Conservation - Natural Resources

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# SAVING OUR SOIL

*Do you know that—*

***Erosion entails an annual loss of $400,000,000?***

***A single dust storm swept away 300,000,000 tons of top soil?***

***Floods can be controlled?***

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No. 14 C.1 1937

# Saving Our Soil*

THREE centuries ago, North America was a virgin continent. It was abundantly rich in soil, timber, minerals, and wild life. Only a fraction of its vast area had ever been touched by the hand of the white man. Its wealth seemed inexhaustible.

Today, many of these riches are greatly reduced. Hunting or fishing on our interior streams does not furnish a means of livelihood except in relatively inaccessible regions. Only about two-thirds of our forests remain. The soil is still with us, reasonably rich in fertility, but large areas have become unfit for cultivation, while wind and floods have seriously undermined the productivity of other sections. Immense quantities of rich top soil have been washed into our rivers where it has either settled to clog the channel or has been swept into the ocean.

As if to add insult to injury, the waters which have carried away our rich heritage have invaded our cities and towns, taking a toll of hundreds of lives. While these great floods have been due to unusual climatic conditions, they reflect in part man's destructive activities on the American Continent.

For we cannot blame Nature for all of the havoc wrought by wind and water. As far as scientists have been able to discover, the rainfall in the various sections of the country has not changed much over the course of the past few centuries. It varies from year to year, and there appear

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* This pamphlet was prepared by Maxwell S. Stewart on the basis of the reports of the National Resources Board, the National Planning Board, the Mississippi Valley Committee of the Public Works Administration, and various publications on erosion and flood control prepared by the United States Department of Agriculture.

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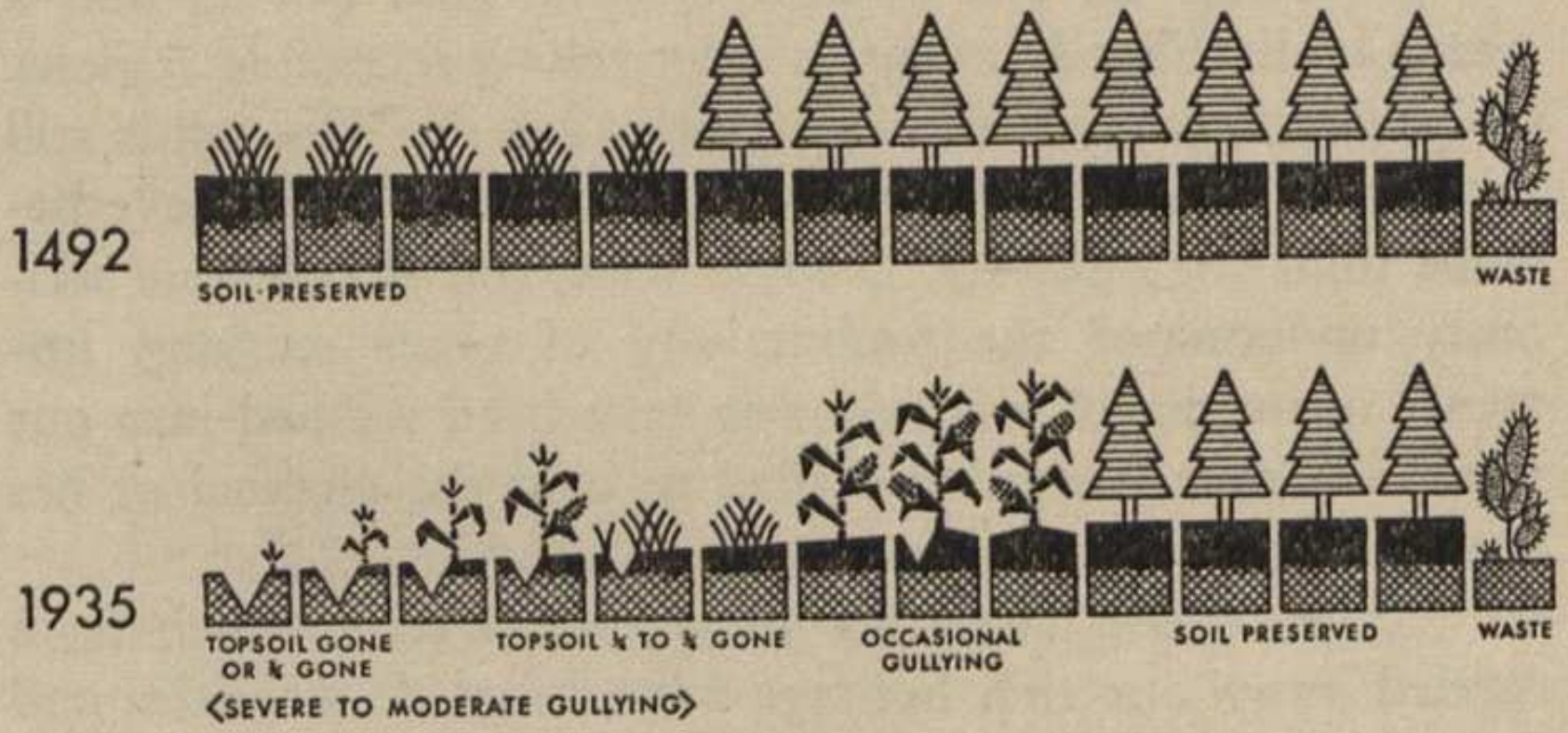
to be cycles of wet and dry seasons extending over a period of years. But the depletion of the soil, and to a lesser extent the destructiveness of the floods, are indirect results of man's activities.

It has been estimated that erosion removes 126 billion pounds of plant food material from America's fields and pastures every year. This is more than 21 times as much as is

## EXTENT OF EROSION IN THE UNITED STATES




EACH BLOCK REPRESENTS 135 MILLION ACRES

(COURTESY OF THE U. S. SOIL CONSERVATION SERVICE)

extracted by crops, and entails an annual loss to farmers of at least $400,000,000. Altogether our soil has suffered approximately 10 billion dollars' damage as a result of erosion, and the loss may reach the staggering total of 25 or 30 billion in another fifty years if the process of deterioration is not checked. By that time a large section of the United States would be as barren as the once fertile areas of North China.

*Water Erosion*

Erosion is caused by two elements: water and wind. Of the two, water erosion is ordinarily the more destructive.

