legumes and grasses.

All control of gullies in pastures should be protected by keeping out livestock until the vegetation becomes fully established. If pasture becomes short, cattle and especially horses graze the first-year, and even second-year, growth of willow and various other trees and shrubs. Moreover, livestock wandering over bare stream or gully banks prevents protective vegetation from getting a foothold and producing protection.

Brush

Brush is decidedly helpful in the control of gullies. A method that has proved particularly effective has been used by Wood⁶ and his associates in Nebraska. They "cased" the sides of gullies, set a row of posts across

⁶Wood, Tom D. Inexpensive methods of gully control. Nebraska Ext. Circ. 741, p. 6, 1922.



WILKINSON, FROM UNITED STATES SOIL CONSERVATION SERVICE

FIGURE 22. BRUSH DAMS

These brush dams are used to control erosion in this gully. Straw had been placed over the brush to enable the dam to catch more silt. Slips of sprouting woods are being placed about the dams for the purpose of producing a live dam in time, since live dams improve with age.

them, covered the sides with wet straw, and then placed live brush in them, preferably with the leaves on and with the butts up stream (the forks in the branches were hung over the posts). The brush is tramped down and held in place with poles wired to the tops of the posts. Wet straw is crowded in among the butt-ends of the branches. The straw helps to filter the soil material and thus enables such brush dams to fill the gullies.

Willow or other slips or stakes of live wood driven through the brush in time produce a "live" dam (figure 22). Its effectiveness improves even after the brush has decayed. Seeding grain or grasses in the silt deposited above the dams helps further to hold soil that is carried in by later rains.

In moderate-sized gullies, wet straw, leaves, or other trash may be covered with brush that is then tramped and staked down. The stakes are slanted upstream to prevent flood water from floating the straw and brush away. Straw staked down in small gullies is temporarily effective. In fact, anything that checks the speed of flowing water reduces its cutting and carrying power and causes the deposition of the sand and silt it carried.

Other dams

Check dams of stones, woven-wire fence, or logs have been used. The dams hold soil material to the top; that above is lost. In a steep gully, the dams must be rather close together since the top of one dam must not be much below the bottom of the next upstream from it. Because the dam

checks erosion, vegetation soon gains a foothold in the newly-deposited silt and helps to control further washing.

Woven wire is fastened to posts set firmly across the gully. Straw, leaves, or other refuse may be used to hold the water back and to catch the soil which then fills in above the dam.

Any type of check dam must have below it an apron of non-eroding material on which the water may fall as it comes over the dam. Concrete poles, loose, large stones, brush, trash, or stiff sod may be used to advantage.

The difficulty with the various types of dams is the cost of materials and the labor required to build them. Woven-wire dams are the most economical. These dams, in particular, and all dams in general ought to be used with live vegetation such as coarse grass and legumes, wild shrubs, cuttings of willow, elderberry, or cottonwood, and locusts and other trees. In fact, dams may often be justified on the score of aiding the vegetation to become established.

CONTOUR FURROWS IN PASTURES

PASTURES on steep slopes suffer some loss of water during heavy rains. Contour furrows on such slopes hold water, and some of this soaks into the soil and helps the grass to keep growing during periods of drought. Also, the furrows prevent any concentration of water. Moreover, the water held goes into the soil, part of it to feed springs, wells, and streams. All water that is held reduces the amount that would go quickly down into the valleys, where destructive floods occur all too often.

Furrows are used only on well-drained soils on contour lines. Gaps of from 3 to 5 feet in furrows, staggered to prevent concentration of water on slopes, are desirable. Seeding furrows and excluding stock until a grass cover is established is desirable to prevent trampling down the embankments.

