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Keep Our Hillsides from Washing

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STOP GULLIES BEFORE THEY START

Erosion must be prevented or the beauty and fertility of our hill-side farms will be ruined.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON, WISCONSIN

DIGEST

Erosion or washing can be controlled or prevented on thousands of acres of land if the proper farming methods are used. Besides cutting up the farm with gullies, "washes" or ravines, erosion causes the washing away of much valuable plant food. Pages 3–5

The amount of land injured by erosion varies in different sections of the state. Probably 50 per cent of the farms in Wisconsin are subject to erosion of some importance. In southwestern Wisconsin erosion occurs on at least 75 per cent of the farms. Pages 5–7.

Erosion depends on four things—the distribution of the rainfall, the character of the soil, the slope and the vegetation. Pages 7–9.

Erosion can be prevented in many instances by careful tillage, by alternating crops on side hills, by the use of horizontal channels and terraces and by protecting the ravines and water courses. Pages 10–14.

Ravines and water courses can be protected by stones which, to a large extent, prevent the removal of the soil, or by grass the roots of which hold the soil. Pages 14–17.

On wooded hillsides remove the trees gradually if there is danger of erosion. If the trees are all removed at once, "washes" and gullies are formed before the grass has time to get started. Pages 17–18.

Side hill land should be used for pasture. If it is necessary to grow a crop, oats and peas, alfalfa, sweet clover, or brome grass make good substitutes for crops which require cultivation. Page 18.

Keep Our Hillsides from Washing

Wisconsin has hundreds of thousands of acres of rolling land which if properly managed can be successfully farmed, but which if carelessly handled will be greatly injured by erosion or side-hill washing.

This injury is partly caused by loss of fertility and partly by the development of gullies and ravines which cut the fields so they cannot be cultivated.

Loss of fertility.—The losses of fertility caused by erosion are due to the removal of the organic matter and fine silt of the soil. The organic matter is not only rich in the essential elements of plant food itself, but its decomposition causes important chemical changes in the remainder of the soil. The finer earthy matter of the soil is not only relatively richer in the plant food elements than the coarser particles, but also has a larger water-holding capacity.

The result of the removal of the organic matter and the finer silt and clay is that soils which have been washed, lose a considerable part of their nitrogen and phosphorus and have a lower water-holding capacity. When not very carefully managed in regard to the application of manure and rotation of crops, these soils show shorter life and are more subject to drought than soils on level land.

As an illustration of the effects of erosion, an instance met in Eau Claire county may be cited. A small pot hole without outlet and surrounded by sandy loam soil received the sediment washed down from the surrounding land, but, due to the coarse texture of the subsoil, underdrainage permitted the escape of water so that only the sediment collected. An analysis of this sediment and of the soil of the side hills from which it had been washed, showed that it contained nearly three times as large a percentage of nitrogen and more than twice as much phosphorus as did the soil from which it had been removed.

In another instance, where determinations were made on a moderate slope from which much of the surface soil had been removed and of the soil which had collected at the bottom of the hill, the analyses showed the following amounts of nitrogen and phosphorus.

	Nitrogen	Phosphorus
Hillside	.340 Per cent	.085 Per cent
Bottom land	.450	.140

This data shows that the soil removed by erosion is the richest part of the land. Especially is this true in regard to the element phosphorus.

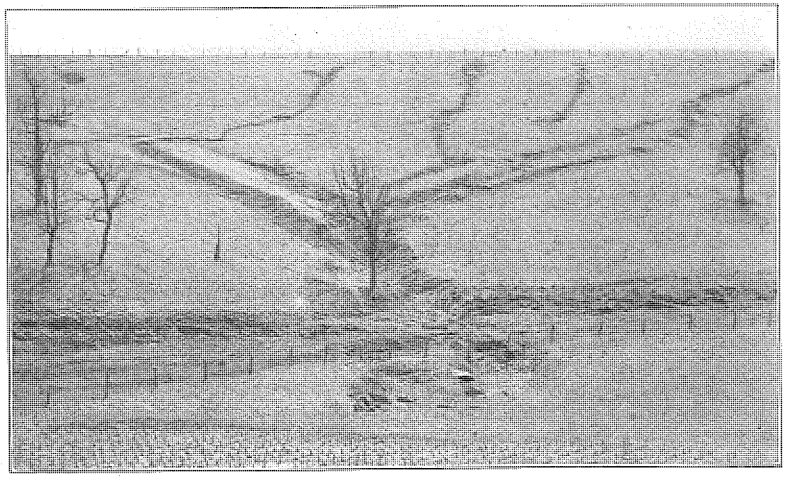

FIG. 1.—ABANDONED BECAUSE OF SEVERE EROSION

This sloping land was once under cultivation. The present ditches could have been avoided by running a shallow ditch parallel with the fence at the edge of the cultivated field near the top of the hill. Such a ditch could have been made to carry off the surface water toward the right at a low angle. This field has a 15 per cent slope which is about the upper limit for cultivation.

