Conserving Soil by Better Land-use Practices
Michigan State University Extension Service
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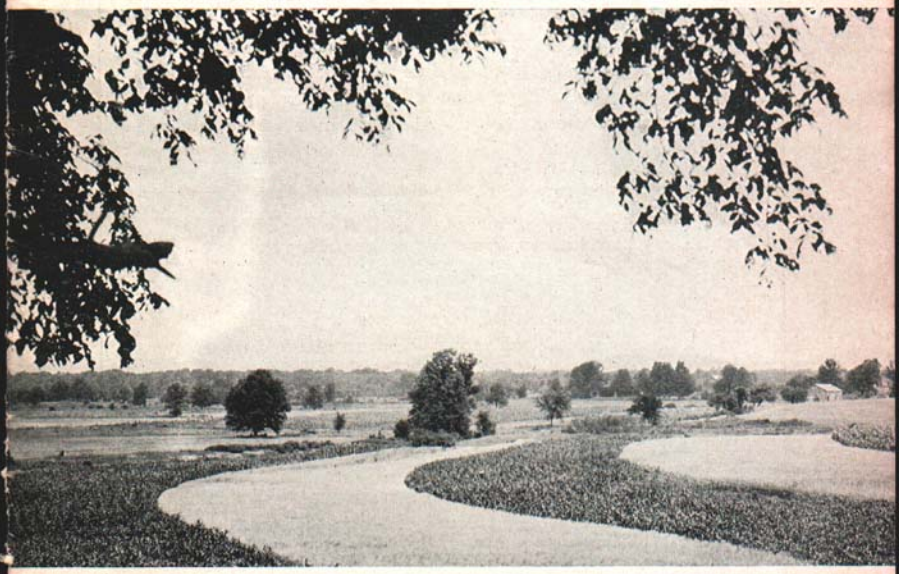
CONSERVING SOIL

By

Better Land-use Practices

By PAUL M. BARRETT



Cropping planned to fit the land.

MICHIGAN STATE COLLEGE :: EXTENSION DIVISION

EAST LANSING

Cooperative Extension Work in Agriculture and Home Economics, Extension Service, Michigan State College and the U. S. Department of Agriculture Cooperating.

SUMMARY

1. Erosion has become a serious problem on most Michigan farms. One field in four has lost much of its topsoil by wind or water action, and unless control practices are adopted, this loss will become greater.

2. The immediate results of erosion are lowered crop yields and greater difficulty in field operations. The final result is loss of farm value to the point of abandonment. Every farmer must be on the alert for signs of erosion just as he is for signs of poor crop growth, low milk production, and disease in various types of livestock.

3. Specific control measures are designed to reduce soil loss under different conditions. Each farm and field is a separate problem and must be treated according to its needs. Control measures are not effective without good general farm management practices, including a good soil management program with proper crop rotations, and consideration of reforestation and woodlots.

4. Sheet erosion may be controlled by the right rotation, contour cultivation, strip cropping, cover crops, and terraces. Any, or all, may be necessary for control, depending on the erosion, soil, slope, watershed and crops.

5. Control of sheet erosion conserves topsoil and prevents gullies. Once formed, gullies may be controlled by proper management of the watershed, aided by diversion channels, vegetation, or dams. Permanent sod waterways in natural water courses will carry water safely and prevent formation of gullies.

6. Loss of soil by wind can be lessened by wind breaks, strip cropping and cover crops. Blowouts are the "gully stage" of wind erosion and are best controlled by brush until trees or other vegetation can become established.

7. It is better to fit the farm program to the land rather than try to fit the land to the farm program. This gives rise to the contention that the whole farm enterprise should be considered and planned if every acre is to be utilized best, and true soil conservation achieved.

CONSERVING SOIL
by
BETTER LAND-USE PRACTICES

PAUL M. BARRETT*

INTRODUCTION

Soil fertility is our most valuable natural resource. For that reason, it is as worthy of defense against loss and depletion as our sea coasts are against foreign invasion. The Warrick County, Indiana, field which grew the prize-winning sample of wheat for the World's Fair in 1893 became so unproductive that it was planted to forest trees in 1934. In less than 40 years the fertility was taken from the soil and the man, who had grown the champion crop, lived to see the field so gullied that cultivation was impossible. The total acreage of good farm land similarly destroyed is large and the rate of depletion so rapid that the conservation of our soil resources must be considered a problem of great national importance. Crops take fertility from the soil, mismanagement destroys tilth and organic matter, but soil erosion by wind and water removes more soil fertility than all the other forces combined. Soil erosion is the farmer's Public Enemy No. 1 and united effort is necessary in order to conserve and protect the resources of the soil.

There is a great need in this country at present for all citizens to acquire a high regard for the soil. The man in the shop, store, or office, as well as the farmer, has a stake in this soil of ours which produces food, clothing, and shelter for all. The farmer, however, has a double interest. He must assume the direct responsibility for keeping the soil permanently productive while making a living from it at the same time. To contribute information concerning the nature and treatment of the erosion problem this bulletin describes soil erosion as it occurs in Michigan and outlines some of the most practical means of erosion control.

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KINDS OF EROSION

Erosion, as discussed in this bulletin, is the moving of soil particles by wind or water. It may occur with every rain or wind on unprotected soils. Kinds of erosion include: (1) Sheet erosion; (2) Gullying; (3) Wind erosion.