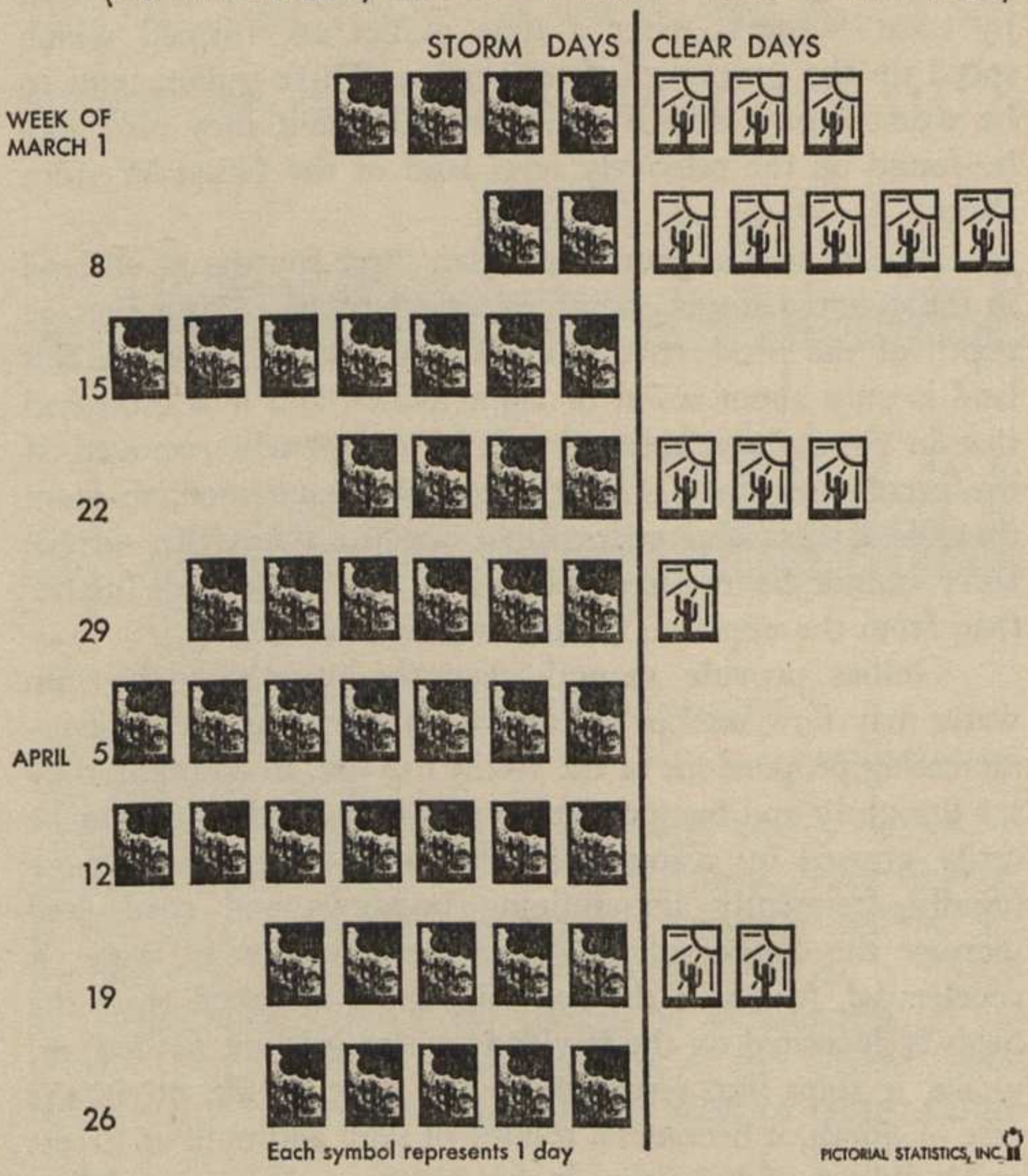
Soil that is protected by forests, grass, or other vegetative covering rarely washes away to any great extent. But when a heavy rain falls on land that has been grazed, ploughed, or cultivated, or where crops have been planted incorrectly, the top soil is gradually washed away. This is known as "sheet erosion." It is particularly insidious because it is not noticed by most farmers. After a time gullies are formed which speed up the process of deterioration. These gullies tend to be worst where land is somewhat hilly, but they also may be found on the relatively level land of the Great Western Plains.

As a matter of fact, more than three-fourths of all land in the country slopes to an appreciable degree. The average depth of the productive, humus-containing top soil on this land is only about seven or eight inches, and it is estimated that in most places this soil will be completely removed, if the present methods of cultivation are maintained, in from three to seventy-five years. Once washed away, this surface layer cannot be restored, even if it has moved no further than from the upper to the lower side of a field.

Gullies provide natural channels by which the rain water may flow unimpeded to the sea, carrying with it ever-increasing proportions of the fertile top soil. In addition, they are unsightly and hamper farm work because they cannot be easily crossed by teams and farm implements. They grow rapidly—frequently undermining buildings and roads—and increase the danger of floods because the flow of water is accelerated. Much of the top soil that is removed from the fields is deposited on the lowlands where it is not needed, or, worse, it seeps into reservoirs in the form of silt, or, in the case of floods, it becomes a residue of sand and mud in streets and buildings of our cities. It also appears as barren mud flats and sand bars in rivers, and is deposited in deltas, a thousand miles away.

*Wind*

The great dust storms on the Western prairies in the past few years have served to dramatize the fearful havoc




wrought by wind erosion. On May 11, 1934, a single dust storm swept 300 million tons of top soil off the fertile wheat plains of the West. This is nearly as much as is washed

annually into the sea by the Mississippi River. In addition to blowing away the soil, these "black blizzards" do serious damage to crops, livestock, machinery, to say nothing of the health of the persons living within the dust-ridden areas. At Amarillo, Texas, during March and April, 1935, there were 47 days in which visibility was limited to six miles or less because of the storms. On several occasions, it was so dark in the middle of the day that artificial lights were necessary. The storms were followed by a notable increase in sickness; some hospitals were filled to capacity. Farm animals also suffered from the dust-laden air, and a large number died from having eaten food containing excessive amounts of grit.

Man did not create the wind any more than he did the rain, but his practices have greatly increased its destructiveness. The Great Plains region was originally covered by a heavy grass that was excellent in its soil-binding qualities. Such land suffered very slightly from the wind, even in years of protracted drought. During the nineteenth century, the more fertile areas of this section were planted in wheat and corn, while the dryer regions, further West, were preserved chiefly for grazing. While grazing frequently prepared the way for erosion, it was not ordinarily destructive when practiced in moderation; but in the early years of this century, particularly during and immediately following the World War, large sections of grazing land were ploughed up and seeded in grain. Much of this land is still in cultivation although it may only yield a crop once in two or three years; but a large proportion has been abandoned and lies wholly unprotected against the wind and rain. It is estimated that from 20 to 50 years are required to develop new sod on such abandoned land. Faulty methods of cultivation have contributed unnecessarily to the losses suffered on the remainder.