It is usually supposed that injury of this kind is limited to rather steep slopes, but careful observation during and immediately after rain storms will convince any one that erosion and removal of the finer sediment actually takes place on slopes having a very slight gradient or fall. Slopes of one and two per cent are subject to some erosion and when

the slope reaches three or four per cent the erosion, so far as the removal of the most fertile soil is concerned, may become considerable.

Gullies develop easily on some soils.—The most obvious, but not the most serious injury produced by erosion, is that of the development of gullies and ravines. These are caused by the concentration of streams on side hills, especially after the removal of some protecting feature such as forest growth, or the breaking of the sod when the land is brought under cultivation. On some types of soils, these gullies are very much more apt to develop than on others. These gullies not only destroy valuable land, but cut the fields so they cannot be worked to advantage. An illustration of the effect of the development of gullies is seen in Fig. 1. A little care and effort at the right time would have saved this field.

EXTENT OF EROSION

It is, of course, difficult to measure with any degree of accuracy the amount of land in the state injured by erosion. An effort to estimate this on the basis of studies in connection with the Soil Survey has been made. The land influenced by erosion has been divided into two classes; first, land which is capable of cultivation, but is so steep that the amount of erosion makes it impracticable to use the ground for tilled crops, such as corn or potatoes more than one year in a rotation of from four to six years. These fields should be in grass or hay the greater part of the time. The second class includes land which is subject to an important amount of erosion, though with proper care the damage is not sufficient to prevent the ground being laid out in shorter rotations—from three to four years, which may include such common rotations as that of corn, oats, and clover. In the southwestern portion of state, covering nearly a third of the area of the state, the first class amounts to 20 per cent of the tillable land and the second class to 40 per cent.

In the remainder of the state which was glaciated and as a whole is not so rough in topography, the land in the first class amounts to about 12 per cent and that in the second class to about 25 per cent of the tillable land. If the estimate is made on the basis of the number of farms on which more

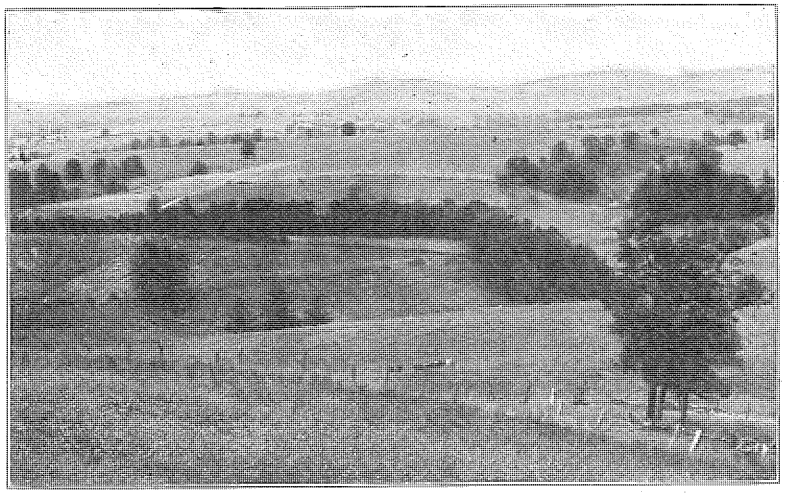

FIG. 2.—VIEW IN WESTERN OR SOUTHWESTERN WISCONSIN

The soil is excellent and with proper care its value can be maintained and increased, but if erosion is allowed to cut it up it may be largely ruined.

