Soil Defense in the South

FARMERS' BULLETIN NO. 1809

FOREWORD

This bulletin describes farming practices that conserve soil, and how such practices may be applied to farms in a large part of the South. Its scope is limited to that part of the Cotton Belt extending west from the Georgia–Alabama line to central Texas and southern Oklahoma. Its subject matter is based largely on the soil conservation practices employed by farmers who live within the various project areas of the Soil Conservation Service in this section of the cotton country. Erosion control practices for cotton farms to the east are described in Farmers' Bulletin 1767, Soil Defense in the Piedmont.

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Soil Defense in the South

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in collaboration with specialists in soil conservation

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FIGURE 1.—*Year after year in the South, row crops are grown on three-fourths of the cropland. Intertilled crops such as cotton and corn afford little or no protection to the soil at any time during their growing period.*

Cotton, Corn, Trees, and Grass

Year after year in the South, cotton, corn, and other row crops are grown on fully three-fourths of the cropland (fig. 1). Owing to this persistent and continuous growing of intertilled crops on lands that, because of the character of soil, slope, and climate, are particularly subject to erosion, soil deterioration from this cause is farther advanced and has destroyed more land in the Cotton Belt than elsewhere in the United States.

If a list were made of field crops that permit Cotton Belt soils to wash most readily, cotton and corn would stand at the top. Neither crop affords much protection to the soil during its period of growth. After harvest, cottonland and cornland enter the winter bare, except for the weeds and grass which appear after the crops are laid by. Winter cover crops follow cotton and corn on only a small proportion of the uplands in the South.

Close-growing, fibrous-rooted plants, on the other hand, hold the soil in place. If a list were made of the crops that hold soil, at its head would stand grass and trees. Grass plants and trees send out hundreds of fine, fibrous roots which lie just under the ground level (fig. 2.)

Dig your fingers into a forest soil or through a thick sod and feel the interlacing roots. These roots help to bind the soil. On sod land and on a forest floor there is a thin layer of vegetable material that performs an important service in helping to prevent soil from washing. It absorbs water, hinders its flow, and removes suspended particles of soil. Clear water soaks into the ground more readily. It will not, as muddy water does, choke the soil pores and retard penetration, which permits run-off to gain volume and speed, and multiply its soil-carrying power. Consider also the dense growth of stems and leaves which protects sod-covered and forested land, breaking the force of falling raindrops.

Before cultivation, the productive surface layer of soil seldom in the Cotton Belt exceeded a depth of 12 or 15 inches on the blackland prairies and smoother parts of forested land or more than 6 or 7 inches on the steeper forested slopes. In the short span of years since cultivation began—usually less than 50 years ago and seldom longer than a century in most of the South—much, and often all, of the topsoil has been removed from large areas. The nature of the process which removes such vast quantities of soil from cultivated fields is, strangely, not widely understood. We have grown accustomed to the gully and accept it as the symbol of erosion; but sheet erosion, the process which precedes gullying, goes on almost unnoticed. Rain water flowing from a clean-tilled field is always muddy, never clear. Laden with soil material, it is the color of the land over which it has flowed. Thus each rain of sufficient intensity to cause run-off, strips a thin layer of surface soil from the land. This process, repeated again and again, is called sheet erosion.

Nature required many hundreds of years to build a thin mantle of topsoil, for soil can become deeper only when less is lost from the surface than is formed from the parent material beneath. Some estimates set the rate of soil formation at 400 to 1,000 years for a single inch. With these estimates in mind let us look at the rates soil is removed under various types of vegetative cover and conditions as revealed in tests at a number of soil and water conservation experiment stations.

At Tyler, Tex., a plot continuously in cotton lost 105 times as much soil as a plot in grass and 237 times as much soil as a plot in forest, in 4 years of an experiment. Differences even more favorable to grass and forest were obtained at the experiment station at Guthrie, Okla. These results are shown in table 1.

FIGURE 2.—*Grass plants send out hundreds of fine, fibrous roots which lie just under ground level. These roots help to prevent soil from washing.*

The Southern Forest Experiment Station, at Holly Springs, Miss., reports that under oak-forest conditions 40,000 years would be required to remove 6 inches of topsoil from a 10-percent slope, at the rate soil was carried away by run-off in a 2-year study period. The figure for a Bermuda grass plot was 10,000 years. Contrast these figures with 28 years, the length of time that would be required to remove 6 inches of soil from a cotton plot planted on the contour, and 10 years for the cotton plot planted in sloping rows, as reported by this station.

Tests of this kind are usually made on small plots, owing to the difficulty of catching and handling run-off from field areas. The plots are surrounded by steel guards to prevent intake of water except from overhead (fig. 3). All of the silt and run-off are caught in concrete tanks and measured.

Figure 3.—*Tests of rates of erosion under various kinds of cover and conditions are made in plots surrounded by steel guards to prevent intake of water except from overhead. The volume of the silt and run-off caught in the concrete tanks is measured.*

The rate at which soil is lost from these experimental plots is revealing. It explains, in tons of soil, in inches of surface soil, why land depreciates so quickly under cotton. It explains the trail of discarded farm land (fig. 4) which followed the advance of cotton across the South—a trail extending from the Carolinas, round the southern tip of the Appalachians, and reaching west through Alabama, Mississippi, Louisiana, part of Tennessee and Arkansas, into Texas and Oklahoma. Millions of acres of land in these States are no longer fit for profitable cultivation. Millions of acres have been turned back to nature. It is said that an experienced traveler can guess the number of years that have elapsed since cotton last was grown by estimating the age of the pine trees with which nature in many places reclaims discarded cottonfields.

Table 1.—Average annual soil and water losses from control plots under various kinds of cover at the Tyler, Tex., and Guthrie, Okla., soil conservation experiment stations

Place	Crop	Slope	Rainfall lost as run-off	Soil losses an acre	Years
		Percent	*Percent*	*Tons*	
Tyler	Continuous cotton	8.75	19.5	19.08	1931–34
	Bermuda sod	8.75	1.35	.18	1931–34
	Forest	12.5	.6	.08	1932–35
Guthrie	Continuous cotton	7.7	14.22	24.29	1930–35
	Bermuda sod	7.7	1.23	.032	1930–35
	Virgin forest	5.2	.20	.017	1931–35

In the whole broad stretch of land known as the Cotton Belt there is little cultivated land, even where the slopes are gentle, that is not marred by erosion, surveys reveal. In upland cotton country, where damage is written across the face of the earth in a scrawl of gullies, advanced erosion has impoverished many farm families (fig. 5) and has caused trade to languish in many towns; and the debris of erosion has clogged stream channels, damaging bottom lands and crops, and has filled reservoirs, causing losses in hydroelectric power and municipal water supply.

FIGURE 4.—*Across the South there is a trail of discarded cottonland made poor by soil erosion. Gullies have ruined much of it.*

Grass to Cotton to Weeds

In the southern part of the blacklands of Texas there is an old abandoned community. It will not be singled out here by name, for there are many others like it in the South equally deserving of mention. An old resident told me, recalling the years after 1880:

I guess this was once the best farming section in the whole country. Crops were mighty good, three-quarters of a bale an acre. There was a general store here then, and it did a thriving business. Forty thousand dollars passed over the counter in a year. Had six full-time clerks on the job. Goods were brought from Austin by wagon freight. There was a doctor here, and a druggist. About 2,500 bales of cotton were ginned annually at the big gin. It's all deserted now, you see.

The year 1900 was a big cotton year, the old man recalled. Land values soared that year, but from then on the story of the town is a story of defeat. The land couldn't stand continuous row cropping. It washed badly. Yields on the steeper slopes, broken last at the height of the period of prosperity, first began to decline; but by 1907 the decline was general. Business fell off. In 1913 torrential rains washed away tons of the remaining topsoil from the fields, cutting gaping gullies. That year land loans went unpaid. By 1919 much of the land was abandoned. The farm families had given up and moved away. Crop failures in 1925 and 1926 ended the life of the trading center. The stores closed, and the merchants moved away. In one store the goods still rest on shelves, dust-covered reminders of a better day. The folks nearby now call it the Ghost Town. It is like an abandoned mining town—the soil mine played out. Some of the land is grazed. Most of it, however, lies there unused, covered with Johnson grass and weeds, the property of loan companies and absentees.

Influence of Climate on Soil Losses

Soils in some European localities unquestionably wear better than ours. The English, notably, have farmed for centuries without serious losses of topsoil, for the climate and the cropping systems there are more favorable to a lasting soil. In England rains are usually gentle. It rains oftener, about 200 days a year, but with less violence and intensity. The average annual rainfall is about 26 inches, hardly more than half that of many of our Southern States, where sharp, steady downpours beat against a bare soil during storm periods. Storm periods usually occur in the South in the fall and winter, when the land is poorly protected, and in the spring, when seedbeds have been freshly prepared and the soil is susceptible to severe washing.

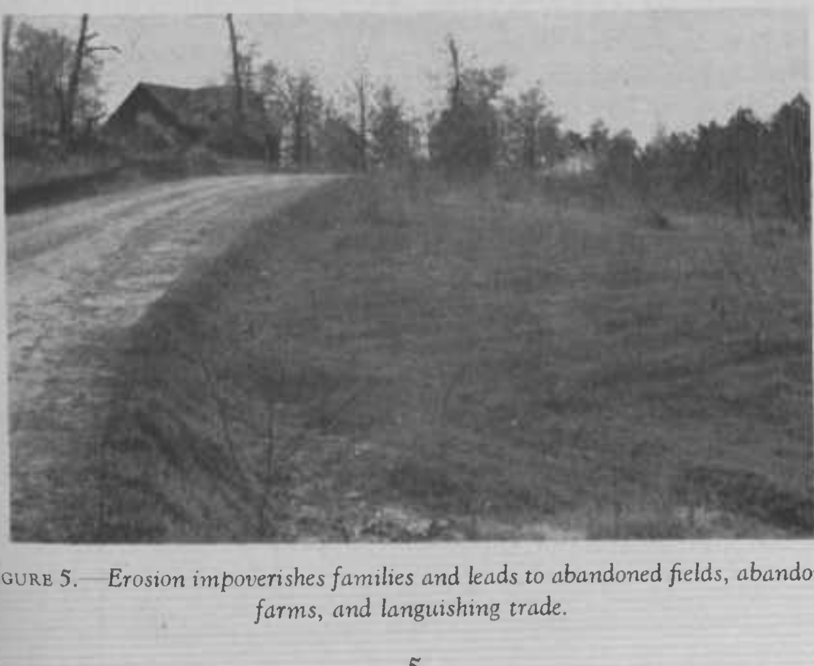

FIGURE 5.—*Erosion impoverishes families and leads to abandoned fields, abandoned farms, and languishing trade.*

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Climate, however, does not account wholly for the slower erosion rates in these old European farming countries. Much of it is due to the difference in the crops grown. European farmers raise more close-growing crops than American farmers grow, more grass and small grains; and they pay better attention to the farm woods. There is in this country roughly 360 million acres of cropland. In 1937 about 100 million acres was in corn, 35 million in cotton, and 20 million acres in potatoes, sorghums, tobacco, and other crops that leave the soil exposed to the rain during the growing season. Europe outside of the Union of Soviet Socialist Republics had almost the same number of acres of cropland as the United States, but only 65 million acres was in row crops, as compared with our 155 million. We, in the United States, expose two and a half times as many acres to the forces of erosion and farm no more land.