*Drought*

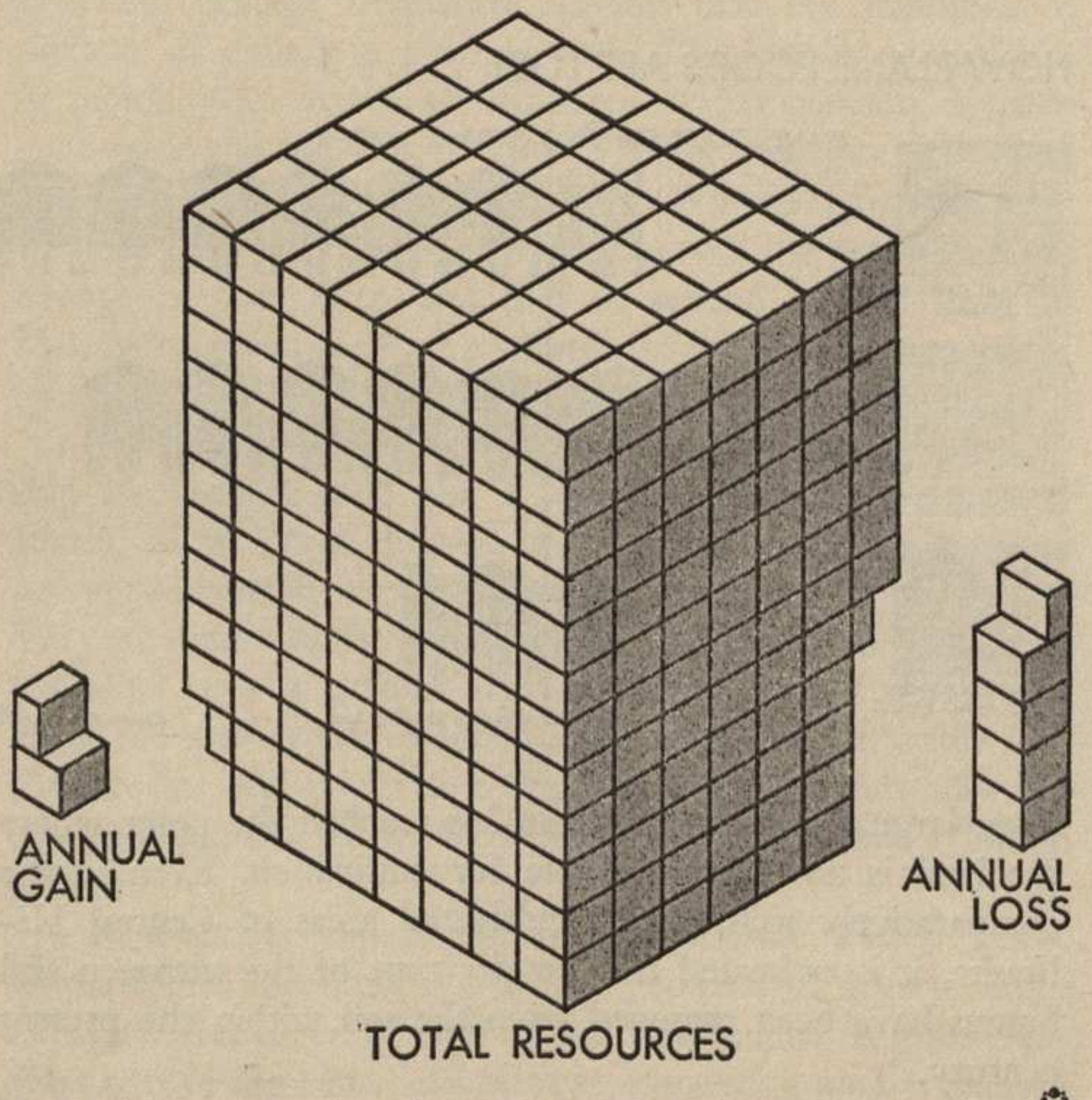
Drought has been a major factor in increasing these losses in recent years. For the six years ending in 1936, there was a serious shortage of rainfall in practically all of the states lying between the Mississippi and the Rocky Mountains. Since much of this region is normally semi-arid, the protracted dry spell proved highly destructive. Crops failed year after year; thousands of head of cattle perished for lack of fodder and water; whole areas of once rich farming land were abandoned.

We have noted that the rainfall for the country as a whole has not undergone any marked change in recent centuries. But even in the better-watered areas, the rainfull during the growing season is usually insufficient for the needs of the growing crops. This lack is offset by drawing on the moisture which is normally retained in or under the soil. In some sections, this underground reservoir has been appreciably reduced by man's activities. Wells for farm and industrial use take large quantities of water. Gullies permit the rainfall to run off before it has a chance to permeate the soil thoroughly. Moreover, the character of the soil in a grass-covered or forested region permits absorption more readily than if the same area were barren or planted in non-humus-producing crops.

*Soil Depletion*

A soil may lose its fertility for any one of a number of reasons. We have indicated the influence of wind, water, and drought. Equally serious is the gradual reduction in the amount of nitrogen and other vital elements upon which the great majority of crops depend. The National Resources Board has estimated that soil of the United States loses approximately 16 million tons of nitrogen, 36 million tons of

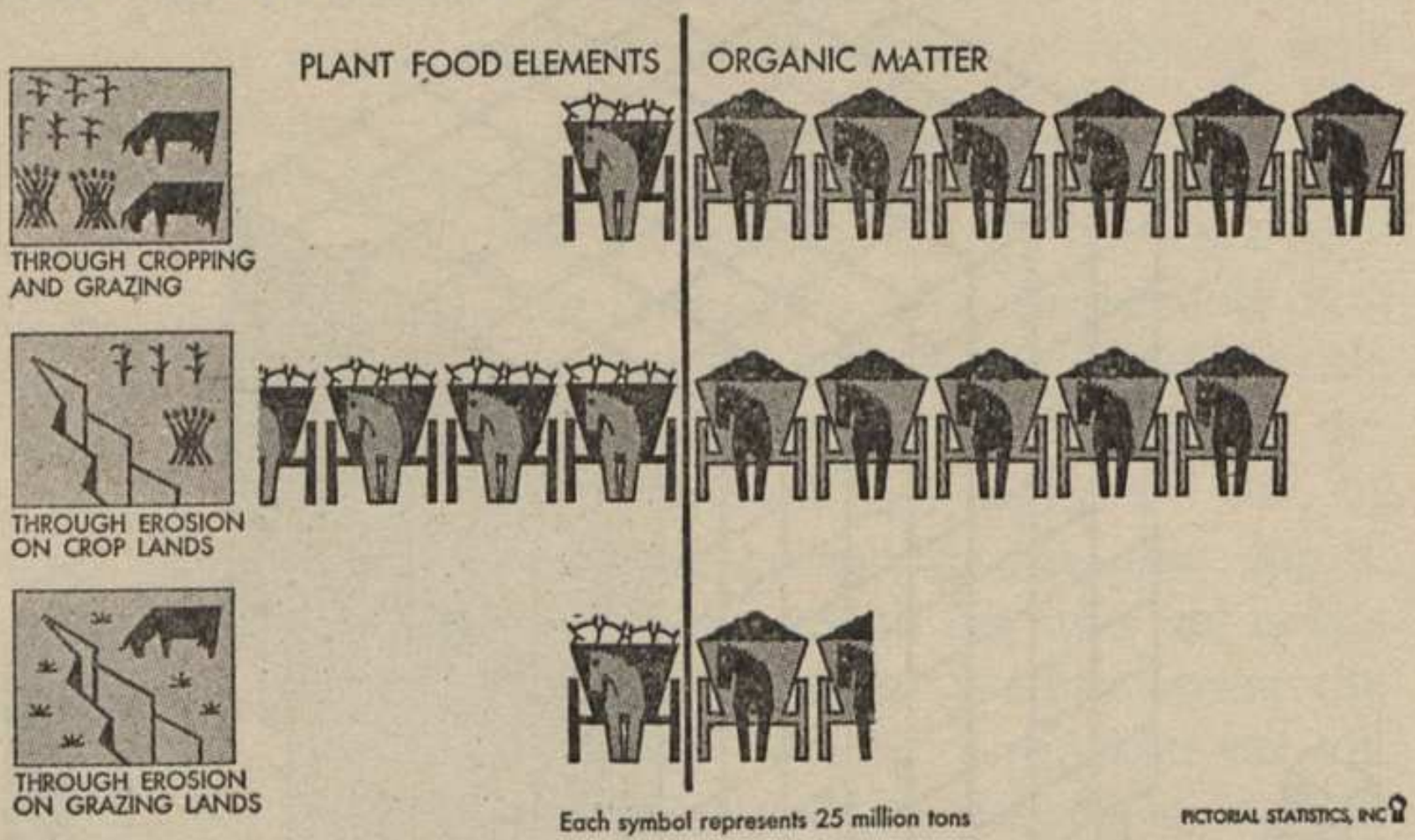
potash, 53 million tons of calcium, 16 million tons of magnesium, and 322 million tons of organic matter each year. One-half to three-fourths of this loss may be attributed di-