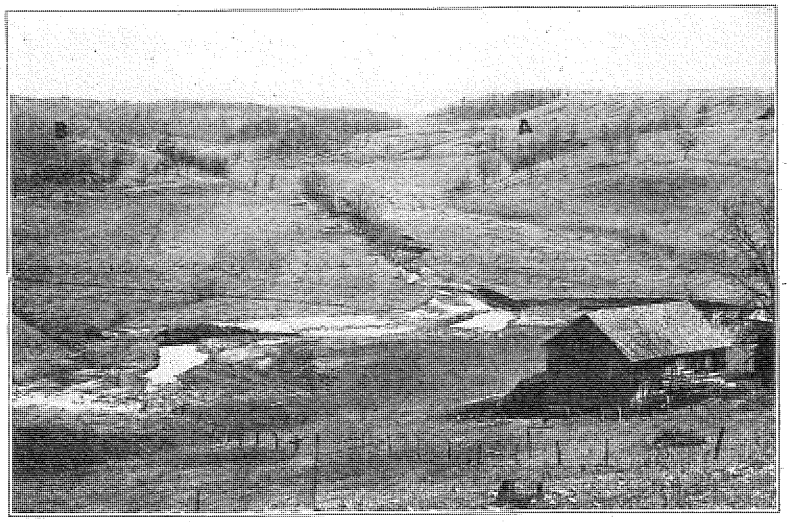

FIG. 3.—NEAR THE HEAD OF THE VALLEY

The eroded and timbered slopes and the outwash soil of the valley bottom are shown. In the foreground is an eroded slope, too steep and full of limestone fragments for cultivation, which is used for a pasture.

or less erosion occurs, the percentage, of course, in each case would be much larger. It is probably reasonable to say that in the southwestern portion of the state more or less erosion occurs on at least 75 per cent of the farms, while in the remainder of the state probably 50 per cent of the farms are subject to erosion of some importance. Considered in this way it is evident that erosion is one of the most widespread sources of injury to soils and therefore one in which a very large number of farmers are undoubtedly interested. (See Figs. 2 and 3)

Above the second barn A at the right in Figure 3 is an eroded field, once cultivated which now has many bad gullies, because it has been unprotected from the surface flow of the ridge land above. There is too much of this steep and stony slope land in the driftless area which is making but a very small contribution to the income of the farmer. The valleys are so numerous that nearly every farm includes anywhere from five to forty or more acres of this steep land on which the erosion problem should be worked out. The side of the valley at the left B which faces northeast is still timbered and serves as wood lot and pasture.

CONDITIONS AFFECTING EROSION

There are several factors which affect the amount of erosion and the injury it produces. Among the most important are the distribution and amount of rainfall, the character of the soil, the slope, and the condition of vegetation.

Rainfall.—Rain falling slowly may be entirely absorbed by the soil and percolate or soak through it so that none runs over the surface to cause erosion. When the rainfall is so heavy that this is not possible, surface washing begins. The heavier rainfalls which occur in the south, therefore, produce far greater damage than usually occurs in the north. A single storm with two to three inches of rainfall in the course of a few hours may cause more damage than several times this amount of rainfall distributed so that a larger portion can be absorbed by the soil.

Character of the soil.—It must be remembered that the flow of water over the surface takes place only when it cannot be absorbed by the soil with sufficient rapidity. Soils of a coarse texture such as sands and sandy loams are able

to absorb water very much more rapidly than heavier soils and are therefore much less subject to erosion. (Fig. 4). On account of the fact that they are very largely composed of silt or soil grains of an intermediate texture, heavy soils are much more seriously affected by erosion than light soils as a rule.

The loessial soils, which are silt loam soils deposited by the wind and occur over a considerable part of the Mississippi Valley, including much of southwestern Wisconsin, are subject to this difficulty. They are especially characterized by their ability to retain perpendicular walls, which leads to the development of very sharp angular ravines and gullies which are especially difficult to control.

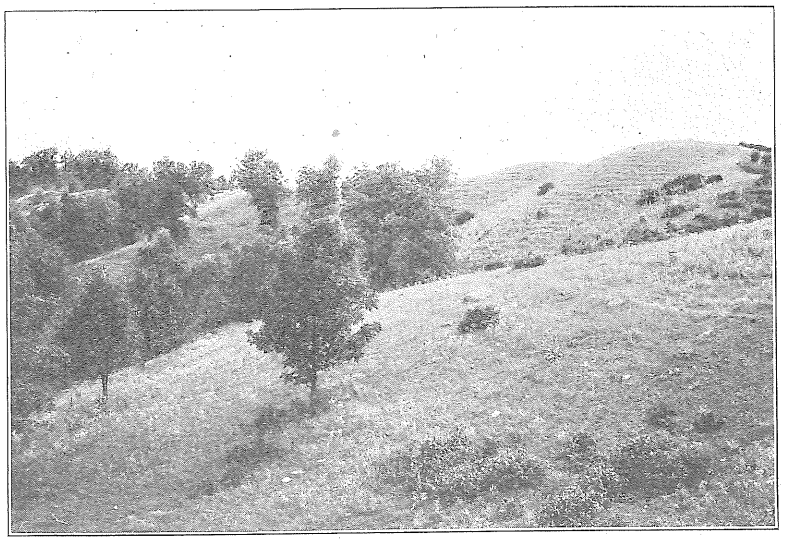

FIG. 4.—GRAVEL KNOLLS NOT EASILY ERODED

These gravel knolls, which are subject to considerable drought, are found in some parts of northern, eastern, and southeastern Wisconsin, especially in the morainic belts. Where they are covered by a heavier type of soil considerable erosion takes place.