Influence of Slope on Soil Losses

The length and the degree of slope directly influence the quantity of soil wash from cultivated fields. Generally speaking, longer slopes lose more soil than shorter slopes, and steeper slopes more soil than moderate slopes, during any given erosive period. Measurements have been made of the influence of these factors at the 15 soil and water conservation experiment stations in the country. The results at Tyler, Tex., on cotton land (which are very similar to the results obtained at the Guthrie, Okla., station) and at Clarinda, Iowa, on cornland, illustrate sufficiently the importance one must give to the slope influence in devising an erosion-control program.

At Tyler a plot 36.3 feet long on an 8¾-percent slope, planted to cotton, lost soil at the rate of 13 tons an acre a year. A plot 72.6 feet long, twice the length of the first plot, lost soil at the rate of 19 tons an acre. A plot 145.2 feet long lost soil at the rate of 36 tons an acre a year. At Clarinda, Iowa, on still longer slopes, a corn plot 157½ feet long, on an 8-percent grade, lost soil at the rate of 40 tons an acre. A slope twice as long lost soil at the rate of 53 tons. From a plot 630 feet long 67 tons of soil an acre were lost.

To measure the influence of degree of slope is experimentally more difficult. Soil conditions change in places with sharp fluctuations in slope. At Tyler, however, there are two plots on Kirvin soil, one on an 8¾-percent slope and the other on a 16½-percent slope, which are comparable. In continuous cotton, the steeper slope lost 57 tons of soil a year; the more moderate slope 24 tons a year.

Defense Measures

In times past when there was plenty of new land it was customary for the Cotton Belt farmer to grow row crops until his land became badly washed and gullied and unfit for further cultivation. Then he moved west and cleared a new farm. The western agricultural lands are now all taken up. All of the good farming land had been claimed long before the public domain was officially closed to homesteading a few years ago. Although the covered-wagon days are past, many of the careless farming habits bred in those days of land plenty remain with us.

However, it is now generally realized that the problems created by soil erosion can no longer be solved, as in earlier days, by moving to new lands. Nor can they be solved by putting all of the land back to trees and grass. We shall continue to need large acreages for growing food and fiber. We can, however, use our land in such a way, apply to each field such proper safeguards, that the productive life of our land will be prolonged, perhaps indefinitely.

Many measures and practices have been suggested for arresting soil erosion. Given trial, certain measures have succeeded partially and earned general acceptance in certain parts of the country. Some have grown popular in one section, others in another. Terracing and contour cultivation, for example, have long been the main reliances of southern farmers. Northern farmers have depended more upon systems of crop rotation to preserve soil productivity, although in a few widely scattered communities they have employed the practice of strip cropping to check soil washing. But few farmers, North or South, have been able to devise a scheme of land use that provided for adequate control of erosion on all of the sloping land in their farms.

Recognizing this, the Congress created the Soil Conservation Service and specifically charged it to bring together information on all known soil conservation measures and to demonstrate these practices where they might be viewed and studied by farmers. To accomplish this, a number of project areas of from 25,000 to 150,000 acres each were selected in the various erosion-problem areas in the United States. The labor of a part of the Civilian Conservation Corps was assigned to the Service to help do the job. The locations of soil conservation projects and camps where soil conservation work is underway in seven cotton States are shown in figure 6.

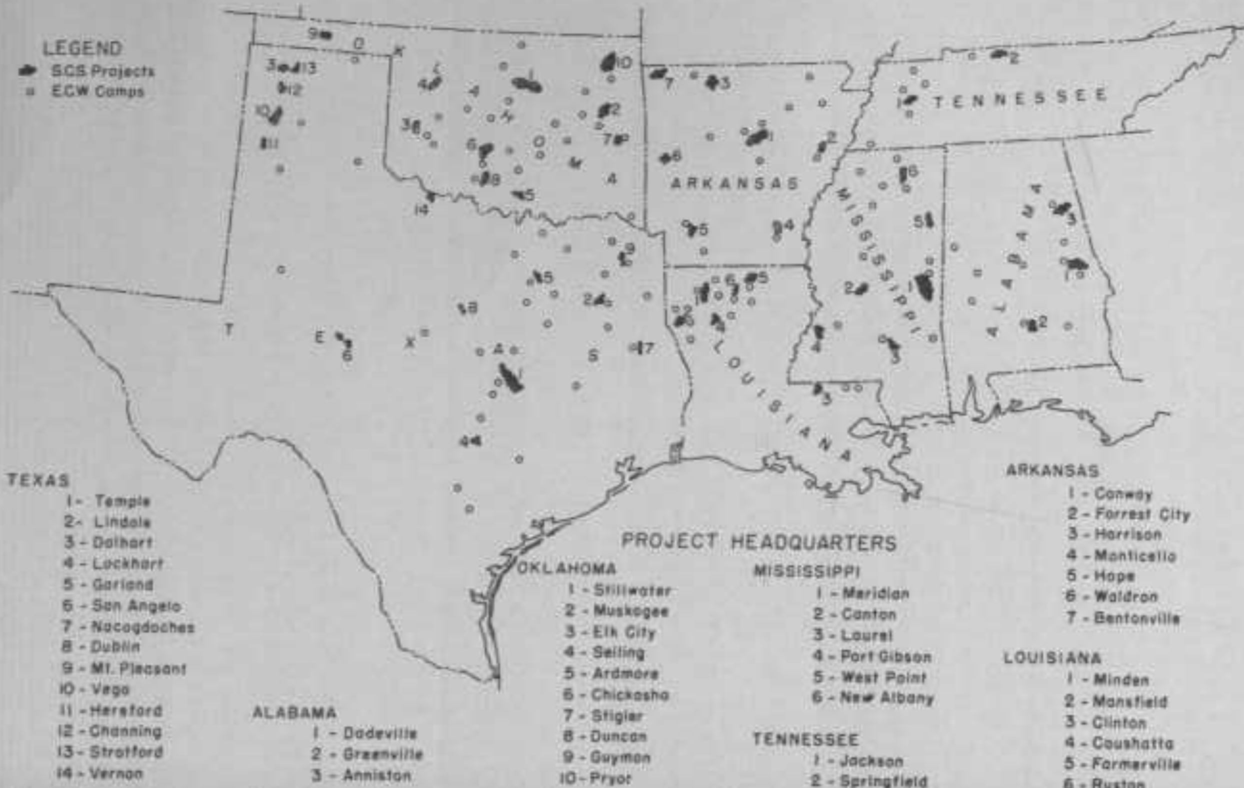

FIGURE 6.—*Locations of project and camp areas where farmers are cooperating with the Soil Conservation Service in effecting a complete, coordinated erosion-control program in seven cotton-producing States.*

In these project and camp areas, farmers sign cooperative agreements with the Soil Conservation Service. These agreements outline the farming practices to be followed. The soil conservation measures agreed to for each piece of land are determined by the farmer and representative of the Service. They go over the farm field by field (including the farm woods) and decide how best to meet the erosion problem on each parcel of land. Together they work out a plan for each field, basing their decisions on crop needs for the farm, surveys previously made as to slope, soil type, and degree of erosion, and personal experience with each field. They depend not upon a single measure or practice to control erosion but upon a combination of measures and practices. On land least susceptible to soil washing, for example, they depend upon contour cultivation and crop rotation to do the job. Land more susceptible to erosion also is strip-cropped or terraced, or strip-cropped and terraced. Land still more susceptible to washing is kept under continuous cover such as meadow crops, pasture grasses, and forest trees provide.

The changes that occur in the organization of a farm as a result of this effort to arrest erosion are discussed and illustrated in the section, The Complete Farm Program. To make that section fully understood, however, it is necessary first to describe individually the various soil conservation measures employed in the Cotton Belt on farms under agreement.

Terracing

In the Cotton Belt the terrace is the most widely used defense against soil washing. The practice of terracing is generally well established there. It followed close on the heels of advanced erosion, coming into use in each agricultural section, however, only after much soil had been lost and erosion had become an obvious menace to cultivation. Unfortunately, terracing too often has been accepted as a cure-all erosion-control practice, whereas experience plainly indicates it is not. In the South, where the cropping system is especially lacking in erosion checks and the climate is conducive to severe washing, soil erosion is too complex a problem to be solved by the application of a single defense measure. The presence of terraces in abandoned fields—sometimes well-made terraces—shows clearly that if cotton farming is to continue on sloping land, other protections in addition to terraces must be provided.

A great deal of progress has been made in terrace design in recent years. When terraces first came into use they were small and weak, of excessive grade along the channel, and seldom satisfactory. In the past, terraces were built in some fields which, owing to the degree of slope, the type of soil, or to an advanced stage of erosion, should not have been terraced. Many of these terraces broke during storms. When a break occurred in an upper terrace, terraces lying lower on the slope usually gave way before the force of the water released from behind the embankments above, and the land gullied. But as the need for size and strength became obvious, implements for building better terraces (fig. 7) were devised, and terraces now are generally much larger and stronger. The broad-base terraces now recommended fail much less frequently than the narrow-ridge terraces used to.

The modern terrace is broad, high, and strong, and of ample channel capacity to withstand the heaviest storms if properly constructed and maintained and properly supported by other erosion-control measures. It consists of an embankment of earth 18 to 24 feet broad and 18 to 22 inches high. On the upper

FIGURE 7.—*Early terraces were small and weak and frequently failed. As the need for size and strength became obvious, implements were devised for building larger, stronger terraces at lower cost.*

side of the embankment there is a definite drainage channel in which water is carried slowly away to a protected outlet.

There are two general types of broad-base terraces. One type, primarily an absorption structure, is used principally in fields in which the soil readily absorbs water, in areas deficient in rainfall, where moisture must be conserved to produce a crop successfully. It is made level throughout its length, and its ends are partially closed. The second type is the graded broad-base terrace, the kind used commonly in all of the Cotton Belt except in dry-farming areas. The purpose of the graded terrace is, primarily, to check the rate of soil loss by providing orderly surface drainage. Its function of promoting absorption of water into the soil, though important, is secondary. For erosion control, the so-called modified Mangum and Nichols terraces are used. The differences between the two are chiefly in manner of construction and in the depth of the terrace channel. In building the modified Mangum terrace, part of the soil is moved uphill and part downhill. In building the Nichols terrace all of the soil is turned downhill. The drainage channel of the Nichols terrace consequently is more ditchlike than that of the modified Mangum; and is frequently cut out of the subsoil. It is claimed for the Nichols terrace that it is easier to cross with machinery, that fewer breaks occur on impervious soils, and that on steeper slopes it costs less to build. The modified Mangum terrace, because it is a better absorptive structure than the Nichols terrace, is preferred for deeper soils and sandy soils.