HOLDING FRUIT SOILS AGAINST WASHING

ORCHARDS and vineyards represent a long-time investment and it seems wise to confine new plantings to the very best fruit soils. Deep rooting is essential if fruit plants are to live long and produce good yields. Trees and vines will not root deeply on poorly drained soils or where hardpan or rock is encountered within 2 or 3 feet of the surface. Before deciding to plant fruit on any site, the soil profile should be carefully examined to determine its adaptability for this purpose. If the land is well drained and deep enough for fruit, then in making the planting it is well to provide against soil erosion on slopes where cultivated fruits, such as peaches or grapes, are to be grown.

Fruits, especially grapes and peaches, are grown in protected areas on slopes adjacent to bodies of water such as the Lakes and the Hudson River in New York. Owing to their location, the slopes near the Finger Lakes are often rather steep and the heavy soils on the lake plain near Lakes Erie and Ontario wash easily. Both conditions prevail in some areas.

Contour planting

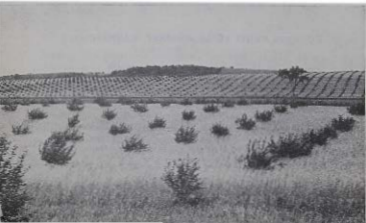
As with cultivated crops, fruits that are to be grown on slopes are best planted on the contour, especially fruit that is to be clean-cultivated. Moreover, some of the usual advantages of contour work apply in large measure to fruit production. If apples are to be grown in sod, they may be planted with the rows near, but perhaps not necessarily exactly on, the contour. Any fruit, however, that is to be cultivated in whole or in part may be expected to give best results over a period of years if planted on, or close to, the contour (figure 23). A slight slope in the rows helps to dispose of excess water, especially on slow-draining soils.

Terracing peach orchards

On erosive moderate slopes, such as on the lake-laid soils in New York, it is probable that terraces may be helpful. Depending on slope and soil conditions, peach trees may be planted on every terrace embankment; on gentler slopes, one or more rows of trees may be set between the terraces.

FIGURE 23. CHERRY TREES PLANTED ON THE CONTOUR

These cherry trees on a drouila in Wayne County were planted on the contour or very near it. This arrangement is desirable on slopes of this kind.



Cultivating, spraying, and harvesting may then be parallel to the terraces or almost on the contour. The saving of power that attends all contour, as compared with uphill and downhill work, is made in terraced orchards.

Many peach orchards that have been set in recent years are not on the contour and consequently those on clean-cultivated slopes are subject to washing. Young orchards may be changed from up-and-down the slopes to the contour. This has been done in Pennsylvania by moving only a very few trees to the acre. New plantings should always be made on or near the contour because severe damage may result from the surface soil washing away from the roots during the normal life of the trees. Any reduction in the exposure of the soil by mulches or vegetation is most desirable from the standpoint of conservation of the soil for future use. How to use soil-conservation measures in a feasible scheme to produce peaches and grapes economically is the joint task of the pomologist, the soil conservationist or agronomist, and the agricultural engineer.

Contour planting of grapes

In the Finger Lakes region grapes are successful in a narrow belt adjacent to the water. Much of this belt is steeply sloping land. Slopes of from 25 to 45 per cent are not unusual. The writer found one vineyard on a slope of 60 per cent in the Hammondsport area. Except for a few areas of well-drained gravelly soil, these grape soils are subject to severe erosion during heavy or prolonged rains (figures 24 and 25). The severity of erosion may

FIGURE 24. EROSION BETWEEN UPHILL-AND-DOWNHILL GRAPE ROWS

After a few decades grape yields are reduced and in time the vineyard becomes unprofitable partly because of low yields





FIGURE 25. GULLYING IN GRAPES

A vine at the right and the post were amply washed out. The soil is good but the rows were not on the contour

be attributed to the steepness of slopes and to clean cultivation. Because the soil is exposed so much of the season to the beating action of heavy summer showers, some erosion is certain to take place.

As a rule, grapes have not been planted on the contour, and destructive erosion has taken place. In fact, a considerable acreage of vineyard has been abandoned largely because the fine soil capable of holding water has been lost. Instead of the original friable silt or gravelly silt loam, stones larger than an inch in diameter now constitute much of the surface material. Such material can hold little water or plant nutrients for use by the crop.