Slope.—The degree of slope determines the velocity which water will acquire and its power to erode. Comparatively slight increases in the velocity give the water greatly increased eroding capacity. A stream running at the rate of two miles an hour can carry sixty-four times as much material as one moving at the rate of one mile an hour.

Vegetation.—Nature's method of controlling erosion is chiefly through the protection of vegetation. In the case of tree or forest growth, the roots of the trees tend to prevent the development of little gullies and ravines, and undergrowth increases the power of the surface to absorb water so that it is held during a heavy rain and permitted to soak into the soil gradually rather than wash down over the surface. The extremely fine roots of grasses have the effect of binding the soil together so as to even more completely protect it from the eroding affect of heavy rains. This is especially true of certain grasses, the root systems of which are masses of felt like fibers.

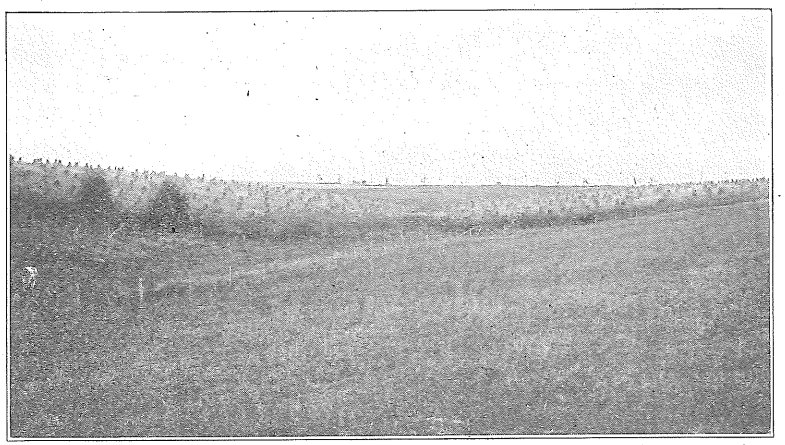

FIG. 5.—SODDED TO PREVENT WASHING

This picture gives an idea of size of the collecting basins or drainage area from which the surface flood water is often concentrated. In this case, it is the shallow depression at the left. This depression or draw is never cultivated and is kept in permanent pasture sod. Cultivation of the draw or establishing a lane or driveway down it would quickly cause ditches to develop.

The explanation of the effect of a grass sod, especially of blue grass, will be quite evident to one who will take the pains to cut out a block of the sod and attempt to wash the soil out of it. The difficulty with which the soil can be removed as well as the fineness of the roots will astonish any one who has not previously made observations of this kind. The effect of grass in preventing erosion is shown in Figure 5.

PREVENTION OF EROSION

There are several ways in which the tendency of soils to wash or erode can be lessened or largely prevented. Anything which can be done to increase the absorbing power of the soil so as to permit it to take in large quantities of water which will find its way down through the soil itself will, of course, lessen the amount which will flow over the surface. The removal of excess water in the subsoil by drainage will have the same effect, since it will permit the soil to absorb larger amounts of a new rainfall. Managing the surface

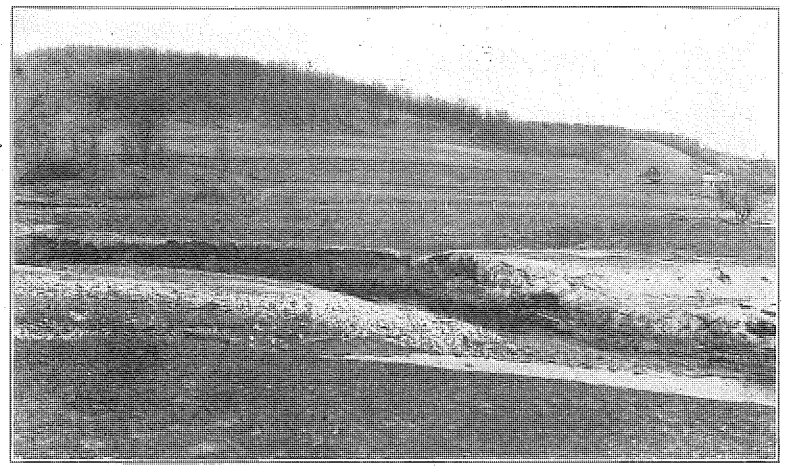

FIG. 6.—PROPER CULTIVATION OF HILLSIDE LAND

This farmer is plowing with the curve of the hill and turning his furrow up hill on the steeper part of the field. The timber left on the steepest upper slope compels the flood water to enter the soil instead of collecting in riverlets to flow over the surface.

of side hills so as to cause the water to take its way downward, when it must run on the surface, through channels of the least possible gradient or fall is a third method. Planning a system of farming for land having considerable slope to include as much hay and pasture land as possible is a fourth available method.