The laying-out of a terrace system requires considerable skill and experience. The use of surveyor's instruments is required for running terrace lines. Survey work must be accurate to allow for the proper terrace grade. The soil Conservation Service recommends, for most of the South, a variable-grade terrace; that is, a terrace in which the grade becomes progressively greater as the terrace approaches its outlet. Engineers in lining out a terrace usually run the first 400 feet level. They allow 1 inch of fall in 100 feet for the second 400 feet and 2 inches of fall in 100 feet for the next 400 feet. As a rule 3 inches of fall is the maximum. Terraces in project areas seldom exceed 2,000 feet in length.

Some of the terraces constructed in project and camp areas in Oklahoma are level throughout their length and open at one or both ends. Level terraces of this type are used in the western part of the State generally, and in the eastern part only on soils which take up water readily. Where the subsoil does not quickly absorb water and the terrace is more than 80 rods long a variable-grade terrace is used with a maximum grade of 2 inches in 100 feet. Where suitable, level terraces are preferred to variable-grade terraces because they store more water, and moisture is generally a limiting factor in crop production through the cotton-producing section of western Oklahoma. Rains in Oklahoma are often so intense, however, that open ends are necessary to permit excess water to escape when necessary without overtopping the terraces.

It has been previously mentioned that under similar conditions of tillage and cover long slopes wash more than short slopes of equal grade. In effect, terracing a field transforms a long slope into a series of short slopes.

For best results, terraces should be spaced so as to intercept the water before it attains erosive speed. This means that as the slope becomes steeper the terraces must be spaced closer. Otherwise erosion may be unduly damaging between terraces. There is no hard-and-fast rule of thumb for spacing terraces. There are, however, two general guides used in the South. On Soil Conservation Service project areas in Texas, terraces are spaced according to a formula worked out by M. R. Bentley, extension agricultural engineer for the Texas Agricultural and Mechanical College. This formula yields spacings as shown in table 2. Elsewhere in the South the spacings in general use are those based on the original investigations by C. E. Ramser, of the United States Department of Agriculture. These recommendations are shown in table 3. In actual field work, spacings are frequently varied slightly in order to reach a desirable outlet or to avoid obstacles.

TABLE 2.—*Spacings recommended in the construction of terraces in Texas*

Slope of land per 100 feet	Vertical fall between terraces		Horizontal distance between terraces	Slope of land per 100 feet	Vertical fall between terraces		Horizontal distance between terraces
Feet	*Feet*	*Inches*	*Feet*	*Feet*	*Feet*	*Inches*	*Feet*
2.......	2	0	100	7.......	4	6	64
3.......	2	6	83	8.......	5	0	62
4.......	3	0	75	9.......	5	6	61
5.......	3	6	70	10......	6	0	60
6.......	4	0	67				

TABLE 3.—*Spacings generally recommended in terrace construction*

Slope of land per 100 feet	Vertical distance or the drop between terraces		Horizontal distance between terraces	Slope of land per 100 feet	Vertical distance or the drop between terraces		Horizontal distance between terraces
Feet	*Feet*	*Inches*	*Feet*	*Feet*	*Feet*	*Inches*	*Feet*
1.......	2	6	180	7.......	4	0	57
2.......	2	9	140	8.......	4	3	53
3.......	3	0	100	9.......	4	6	50
4.......	3	3	80	10......	4	9	48
5.......	3	6	75	12½.....	5	4	43
6.......	3	9	63				

Disposal of Terrace Water

For many years it has been the custom in the South to turn water loose from the end of a terrace to go where it will. Few have tried to hold terrace water under control until it reached a stabilized drainage course. This neglect has resulted in severe damage to public roads as well as to farm lands. Estimates obtained from expenditure records of the Texas Highway Department showed that run-off from agricultural land and highways caused $1,566,540 damage to the State road system in an 8-month period beginning in September 1935. This figure does not include cost of repairs to county roads. Many miles of county roads in the South, particularly in Oklahoma, have been damaged by run-off from terraces and other drainage to the extent that it was necessary to relocate them at great expense. Deep gullies parallel to the roads made relocation necessary as a public-safety measure. And water concentrated in roadside ditches, from run-off from the road itself and from terraced fields, has destroyed much good land when turned back into cultivated fields. But the principal damage caused by neglect of terrace-water disposal is incurred in the fields which the terraces are designed to protect. Gullies extending from terrace ends are a common sight in the South.

In project areas of the Soil Conservation Service terrace water is held under control from the time it reaches the terrace channel until it is discharged into a stabilized drainage course. After the water leaves the terrace ends, this control is effected largely by use of close-growing vegetation. If it is possible to do so, terrace water is turned into and spread over a well-sodded pasture field or an unburned, ungrazed woods on a moderate slope. In many instances, this cannot be done. It is sometimes possible, however, to extend a strip of pasture up the side of a field along the ends of the terraces and to relocate the fences to include this strip in the farm pasture, first establishing a good sod cover (fig. 8).

When pasture fields or woods are not conveniently located, or it is not safe to use them, the next-best plan to consider is the use of a meadow outlet strip. Most fields have depressions running through them which, if not terraced, would provide natural drainage. One such troughlike piece of land in a field may be converted into a meadow (fig. 9) or pasture strip by filling in trickle channels, preparing a seedbed, and seeding or sodding the area, using grasses adapted locally for hay or pasturage. On poorer soils, where growth would normally be slow, the outlet strip should be fertilized to hasten the establishment of a protective growth of vegetation. Whenever possible, the terraces should be built and the water turned on the strip after the vegetation is established, and not before. Meadow or pasture strips, which serve the double purpose of supplying forage and caring for terrace water, should be not less than 100 feet wide. The terraces should extend well into the outlet strip to prevent water cutting back and forming a gully along the edge of the cultivated part of the field.

FIGURE 8.—*It is sometimes possible to extend a strip of pasture along the side of a field or through the center of it to take water from the ends of terraces, and to relocate fences to include the strip in the farm pasture, first establishing a good sod cover.*

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FIGURE 9.—*Water from terraced fields at the right and left is turned into this strip of meadow extending down a natural depression in the fields.*

Should none of these plans seem to meet conditions, it is necessary to build a sodded channel. Though sodded channels are satisfactory for erosion control, they are more expensive to provide. Sodded channels vary in width, depending on the size of the drainage area served by the outlet and the grade of the slope on which it lies. Little bottom width is required for terrace outlet channels on gentle slopes or where the drainage area is small. On steeper slopes and in channels serving large drainage areas the bottom width may be 18 or 20 feet. In many instances drainage water from more than 100 acres has been carried by properly designed and vegetated channels without apparent damage (fig. 10).

FIGURE 10.—*Water from more than 100 terraced acres has been carried safely to a stabilized drainage in sodded outlet channels.*

If the slope in the channel is not more than 4 or 5 percent, it is usually not necessary to sod completely. Except in Oklahoma, strips of sod spaced about 4 feet apart have proved able to withstand the heaviest rains on moderate slopes; in time, the sod will spread from strip to strip and cover the entire channel. Completely sodded channels have been successful on slopes up to 10 or 12 percent. The sod used in most project areas is Bermuda. Carpet grass provides full protection in some localities on the better-watered areas farther south. It is less resistant to cold than Bermuda grass. On the Temple, Tex., project in the blacklands buffalo grass is used in some outlet channels. In the project area at Greenville, Ala., centipede grass is being used successfully.

When it is possible to divert terrace water away from the outlet channel temporarily or to build the channel before constructing the terraces, sodding may be done more cheaply. Sprigs of Bermuda sod dropped in plow furrows in the channel, and fertilized, provide a dense cover more quickly and surely than strip sodding.

A strip of sod usually is placed across the channel at the end of each terrace to prevent scouring back from the outlet.

Contour Farming

Although contour tillage by itself seldom gives sufficient protection to control soil washing except on moderate slopes, it is invaluable as a companion measure to all other defenses. Unless terraced land, for example, is contour-cultivated, the useful life of the terrace system is very short if the land is planted to row

FIGURE 11.—*Under a system of contour farming all rows in a field follow horizontal lines around a slope. Field operations following the contour throw up ridges of soil which confine rain water. Contour cultivation is invaluable as a companion measure to terracing and strip cropping.*

crops. It is impossible to maintain terraces satisfactorily in fields that are not contour farmed. The down-slope movement of soil between terraces is too great, and the channels quickly fill. Only in country new to terraces do farmers attempt to cultivate across them rather than with them. Cross cultivating is usually abandoned as a result of experience.

Under a system of contour farming (fig. 11) all rows in a field follow horizontal lines around a slope. Field operations following the contour throw up ridges of soil which confine rain water. Water cannot flow downhill until the ridges are overtopped, which occurs only after considerable rain has fallen. But the rains of high intensity and long duration are the ones that cause the greatest soil movement, and contour cultivation therefore fails as a single measure when the land most needs protection. As a lone defense measure, contour cultivation coupled with a sound rotation may be relied upon to control erosion only on gentle, smooth, short slopes with a fall of not more than 1 or 2 feet in 100. Such slopes are rare. Most cultivated slopes in the South must be terraced or strip-cropped or terraced and strip-cropped and planted in proper rotation if erosion is to be arrested.

Contour tillage saves moisture. During the lighter rains the furrows and rows hold most of the rain water where it falls, which helps to bring a crop through the long and sometimes droughty summers of the Cotton Belt. Moisture-penetration tests strikingly illustrate the value of contour tillage as a water-conservation practice. In one test after a series of fall rains on the upper Concho River watershed in Texas, where moisture is regularly a limiting factor in crop production, land that was contour-tilled held approximately three and one-half times as much available moisture for plant growth in the upper 5 feet of soil than land of the same slope on which the rows ran downhill.

Strip Cropping

When the practice of stip cropping engaged the popular fancy a few years ago, the idea was thought to be new. It has since been learned that for years some farmers in parts of Ohio, Pennsylvania, West Virginia, Wisconsin, and the blacklands of Texas have been planting strips of erosion-resisting crops between strips of clean-tilled crops to control erosion. A community of farmers in Ohio has followed the practice for almost a quarter of a century. But in most of the Cotton Belt, where farmers early became engrossed with contour tillage and terracing, hardly more than half a dozen years of trial lie behind this newest defense measure. Country-wide trials on more than a million acres, however, have demonstrated the value of the practice as a companion measure to contour tillage, with or without terraces.

As we have seen, crops differ widely in their ability to hold soil. The practice of strip cropping recognizes these differences, and takes advantage of the superior soil-holding and water-filtering properties of densely growing plants to retard soil washing. In a strip-cropped field two or more crops are grown rather than one. The close-growing crop, which is called the control strip, is planted around the slope, on the contour like a terrace, between bands of clean-tilled crops. Placed in this position, the stems of the densely growing plants obstruct the flow of run-off from land in erosion-permitting crops like cotton and corn, checking the velocity of the water so that soil particles settle out in many tiny slack-water pools.

Well-grown control strips catch a surprisingly large amount of soil. During heavy rains it is not uncommon for a control strip to collect several inches of soil (fig. 12) near its upper edge where the strip crosses a depression in the field.

FIGURE 12.—*It is not uncommon for a close-growing strip crop to catch several inches of soil near its upper edge during heavy rains. The layer of soil shown here between two lines settled out of the run-off from the area above planted to cotton.*

Toward the center of the strip this soil layer becomes shallower and may shade to a trace at its lower edge. In field trials most of the soil has been caught in the upper 12 feet of the strip. After it is freed of its soil load, much of the water passes into the soil in moving across the rest of the strip.