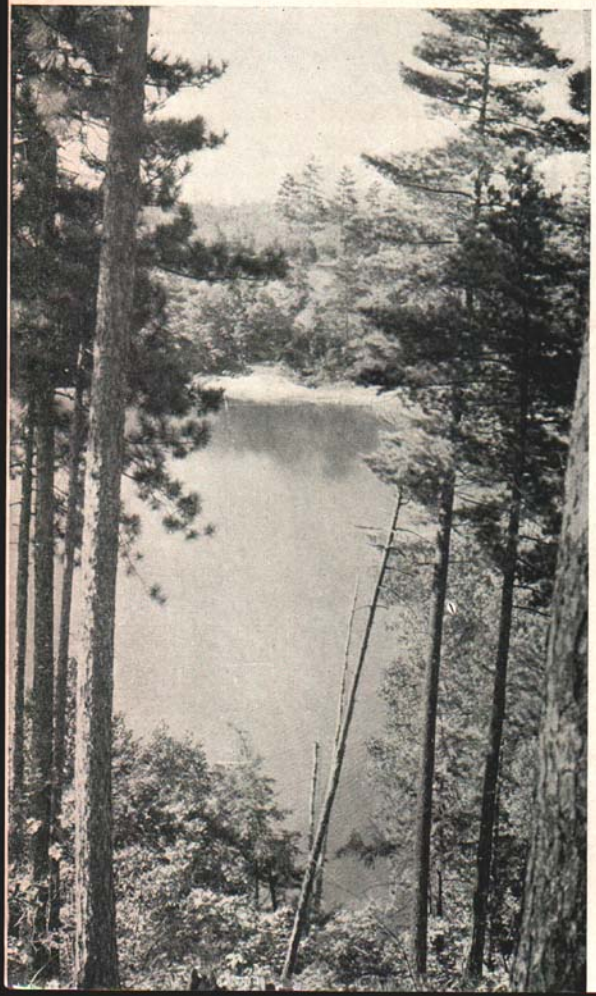


Fig. 1. One of Michigan's beautiful lakes being gradually filled up by erosion. On the opposite side can be seen a gully with the soil deposited below. Silting in streams and lakes destroys spawning beds and sources of food for fish.

Sheet Erosion Most Common and Most Costly

Gradual removal of the surface soil by water without formation of gullies is called sheet erosion; this may progress unnoticed for years because the small rills and miniature gullies produced on the slope by rains are obliterated by tillage operations and forgotten. Repetition of this process, however, brings changes which are apparent to the alert farmer. The soil on the eroded parts of the field changes color as portions of subsoil are brought to the surface by plowing and mixed with the topsoil. There is an actual lowering of the land, indicated by the height of old fence rows above the field level, and by exposed tree roots. In more serious cases, the subsoil appears on the slope and then one realizes that the "clay knobs" on the farm were once covered with topsoil like the rest of the field. Sheet erosion is the most serious and costly because it results in decreased crop yields. Tests and observations show that yields of most crops are in proportion to the amount of topsoil in a field. Where sheet erosion has taken its toll of topsoil, the life of the soil is gone and nature's work of centuries is wasted, possibly in one generation.

Fig. 2. Remains of what was once an orchard. An extreme case of what happens on a poorly chosen site with lack of adequate care. Use of cover crops, sod under proper conditions, and mulch are a part of good soil management for orchards.

Gullies

Nature's protest against abuse.
The end product of sheet erosion.

Nature gives little warning of her actions. Usually, insidious sheet erosion continues at an increased rate of soil loss until suddenly gullies appear. In many instances, these are the first signs of erosion recognized by the farmer. Gullies are evidence of erosion that cannot be ignored. Their presence obstructs the operation of farm machinery. Gullies eat their way into fields, dividing them, and like a parasite, seem to grow on the fertility they drain from the land.

Wind Erosion

Erosion by wind, as by water, may be slow in making itself evident. Nevertheless, the removal of the lighter soil particles and humus is a serious loss. In addition to the loss of soil, often there is serious damage through the cutting off or bruising of young tender plants by blowing soil particles. Drifts of wind-blown soil often smother considerable areas of crops and bury good soil. Sand drifts, accumulations of soil along fences, and "blowouts" in fields are some of the signs of erosion by wind.

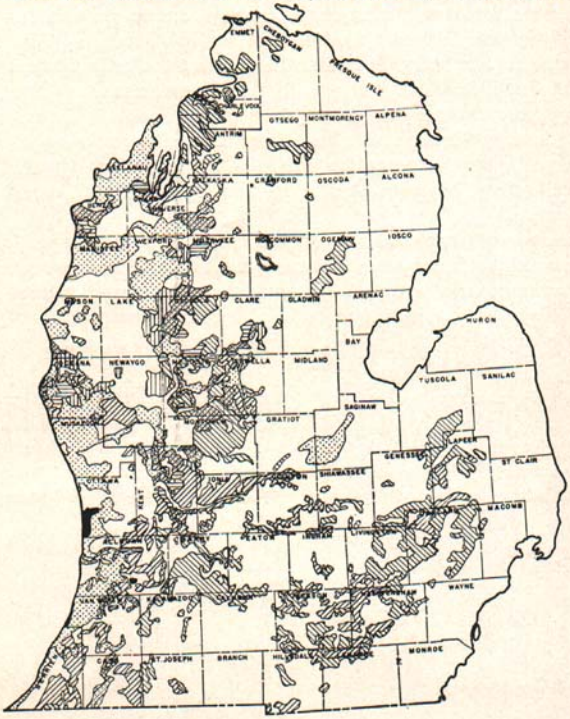
"Blowouts" represent advanced stages of wind erosion. These vary from "pockets" a few feet in diameter to holes of considerable depth and several rods in width. These, like gullies, effectively ruin the land for further production of anything but forest trees, and some difficulty is often experienced in establishing plantations of trees on them. However, by use of brush, mulching material or other protection, trees usually may be established.

Sand dunes, the result of wind erosion of lake sand, are often a hundred feet or more in height. They are attractive to tourists and constitute a scenic asset to the state. They will support a surprising stand of desirable woods cover when stabilized through vegetation. Uncontrolled, they move slowly with the wind, covering roads, trees, buildings, and everything in their path, occasionally filling streams and harbors with sand. Dunes occur principally along the shore of Lake Michigan and usually are not a menace to agricultural land.