rectly to erosion, while the remainder is regularly absorbed by crops and pastures. A portion of these vital elements is restored each year by commercial fertilizers, rainfall, and the rotation of crops, but there is a huge net deficit which

has not and cannot be replaced without a revolutionary change in agricultural methods. The net loss in organic material alone amounts to some 220 million tons annually, to which must be added a deficit of 4 million tons of nitrogen, 31 million of potash, 40 million of calcium, and 12 million of magnesium—a total of over 300 million tons annually.

## HOW PLANT FOODS ARE LOST




Over large areas, soil depletion has reached the point where the land is no longer suitable for cultivation. Even in the comparatively rich, newly cultivated areas of Central Nebraska, it is estimated that 40 per cent of the nitrogen and humus have been removed from the soil within the present century.

Nevertheless, water, not soil, is the resource that will ultimately limit the agricultural capacity of the United States as a whole. Adequate rainfall or irrigation would contribute at least in part in restoring the lost fertility of the soil.

*Floods*

We are still too close to January, 1937, and March, 1936, to need reminding of the tragic consequences of floods. While the economic depredation of high water is by no means as severe as that wrought by the less spectacular forces of erosion, the damage frequently mounts into the hundreds of millions of dollars in a single year. The average annual loss in recent years has been estimated at $35,000,000. Experience over the last ten or twelve years indicates that flood levels are rising on many streams. We find, for example, that the 1927 flood on the Mississippi was the greatest in the history of that river, and that its second highest mark at Memphis was in 1916. The floods of 1936 and 1937 established records along the Ohio and many other streams.

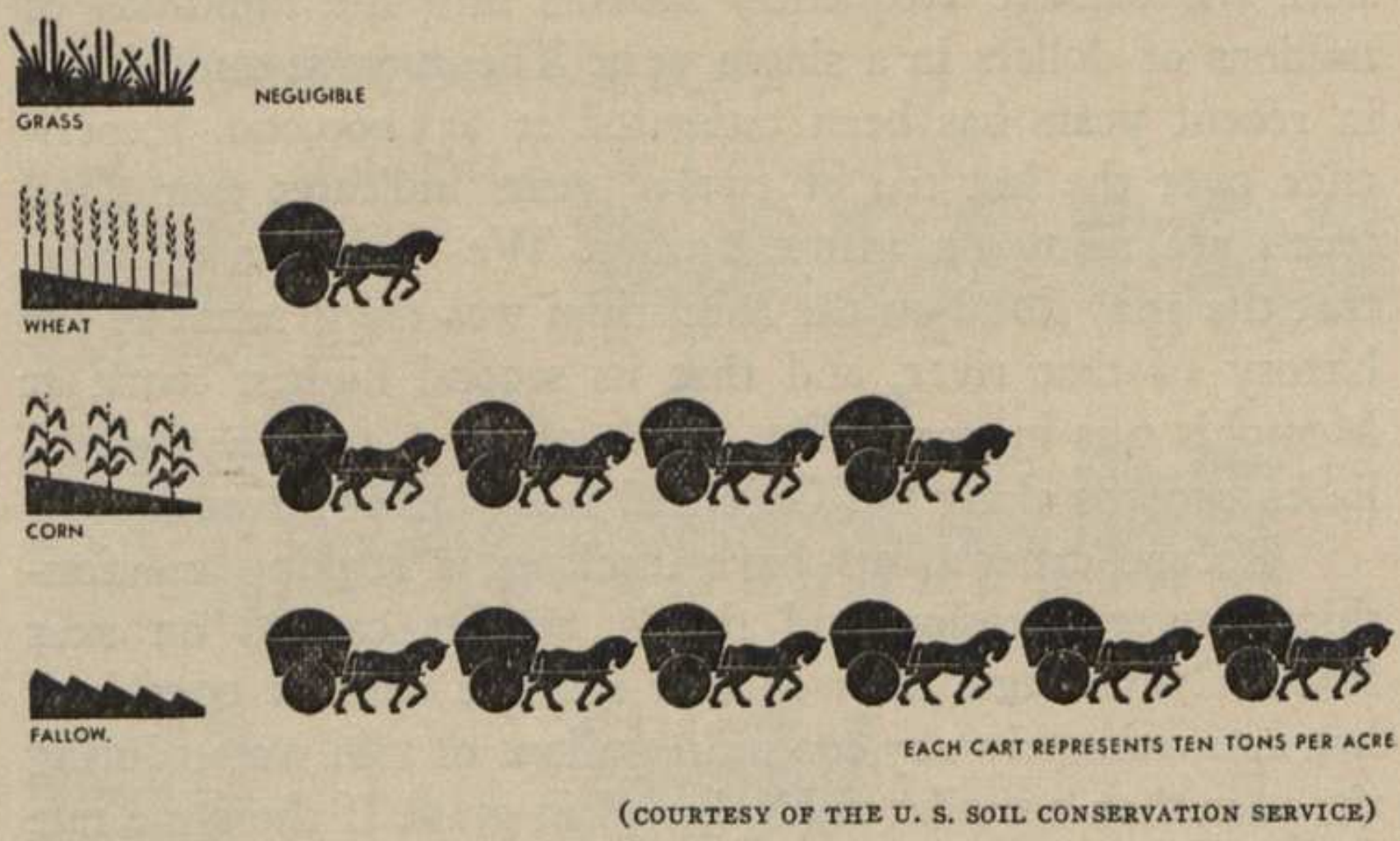
Recent experiments have disclosed a striking relationship between erosion and floods. Studies carried on near Ithaca, New York, showed that a single acre of corn land lost approximately 127,000 more gallons of rain water during the year than a similar field planted in grass. If the same rate prevailed over a million acres of land, planted entirely in corn, the area would pour 134 billion gallons of water into the streams and rivers in a single season. The run-off from the same amount of meadow land would be only 7 billion gallons.