Experimental trials with strip cropping sometimes produce surprising results. In a trial at the soil and water conservation experiment station at Temple, Tex., in 1934 and 1935 the plot planted in cotton on the contour lost almost 10 times as much soil as the plot protected by contour strips. The rate of loss from the strip-cropped plot was 12.3 tons for the period; the loss from the all-cotton plot was at the rate of 118.6 tons. The plots at Temple lie on a 4- to 6-percent slope. The station is located on typical Houston clay in the heart of the Texas blacklands. Oats seeded in the fall is the crop used in the control strips in the experiment. The oats are followed by hairy vetch for green manure, and the land is later bedded for cotton.

Soil under a close-growing crop, as we have said, absorbs water more readily than soil planted to tilled crops. This accounts for much of the erosion-resisting effect of strip cropping. Results at the Temple station illustrate this point. During a 3-inch rain in April 1936, less than 5 percent of the rainfall left a strip-cropped plot as run-off, while a plot without strips lost 57 percent of the precipitation. It can readily be seen that the large number of stems retard the speed of flow, which gives more time for water to soak into the ground. But this is perhaps not the principal reason for the superior water-holding properties of the land in strips. The explanation seems to rest on the fact that the close-growing plants obstruct and clarify the muddy water, and then the water, made clear, penetrates into the soil more readily.

On entering a strip, water spreads out fanlike, its velocity is checked, and it drops its soil load. Because water gravitates to the lower-lying places, these receive more of the silt deposit, and fill in, which tends to smooth surface irregularities in fields. Irregularities in the surface of clean-tilled land, on the other hand, become more pronounced and grow into gullies, owing to the quickened flow of the concentrated water as it passes down depressions in a field.

The close-growing crops most commonly used in a strip-cropping plan between strips of row crops are the small grains, winter legumes, and the forage crops, although occasionally a special crop like crotalaria is used. Oats or other small grains are used over most of the Cotton Belt for winter protection. After the oats are harvested, either for hay or for grain, the stubble is left standing for continued protection or is turned under, to be followed by a summer strip. Sorghum or Sudan grass or a mixture of either of these with cowpeas usually succeeds the small grain. Hubam sweetclover, a recently introduced annual white variety, is gaining recognition in the Texas blacklands for use in strips. Common and Korean lespedezas are used widely in project areas east from eastern Texas and Oklahoma. For strips that are to stand more than 1 year, little bluestem, *Lespedeza sericea*, kudzu, alfalfa, and sweetclover are popular in certain localities. Of these, *L. sericea* and kudzu have the widest range of usefulness east of the Mississippi River. The use of little bluestem is confined to the prairie lands of Texas and Oklahoma; it is particularly well adapted to the black-belt soils of Texas. Alfalfa and sweetclover are recommended only for soils most favorable for their growth. These strips of biennial and perennial plants are especially recommended for certain steep slopes, or steep parts of otherwise moderate slopes, which require more continuous protection than strips of annual plants can give.

Like other soil-defense measures, strip cropping is not a cure-all; and it is not recommended as a substitute for terracing except on short gentle slopes. After several years of trial, the soil and water conservation experiment station at Guthrie concludes: "Strip cropping is an effective means of conserving soil on moderate and ungullied slopes but does not afford sufficient protection on gullied or steep slopes." In project areas of the Soil Conservation Service, strip cropping is used most often as a companion measure to terracing (fig. 13). The two defenses, one supporting the other, go well together. Strips of close-growing crops on terraced land help to prevent excessive washing of the soil between terraces, which aids incidentally in preventing the clogging of terrace channels and lessens the cost and difficulty of maintenance. Close-growing crops placed astride terraces protect them from failing during periods of excessively rapid run-off; also, cultivation of terraces the first year, before they have settled, tears them down. Short point rows may be avoided by widening the strips to include the areas these normally occupy.

On land affected by sheet erosion only, strip cropping, contour tillage, and crop rotation are employed without terraces, in project areas. Gullied fields are given the fuller protection afforded by a combination of these three measures with terracing.

It has proved unwise in the Soil Conservation Service project areas to depend for erosion control altogether on a system of strip cropping without terraces

FIGURE 13.—*In project areas of the Soil Conservation Service, strip cropping is used most often as a companion measure to terracing. The two defenses, one supporting the other, get along well together.*

on slopes that are long even though gradual. Long slopes receive tremendous quantities of water during the heavier rains, and it is usually necessary, especially where the soil takes up water slowly, to provide surface drainage by a system of terraces. Often in such instances, the upper part of the slope is strip cropped and terraced and the lower part strip cropped only.

There are several different kinds of strip-cropping plans in use in the Cotton Belt. The plan that is selected is determined by a number of factors: The slope of the land, the degree of erosion, the crops adapted to the locality, the need on

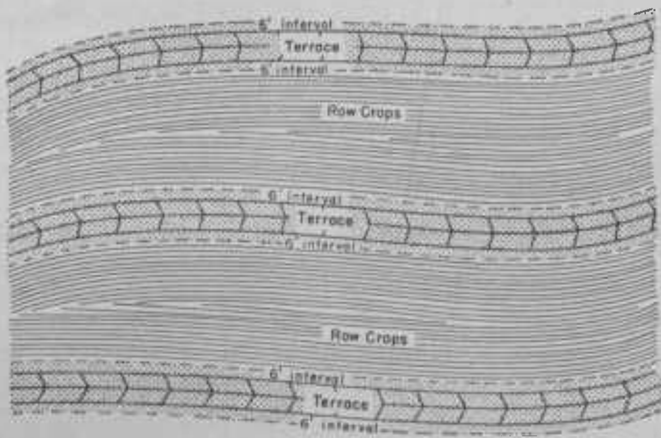

FIGURE 14.—*This method of strip cropping is used to protect newly made terraces during the settling period. The width of the strip is uniform, extending from 6 feet above to 6 feet below the terrace.*

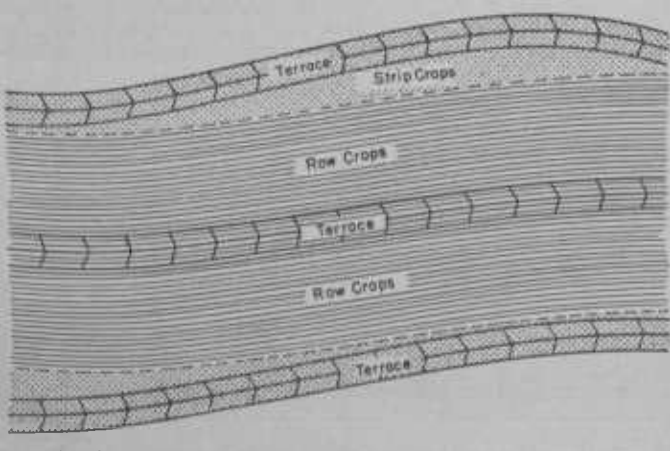

FIGURE 15.—*In this method of strip cropping, close-growing vegetation is planted on every second terrace. The control strip extends as far as necessary to take up the short-row area.*

the farm for forage, the soil type, the necessity for maintaining a balance between cash and other crops—among others. Further on in this bulletin, in a section entitled "Recommendations by Regions," control practices for the major agricultural divisions of the Cotton Belt are discussed in more detail; included is some further mention of local adaptations of the strip-cropping principle.

On terraced land the spacing of strips is adjusted to the spacing of the terraces. The arrangement of strips used with terraces is explained in the legends under the diagrams in figures 14 to 19. The width and spacing of strips on unterraced land is still a debated question. As a tentative recommendation for the South,

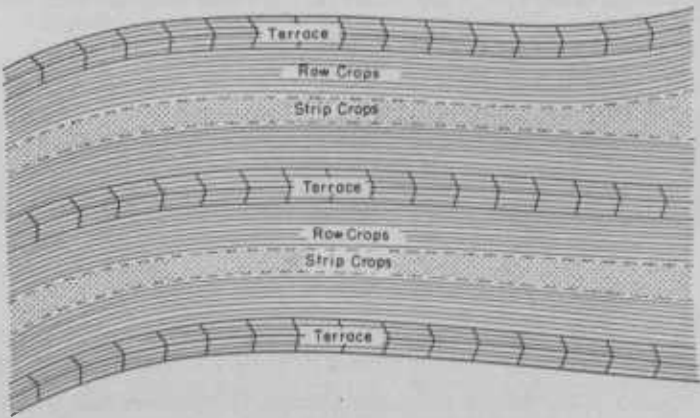

FIGURE 16.—*Here the erosion-control strips are placed in the center of the terrace interval. Their minimum width is 12 feet. They are widened when necessary to take care of the short-row area.*

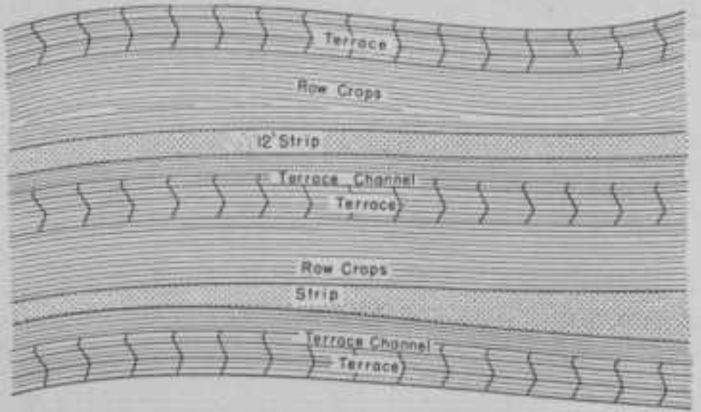

FIGURE 17.—*Here the control strip is located just above the terrace channel. The minimum width is 12 feet. If the short-row area is not included in the strip, the short rows are made to fall in the center of the interval between terraces.*

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the following width and spacings have been advanced: About 25 feet of close-growing crop for each 100 feet of slope length on land that rises not more than 3 feet in 100; about 35 feet of close-growing crop in each 100 on slopes rising 3 to 5 feet in 100; at least half of the area in close-growing crops, in strips about 50 feet wide, on steeper slopes.