SOIL EROSION IN MICHIGAN

The diversified agriculture of Michigan, requiring rotation of crops and large acreages of meadow and pasture for livestock, is a major factor in reducing soil losses and has helped to keep this state in a favorable position as compared to many others in respect to soil de-

GENERAL EROSION SURVEY, STATE OF MICHIGAN



LEGEND

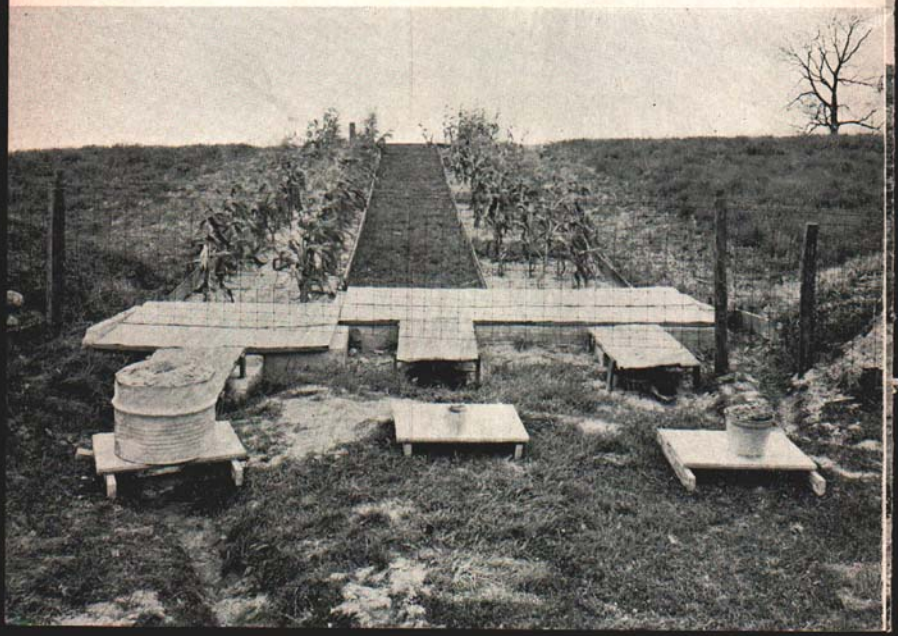
- LITTLE OR NO EROSION
- MODERATE SHEET EROSION
- MODERATE SHEET EROSION OCCASIONAL GULLIES
- SLIGHT WIND EROSION
- MODERATE SHEET EROSION SLIGHT WIND EROSION OCCASIONAL GULLIES
- SEVERE WIND EROSION
- MODERATE SHEET EROSION SEVERE WIND EROSION OCCASIONAL GULLIES
- VERY SEVERE WIND EROSION

Fig. 3. Recent surveys show that about 25 per cent of Michigan land has lost 2 to 3 inches of topsoil and in some areas, the loss has been much greater. Erosion is, or is likely to be, a problem on every farm in this state because we find fields with slopes as low as 2 per cent which have the top soil washed away and gullies formed. Many cases of serious erosion occur in places shown as having little, or none on this map.

pletion through erosion. Michigan soils, however, do suffer serious loss from erosion on the majority of farms, and in many communities, erosion control demands immediate attention if successful farming is to continue. The need for erosion control in these critical areas is very evident, but it is equally important that control measures be taken on farms where erosion is occurring but as yet is not so apparent. The farms that have suffered the least from erosion have the most to save, and usually soil conservation methods are more easily established. Thus, the adage of prevention being more desirable than cure is again appropriate.

Erosion on farms in Michigan has reached serious proportions and with a continuation of present farming methods will increase unless control measures are adopted. A day's ride through the agricultural section of Michigan or a critical survey in almost any community will bring a realization that erosion is taking a heavy toll of our farm lands.

Fig. 4. Plats arranged to measure the effect of different cropping and tillage systems on the loss of soil and water by surface run-off. The soil in the containers in the foreground represents the quantity lost by erosion. The corn on the left was cultivated up and down the slope while that on the right was cultivated across the slope. The sod strips in this plat also decreased erosion. The small amount of soil lost from the center strip demonstrates the efficiency of sod in controlling erosion.



Farm credit organizations, both private and federal, now recognize that uncontrolled erosion destroys security in a farm. The time has come when permanency of land values is determined in a large part by the extent to which erosion is controlled.

Recent surveys show that about 25 per cent of Michigan land has lost from 2 to 3 inches of topsoil while, in some areas, the loss has been considerably greater. Erosion losses occur largely on cropland, and since most fertile land already is in farms, the conclusion is that in less than a century we have lost about one-fourth of the available productivity of our soil. The first hundred years have been the easiest so far as soil management is concerned, and hence the generations of the next hundred years will have a more difficult task if they control erosion, maintain soil fertility, and make an adequate living.

Erosion is, or is likely to be, a problem on every farm in Michigan. Some fields with slopes as low as 2 per cent have had the topsoil washed away and gullies formed. In localities where the organic matter in the soil has been depleted and the land is rolling, evidence of soil washing may be found in every field. On level land, unprotected by windbreaks or cover crops, it is not unusual to find a serious loss of topsoil by wind, even on loam and clay loam soils.

Some areas are particularly affected by certain kinds of erosion. Land in the western part of the state, along Lake Michigan, suffers extensively from wind erosion. Large areas frequently damaged by wind extend east through Wexford and Osceola counties. Blowing of soil by wind is not confined to the western part of the state as it occurs to some extent in every county and, as is the case in Saginaw County, the area affected may be large.

Loss of soil by water erosion is even more extensive and involves more farm land that that affected by blowing. Often the combined forces of wind and water are active in the same area, and in some cases, even on the same field. Water erosion is most destructive in rolling country that has been cropped for a long time. The land in the western and south central part of the state has suffered most from erosion by water.

In 27 counties of the lower peninsula more than 30 per cent of the land is seriously affected by wind or water erosion. These counties are Allegan, Antrim, Barry, Berrien, Cass, Charlevoix, Clinton, Grand Traverse, Ionia, Isabella, Jackson, Kent, Lapeer, Leelanau, Livingston, Manistee, Mason, Montcalm, Muskegon, Newaygo, Oceana, Osceola, Ottawa, Van Buren, Washtenaw, and Wexford. Other counties may have less total area affected, but in certain localities within them, erosion is very serious.

The erosion survey map of the State (page 7) was made by the Soil

Conservation Service in 1934. This is a very general map and indicates only the larger areas of most severe erosion. There are enumerable small areas not shown on the map where erosion is doing great damage.