In a similar experiment conducted near Tyler, Texas, it was found that only .35 of one per cent of a very heavy rain ran off a piece of land which was sodded in grass. Another part of the same field, with an identical slope but planted in cotton, lost 31 per cent of the rainfall. A fallow plot with half the slope lost 35 per cent of the total precipitation.

Closely linked with the problem of controlling our surplus waters are the questions of irrigation and power production. If some method could be devised to withhold and utilize a substantial proportion of the flood waters which

now pour off the Great Plains, agricultural production and living standards might be materially raised. Less water in the streams in March means more in July and August. And it is possible that in the interval this water can be made to

## SOIL LOSSES THROUGH CULTIVATION

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do double duty for irrigation and the production of cheap power.

## METHODS OF CONSERVATION

We cannot replace the tons of fertile top soil which have been washed into the ocean. Nor can we wholly put a stop to the natural process of erosion. It is within our power, however, to reduce these losses to moderate proportions. Some areas in Europe have been farmed for centuries without destruction of the soil. Japan, with infinitely less soil resources than those of America, has fed a rapidly increasing population for an equally long period. What these countries have done without the aid of modern

science should be infinitely less difficult today, given the great strides in erosion control which have been made in recent years. With care it can be done cheaply.

A national Soil Erosion Service was established in October, 1933, under the Department of the Interior. This agency, now known as the Soil Conservation Service under the Department of Agriculture, has established a series of model projects in various parts of the country for the demonstration of conservation practices. Each project has a staff of specialists experienced in the technical aspects of erosion, land use, agronomy, forestry and farm management. The conservation methods employed on these projects vary with dissimilar conditions in different parts of the country. The Government enters into five-year cooperative agreements with the farmers in each area under which it agrees to provide all necessary technical advice and assistance and such labor and materials as the farmer cannot supply, together with a land-use and cropping plan for the five-year period. The farmers, in turn, must follow the plans laid down and provide their share of the labor and materials. At the present time, the Service is conducting 174 demonstration projects in 45 states. In addition, it is responsible for similar demonstrations on farmlands surrounding some 450 camps of the Civilian Conservation Corps.

The problem as it affects the country as a whole has been carefully surveyed by the National Resources Board. This body has made valuable suggestions with regard to the broad policies which the country should adopt in a conservative program. They have found much, as we shall see later, that can be done by the federal and state governments by means of careful planning. But the immediate responsibility for care of the soil lies in the hands of millions of individual farmers scattered throughout the country. Each farmer must decide for himself whether to continue the old soil-destroying practices or to adopt modern soil-saving methods of cultiva-

tion. For many years the Department of Agriculture has been publishing material designed to aid the farmer in his conservation efforts. Recently this educational program has been supplemented by the Agricultural Conservation Program, authorized by the Soil Conservation and Domestic Allotment Act. Provision has been made for payments in cash to farmers who have lived up to the soil-improving standards established by the Agricultural Adjustment Administration. A number of states have adopted legislation facilitating cooperation with the Federal Government in this program.

*A Planned Farm*

A farmer's first task should be to determine to what use the different parts of the farm are to be put. Here he need not depend solely on common sense or general technical advice. The Soil Conservation Service will prepare maps for all farms included in the area of its demonstration projects showing how each section of the farm should be utilized, and its expert assistance is available even outside the demonstration areas. Only the most fertile and level lands should be devoted to crops. The remainder should be given over to pasture or woodlots. Where erosion has already started, special treatment, such as the use of terraces, strip cropping, or possible retirement to trees or permanent vegetation, may be necessary.

*Forests*

Wooded land is perhaps the best safeguard against erosion. Trees, with their canopy of foliage, break the force of the rain. They drop a protective carpet of leaves and twigs through which the raindrops trickle slowly into the ground. And their roots bind the soil so that it cannot be easily washed away. Even on the steepest hillsides, forest land is seldom eroded.

Reforestation on a large scale is primarily for the state and national government rather than the individual farmer. Comparatively few farmers can afford to devote any considerable portion of their land to trees. Yet hillsides should, wherever possible, be given over to woods as should the poorer soils. The woodland that already exists should be carefully preserved and used to furnish seedlings for the new plantings.

The National Resources Board recommends the reforestation of some 22 million acres of abandoned crop and pasture land to prevent erosion. Most of this is in the East or South, country which was formerly covered by forests. But the Board points out that forestry knowledge is now sufficiently advanced to undertake plantings in the eastern portion of the Great Plains area. It suggests that at least three million acres in this region be devoted to protective belts of trees. Forty-four thousand acres have already been planted. Later, when experience in dry regions becomes more highly developed, another three million acres of forest are contemplated further west.

Parallel with this program of reforestation, the Board recommends the purchase by the Federal Government of some 20 million acres of submarginal crop land and 35 million acres of pasture land, most of which should ultimately be established as forests.

*Grass*

Where trees are not practicable, grass may do the job with almost equal effectiveness. Fibrous, close-growing roots bind the soil in position, while the blades and stalks prevent the rain from actually striking the surface. Fallen blades and roots serve as innumerable little dams to prevent water from flowing downhill rapidly. In a recent experiment at Bethany, Missouri, a plot of grass lost only 9 per cent of the snow and rain which fell during a five-year period of observation.

On an adjacent plot with the same slope, which was without vegetation, 31 per cent of the precipitation was lost. The erosion which takes place under grass is so gradual that it is usually counterbalanced by the new soil which is constantly, if slowly, being built up from beneath the surface.

Any type of grass will aid in controlling erosion, but certain types of grass have proved much more satisfactory than others. Blue grass is excellent in many regions, but it does not grow well on poor land or in dry areas where erosion is often the most severe. Buffalo and blue gamma grass, the two most satisfactory grasses for the Great Plains and Rocky Mountain States, are notoriously slow in spreading. Recently, however, methods have been worked out for reestablishing these grasses much more rapidly than was formerly believed to be possible.

Grass is particularly useful to prevent gullies from forming on good land. It is also helpful where gullying has already started. Sod planted on the banks of a deep gully may check further erosion. It is often possible to eliminate a small gully by sloping down the sides and planting a combination of various grasses. Sod may also be used effectively on check dams to delay the flow of water on the gully bottom.

### *Crop Rotation*

Most farmers will be able to set aside only a small portion of their land for woods and grass. This imposes a special responsibility on them to care for the soil which is to be devoted to cultivation. No land should be continuously used for a single crop. Uninterrupted cultivation not only accelerates erosion but tends to deplete the soil of vital elements. This may be avoided by a scientific rotation of crops from year to year. The Department of Agriculture recommends that the moisture and humus supply of the soil be replenished by planting legumes every second or third year wherever

possible. Where this is impossible, it suggests changing the crops from year to year so as to avoid a continuous drain on the same plant food resources.