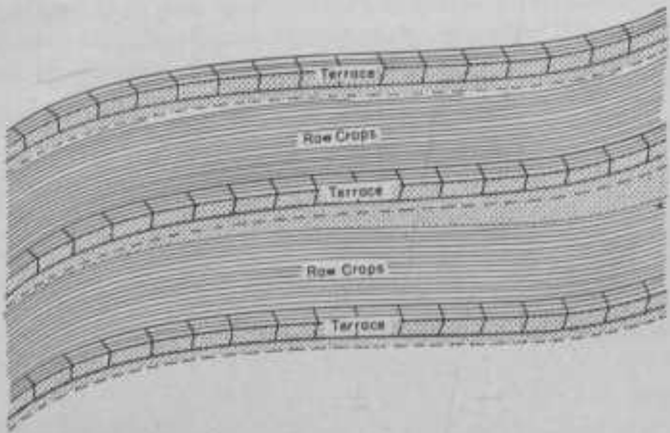

FIGURE 18.—*Here the control strip begins on the terrace ridge and extends at least 6 feet below the base of the terrace. The control strip is widened when necessary to take up the short-row area.*

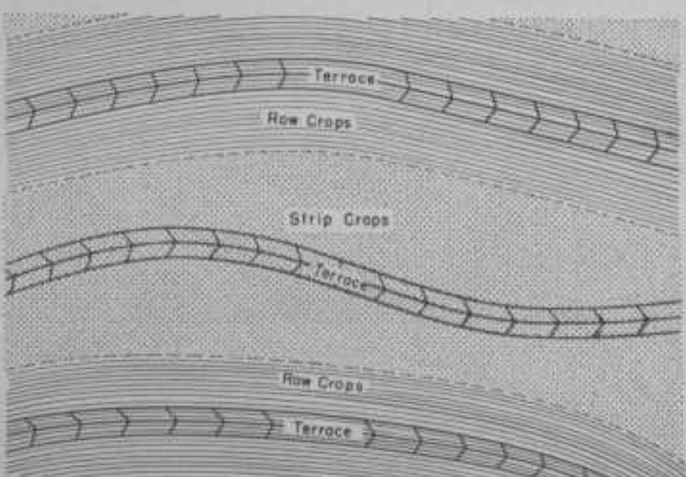

FIGURE 19.—*The control strips are placed astride alternate terraces in this method. The control strip begins in the middle of one terrace interval and extends over the terrace into the middle of the terrace interval below. It is widened to take care of the short-row area.*

Border Strips

The use of border strips of close-growing fibrous-rooted crops seems a natural development of the strip-crop idea. The function of border strips is to protect places in a field that are especially vulnerable to erosion when planted in row crops, such as, for instance, the borders of fields, drainage ditches, terrace-outlet channels, and roadside ditches. Used in connection with a strip-cropping program, as they are most frequently, border strips provide a convenient tie between contour strips and space for turning, which aids in planting, cultivation, and harvesting operations. Usually the same crops are used in the border strips as occupy the field strips, although some farmers use woody shrubs bordering particularly hazardous locations, such as deep cuts along roads, ditches, or gullies. Shrubs providing food for wildlife are selected.

Green-Manure and Cover Crops

The lighter colored, sandier soils in the cotton country generally lack sufficient organic matter, having developed under forest cover. Continuous clean tillage and the climate have further reduced the supply. After a row crop is harvested there is little plant material to turn back into the soil to replace the organic matter carried away by run-off and used up by plant growth and decay during the growing season.

This lack of organic matter in the lighter colored, sandier upland soils is known to be one of the principal reasons they wash more readily than other soils; it also helps to explain why subsoil materially usually washes more rapidly than topsoil. Decaying plant parts and humus hold soil particles together. To say that the action of organic matter in soil is like that of cement in concrete is not a too-careless comparison. Organic matter, as humus, combines the coarser and finer soil particles into aggregates which are more resistant to washing than particles finely separated.

Erosion begins slowly on land freshly broken from grass or from forest. This is because of the presence of accumulated organic matter in the soil. Soil leaves new fields a little at a time at first, in very thin sheets, with each rain of sufficient intensity to cause sheet wash, and the rate gradually increases as the supply of organic matter becomes depleted. Once the upper layer, which contains proportionately more organic matter than the soil underneath, is cut through, the rate of erosion becomes rapid, and gullying begins. Erosion goes forward exceedingly rapidly into the subsoil, which contains little organic matter.

The most practical way to replace lost organic matter is to grow crops of green manure, preferably legumes. When a well-grown green-manure crop is turned under, several tons of vegetable material (fig. 20) to the acre is added to the soil, which greatly improves its physical condition and enables it to take up and hold larger quantities of water in a way favorable to plant use.

In the Cotton Belt green-manure crops may be grown either in summer or winter. Fortunately, the South may depend on a number of legumes for cover crops for green-manuring purposes. These may be planted in rotation with cotton and corn. Vetch is adapted to a great part of the South, and Austrian Winter peas likewise may be used widely. Hubam sweetclover is growing in favor for green-manure purposes in the blackland and Grand Prairie sections of Texas. Bur-clover and crimson clover are acquiring prominence as winter cover crops in parts of the South. For summer use there are cowpeas and velvetbeans, which are now grown in many localities in alternate rows with corn.

Experiments with cover crops in the South conclusively prove the value of these legumes in a soil-improvement program when turned under for green manure. Amazingly better yields of cotton and corn have followed their use in rotation with these row crops. Alabama investigators state that turning under vetch or Austrian Winter peas increased corn yields 18 bushels an acre at a cost of 14 cents a bushel, in a series of experiments.

Green-manure or cover crops, besides affording winter grazing for livestock and supplying organic material to the soil, are also directly helpful in controlling erosion. They provide cover for fields which otherwise would be bare of vegetation during seasons when erosive rains commonly occur. Over a great part of the Cotton Belt damaging rains cause severe soil washing during the winter months. In these extensive areas cover crops of vetch, winter peas, crimson clover, and bur-clover are invaluable in reducing erosion rates in this season of

FIGURE 20.—*Turning under well-grown cover crops adds organic matter to the soil. Soil charged with organic matter is in good physical condition to resist erosion. It can take up and hold large quantities of water in a way favorable to plant use.*

the year. In southern Oklahoma rye, barley, mixed seedings of rye and vetch, and some soft winter wheat are used for winter cover crops, and pastured. These are broadcast following cotton, corn, or grain sorghum.

Continuous Use of Close-Growing Cover

Slopes that still retain a portion of their topsoil but, owing to soil type or excessive grade, are especially susceptible to erosion, are frequently made into permanent meadows or kept continuously in close-growing, fibrous-rooted crops, in project areas. Several crops used for this purpose deserve special mention.

Kudzu, particularly in the eastern half of the Cotton Belt, is used widely as forage crop on these so-called critical slopes. Kudzu does well even on severely eroded land where there is ample moisture. It is a strong-growing legume that spreads by runners that sometimes attain a length of 35 feet or more in a single season. Kudzu meadows are established by setting out about 1,000 crowns, seedling plants, or vine cuttings an acre. Cultivation is necessary during part of the first season to eliminate competing vegetation. In a year or two the kudzu plants cover the ground completely. On eroded land a shovelful of manure should be placed beneath each crown.

FIGURE 21.—*Many eroded hillsides are retired from the production of row crops and planted in crops that provide continuous cover for the land. Lespedeza sericea is used widely and successfully for this purpose east of the Mississippi River. This stand is 3 years old.*

Lespedeza sericea has a wide range of usefulness throughout much of the Cotton Belt. It is an excellent erosion-resisting plant, is a legume, and makes excellent forage when properly handled. A perennial lespedeza, it is especially desirable for use on vulnerable slopes (fig. 21).

In the southern part of the Texas blacklands there are communities of farmers of German and Bohemian extraction who have kept their more erodible slopes in native meadow. The meadows are usually made up of a mixed stand of little bluestem, big bluestem, and Indian grass. In project areas in the blacklands of Texas this meadow mixture is seeded on slopes that are too steep for growing row crops safely.

A rotation used on especially vulnerable slopes in some areas is oats followed by Sudan grass. The oats are harvested either for forage or grain; the Sudan grass is used for temporary pasture. Since seedbeds are prepared regularly for these crops, slopes designated to be planted in "continuous broadcast" are terraced to prevent excessive soil losses should erosive rains occur while there is no protective cover of vegetation.

Converting Cultivated Fields to Pasture

Perhaps much of the eroding land in the South that is now planted to row crops would, in the long run, yield more profit with less effort if it were made into pasture. Certainly this is the case with the steeper slopes—slopes that are losing too much soil to remain long in profitable cultivation. As a soil conservation measure in project areas, many of these slopes are retired from cultivation and planted to grass, where the soil is suitable for pasture purposes.

In the majority of instances Bermuda grass is used for the pasture base. Several methods of planting are employed to establish Bermuda grass. One is to flat-break the land on the general contour with a turning plow, dropping roots or chunks of Bermuda sod at 3- to 4-foot intervals in every third or fourth furrow. The sod is covered by the succeeding round of the plow. Another method is to run furrows on the general contour with a small lister or a large shovel plow at 4- or 5-foot intervals. The roots or sod pieces are dropped 3 or 4 feet apart in the furrows and covered with another light furrow, a drag, a broad wheel, or a two-shovel cultivator (fig. 22).

Bermuda sod spreads extremely slowly unless it is cultivated. When Bermuda grass is cultivated between the rows runners may almost cover the ground in a single season. Cultivating is done in the early spring while the soil is moist; cultivating when the soil is dry damages Bermuda grass. A disk cultivator does good work, but when it is not available ordinary cultivating implements may be used instead. The idea is to work up enough loose soil to permit the runners to catch hold. Established Bermuda-sod pastures should be cultivated at intervals of about 3 years. It is a good plan to cultivate about one-third of the pasture each year.

FIGURE 22.—*Where the land is suitable for the purpose, slopes which are losing too much soil under cultivation may be made into pasture. Fifteen men working with seven teams sodded 200 acres on this farm in 5 days, using Bermuda grass roots.*

In some project areas in Arkansas and Oklahoma Bermuda sod for pasturage has been established successfully by planting it in rows with corn or cotton. The cultivation of the row crop cultivates the Bermuda grass. This method permits production of a crop while the sod is becoming established.

Where there is danger of heavy soil losses before the sod becomes established, a light seeding of oats, rye, wheat, or any temporary grass is made after the sodding operation to give immediate erosion control. In season, overseedings of adapted grasses and legumes are sown to thicken the cover and to provide a more-balanced pasture mixture and a longer pasture season, except where competition for moisture is too keen. Most upland soils must be fertilized and limed before the clovers will thrive; in fact, in most of the South, east of the Texas blacklands, fertilization is considered more important than any other practice in establishing good pasture. Other measures are ineffective in helping to establish cover if mineral plant foods are lacking.

On some lands, usually the moist soils, carpet grass is the pasture base. The methods of establishing carpet grass sod are like those used for Bermuda grass. In the prairie sections, where there is less annual rainfall, buffalo grass is used for pasture development where sod is available. In establishing buffalo grass pasture, furrows are opened, into which sod is dropped, roots down, and pressed into the soil. Soil is pulled around the sod. Buffalo grass sod is not covered.

Pasture Management for Erosion Control

The cover of vegetation in many pastures is too poor and sparse to check erosion effectively. This is especially true of pastures grazed too early in the spring or too heavily during the pasture season. Where Bermuda grass is the pasture base, grazing should be close enough to prevent high growth. Kept low, the runners cover more ground, and the grass is more palatable to stock. For erosion control, therefore, as well as for the general improvement of the pasture itself, it is necessary to manage the pasture so that the cover of desirable plants will thicken and remain intact. A variety of practices are employed in project areas to accomplish this.