Sometimes the loss by erosion is so gradual that it escapes attention, but, if unchecked, the result is a worn-out, abandoned farm, a loss to the owner and society. Soil, in its natural undisturbed state, is covered with a growth of forest or grass which, together with the accumulated humus, holds the soil in place against the action of wind and water and leads to the absorption of a large percentage of the rainfall. Bringing of the land under cultivation destroys this natural cover and unwise farming results in a rapid decrease in organic matter content, thus leaving the soil subject to erosion.

EVERY FARM A PROBLEM

Specific control measures have been developed for the different kinds of erosion and for various soil conditions. This bulletin describes briefly those practices most applicable under Michigan conditions, as recommended by the U. S. Soil Conservation Service and the Michigan State College. The circumstances of each individual case will determine which practices or combinations of practices should be adopted.

Fig. 5. A grazed woodlot provides little pasture and prevents growth of young trees to replace the old. It is generally true that a pastured woodlot soon becomes neither pasture nor woodlot.

Fig. 6. This ungrazed woodlot directly across the road from that shown in Fig. 5 shows a vigorous reproduction of new growth that will replace the mature trees now ready for cutting. A well managed woodlot can be a profitable part of the farm supplying wood, posts and lumber for repair of buildings.

It is interesting and important to note that every control measure recommended is consistent with good farm practice. Properly applied and carried out, these practices will improve the fertility of the soil, usually increase crop yields, and maintain the value of the farm by conserving the soil. These measures are designed to supplement present farming practices. Good soil management and conservation practices are the foundation of permanent agriculture.

LAND USE

Non-crop Land

As thought is given to the problem of land use, it becomes more apparent that a complete farm plan is necessary if every acre is to be put into proper use and the soil conserved. In the determination of the best use of land on the farm, it is possible that certain areas will be found too steep, too badly eroded or too infertile to be used for cultivated farm crops. Often the best use of these portions of the farm would be to retire them to permanent meadow, pasture, or to the production of forest products such as firewood, fence posts, timber or Christmas trees. If reforestation is decided upon, the best adapted species should be determined and plantings made consistent with best

farm forestry practices. In woodlots already established, attention might well be given to their improvement.

Grazing the woodlot is a practice that does not pay. The pasturage obtained in a woodlot is meager and the possibility for sustained yield of timber from the grazed woodlot is remote. It is generally true that the pastured woodlot is neither pasture nor woodlot. There is a place for forest products on most farms and the farm woodlot can be made a valuable source of material and income.

GOOD PASTURES SAVE SOIL

In allotting the different areas of the farm to the various uses to which they are best suited, serious consideration should be given to pasture, not only because a sod is effective in controlling erosion and restoring the humus content of the soil, but also because good pasture is one of the most profitable crops that can be grown. Land too steep to be cultivated without excessive loss of soil or too difficult to work because of stones might well be devoted to pasture. This does not mean that land too poor for anything else is suitable for pastures. Good soil is necessary for good pasture.

Michigan pastures need more attention if they are to make the returns of which they are capable. The selection of a suitable seed mixture is the first step in pasture improvement. In this connection, attention is called to a combination of alfalfa and smooth brome grass which offers great possibilities for the best of pasture on certain soils and at the same time is very effective in erosion control. If the soil is acid, liming will be necessary before this pasture mixture can be established.

Pasture improvement experiments have demonstrated that it pays to fertilize, and re-seed when needed, and sometimes lime to bring about the best of conditions even though the acreage so treated may be limited. Large acreage alone will not offset the results of mismanagement and overgrazing. A good pasture provides the best of feed at the lowest cost and protects the soil. A poor pasture does neither.

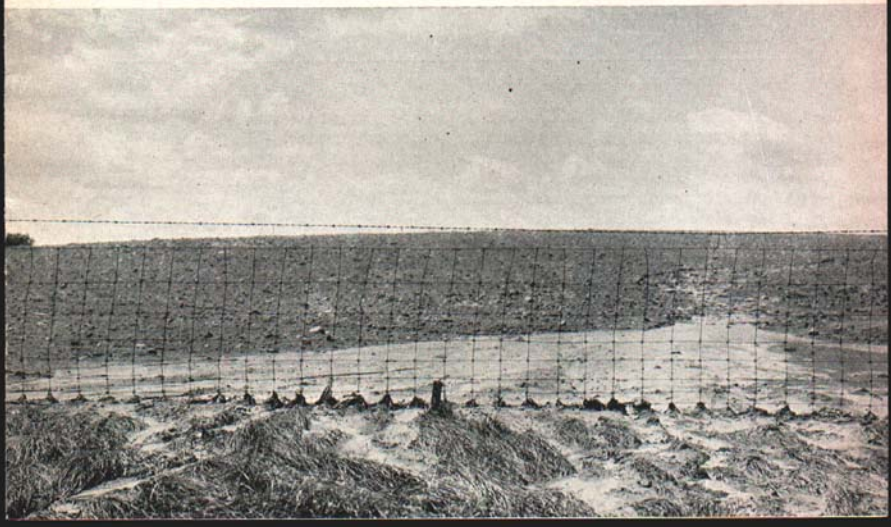
Rotation Land

On the part of the farm devoted to crops in rotation, there may be many slopes that erode when in tilled crops unless cultivation is either on the contour or across the general slope. Erosion may occur on slopes as low as 1 per cent, and in these places the rotation should include a maximum of soil-protecting sod crops. The entire farm program may be affected by the rotation as it is changed to suit the land. A rotation for soil conservation purposes may contain a smaller acre-

age of cultivated crops and grain. This, in turn, may involve a change in the livestock feeding on the farm. An increase of legume hay and decrease of grain and corn silage, in some livestock feeding, are advocated since the most economical source of protein is alfalfa hay. Further efforts to use more alfalfa in the ration have led to experiments in making alfalfa silage. The addition of 40 pounds of molasses to each ton of alfalfa as it goes into the silo seems to be all that is necessary to convert alfalfa into palatable silage. As this practice becomes more widely accepted, it will aid materially in reducing the acreage of cultivated crops which permit erosion.