The plowing of side hills as deeply as practicable and along the contour lines as shown in Figure 6 has the effect of increasing the amount of water which can be absorbed. This is particularly true if a reversible or side hill plow is used and always in such a way as to throw the furrow slice up hill. This has two beneficial effects, (1) to return the soil

to a certain extent as removed, and (2) on account of the position of the furrow slice to permit a larger amount of the water to find its way into the soil than is the case when the furrow slice is turned down hill.

Tillage.—In cultivating corn which is check-rowed, it is important that the last cultivation before it is to be left for a few days be along the side of the hill rather than up and down. But it is also important to take care that any small ditches into which the water from the cross-rows runs are protected by grass or by sowing in some oats or they will be enlarged by the water coming in from these cross-rows.

Alternating crops on side hills.—One of the chief difficulties on long slopes is that of the tendency of little streamlets to collect into larger and larger streams which greatly increases their eroding power. This difficulty can be to a considerable extent overcome by laying out the fields in long and comparatively narrow strips on the side hills so that the land which is in tilled crops such as corn or potatoes will alternate with land in grain and hay, thus greatly shortening the distance down hill through which this accumulation of streams may take place. The sodded strips serve to check the flow of surface water, absorbing it and carrying it off beneath the surface. The proper arrangement of fields on hillsides is illustrated in Figure 7.

FIG. 7.—METHOD OF ARRANGING FIELDS ON A STEEP SLOPE

The cultivated and uncultivated crops are arranged in alternate strips across the slope, all cultivation being at right angles to the natural surface flow of the water. The grass strip appears wider than it actually is, due to the position of the camera. Timber still covers the steepest slopes below the field.

Use of horizontal channels and terraces.—When the slope of the side hill is considerable and the land is to be used for tilled crops, resort may be had to special methods for reducing erosion. These consist primarily in reducing the gradient or slope over which the water moves to lower levels, and secondly in having those channels which must have considerable slope thoroughly protected from erosion. On practically all hillsides there are already well developed ravines which if kept thoroughly sodded offer water courses which will not be subject to erosion. The problem then is

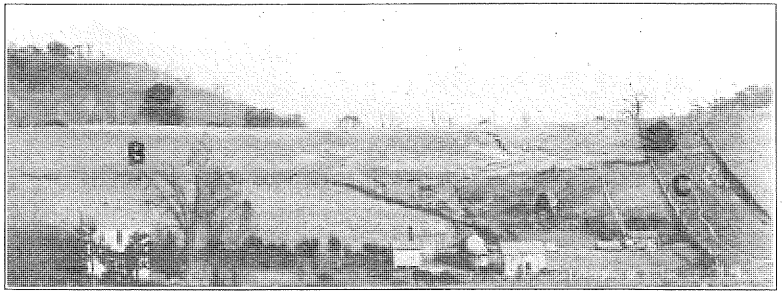

FIG. 8.—LANES OFTEN CAUSE EROSION

The danger of erosion is invited by having a lane or cultivated field run with the slope instead of across it. The steep land A could have been protected by a shallow sodded ditch above it running at a small gradient. The land C is developing bad ditches caused by the paths made up the slope. At B is represented land too steep to cultivate.

how to get the water from the areas between these ravines into the ravines prepared without washing down in the steeper direction of the side hill. This can be accomplished in different ways dependent on the difficulty of the situation.

When the slope is not too great laying out the fields in long narrow lands which are plowed in such a way that the dead furrow has a slight fall and discharges at each end into the grassed ravines, is a practicable method. When the slope is too great for this method to be effective, more care must be taken and some form of terrace must be developed. It is necessary to lay out the lands or fields so that they will be plowed along the lines which are nearly level running around the side hill, that is, having just enough slope so the water will run slowly and not erode. To determine the location of these lines some leveling must be done. This, however, is comparatively simple.

The level is set up and adjusted at the top of the hill and the target rod held beside the instrument and the target adjusted three feet above the "line of sight." One person then carries this target along the side hill under the direction of the level-man who sights the instrument, giving directions for the placing of stakes from point to point along the line so as to make the contour line. These stakes mark a level line three feet below the ground the instrument stands on. After one line has been run in this way the target is adjusted at a height of three feet above its original height and the process repeated, thus running out a second contour line at three feet below the first. The instrument is then moved down, readjusted, and the process continued.