Control of Weeds

Many of the better pasture grasses and clovers cannot thrive in the shade. Bermuda grass is especially prone to die out when shaded by weeds or brush. The brush should be removed, except on stream banks or other drainageways with well-defined channels. Weeds may be controlled by mowing or pasturing with sheep and goats. It is not exaggerating to say that pastures may be made with a mowing machine and fertilizer in some of the more humid areas of the Cotton Belt. Several mowings each year may be necessary while the pasture is weedy. However, such weeds as the bitterweed should not be cut low when young, as this induces multiple branching and low fruiting. A low cutting in August may be necessary. In central and western Texas one close mowing in late July or early August as broomweeds begin to bloom has controlled this weed except in wet years, when two mowings are necessary. Pasturing heavily with sheep when the particularly bothersome weeds are very young is effective where this class of livestock is raised.

Overseeding Pastures

Overseeding a pasture with legumes and supplementary grasses not only aids in erosion control by filling in the voids in the turf but lengthens the pasture season. If a Bermuda grass pasture is overseeded with hop clover and lespedeza, for example, the pasture is made to produce forage earlier in the spring. Bermuda grass is one of the last of the grasses to become ready for grazing in the spring. The hop clover is ready first, the Bermuda grass next, and then, for the summer season, the lespedeza.

Supplemental Feed

Seasonal relief to permanent pastures, to eliminate damage by overgrazing and to permit the pasture plants to mature seed, is provided in project areas, (1) by the production of ample supplies of winter feed in strip crops and meadows, and (2) by establishing temporary pastures. When adequate feed supplies are available, it is not necessary to turn livestock out on pasture until the pasture is ready for grazing. Temporary pastures will provide relief during both summer and winter. Such crops as Sudan grass, soybeans, millet, and sweetclover are used to provide summer pasture, and the small grains, vetch, winter peas, and Italian ryegrass for winter pasture.

Pasture Furrows and Ridges

Pasture furrows and ridges serve several purposes. They help to hold soil, seed, and water in the pasture, thus aiding vegetation in becoming established (fig.23). In the earlier field work of the Soil Conservation Service in the Cotton Belt, ridges rather than furrows were used in pasture-improvement programs. More recently, however, the trend has been away from the use of ridges toward the use of shallow furrows. It has been found that furrows, which are more closely spaced than ridges, give better distribution of water over the surface of the land and more uniform aid to vegetation than ridges. Also, a furrowed pasture may be mowed more easily than a ridged pasture.

FIGURE 23.—*Ridges and furrows hold soil, seed, and water in a pasture, thus aiding vegetation in becoming established.*

The contour ridge resembles a miniature absorption terrace. It is built on the contour around a slope with two rounds of a long-wing plow, and the ends are turned uphill to prevent wastage at these points of the water that collects behind the ridges during periods of run-off. The ridges are turned uphill also before

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crossing washes or draws in the pasture. Ridges are spaced 12 to 20 feet apart on a slope.

Contour furrows are spaced 5 to 7 feet apart on a slope. They also follow the contour. Some are made with one through of a walking plow; others with one through with an ordinary plow followed by a long-wing plow. The furrow slice is thrown either uphill or downhill. All pastures in project areas where the average rainfall is low or where the rain is poorly distributed through the pasture season, are contour-ridged or furrowed. Moisture conservation in such areas is of utmost importance. In areas of greater rainfall and where the rainfall is well distributed through the growing season, they are constructed on long slopes of even conformation where the turf is thin. Contour ridges or furrows also are used to hold water away from gullied areas in old permanent pastures and in permanent pastures lying above cultivated fields.

On steeper, irregular slopes it is difficult to hold to an exact contour line. Should the completed furrow or ridge deviate from the contour, its water furrow may be blocked at 50-foot intervals with a few shovelfuls of soil.

Converting Fields to Woods

Much of the cropland retired from cultivation in project areas is planted to trees, in those parts of the Cotton Belt where trees are adapted. Forest cover, as previously mentioned, is the most stable type of cover for soil protection. On most farms in the humid areas of the Cotton Belt there is much land too steep or too badly eroded to be suitable for row crops, meadow, or pasture. Where there is sufficient depth of soil, planting such areas to trees brings the land back into productive use. Even on many farms where all of the soil is suitable for other purposes, space may be profitably set aside for a farm woods, for often a farmer can produce his own fuel, posts, poles, and building timber more cheaply than he can buy them. Foresters estimate that in northern Louisiana, for example, 15 acres of woods is required to meet the day-to-day needs of the average farm for wood products.

The South as a whole has advantages for growing crops of timber hardly equaled elsewhere in the United States (fig. 24). The southern pines as a group rank among the most rapidly growing tree species. Loblolly, shortleaf, and slash are the pines planted in most project areas. However, clumps of hardwoods are included in the larger plantings of pine. This creates a type of leaf litter that improves soil-moisture conditions, prevents the soil from becoming too acid, and increases the activity of soil organisms. Mixed stands are more valuable to wildlife. Pine woodlands therefore are often edged with hardwood trees and shrubs to encourage birds. Hardwoods are set out only on carefully selected sites in suitable soil. There is evidence that the presence of black locust among other hardwoods stimulates the growth of the slower growing, longer lived hardwood trees.

Plantings of black locust, however, are often made in pure stand for fence-post production (fig. 25). The black locust is an excellent tree to plant behind check dams in gullies, where the soil is loose and moist. Black locust will grow fairly well in poor soil, but it has been found necessary in project plantings to cultivate the trees for the first year at least. Small black locust seedlings are like corn seedlings; they need early, shallow cultivation to keep weeds down and to loosen the soil. Two cultivations are considered sufficient. Cultivation late in the season, however, reacts unfavorably. An application of fertilizer is of course helpful. On the better soils black locust trees have grown to fence-post size in 8 or 10 years.

FIGURE 24.—*The South as a whole has advantages for growing crops of timber hardly equaled elsewhere. This young pine woodland has been thinned and pruned to permit better growth by the desirable trees.*

Woodland Management for Erosion Control

When the excellence of forest cover as a protection for the soil is emphasized, the reference is to woods in which the ground cover of vegetation and leaf litter are undisturbed by grazing or fire. It is a common practice in the South, no doubt owing to a general lack of good open pastures, to graze the farm woods; and many farmers set fire to their woods each spring. These practices combine to reduce materially the value of the stand of timber and the erosion-resisting value of the woods' cover.

In project areas the farm woods is protected from grazing by fencing, where necessary, and from fire. A provision in the cooperative agreement between the farmer and the Government calls for protection of woodlands and forest plantings from damage by grazing. Firebreaks are constructed to protect woodlands where an unusually high fire hazard exists. Firebreaks are designed to stop or check fires that may occur and to be used as a line from which to work in fighting fire. A firebreak may be either a natural or constructed barrier or a combination of these. Thus a firebreak system may include a road, a stream, a cleared field, a wide trail, a closely grazed pasture, all connected by specially prepared strips made free of burnable material. Smaller woodlands may be protected adequately by constructing firebreaks along the woods' boundaries where the fire hazard is exceptionally high, such as along public roads and railroads.

After reforestation of retired land has been provided for, and the control of fire and grazing in woodland, a plan of woodland management is prepared for each cooperator in project areas, and the initial steps in executing the plan are demonstrated. The objectives of management are (1) to increase the proportion of valuable species in the stand and (2) to provide for an orderly system of harvesting crop trees that maintains a full stand of trees for erosion control and water conservation and assures the owner of maximum yield from his woodland. The particular procedure followed to accomplish these objectives varies from farm to farm, according to varying soils, financial limitations, needs for wood on the farm, present condition of the woodland, and availability of markets. In badly deteriorated woodlands from which the better species have disappeared entirely as a result of long-continued abuse, interplanting the scrub stand with trees of desirable species is sometimes resorted to.

FIGURE 25.—*Within 13 months after black locust trees were planted erosion was brought under control on this slope which had lost three-fourths of its topsoil and some subsoil while in cultivation. Black locust makes excellent fence posts.*

Wildlife Plantings

While planting to control erosion, it is often possible and always desirable to use plants that provide food and cover for the various species of wildlife one wishes to protect and encourage.

Almost any type of vegetation used to control erosion is of some value for wildlife. Strip crops, winter cover crops, tree plantings, woodland-conservation practices, all contribute to the improvement of the wildlife habitat.

In working out a complete erosion-control and improved land-use program for each farm, many small areas are found which may be devoted strictly to wildlife plantings. Wildlife plantings are of various kinds. Often small eroded corners of fields, steep slopes in cultivated fields, badly eroded boundary areas between cultivated fields and woodlands are planted to *Lespedeza sericea* and common lespedeza, browntop millet, and, in many cases, to low-growing shrubs such as blackberry, hog plum, coralberry, and hedge privet (fig. 26). Lespedeza and shrubs are frequently planted in gullies or in thin soil in pastures.

Trees especially useful for wildlife support are the red cedar, dogwood, mulberry, hickory, pecan, black cherry, most kinds of oak, sumac, hackberry, black gum, beech, red gum, and walnut, which bear food for squirrels and birds. These may be planted in single and double rows on the outer borders of new woodlands, thus providing diversified foods, nesting sites, and coverts for various species of wildlife. Likewise gullies in woodland edges are planted to legumes and shrubs for the same purpose.

FIGURE 26.—*It is often possible and always desirable to choose plants for erosion control that provide food and cover for the species of wildlife one wishes to encourage. The shrubby dogwoods have a wide range of usefulness in the South.*