Grass with its millions of roots and trees which provide leaf litter and soil-retaining roots are nature's front line of defense against erosion. However, cultivated crops are necessary in our agriculture. Cultivation of slopes or places subject to blowing will be followed by erosion unless special care is given. Results of a demonstration on the Soil Conservation Service project in Berrien County offers a comparison of different types of crops and of crop arrangement on soil erosion and moisture absorption.

Fig. 7. A strip of sod along the fence slowed down the water and caught at least a part of the soil it was carrying from this field. If a strip of sod had been left across the slope part way up the field, most of this soil would have been kept on the farm.



RUN-OFF PLOT RESULTS

"Although the loss of surface soil by sheet and gully erosion has been widely discussed the last two years by many groups in Michigan, little information was available as to exactly how much erosion actually was taking place.[1] To make a visual demonstration that might be viewed by visitors to the Berrien County Soil Conservation Service demonstration project, run-off plots were laid out on two different soil types and two different slope conditions.

"These plots were one-hundredth of an acre in size and were enclosed with a 10-inch board set 6 inches in the ground, to keep all the water that fell outside of the plots from running in and to keep the water that fell on the plots inside. A cistern was constructed at the lower end of each plot to collect all the water and soil that ran off the plot.

"Inasmuch as these plots are located in a fruit section, treatments were established to correspond to cultural practices in orchards, such as clean cultivation up and down the slope, complete sod, and cross-slope cultivation with a 4-foot sod strip in every tree row.

"The necessary apparatus to make accurate determinations was not available at the project, and the results shown in Table 1 are only approximately correct. However, these results check closely with the visual observations made on soil and water collected in the cisterns at the foot of the slope.

TABLE 1.*

Soil	Per cent of slope	Tons Soil Loss Per Acre With			Per Cent of Rainfall Lost By Run-Off		
		Cultivation up and down slope	Sod	Cultivation across slope and sod strips	Cultivation up and down slope	Sod	Cultivation across slope and sod strips
Hillsdale Loam	13½	152.	.22	26.	37.5	5.4	19.4
Hillsdale Sandy Loam	6	40.	.0	2.	28.6	7.4	11.4
Coloma Sandy Loam	14	26.	.06	1.	9.2	1.3	3.5
Coloma Sandy Loam	6	9.	.0	.9	7.2	0.5	4.6

*Results are for period June 1, 1937 to June 1, 1938.

"The results shown in Table 1 (Fig. 4) indicate that sheet erosion is each year removing large amounts of fertile topsoil—but is removing it in thin layers, not readily observed under field conditions.

"The Soils Department of Michigan State College has cooperated in making moisture determinations throughout the growing season to study the effect of these various treatments on soil moisture. This information will undoubtedly be published at some future date.

"These observations made at Benton Harbor cover only a short period and hence are not advanced as final. They are, nevertheless, in accord with research data obtained elsewhere.

"A study of this demonstration brings us to the conclusion that the use and arrangement of cover is of vital concern in controlling erosion on land under cultivation."

[1]From "Soil Losses in Berrien County," by E. C. Sackrider, Soil Conservation Service, and G. M. Grantham, Section of Soils, in the Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 20, No. 3, February 1938.

REARRANGEMENT OF CROP FIELDS

Recognizing that the distance water travels is one of the factors governing its destructive power, it is obvious that shortening the cultivated slopes will do much to prevent soil loss. This fact supports the theory of planting crops in strips as a means of decreasing soil loss and experience under field conditions justify the practice. Strip-cropping is an arrangement of crops in long narrow fields at right angles to the slope, or on the contour, with crops arranged in the rotation in such order that a sod alternates with open-growing cultivated crops that leave the soil susceptible to washing.

The width of strips may vary from 70 feet on a 15-per cent slope to 125 feet wide on a 5-per cent slope. On the ordinary loam soil it is convenient to use 100-foot strips on a 10-per cent slope, decreasing the width of strips on steeper slopes and increasing the width of strips on the more gentle slopes. Usually the heavy soils or sandy loams with clay subsoil are most likely to erode, hence narrow strips are desirable on these soils.

By eliminating one or more fence rows and combining fields, the length of rows can be considerably increased, a procedure that offers a mechanical advantage in working the land with machinery.

CONTOUR STRIP-CROPPING

It is recognized that on much Michigan land it is impossible to travel far in one direction without going either up or down a slope. Cropping a field with strips laid out on the level or contour to avoid running rows up and down hill is called contour strip-cropping. This is a radical departure from the long established practice of square farming with accompanying pride in straight rows, but it does have its advantages. First, and most important, is keeping the rows across the slopes to save soil and moisture. This is justification enough for the practice. Second, it has the advantage of rows that may be longer and easier to work because it takes less effort to work on the level than up and down hill.

The disadvantages of strip-cropping are the necessity for rearrangement of fields, the difficulty in pasturing a part of the field and the location of a lane to connect fields with the buildings. However, by means of electric fences any field may be pastured, and careful arrangement of fields does allow convenient access for harvesting. In contouring there may be some short rows but these can be avoided to some extent by leaving correction areas in sod.

Fig. 8. Oats and corn in contour strips across the slope. On fields so arranged, the speed of the water is checked by the cultivator marks and rows of corn and what soil is carried from the cultivated areas is deposited in the sod or close growing grain. A regular rotation must be followed under this system and farmers are finding it practical.

As with any other problem, the conditions on each farm must govern the practices adopted, and, in some instances, the land is too irregular for practical operation of strip-cropping. In such cases and where erosion is a major problem, the only alternatives are either field stripping or a rearrangement of farm program and enterprises to allow a large part of the land to remain in sod much of the time. It is possible to carry on a livestock program with a minimum of cultivated crops and this, it seems, is the answer on many farms. For further information on strip-cropping refer to U. S. Department of Agriculture Farmer's Bulletin 1776, "Strip Cropping for Soil Conservation."

FIELD STRIPPING

Field stripping is the growing of crops in strips at right angles to the prevailing slope or wind direction.