After these contour lines are located, different methods of terracing may be used. One of the simplest consists in back-furrowing along the contour lines with two or three turns of the plow after which by the use of the side hill or reversible plow the plowing is continued over the strip between the contour lines. The back furrow should be seen across the level line staked out so there will be a slight fall toward the sides of the field or grassed ditches. By plowing so as to throw the dirt all down for the first two or three years a fairly well developed terrace is produced. After this the soil should be thrown one way one year and the opposite the next time it is plowed. This method is especially helpful on lighter soils which have a larger power to absorb water.

In the case of heavy soils which cannot absorb water as fast as it falls, some combination of this slight terrace and of a ditch is necessary. This may consist either in cleaning out the last furrow on the lower side of the incline in each terrace so that it may serve as a slight ditch, or of reversing the direction of plowing after the first two back turns of furrowing have been accomplished so that by the use of the harrow the dead furrow may be turned into a shallow ditch just above the steeper portion of the terrace. When either of these methods is to be used, the plowed land should not agree exactly with the contour line, but should run across it at a very narrow angle so that the slight ridge produced will have a gentle fall toward the ravines at each end of the plowed land.

In developing these narrow lands, thought must be given to the tools which are to be used on it so that if a binder is to be used the width will give an even number of cuts so that

the machine may be moved along the side hill at one end of the field without running empty across the field. Crops are planted in rows running obliquely across both ditches and dikes.

Protection of ravines and water courses.—Since it is frequently necessary to permit water to run down rather steep slopes the water courses may be paved with cobbles or stones which prevent the removal of soil to a large extent, or seeded with grass. the roots of which bind the soil. This latter

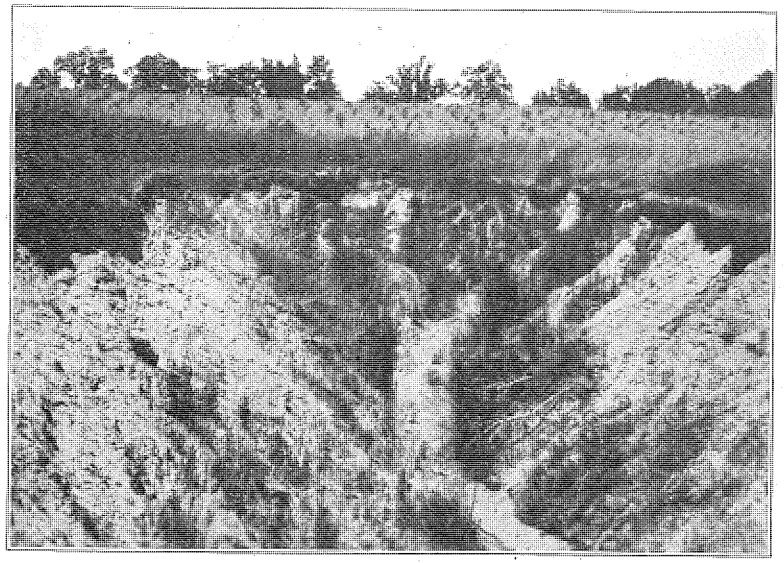

FIG. 9.—STOP THE WASHES EARLY

Such a ditch as this is a menace often to a whole 40-acre field. This one should be sodded over and willows planted in the bottom.

method is most available. In producing such ravines and water courses, the greatest care is necessary to prevent their being seriously eroded before the grass is well established.

For this purpose it will usually be found most practicable to dig these ditches or straighten and even up ditches already existing in the early fall at which time comparatively little erosion takes place. By seeding these ditches at this time with rye which will grow in the fall and assist greatly in holding the soil in the spring, and then seeding in grass two or three times as thick as it would be in laying down a meadow, a good sod may be quickly developed so that by the

time the heavy down-pours of June and July occur a very good protection has been produced.

On the level terraces or where heavy soil lies on unsubstantial sandy or gravelly subsoil, small ditches must be promptly attended to because in such conditions they are always dangerous.

Figure 10 tells the story of an unsuccessful attempt to cultivate all of the hillside slope the same season. This farmer liked large fields and not realizing the necessity of

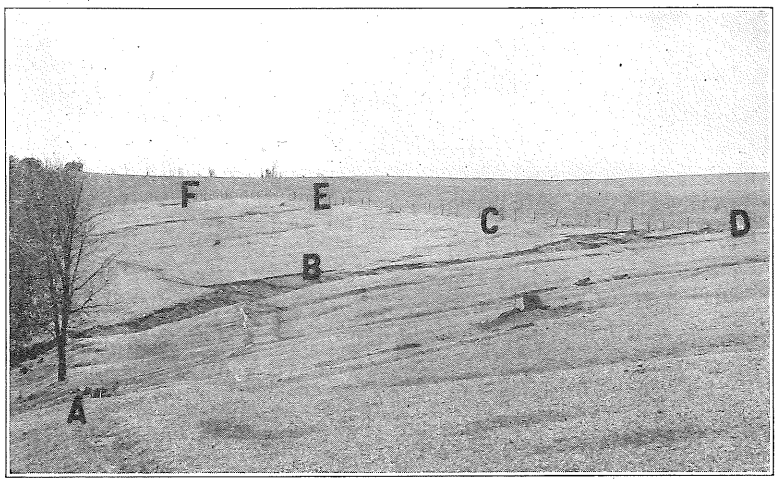

FIG. 10.—DITCHES WHICH COULD HAVE BEEN PREVENTED

A field largely ruined by erosion which could have been prevented by a little work at the right time.