*Contour Tillage and Terracing*

The extent of erosion has been found to vary considerably with the type of cultivation which is employed. It is particularly important that sloping land be ploughed at right angles to the grade. The American custom, particularly in the Middle Western States, of laying out counties, townships, and sections on rectangular lines has led many farmers to form the habit of ploughing parallel to the fences, regardless of slope. Thus the furrows may extend up and down hill and furnish natural channels to hasten the run-off of rain water. The most scientific method of ploughing is to follow the contour so that each furrow may act as a miniature dam to block the downward rush of water.

Frequent cultivation is also important, but it is inadvisable to pulverize the soil to too great an extent. In relatively hilly country, terraces have been found to be an important means of protection. It is not necessary for these terraces to be of the elaborate type used in countries like Japan and Italy. Land is not scarce enough in the United States to demand the use of every available square foot of hillside as is the case in some foreign countries. The type of terracing used in this country is usually that of building parallel ridges of soil, ranging from one to three feet in height, along the side of the hill. These ridges serve to slow up the flow of water, and thereby increase the amount which is absorbed. They also make it possible to divert the water to natural channels on the side of a field, and thus prevent the formation of gullies. It is ordinarily desirable to support the ridges by grass or some other form of vegetation. Contour stripcropping is particularly effective in conjunction with terraces.

*Strip-Cropping*

Where the slope is not too great, strip-cropping may serve as an alternative terracing. Under this plan strips of soil-conserving plants, such as grass, or legumes and sometimes bushes, are alternated with clean-tilled crops like corn or cotton. The strips are planted in parallel lines at right angles to the slope in much the same manner as the terraces are constructed. They may be either temporary or permanent in character. On a comparatively gradual slope, it is often advisable to rotate crops on the same field, with alternate strips of legumes and a tilled crop. The following year the same crops may be planted with their positions reversed. Where the slope is more pronounced, permanent strips of fruit trees or berry bushes have been found to be more satisfactory.

If all of the farmers in the country made a regular practice of crop rotation, contour ploughing, and such terracing and strip-cropping as is necessary, there would be considerably less cause for concern over the effects of erosion on our soil. These practices, if accompanied by reforestation and restoration of sod cover, should also alleviate existing fears regarding the depletion of our underground water resources. But soil conservation practices of this sort seem, and often are, too expensive for the average farmer. Soil-restoring crops usually do not pay as large an immediate cash income as soil-depleting crops. Land which is set aside for woodlots or grass may pay even less.

Yet the period in American agriculture in which it was profitable for the individual farmer to exploit his land to the utmost and move on is definitely passed, at least for farm owners. The free land of the frontier is a generation behind us. The soil is the farmer's greatest asset. If carefully preserved, it will afford a livelihood year after year and lose none of its original value. But if it is robbed of its fertility, it will ultimately become valueless both to the farmer and to

the nation as a whole. Intelligent and conservative use of the soil will ultimately pay the land-owning farmer many times over in dollars and cents. The advantage to the tenant—and two-fifths of our farm area is tenant-farmed—is not so apparent, but even he will be the gainer if he can obtain a long-term lease.

### *Checking Wind Erosion*

Many of the steps taken to prevent gullying and a loss of surface water will also afford protection against wind erosion. Soil never blows if it is adequately covered by vegetation, while barren fields or land which has been overgrazed are particularly susceptible to blowing. Soil usually starts drifting in small areas in a field. If these areas can be restricted, little damage will be done. But, if no measures of protection are taken, these areas, often called "blow spots," tend to spread until they become a menace to the surrounding fields.

Wind erosion may be checked by applying the same principle used in controlling water erosion. Obstructions block the wind currents and cause at least part of the soil which has been caught up to be deposited. These obstructions need not necessarily be large. Stubble left over from the previous year's crops offers some protection, provided it has not been tramped down by cattle. Woodlots, wooden or woven wire fences serve as more effective barriers to the air currents, and even weeds or thistles will offer considerable resistance to an ordinary wind.

Where possible, therefore, a farmer should see to it that his fields are covered with stalks or stubble at the beginning of the winter. Much damage is done by the common practice of grazing cattle on the stalk fields after harvest. The animals not only remove the weeds and grass which might serve as a wind-break, but loosen the soil with their hoofs, making it ready to move with the first strong wind.

But there are times, such as after a severe drought, when there is no stubble or vegetation to protect the soil. In such instances, it is possible for the farmer to adopt emergency measures to reduce the amount of blowing. Anything which roughens the surface of the ground will help. It is important that clods be brought to the surface, and that the furrows run in such a way as to retain any rain that may fall. If there is not time to till the entire field, it is advisable to dig up strips so as to prevent the wind from getting too much headway. These strips will also serve to conserve the water and thus promote the growth of vegetation.

In the long run, water is the key to the problem of wind erosion. Most areas subject to dust storms are definitely deficient in moisture. It is especially important, therefore, that such rain as does fall be retained. The value of the methods suggested above was shown in the great drought of 1936. Through Government assistance more than two million acres of land on the Great Plains were ploughed on the contour (i.e. crosswise to the slope) in the spring of that year. When the rains finally arrived late in May, tests were made on the land, and the results compared with land which had not been so treated. It was found that about one inch of additional moisture had been retained as a result of contour ploughing. The soil was wet approximately a foot deeper on the protected land, and, as a result, it is estimated that plant growth was increased by 500 million pounds. Had the same methods been resorted to in time throughout the entire drought area, tremendous losses might have been avoided.

In December, 1936, the Great Plains Committee submitted a comprehensive program for the rehabilitation of the "dust bowl." In addition to recommending a complete plan for research and study, the Committee advocated the development of new methods for storing water, and supplemental irrigation. It suggested that wherever practicable trees

and shrubs be planted on the borders of fields and around houses as windbreaks. State action for zoning rural land to insure its proper use was also urged.

The Federal Government has also undertaken, in the Taylor Grazing Act, to regulate grazing. New government lands have been opened to private individuals for grazing purposes on condition that the number of cattle per acre be carefully controlled. The Secretary of Interior is permitted to exchange government land for that belonging to states, localities, or private individuals. While few exchanges have been made thus far, a large number of applications are being considered by the Department. The "shelterbelt" plan of tree planting in the "dust bowl" should also aid materially in limiting the destructiveness of wind erosion.

*Flood Control*

We have suggested that the control of erosion is an important, if not the most important, means of preventing floods. Floods are simply raindrops, infinitely multiplied, which have accumulated too rapidly in a single channel. Anything which impedes the progress of these raindrops, whether it be forests, grass, terraces, or contour cultivation, tends to reduce the concentration of water. Thus, erosion control might also be called "up-stream flood control."

There are, however, other methods by which water can be checked on its march to the sea. The United States Soil Conservation Service has recently devised a low-cost method of slowing the flow in gullies and small streams. Small porous dams, known as "check dams" are constructed of logs, brush, and straw—or occasionally stone—which hinder but do not actually stop the flow of water. In small streambeds a somewhat more substantial dam may be constructed which will create a reservoir of water for animals and wild fowl.