While not so effective as contour cropping, field stripping offers the best solution to the water erosion problem on irregularly sloping or "choppy" fields.

By arranging the strips across the direction of the prevailing wind, the velocity is checked at intervals, thus lessening the movement of topsoil. The tall-growing crops act as buffers and protect the shorter, more open-growing crops such as beans.

COVER CROPS TO HOLD SOIL

Cover crops have an important place in holding soil. One of the most effective and convenient methods is to use a cover crop following a cultivated crop. An example of this is rye planted in corn at the time of the last cultivation which gives growth sufficient to protect the land during the fall, winter, and spring. Cover crops may include any of the grain crops or even legumes, and are useful not only for protection of the soil but also to furnish material to incorporate with the soil in the spring as organic matter. Farmers are finding that sweet clover sown in corn about the first of July decreases erosion and builds up the soil. Fall plowing and fields left bare over winter are likely to result in erosion that takes more fertility from the soil than was removed by crops during the growing season.

Fig. 9. A strip in this corn field left without a seeding of rye for a cover crop shows the power of water to move soil unprotected by cover.

Fig. 10. One of three gullies doing serious damage in a valuable orchard. The owner is asking the county agricultural agent and a representative of the Soil Conservation Service to suggest means of control.

EROSION CONTROL IN ORCHARDS

Cover crops and use of sod for erosion control in orchards is a special problem and is discussed in Michigan Agricultural Experiment Station Circular Bulletin 163. This bulletin points out the advantages and disadvantages of different types of cover and their usage under various conditions. The main consideration is that of getting maximum protection with a minimum of competition for moisture and plant food. The choice may be sod where soils are fairly well supplied with moisture and the trees, such as apples, are not unduly sensitive to drouth. A sod cover may necessitate use of more commercial fertilizer (possibly 50 per cent more in the case of apples) but the conservation of the soil and better color of the fruit may more than justify the change. When soils are lighter and trees more sensitive to drouth, annual cover crops of sweet clover, vetch, Sudan grass, and small grains may be used. Lime or marl and manure should be applied when needed. A complete fertilizer, as a 4-16-4 on heavier soils and 10-6-4 on lighter soils, at the rate of 100 to 150 pounds per acre, is essential to get the maximum benefit from the cover crop. Seedings of cover crops in young orchards may be made early (June 10) but in bearing orchards about a month later or even after harvest. In most cases it will be advisable to disk in the cover crop early the following spring before growth starts.

A combination of sod strips and cover crops is effective. The sod strips can be used in the tree rows across the slope for permanent protection while cover crops can be used between the rows to prevent washing and blowing during critical periods, later to be turned under to add humus and conserve moisture. In young orchards it is well to take every opportunity to build up fertility and organic matter to make possible other practices in the future that will help control erosion.

ORCHARDS ON THE CONTOUR

It is easy to get the advantages of cultivation across the slope by simply following the rows across the hill and when the grade is uniform and in the same direction this works nicely. However, much of our fruit land in Michigan changes direction of slope so often that a straight row soon leads up or down the hill and invites erosion. Many new orchards are being planned to fit the land and are set with the rows curving around the hill. In these orchards that are set on the contour it is found that it is much better to change direction than to go up

Fig. 11. The same gully shown in Fig. 10 under control. Run-off water is cut off from the heads of other gullies further up the slope by a diversion channel and is led to the concrete catch basin from which it is carried safely down the abrupt slope by a pipe made of oil drums with ends cut out and bolted together. The sides of the gully were seeded, lightly mulched with straw and held in place by old woven wire pegged down.

and down the hills. Contour planted orchards save moisture, soil, and work.

In setting an orchard on the contour there may be a slight departure from the exact contour in order to space the rows evenly and to avoid short turns. Curving rows in a rectangular field will likely necessitate some short rows but, it will also permit some longer rows than the straight distance across the field, so that in the end the rows will average about the ordinary length and will permit about as many trees.

Orchards set on the contour lend themselves readily to terraces and diversion channels. It is on such plantings that these devices are the most practical and effective. In some instances, each row has the trees set on the crown of a small terrace.

MULCH

Mulching in orchards is often an effective means of controlling erosion, building up a supply of organic matter and establishing a seeding. Lack of sufficient quantities of mulch is the major reason for its limited use. In many orchards mulching material is so essential that special acreage is devoted to growing it. Sudan grass, millet, and sweet

Fig. 12. Erosion does double damage. It takes soil from where it cannot be spared and deposits it where it causes damage, as shown by the deep deposit around the tree in the foreground.

Fig. 13. Straw mulch around trees to hold moisture, reduce the competition from the grass, and build up a supply of organic matter in the soil. Mulching requires application of a nitrogenous fertilizer to aid in decomposition, more care to prevent damage from mice and is somewhat of a fire hazard, but, if properly handled, is a part of good orchard management.

clover, as well as straw, are suitable materials grown especially for this purpose. Mulching may be done in two ways. The mulch may be applied 2 or 3 inches deep under the trees and smother all vegetation, or it may be applied very sparingly, 2 or 3 tons per acre between the trees to assist in obtaining seedings in areas where it is otherwise difficult to obtain a stand.

SOD WATERWAYS TO CARRY WATER SAFELY

In most sloping fields there are natural watercourses that must be recognized and maintained as such. Usually a permanent sod once established will carry the water safely from the land. It also accumulates considerable silt dropped by the water. Moisture and fertility make these sod waterways productive and they become valuable hay-producing areas instead of gullies.

A sod waterway may be difficult to establish where considerable water must be handled and washing occurs. One of the most practical and effective means of getting sod started in such places is to seed heavily and cover with a light straw mulch, held in place by old woven

Fig. 14. The soil in this corn field will be held during the winter by a good growth of winter barley. Cover crops following cultivated crops are one of the most practical ways of protecting the land from soil losses during the fall, winter and spring. Rye, wheat, barley or even oats may be used. In some cases, sweet clover is sown in corn the last of June to provide cover for the soil and pasture the following year.

wire fencing staked down. With an area protected in this manner and fertilized, the chances of getting a good sod are good. Since sod waterways are recognized as a necessary and valuable part of the producing acreage it is wise to allow ample width of waterway to avoid building up the center, with soil deposited by the water, and subsequent cutting along the sides. At least two mower's widths or from 12 to 24 feet seem to fit most cases.