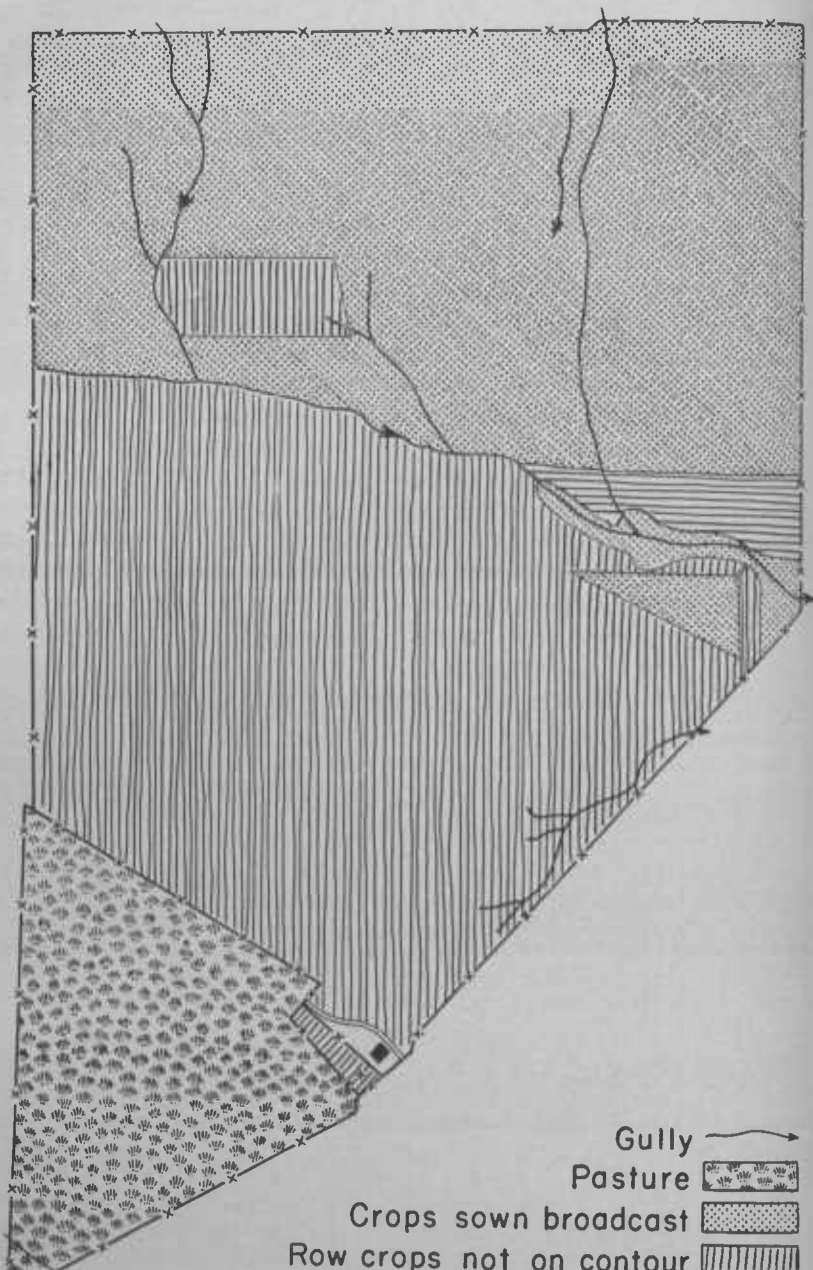

FIGURE 27.—*Diagram of a farm showing field arrangement and land-use system before erosion-control measures were applied. The fields on this farm are large, the slopes long and gradual.*

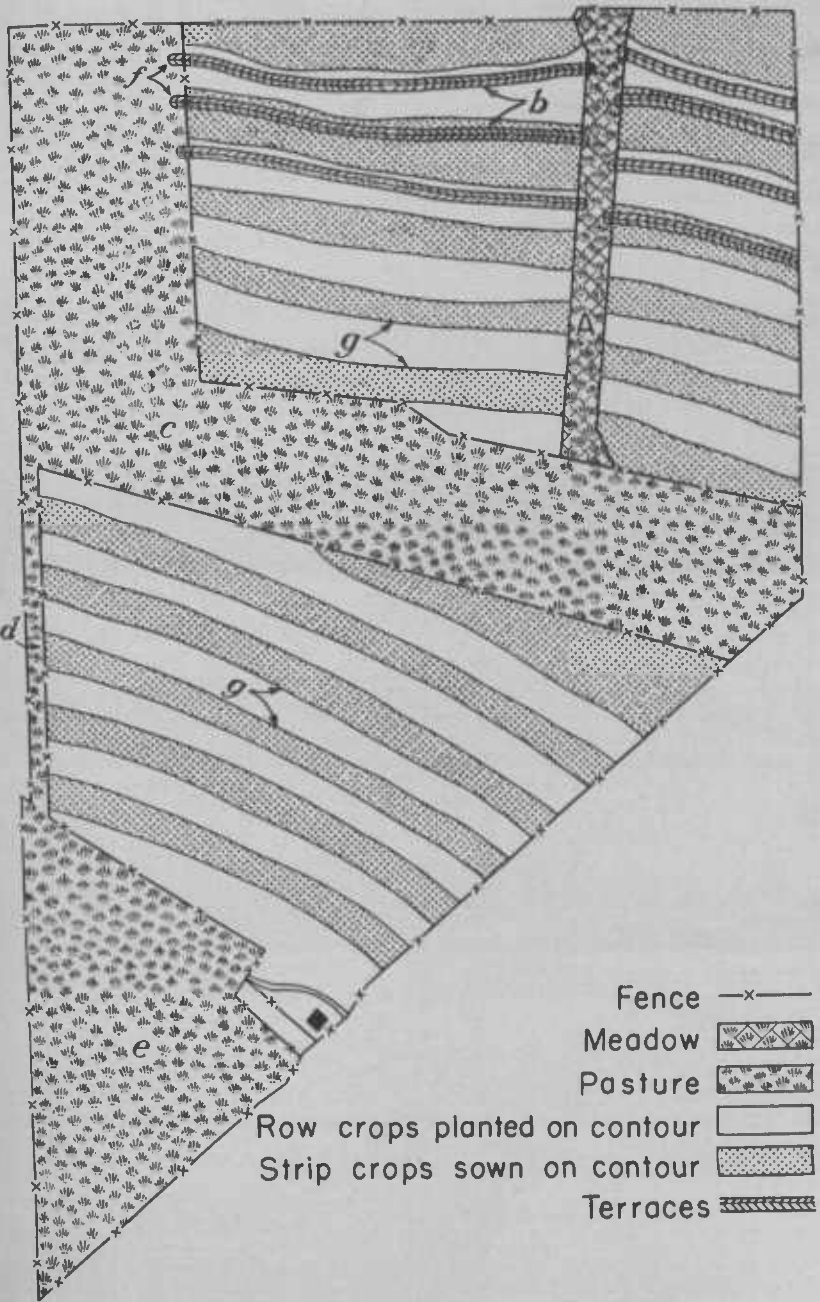

FIGURE 28.—*Diagram of the farm shown in figure 27 showing field arrangement and land-use system after erosion-control measures were applied.*

The Complete Farm Program

So far in this discussion the relationship of one erosion-control practice to another has been touched on only lightly. Each practice has been described and discussed separately. It is the purpose of this section to show how the various soil conservation measures are made to merge into a harmonious whole

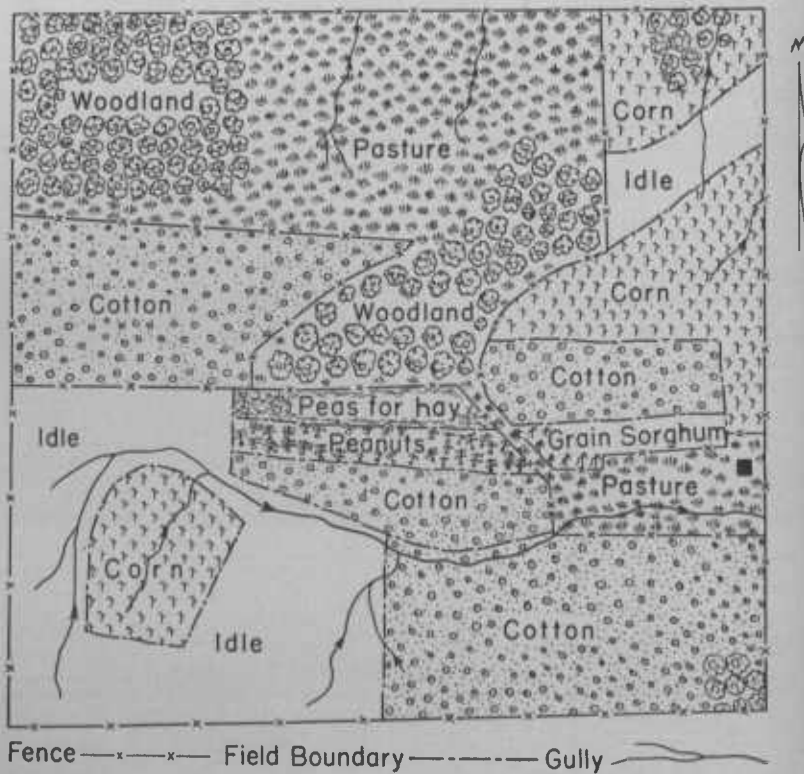

FIGURE 29.—*Diagram of a farm on the upper Coastal Plain showing field arrangement and land-use system before erosion-control measures were applied. The fields are generally smaller, slopes generally steeper, erosion damage greater than on the type of farm shown in figures 27 and 28.*

farm program; how one measure is made to support another, and how each field is treated according to its needs and adaptabilities. Perhaps this can best be done by taking actual farms for examples and diagramming them, showing the farm arrangement and field plans before and after the erosion-control program was put into effect.

The farm diagrammed in figures 27 and 28 is located near Gatesville, Tex., on the Grand Prairie. The farm is representative of its section.. Fields are large, and slopes are long and gradual. In a general way the plan employed on this farm is like those employed on other farms where slopes are long, moderate in grade, not seriously gullied and the fields retain much of their topsoil. Income from this representative farm is derived from the sale of cash crops and livestock.

As shown in figure 27, no erosion-control practices were employed before the farm plan was changed. There were no terraces on the farm, rows ran down-

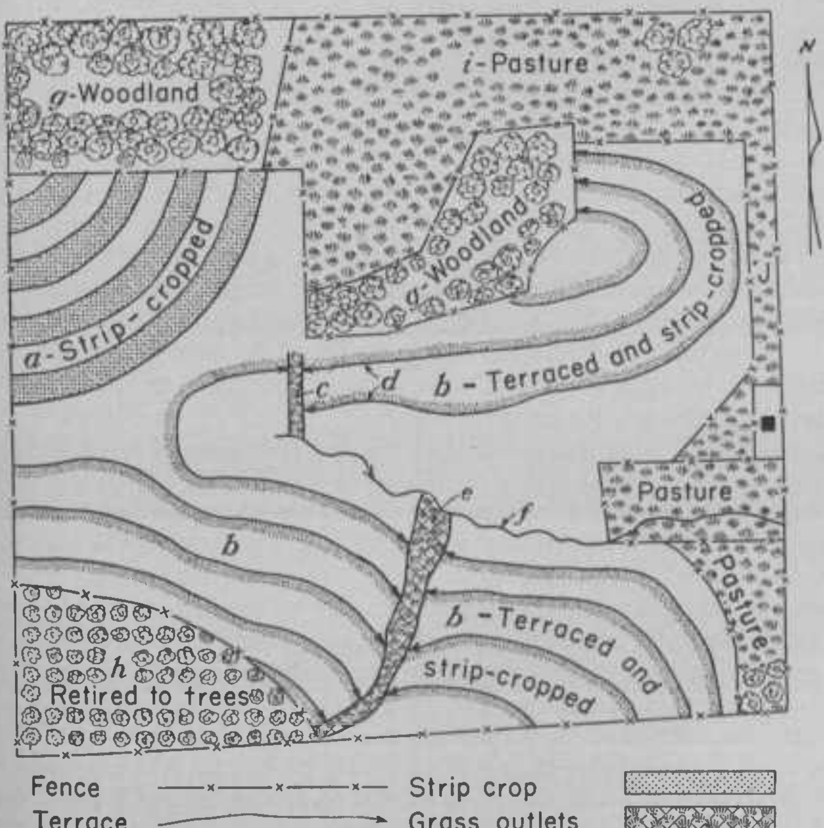

FIGURE 30.—*Diagram of the farm shown in figure 29 after erosion-control measures were applied, showing revisions in field arrangement and land use.*

hill, and no established crop-rotation scheme was being used. Figure 28 shows the farm arrangement after erosion-control measures were applied. All of the gullies (shown by winding lines in fig. 27) were plowed in and sodded. One gullied area was seeded to grasses after being sodded to form a meadow strip (*a*). This meadow strip takes water discharged from the terraces (*b*) constructed across the upper end of the long north slope where the field receives water from a farm lying on higher land. Erosion here was farthest advanced. The gullied area to the west and the gullied area through the middle of the farm were converted into pasture (*c*), connected by a fenced lane (*d*) to the original pasture (*e*) by the homestead at the south. Water from the west half of the three long terraces is discharged into the new pasture; water from the east half of the long terraces and the four shorter terraces on the side of the field to the east is discharged into the meadow strip (the longer terraces were graded to drain in both directions from a center point). The ends of the terraces were sodded (*f*). Instead of growing row crops in one field and close-growing feed crops in the other, both classes of crops are grown in each field, in strip-crop arrangement (*g*). Rows were turned so that cultivation follows the contour of the land. A definite crop-rotation system was established by following a row crop with a close-growing crop.