*Ponds and Reservoirs*

On many farms it would be advisable to construct small ponds for storing water for use in dry seasons. In some instances the pond would serve primarily to promote infiltration and thus increase the supply of ground water. In most cases, however, the water could be used directly for irrigation purposes. Supplementary irrigation is important even in regions where the average annual rainfall is adequate. Nature is notoriously improvident. There is frequently an oversupply of rainfall in the early spring, and a serious deficiency during the growing season when it is most needed. A small reservoir permits regularity in application, and will ordinarily tend to increase yields. Supplementary irrigation of this type has proved especially useful for truck and vegetable gardens in the eastern part of the country.

A somewhat more ambitious use for ponds and reservoirs has been developed in the Upper Rhone Valley in France. This region is markedly similar to our own Upper Mississippi Valley. It contains hills and gentle slopes; fertile soil mixed with rocks, gravel, sand, and clay. The whole valley is dotted with ponds and lakes, the majority of which are man-made. The locations of those ponds is changed from year to year as the farmers practice a sort of rotation of crops. One or two years is devoted to "water farming" and the following year to "land farming." In the period given over to "water farming," the pond is stocked with fish and fowl; in the following year, the land is seeded to wheat or barley. This type of rotation has proved highly successful. When covered by water, the stubble of grain, dead leaves, and twigs are attacked and eaten by fungi. Aquatic vegetation develops which serves as food for fowl and fish. After the pond is drained, the aquatic vegetation is greedily consumed by farm animals, while the protein material left behind serves as fertilizer for the soil.

*Swamps and Marshes*

Even swamps and marshes may have a definite social utility in connection with erosion and flood control. Many of the swamps which have been drained in past years have been found to be useless for the growth of ordinary crops. Soil experts now recommend that these marshes be restored. Marsh hay has some value for pasturage, while huckleberries, blackberries, and cranberries can be commercially developed. While large-scale revival of swamps and wet lands can only be undertaken by the federal or state governments, the individual farmer may occasionally find it to his direct interest to undertake a project of this type.

*Need of Up-Stream Control*

All of this, the sceptic may say, has little to do with actual flood control. There were severe floods long before America was subjected to the ax and plough of the white man. When De Soto first saw the Mississippi in the sixteenth century, it was in full flood. But that there is a difference between the floods of pre-agricultural days and the more recent ones is indicated by the residue which they have left. Overlying the alluvial deposits which have accumulated through the centuries is a new and different kind of deposit which has accumulated since the arrival of the white man. This upper deposit is coarser and more varied in composition. In many instances, the depth of the new material is greater than that of the old, even though it has all been deposited in 50 to 100 years while the bottom layer represents the accumulation of thousands of years. Most authorities declare this to be ample proof that the present-day floods are much more severe than those which took place in pre-agricultural days.

*Dams and Levees*

It should be recognized, however, that even the most ambitious program for up-stream flood control does not eliminate the necessity for the large engineering projects that are ordinarily listed under flood-control measures. Large dams serve precisely the same purpose as small ones in delaying the flow of water, and they have the additional advantage of being useful for irrigation and power purposes. This does not mean that dams should be constructed hit or miss solely for the purpose of flood control. Dams are usually expensive undertakings, and a careful study should be made of the possibilities for paying off the investment through the sale of power and water. In this connection the very real soil-conserving value of irrigation should not be overlooked; nor should the usefulness of dams in transforming shallow rivers into navigable streams be forgotten. Dredging of channels has occasionally aided somewhat in restricting floods, although the results have usually been disappointing. One of the by-products of erosion has been the rapidity with which river channels have become clogged with silt in recent years.

Somewhat more helpful has been the construction of levees, revetments, and spillways to control the flood waters. The value of the wall at Cairo, Illinois, was dramatically shown in the flood of February, 1937, when the city was saved from inundation by a margin of a few inches. The system of Mississippi levees also held up notably in the 1936 and 1937 floods. But since no system of walls and levees can possibly be built high enough to confine every conceivable flood, their value is a distinctly limited one.

## WANTED: A NATIONAL PROGRAM

It should be evident from the foregoing discussion that the problem of erosion and flood control cannot be solved solely by the action of individuals, localities, or even states. The problem is national in its implications. A flood which originates in Pennsylvania or the Dakotas may do its greatest damage in Arkansas and Mississippi. The soil which is washed off the wheat fields of Kansas and Nebraska may silt the Mississippi channel at New Orleans. The Government's interest goes further than that of any individual. Owners have merely an interest in preserving their land for themselves and their immediate descendants. That of the Government is perpetual for conserving an indispensable asset for future generations. Moreover, the Government alone is in a position to bridge the gap between big waters and little waters, and between soil conservation and flood control.

That the Federal Government must be responsible for coordinating activities designed to overcome the joint threat of floods and soil depletion is clearly recognized in the Flood Control Act passed by Congress in the spring of 1936. This Act states:

"that it is the sense of Congress that flood control on navigable waters or their tributaries is a proper activity of the Federal Government in cooperation with the States, their political subdivisions, and localities thereof; that investigations and improvements of rivers and other waterways, *including watersheds thereof*, for flood control purposes are in the interest of the general welfare; that the Federal Government should improve or participate in the improvement of navigable waters or their tributaries, *including watersheds thereof*, for flood control purposes. . . ."

Section II of the Act places the responsibility for flood control activities on rivers and other waterways in the

hands of the Secretary of War, and gives the Secretary of Agriculture authority over measures for waterflow retardation and the prevention of soil erosion on watersheds.

The preliminary work for the creation of a national program for soil conservation and flood control has already been carried out in the reports of the Mississippi Valley Committee of the Public Works Administration and the National Resources Committee. Much more needs to be done, however, in the way of study and the collection of information before the task can be carried to completion. Some of these studies are now underway; the majority are still awaiting an appropriation of funds.

One of the primary tasks which must be faced lies in the division of responsibility between the state and federal governments. Many aspects of flood control and conservation may be dealt with best on a regional basis; they cut across state lines and yet do not embrace the entire nation. The establishment of the Tennessee Valley Authority was a recognition of the value of a regional coordination through interstate compacts, but these have not always been successful. A particularly bitter conflict marked the development of the Boulder Dam project which is based on a six-state compact. The State of Arizona not only refused to join the compact but appealed to the Supreme Court in an unsuccessful attempt to prevent the building of the dam. More recently, interstate planning commissions have been established in New England, the Ohio Valley, and the Pacific Northwest. But the 75th Congress refused to approve the four-state Connecticut Flood Control Compact on the ground that it did not conform to the terms of the 1936 Flood Control Act. The Mississippi Valley Committee of the Public Works Administration also faced the regional problem in its general plan for erosion and flood control in the Mississippi basin, and its recommendations envisioned both federal and state action. For the control of erosion it recommended:

1. Federal legislation authorizing Government agencies to cooperate with the owners of land in the establishment of such measures as may be appropriate in the control of soil erosion; this cooperation to be carried out through the established agencies in states, and counties, or the responsible land districts, or directly with the owners.
2. Strong emphasis on control of erosion in the general program of land acquisition for national and other public forests, and in connection with the withdrawal of marginal lands from agriculture.
3. Liberal appropriations by the Federal Government to continue and extend research, experiments, and demonstrations in erosion control, to make adequate surveys of the character and extent of erosion, and to cooperate with the states in classifying land as a basis for the application of the cooperative program of erosion control.
4. State legislation authorizing cooperation with the Federal Government in a national program of erosion control.
5. State legislation authorizing the organization of conservancy districts for erosion control, with authority analogous to that of existing drainage, water, or levee districts.
6. Federal legislation enlarging and making more effective the control of erosion on lands owned by the Government.