TERRACES TO SLOW THE WATER

Thus far vegetative cover and arrangement of crops to control erosion have been discussed and it is believed that in most cases they will be sufficient to give good soil protection. However, there are conditions where mechanical devices may be required to aid in effective control of soil erosion. Of these, the oldest and most commonly employed is the terrace. This is simply a broad-base ridge built across the slope to check the water which is then absorbed into the soil of the terrace channel or led off slowly. To prevent the water's breaking through at points of concentration, terraces should be spaced at proper intervals

to keep the volume of water within the capacity of the terraces. On medium heavy soil with a slope of 5 per cent the terraces should be spaced about 75 feet apart. They should be wide enough and deep enough to have sufficient capacity to hold the water they may be expected to carry. About 10 feet from center of bottom to crown and about 15 to 20 inches deep will be average dimensions and will permit free use of machinery. The terrace should have a gentle grade of 1 to 3 inches per 100 feet depending on length of slope and type of soil, thus allowing the terrace to carry off the water and allow maximum absorption. The spacing, size, and gradient of the terrace will vary with the soil, slope, and watershed. Careful study of all conditions should be made and experienced supervision employed.

Terraces must be maintained by not being allowed to fill up. Careful plowing, including turning the dead furrow, in the bottom of the terrace and throwing the back furrow on the ridge will help. A safe outlet for the water from the terraces is a factor demanding careful consideration. This is important and must be provided or we have all

Fig. 15. A diversion channel emptying into a sod waterway. The brush staked down will slow the water until a sod can be established. A light straw mulch over the seeding held down by old woven wire is fully as efficient and easier to use. The diversion channel will carry the water across the slope to a new outlet and so prevent it from flowing down through the old gullies and making them larger.

the elements for gully formation and are likely to have one started if a good sod waterway or safe outlet is not established. Another point to remember in connection with terraces is that these structures in themselves are not often completely effective in controlling erosion permanently. Strip-cropping, contour farming, cover crops, and good soil and crop management must be observed. Terraces are a part of the means of control and not a complete solution in themselves. For detailed information on terracing refer to U. S. D. A. Farmer's Bulletin 1789, "Terracing for Soil and Water Conservation".

DIVERSION CHANNELS

Diversion channels are similar to terraces but are specifically designed and placed to protect certain slopes and critical areas. Diversion channels are designed differently from terraces and must be maintained in sod at all times, with a sod filter strip immediately above the channel. They may be used for a temporary diversion of water until a gully is sodded over or covered. They may be used in an orchard to carry off water that threatens to cut a gully or from a slope on which it is difficult to obtain a good cover crop or they may be used to break a long slope where it is not practical to establish a complete terrace system. Like terraces, the diversion channel should be wide and deep enough to carry the water it is likely to get and should slope gently enough to carry the water without cutting the channel bottom. Outlets protected by good sod or masonry must be provided or trouble will result.

GULLY STABILIZATION

Gullies, like many other soil afflictions, are better prevented than cured, but if they are already present, some means of control is needed. The place to start controlling a gully is on the watershed above it—the real source of the trouble. Any of the previously described measures may be needed, and it is likely that if they are not applied the gully will not be controlled nor will there be much topsoil left on the land above. With the watershed under control, the gully is ready for consideration. Sides may need sloping, mulching, sod stripping, or seeding, and trees or shrubs may be planted. The head may require a check dam, and, if so, it should have adequate wings on each side, a wide lip for water to spread over evenly, and a concrete apron for water to strike upon. Those are essential, and complete directions and specifications for each dam may be obtained from the Michigan Agricultural Extension Division. Sometimes a series of small dams made of brush,

posts, poles, or wire are effective in checking the water. However, this type of structure is temporary and must be supplemented with plantings of trees, shrubs, or other vegetation. Farmer's Bulletin 1234 on "Gullies" is recommended for information on gully control.

In many cases small gullies are indications that a permanent sod waterway should be established. In any event, and irrespective of size, it is not effective only to dump in loose brush, boulders, or junk because the water will continue to cut around and under the trash. Too much brush is likely to defeat the purpose for which it is intended since it shades and kills out grass which might otherwise grow. Seeding, with a light mulch of straw held in place by old woven wire, is most effective.

Fig. 16. A single rain on this unprotected slope caused serious damage. Mulch and sod are effective means of avoiding such loss.

Fig. 17. The brush on the left piled in this gully failed to stop its growth into the next field to the right of the fence. Gullies are stopped by diverting water into new channels further up the slope. Grass, cover crops, contour cultivation and diversion of water by terraces or other means are necessary to prevent formation and growth of gullies.

WIND EROSION

"Blowouts" usually occur on sand and it may be difficult to establish vegetation on these spots even with a scattering of brush to stop sand from blowing. In the driest and sandiest areas beach grass will grow and is quite effective in holding the sand. This can be followed by planting trees, usually conifers. Jack, red, and Scotch pine will grow well on the most drouthy soils while white pine and spruce require sites having better moisture conditions.

Windbreaks are effective in reducing erosion by wind as well as affording many other advantages, such as winter protection to save seedings from being cut and injured. Low-branching evergreens are desirable as they offer best protection the year around. Two or three rows with trees spaced alternately are the most effective. Prevention of blowing on muck land is a special problem and is fully discussed in Circular Bulletin 103, Michigan Agricultural Experiment Station.

SOIL CONSERVATION DEMONSTRATION PROJECTS

Three soil conservation demonstration projects have been established in Michigan in recognition of the need for adoption of erosion control practices. The Michigan State College assisted in the selection of the Berrien, Grand Traverse, and Livingston county demonstrations and the Soil Conservation Service has carried on the work.