Experiments on losses of soil and water and on yields of grapes in the Hammondsport area were begun in 1935 by the Research Division of the Soil

Conservation Service in cooperation with the New York State experiment stations.⁷ Comparisons are made between grapes planted on the contour and those planted uphill and downhill on similar slope and soil conditions. As an average of the 7 years, 1935 to 1941, the contour grapes produced 5082 pounds of fruit a year and the uphill and downhill rows produced 4278 pounds. This is a gain in yield of 804 pounds an acre a year. In years of ample and well distributed rainfall there was little difference in yield. In 1940 the May-through-October rainfall was 17.54 inches and the yield was about 6500 pounds of grapes an acre. Because of its good distribution throughout the growing season, 11 inches of water in 1941 produced the third highest yield of grapes (also about 6500 pounds an acre) for the entire period.

The loss of soil was highest in 1936 with 12.43 inches, and second highest in 1939 with 16.05 inches. During these two years the average loss of soil was 2997 pounds on the uphill and downhill rows and 41 pounds of soil an acre on the contour rows. The loss of soil was not large during the other years on either type of planting. This narrow zone along the lakes has climate suitable for grapes, and presumably the climate will continue indefinitely to be suitable for this crop; therefore, if future generations are to benefit from this favorable climatic situation, the soil now left must be saved and held in place.

A study of permanent cover crops of clover has been started. Apparently, clover reduces yields because it uses water needed by the grapes. Clover in

⁷Soil and water investigations in four problem areas of New York State, by John Lamb, Jr., and associates. Unpublished data. 1943.

each fourth space between the rows caused a slight loss in yield. Mulches of straw (12 tons an acre) or similar material held soil and water and increased the yield of grapes 1500 pounds an acre in 1939 and 2100 pounds in 1940. Further work is needed with both various types of cover crop and different quantities of mulch.

All new vineyards should be planted on the contour on well-drained soils (figure 26). On soils with slow drainage sloping the rows enough to provide surface drainage is recommended. Planting new grapevines on low terrace embankments has proved desirable. On the drier soils, mulching the young vines gives excellent growth.

HOLDING SOILS AGAINST BLOWING

MUCK and sandy soils in New York are blown considerably by the wind. Damage to crops on muck soils is reported almost every spring. In addition, muck blown into field and road-drainage ditches clogs them. Sands and sandy soil are blown about whenever they are bare and dry.

Muck

During windy periods in late spring, the dry surface of muck soils is blown by the wind. The bits of wood, of which much of the cultivated muck of the State was formed, are hurled against the tender stems of plants. These fragments eventually cut through the outer covering of the tender stems and the plants soon die. Another crop must then be planted to obtain

FIGURE 26. GRAPES ON THE CONTOUR

The soil under these contour-planted grapes southeast of Hammondsport did not suffer serious damage from 8 inches of rain in one day in 1935. The slope is 31 per cent. Under similar conditions with uphill-and-downhill planted grapes soil washing was severe.



any income whatever from the land. Much additional labor is required, and the crop planted seldom gives as good returns as the original crop would have done.

Windbreaks of willows have long been used to control soil from blowing (figure 27). The ordinary tree-type of willow may be used but the basket willow is much better. It may be planted wherever a relatively low windbreak gives enough protection. The disadvantage is that the willows occupy tillable land.

Under conditions that are unusually favorable for blowing, permanent windbreaks fail to give complete protection. Woven picket fences (snow fences) placed at regular intervals parallel to the willow windbreaks, help materially to hold the muck against blowing and thus protect tender crop plants. These snow fences have the advantage of not keeping valuable land permanently out of cultivation.

Strips of rye seeded in the fall might serve as windbreaks. By the time the "blowing" season arrives, the rye will have attained a height of several feet and, since it is thick, will check the movement of soil. Unless the rye is in strips of approximately the width of the ordinary beds and can be seeded to other valuable crops later in the season, considerable land is thus taken out of the cropping system.