Some of these objectives have already been partially carried out. The Agricultural Adjustment Administration's report for 1936 indicated that farmers cultivating 67 per cent of the total crop land of the United States had applied for grants under the Soil Conservation Act of that year. A standard soil conservation districts law drafted by the Department of Agriculture was submitted to the various state legislatures by President Roosevelt in February, 1937, and has already been adopted by more than 20 states. It provides for the establishment of committees in each state with authority to form conservation districts to administer erosion control

projects, and delegates to committees in these districts power to prescribe such land-use regulations as are appropriate to the needs of each district.

For "down-river flood control," the Committee worked out a rather elaborate scheme involving a sharing of costs and responsibility between the federal and local governments. In general, it is suggested that the costs of land, rights-of-way, and local damages be met by local interests, and that the Federal Government assume the entire costs of construction where the value of the project to the locality was only incidental. Where the benefit was chiefly to the local community, it was suggested that the Federal Government contribute approximately 30 per cent of the cost of labor and materials. This arrangement applied only to the period of economic emergency for which the Public Works Administration had been made available.

*Plan of the National Resources Committee*

In December, 1936, the National Resources Committee * issued a detailed six-year plan for public works in the United States which contained recommendations for a large number of dams, levees, irrigation, and other water-control projects. Still other undertakings were listed as desirable but not of first importance. In other instances, the Committee asked that an appropriation be made for further study of proposed projects to determine whether they were economically practicable. It also asked that sums be set aside for further study of the relation between erosion, silting, and flood control, and for the collection of data on rainfall, ground water, evaporation, and related subjects.

In this report, the National Resources Committee emphasized the close interrelation between land and water plan-

* On June 15, 1935, the National Resources Board was transformed into the National Resources Committee. The duties and powers of the two bodies were virtually identical.

ning, and also stressed the need for a coordinated federal water policy rather than a collection of *unrelated* policies such as had hitherto been in effect. It suggested that a sound water policy should have the following characteristics:

1. It would be concerned, in the final analysis, not with water itself, but with the promotion of public safety, public health, the public convenience and comfort, and the establishment of high living standards.
2. It would seek to promote the fullest use and control of water that is technically possible and that is justified on economic and social grounds.
3. It would normally treat drainage areas as units, but would scrupulously observe state rights in the use of the waters of all streams.
4. Costs should be distributed in proportion to the benefits received.

### *Conservation Measures in Congress*

More than a score of bills were introduced into the 74th Congress for the establishment of regional agencies roughly similar to the T.V.A. All of these were concerned with the development of navigation, power, flood control, and irrigation facilities. They were superseded in the 75th Congress by comprehensive bills introduced by Senator Norris and Representative Mansfield.

While the Norris and Mansfield bills are identical in many respects, they differ on several important details. Both bills would divide the country into seven regions: (1) the Atlantic seaboard, (2) the Great Lakes and Ohio valley, (3) the Tennessee and Cumberland River basins, (4) the Missouri and northern Red River valleys, (5) the basins of the Arkansas, Red, and Rio Grande rivers, (6) the basins of the Colorado River and the rivers flowing into the Pacific south of the California-Oregon line, and (7) the Columbia valley. The Mississippi River would be left in the hands of

the Mississippi River Commission which is under the War Department.

The Norris bill would set up conservation authorities for each of the seven districts modeled after the Tennessee Valley Authority. These authorities would be responsible not only for general planning, but for administering such power projects as might be created.

In contrast to this, the Mansfield bill would establish seven agencies whose sole functions would be that of planning. It would permit the President at his discretion to create separate regional power authorities to exercise administrative functions. It also differs from the Norris bill in placing certain development projects under regular federal agencies rather than under the regional authority. Both the Norris and Mansfield proposals have been vigorously criticized by conservative interests on the ground that they place too much power in the hands of the Federal Government. The Mansfield measure, however, has received Administration support.

In a special message to Congress on June 3, 1937, President Roosevelt called for immediate action to conserve our natural resources and prevent floods, droughts, and dust storms. He declared that:

> Our recent experiences of floods have made it clear that the problem must be approached as one involving more than the great works on main streams at the places where major disasters threaten to occur. . . . A comprehensive plan for flood control must embrace not only downstream levees and floodways, and retarding dams and reservoirs on the major tributaries, but also smaller dams on the lesser tributaries, and measures for applying conservation throughout an entire drainage area, such as the restoration of forests and grasses on inferior lands, and encouragement of farm practices which diminish run-off and prevent erosion on arable lands.

On the day previous to the President's message regarding water-control policy, Secretary Wallace announced the in-

auguration of a regional program to combat wind erosion in the "dust bowl" of the Southwest which extends over parts of Colorado, Kansas, New Mexico, Oklahoma, and Texas. A new agency was established under the Department of Agriculture to coordinate the work of the Resettlement Administration, the Agricultural Adjustment Administration, and the Soil Conservation Service in working out a plan for preserving this potentially rich area. All five of the "dust bowl" states have passed laws within the past two years which provide a basis for federal-state cooperation in a regional program.

In order to achieve the type of integrated planning which is necessary to preserve America's rich natural heritage, the National Resources Committee has repeatedly recommended the creation of a national planning board which would be responsible directly to the President. The President's Committee on Administrative Management suggested that the National Resources Committee itself be reconstituted to serve this purpose, but the Administration bill introduced into the Senate on June 23, 1937, by Senator Robinson, provided for a somewhat broader national planning board to replace the present National Resources Committee. The President has indicated that he intends to use this board to coordinate the programs of the proposed regional planning boards.

*Need for Action*

If we were to list the soil conservation and flood control projects which have actually been undertaken within the past few years, the list would be extremely impressive. In addition, a great deal of information has been compiled by various government agencies and planning boards looking toward future activities. Thus the foundations have been laid for a comprehensive educational and practical program designed to overcome one of America's greatest problems. But we should

not allow the volume of preliminary work which has been done to blind us to the fact that we have not yet begun to meet the challenge of erosion. Our soil is still pouring into the ocean at the rate of approximately a billion tons annually. In certain sections of the country, our floods appear to be growing more disastrous every year. Taken all in all, it is estimated that not more than 30 per cent of the cultivated land of the country is adequately protected from the more serious types of erosion. Even with the most intelligent, careful methods of control, years of work will be necessary before we are safe from the insidious enemy which is already within our gates. The problem of conservation, however, is not merely a matter of passing laws and taking measures to check erosion. Many erosion-control projects cost more than they can possibly save. Sound conservation implies careful consideration of the cost in each case.

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