Berrien County was selected as typical of the fruit area and because over half of its land is seriously affected by erosion. This project was first to be established and includes an area of about 37,000 acres. Within this area some 130 farms have been selected that are suitable for demonstrations of the recommended practices of erosion control. Each farm has been mapped to show the soil types, slopes, degree of erosion, crops and cover. A study has been made of the farm business, the crop yields, income and expense. Considering all this information, a plan was made offering a farm program that would provide sufficient income, make the best use of every acre and conserve the soil. In some instances, this necessitated new farm enterprises to make the best use of the land, and abandonment of others which the land could not support permanently. In some cases, parts of the farm were retired from

Fig. 18. Sandy soils will support a profitable orchard if properly handled. Poor management that fails to protect the soil from blowing and allows the organic matter to be depleted may soon reduce a profitable orchard to a sand pile.

cultivation and put to other uses. The direction of cultivation, arrangement of fields, use of lime, fertilizer, green manure, cover crops, mulch, pasture improvement, windbreaks, terraces, sod waterways, dams, diversion channels, and reforestation are among the practices demonstrated on these farms. They show the effectiveness and practicality of control methods under actual farm conditions. They provide an ideal subject for study and tours for farmers, county agricultural agents, vocational agricultural instructors, and others interested in the conservation of the soil.

The demonstration project with headquarters at Howell has most of its 30,000 acres in Livingston County. This area was selected as

Fig. 19. Results of tests on "run-off" plots as illustrated in Fig. 4 show many tons of topsoil went down the back furrow of this fall-plowed field. Sloping fields which are fall-plowed or left bare without the protection of a cover crop are likely to suffer erosion that takes more fertility from the soil than was removed by crops during the growing season.

(Photo, E. B. Swingle)

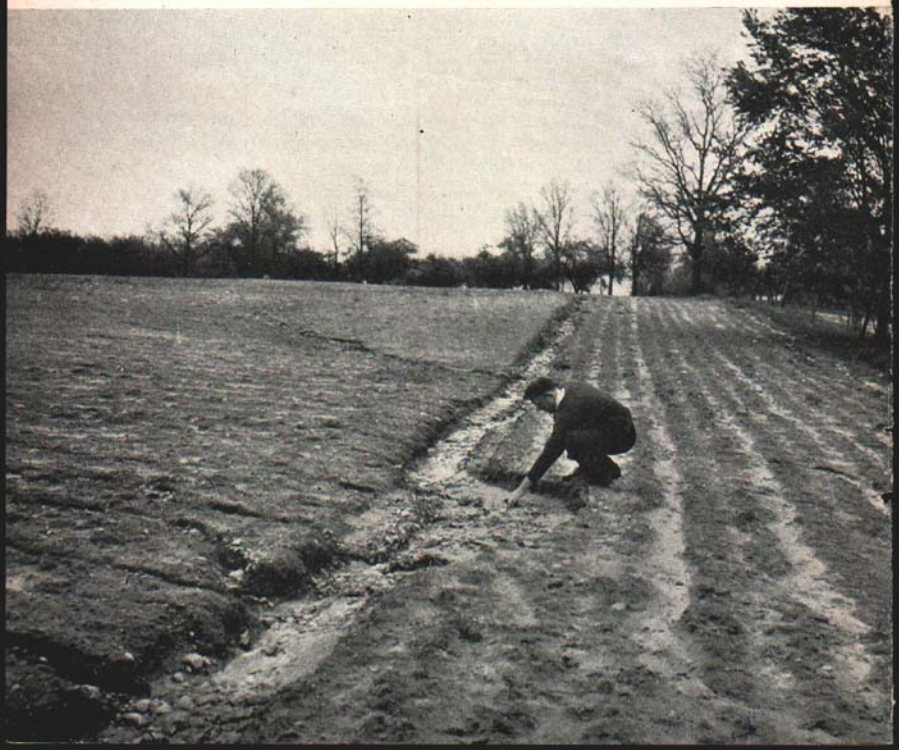


Fig. 20. Erosion ruined this farm. Everybody lost, the owner, the creditor and the community.

typical of some 4,000,000 acres devoted to general farming in south central Michigan. It offers all the combinations of land use problems which confront the farmers of this part of the state. Here, on individual farms, are being established demonstrations of the recommended practices that will provide the best returns and still maintain the productivity of the soil.

The Grand Traverse county project is located in one of the most extensive cherry growing areas of the state. The soil on many farms in this area and in other sections with large cherry plantings is being seriously depleted by erosion. The purpose of this demonstration project is to establish soil conserving practices on a large number of farms. The practices suggested will be designed to meet the conditions existing on the individual farms. In addition to controlling erosion, the soil management program will have in view the building up of the humus content and general fertility of the soil.

Individual visitors and groups are welcome to the demonstration projects. Arrangements should be made through your local county agricultural agent.

SOIL CONSERVATION DISTRICTS

Erosion has reached the point on many farms, and in many communities, where control is beyond the means of single individuals. To meet this situation, the Michigan Soil Conservation Districts Act was enacted as law by the 1937 State Legislature.

This act provides a means whereby a community may organize itself as a District in order that the farmers of the District may effectively combine their efforts to control erosion in cooperation with State and Federal Agencies.

A district is formed when a petition for organization has been filed with the State Soil Conservation Committee, a hearing conducted as to need, and a majority of land owners voting have declared themselves in favor of creation of a district. Two Directors are appointed by the State Committee, and three elected by the people of the area. These five are the governing body of the District. They may cooperate with other agencies in making surveys and demonstrations, they may accept donations, gifts, or services in the interests of the District, but they have no authority to levy taxes or make assessments. In extreme cases, the Directors may propose land use regulations in the interests of public welfare and such regulations may be adopted if favored by two-thirds majority of all land occupiers in the District voting on the question.

The West Ottawa Soil Conservation District has been organized in the west side of Ottawa County, comprising seven townships. A survey has been made, a program developed by the directors, and demonstration work is being carried on with individual farmers much the same as on the Projects. The South Muskegon Soil Conservation District is now organized and preliminary work for establishing other Districts is under way.

Further details concerning Districts are available in the Michigan State College Extension Mimeograph leaflet: "Basic Provisions of the Michigan Soil Conservation Districts".

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