cultivating land on such a slope as this in narrow strips across the slope, he extended his ridge-top field down the slope and removed the timber on the lower part, till there was nothing to break the eroding force of the water flowing off from the ridge fields above.

The slight ridge along the edge of the woods at A indicates the former location of his lower fence and the back furrow along it when this field was cultivated. It was here too where the ditch B started and in spite of the tree and grass roots deepened itself on the steepest wooded slope below and then started up across the cultivated field to D.

At first this farmer by plowing across the ditch and shoveling the sides and filling the lower end with brush, straw, and

logs, was still able to cultivate the whole field one year and then seed it down. But one or two severe storms in the spring of the year when the slope was bare produced such a volume and velocity of water that obstructions were undermined and the ditch deepened and widened till it is now 10 feet deep and 15 feet wide near the trees. This ditch now prevents the cultivation of this slope as far as the fence at C together with ditches E and F and threatens the plow land farther up at the top of the ridge from which valuable fertility and organic matter are being carried away. This ditch could be made to fill itself gradually by means of an effective screen or dam among the timber, and its further growth halted by keeping in continuous sod a sufficient piece of the ground at the head of the ditch all of which is now cultivated down to the fence and the head of the ditch. The correct cultivation of such land in narrow strips of alternate sod and cultivated field is shown in Figure 6.

Where the subsoil is clay and where clay or silt soil material is being carried by flood water, large gullies may be made to fill themselves by putting in a dam of stumps, logs, or brush Where the subsoil is sandy, more care is needed and dams need to be carefully constructed to prevent the water from undermining or cutting around them.

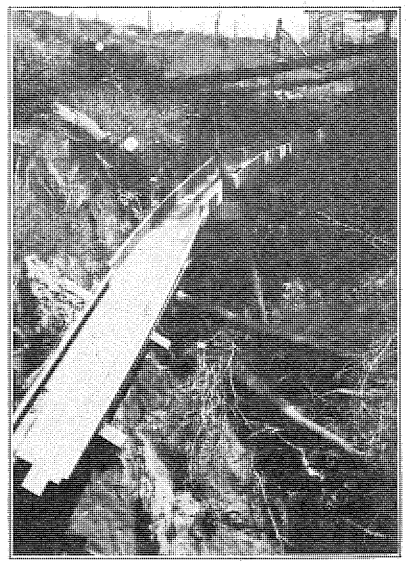

FIG. 11.—A FLUME PREVENTS UNDERMINING

Where the fall is great, a flume such as this serves to carry the flood water over the head of the ditch and prevents further undermining and extension of the ditch.

Dams of concrete stone, wire, mesh, boards, or brush, have been successfully used. Board flume devices have also been used to carry the water over the head of the ditch and down into it, preventing continued undermining.

Planting willows and bushes on the sides and bottom of ditches which are too deep to fill often

arrests the growth of a ditch. Sorghum, sweet clover, or rye, make good emergency crops on eroded spots or fields which later need to be seeded to grasses and left in permanent sod.

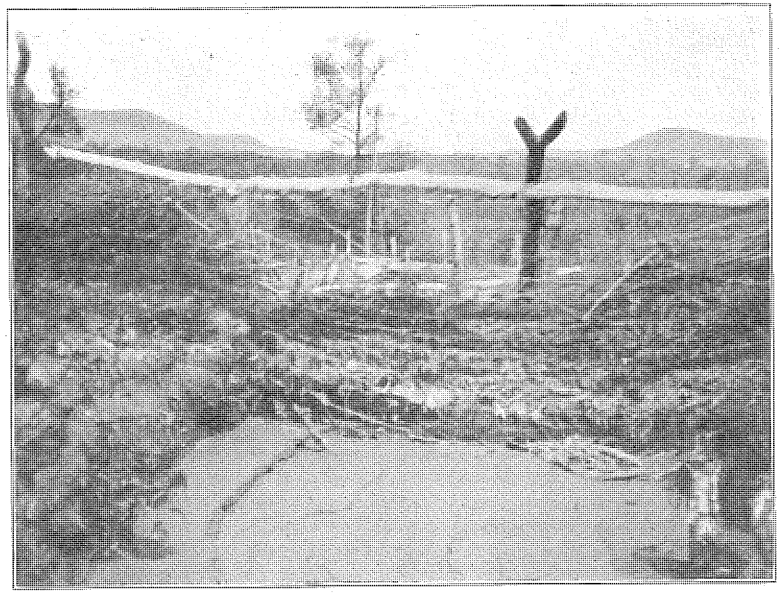

FIG. 12.—DAMMING A DITCH

A combination wire and brush dam such as this is often a good preliminary move in halting an actively growing ditch.