FIGURE 27. WINDBREAKS USEFUL ON PEAT SOILS

Willow windbreaks are planted at regular intervals. Woven picket fence is used to some extent to supplement the permanent windbreaks. Lettuce is on the area where the onions had been "blown" out.



Single rows of oats between the rows of onions are drilled at intervals, the oats being removed when danger of further blowing is over.

A cover crop of wheat or rye seeded in August or early September protects the soil against possible blowing during the fall and the winter. Moreover, such a crop takes up some of the residue, especially nitrogen, from the season's fertilizer. The nutrients are thus held in live material against leaching during winter and spring when the soil is not protected by crops. Ways to prevent muck from blowing are discussed in Cornell Extension Bulletin 482, *The Control of Wind Erosion on Muck Lands*.

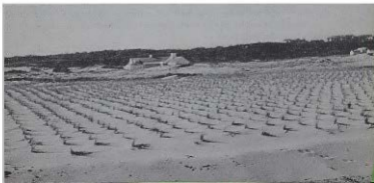
Sandy soils

Bare, sandy loams and sands are subject to blowing. Crop damage by blowing sand in New York is seldom serious, although there is some blowing on the sandy areas of the lake plain, in the foothills of the Adirondacks, and on Long Island, particularly on the south shore. The storm of September 1938 undercut the protective vegetation and exposed much additional sand. Even before that, however, destructive movement of the sand had been taking place regularly.

Plantings of American beachgrass in the actively blowing sand have been made near Jones Beach and on the causeway leading to the beach and about the Adirondack foothills. The grass has made fairly good growth in some places but has died out in others. In the bare spots blowing is beginning again. A legume is needed to supply nitrogen to the growing grass. Nature has helped, as the trailing wild bean (*Strophostyles helvola*) has already made a start in this area. It appears probable that this legume may be particularly useful wherever sands in New York are blowing or threatening to blow (figure 28).

FIGURE 28. BEACH GRASS IN SAND

This beach grass on Long Island was planted after the storm of September 1938. As the grass grows it holds the sand against blowing.



The bayberry grows wild and holds the soil well near the plants. The black locust when thoroughly inoculated makes fairly good growth on sands. If interplanted in strips with native or adapted conifers or evergreens, the combination affords year-round protection. Being a legume, the black locust collects nitrogen that may be used by non-legumes that grow near it. On loamy sands, the locust often brings grass into the partial shade under it. This is ideal since the grass covers and holds the sand in place.

The woven picket fence holds sand temporarily, especially while vegetation is being established. It is being used on Long Island against the blowing of sand in the same way as it is used against snow.

An effort has been made in the Adirondacks to reforest and thus to stabilize blowing sands. This did not succeed because many of the planted pine seedlings were blown out and others grew slowly.

A partial cover of straw, pine needles, or other low-value material held in place by brush may be expected to aid the pines greatly. A partial cover of pine brush between the planted seedlings prevents serious movement of sand until the plantings become established and afford protection.

Locusts planted among the brush suggested, or locusts in belts alternated with conifers, may be expected in time to hold sand against blowing. Since wind shifts, an occasional cross belt of the adapted or native conifer may aid still further in preventing the sand from blowing.

On cropped sandy land, windbreaks and a protective cover of vegetation may be all that is needed. Thoroughly inoculated wild or tame legumes mixed or interplanted in belts with non-legumes aid in the stabilization of sandy soil. On Long Island, considerable use is made of winter cover crops. Rye or rye and barley are most commonly used. Because of shifting winds, an occasional drill width or two across the main direction of seeding may help to check movement of sand. The main seeding is made at approximately right angles to the prevailing wind direction. A light hand-seeding of grain before drilling the main cover crop fills the spaces between the drill rows and thus checks movement of sand. While such a seeding over the entire field might be most desirable, a trip every 50 to 75 feet ahead of and at right angles to the main seeding will check much movement of sand along the drill rows.