CUTTING TREES FROM HILLSIDES

When wood is to be cut on hillsides which are so steep that erosion is likely to occur it is best to thin out the trees gradually, allowing grass sod to develop which will hold the soil. By transforming wooded slope into pasture gradually, erosion can be prevented, while if the wood is all cut off at once, erosion will take place before the grass has had time to establish itself. Even if the land is later to be broken and used for cultivated crops, it will be found that the grass sod will greatly lessen erosion. By using such land in a rotation in which it is in a tilled crop but one year out of four to six years, serious erosion can usually be prevented where otherwise it would be certain to take place. Figure 13 shows the result of the sudden removal of the timber protection from a steep slope. The roots and litter in a wooded area furnish efficient protection from erosion.

FIG. 13.—THE TREES PROTECT THE HILLSIDES

This illustration shows very clearly the danger of cutting all of the trees from side hills at one time and before grass has come in to protect the soil.

SPECIAL CROPS FOR SIDE HILLS

Much of the side hill land should be used for pasture, but in some sections of the state practically all of the farm is on side hills so that other crops must be grown. On such land the tilled crops such as corn and potatoes should be grown only to such an extent as is absolutely necessary. Crops which can be grown without danger of erosion should be substituted for corn as far as possible. Oats and peas grow together may be used, and alfalfa, sweet clover, or Brome grass are among the best hay crops for such land.

In the southwestern part of the state, most of the side hill land is underlaid by limestone, and alfalfa or sweet clover do exceptionally well. In seeding alfalfa on such land, care must be taken that the land is not injured by erosion before the crop becomes established. If the land can be plowed and seeded to rye in the fall and the alfalfa seeded early in the spring, this danger can be greatly reduced. The method of seeding alfalfa on land which is dragged or disced several times during the spring and the seeding not done until the last of May or in June greatly increases the danger of erosion, since the cultivation leaves the ground in a very loose condition and the rain storms causing the greatest amount of erosion most commonly occur during the early summer months.

Brome grass is well suited to such land, as its strong root system permits it to withstand drought to which such land is subject better than most other hay grasses.

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D. H. OTIS, Farm Management
W. H. PETERSON, Agr. Chemistry
J. L. SAMMIS, Dairy Husbandry
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A. L. STONE, Agronomy; In charge of Seed Inspection
H. C. TAYLOR, In charge of Agr. Economics
J. L. TORMEY, Animal Husbandry
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R. E. VAUGHAN, Plant Pathology
H. L. WALSTER, Soils
F. M. WHITE, In charge of Agr. Engineering, pro tem.
A. R. WHITSON, In charge of Soils
H. F. WILSON, In charge of Economic Entomology
J. F. WOJTA, State Leader and Field Supervisor Extension Courses and Schools

C. L. ADAMS, Feed and Fertilizer Inspection
A. R. ALBERT, Soils
VERMILLION ARMSTRONG, Agr. Bacteriology
FREDA BACHMANN, Agr. Bacteriology
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MYRTLE JONES, Agr. Economics
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A. KUHLMAN, Animal Husbandry
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F. D. LEWIS, Assistant to Dean
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E. C. SAUVE, Agr. Engineering
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W. A. SUMNER, Agr. Journalism
H. V. TENNANT, Agr. Engineering
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H. ULLSPERGER, Soils (Sturgeon Bay)
J. C. WALKER, Plant Pathology
H. O. WATRUD, Agr. Economics
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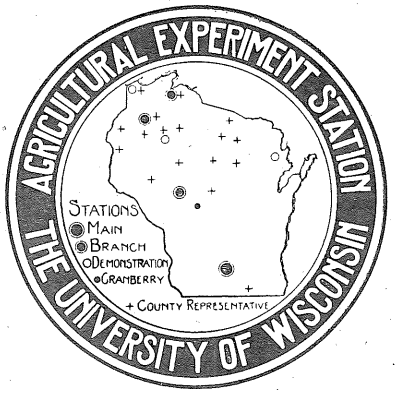
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