The second pair of diagrams (figs. 29 and 30) represents a farm on the upper Coastal Plain where the fields are small, slopes generally steeper, erosion damage usually greater, and a wider variety of erosion-control measures must be used.

As shown in figure 29, this farm consisted of a number of small irregularly shaped fields, some of them only 3 or 4 acres in size. Gullies had appeared in the fields, destroying about 12 acres of land. A survey revealed that from one-fourth to all of the topsoil had washed from 79 percent of the farm. About 65 acres remained in cultivation; 40 acres were woodland, pasture, and idle land. No definite crop rotation was being followed.

Figure 30 shows the farm after the fields had been rearranged and erosion-control measures applied. Only one field (*a*) was sufficiently moderate in slope and regular in its surface features and retained enough topsoil not to require terraces. This field was strip-cropped. All other cultivated fields were terraced and strip-cropped. Gullies in all fields were plowed in, and a short sodded terrace outlet channel (*c*) was constructed to care for water from one end of the terraces (*d*). A gully (*e*) was plowed in and seeded to meadow grasses to carry water from the new terraces to the natural drainage (*f*) which passes through the middle of the farm. Livestock was fenced out of the woodlands (*g*). Water from one end of the terraces (*d*) was turned into the protected woods. The eroded, steeper slope (*h*), mostly idle land, was planted to trees. Some of the cultivated land, about 10 acres in all, was made into pasture (*i*) by sodding and seeding. All of the pasture land was contour-ridged. The pasture at the northern side of the farm was connected to the pasture by the homestead by a fenced lane (*j*). All of the rows follow the contour, and a definite crop rotation has been established.

Recommendations By Regions

Throughout the South there is wide variation in agricultural conditions. Soils differ widely not only in fertility but in susceptibility to erosion. There is a wide variety of conditions of rainfall and climate, a wide range in vegetation. Some sections are drained by an intricate network of small streams, and fields are therefore small and the slopes short and, in many instances, steep. In other sections there are fewer streams, and the slopes are long and gentle and the fields large. In some localities farmers use small equipment, elsewhere large-scale power machinery. Some are old farming sections, badly washed; in others cultivation is relatively new, and the problems of erosion are only beginning to cause concern. Then there are the vast alluvial bottoms along the trunk streams where the erosion problem is slight. Obviously under such diverse conditions no standard set of erosion-control practices may be applied universally, and erosion-control practices therefore must be adjusted to each region, just as a suit of ready-made clothes must be altered and tailored to fit the purchaser.

The parts of seven States of which this bulletin treats may be divided into a number of so-called erosion-problem areas (fig. 31). Within these areas, or agricultural regions, conditions are fairly uniform, and recommendations as to crop rotations, arrangement of strip crops, type of terrace structures, treatment accorded severely eroded cropland and pastures, and other erosion-control measures are sufficiently similar to admit of descriptions less general in nature than it has been possible to give heretofore in this bulletin. Methods are described for the Gulf Coastal Plain, the blacklands of Alabama and Mississippi, the Mississippi loessial region, the upland Coastal Plain, the blacklands of Texas, the Grand Prairie, the West Cross Timbers of Texas, and southern Oklahoma. It is suggested that you turn first to the region in which your farm is located.

Gulf Coastal Plain

That part of the Coastal Plain of which this section treats (fig. 31) is gently rolling to rolling. Along some of the streams there are narrow overflow bottoms and wide second bottoms, or terraces, which slope very gently. Along many streams there is little first- or second-bottom land.

Cotton and corn are the principal crops grown. Oats, the leading small grain, are widely used as a nurse crop with lespedeza. Soils are generally deficient in organic matter. The seasons of severe erosion are in the summer and winter, when many of the rains come as quick downpours. In other seasons rains are usually less violent and less damaging.

In much of the area terracing and contour cultivation are commonly practiced, but in some sections these practices are not yet employed. Where terraces have been used they have held better than in most areas of the Cotton Belt, as the soils for the most part are sandy and well drained and take up water readily.

On cultivated slopes up to 2 percent, in project areas, contour cultivation and a systematic crop rotation to maintain organic matter and fertility have been found sufficient to control erosion. In the rare instances where very moderate slopes are sheet-washing badly it is necessary also to use strips of close-growing crops to check effectively the rate of erosion, and to terrace where small gullies have appeared in the fields.

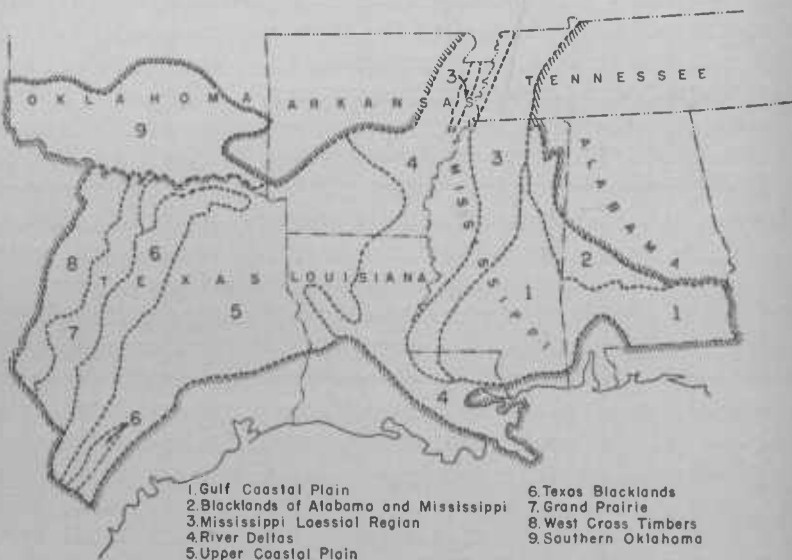

FIGURE 31.—*Map showing the principal erosion-problem areas in that part of the Cotton Belt for which detailed erosion-control measures are discussed in this bulletin.*

Slopes from 2 to 5 percent are terraced or strip-cropped or terraced and strip-cropped, and crops are grown in rotation. Strip crops are used without terraces on slopes of 2 to 5 percent only on land where there has been little erosion and where the conformation of the slope is uniform. But in many cases, especially on farms where most fields slope more than 4 or 5 percent, these moderate slopes are not strip-cropped; they are protected by contour cultivation, terraces, and rotation of crops, and the acreage that can be devoted to close-growing crops in strips is reserved for the steeper and more erodible slopes. On farms where livestock provides one of the principal sources of farm income, and therefore there is need for a larger proportion of close-growing crops for feed, the moderate slopes of 2 to 5 percent are also strip-cropped.

Cultivated slopes from 5 to 8 percent are strip cropped and terraced and crops are grown in rotation to give the full protection these steeper slopes require. Whenever possible, slopes of above 8 percent are planted to close-growing crops and not to row crops. Where such slopes cannot be retired from cultivation they are terraced and kept under close-growing cover as much of the time as possible. On most farms, however, slopes of above 8 percent are made into pasture or permanent meadow or are planted to trees and shrubs.

The crop rotations used in project areas in this region are quite varied. However, one of three systems is used in the majority of fields. In the section represented by the Canton, Miss. project, the hill land is adapted to cotton and the bottom land to corn. The rotation used, therefore, is either cotton or corn followed by a winter legume. The corn is often grown in alternate rows with cowpeas or velvetbeans. Vetch and Austrian Winter peas are the principal cover crops. Austrian Winter peas are preferred for a winter cover crop on land to be planted to cotton because they are ready to be turned under in the spring for green manure about 2 weeks earlier than vetch, in time to decompose partially before cotton-planting time. Where corn and cotton are grown in the same fields, crops usually are planted either in a 2-year or a 3-year rotation. The 2-year rotation is cotton, followed by vetch or winter peas, followed by corn interplanted with cowpeas or velvetbeans in alternate rows with the corn. The 3-year rotation is oats or oats with vetch, followed by cowpeas; cotton, followed by a winter cover crop; and corn. In this rotation the oats are planted in strips and occupy a third of the land. The cowpeas or beans are not harvested but are turned under to improve the soil. When it is not possible to follow all of the cotton with a winter cover crop, the cover crop is planted on land that is to be in late corn the following year. On most farms there are fields in 2-year rotation and fields in 3-year rotation. The 3-year rotation is necessary to provide sufficient feed for livestock.

The placement of the close-growing crops in strip-cropped fields is changed from year to year. In effect this brings into play a longer rotation which goes along with the shorter rotation. The crops used in erosion-control strips are mainly oats followed by lespedeza. The lespedeza stands 2 years. After the lespedeza is turned under, the land goes back into row crops. Since on most farms only about 20 percent of the land can be devoted economically to lespedeza, 10 years are required to complete the rotation cycle. Other close-growing crops used in strips are sorghum with cowpeas, crotalaria, and soybeans in close rows.

Strips are adjusted to the terraces on terraced land. Strips range in width from not less than 20 feet to 80 feet or more, although 40 to 50 feet is the width most generally recommended.

Some permanent strips are used. These generally are confined to the steeper parts of slopes. In parts of the Coastal Plain many gradual slopes break sharply and then lower down again assume a gradual grade. The breaks are generally short, but owing to their steepness they wash and gully badly when in row crops. In project areas these are seeded down permanently to lespedeza or planted to kudzu. Many entire fields on steeper slopes are planted to kudzu (fig. 32) or lespedeza.

FIGURE 32.—*Kudzu, a legume, is planted on washed and gullied slopes, or slopes too steep for row crops, in project areas. Its greatest success as a plant for erosion control is in the cotton States east of the Mississippi River. Kudzu makes excellent forage.*

Terraces are made 18 to 24 feet broad and raised to a settled height of about 18 inches. Terraces are built either with large power equipment or, as at the Laurel, Miss., project, with long-wing horse-drawn terracing plows. With the latter equipment about 2 years is required to raise the terraces to the desired height.

Where the soil takes up water readily, as the deeper sandy soils do, there is little run-off from terrace ends except during torrential rains in the summer. In these circumstances it is not difficult to dispose of terrace water safety. Terrace water is turned into pastures, meadows, or woods. When such outlets are not available outlet channels sodded with Bermuda or carpet grass are provided.

About a fifth of the land, roughly, in coastal plain project areas, is retired permanently from cultivation, not including new land in meadow. Most of this land is converted into pasture, although forest and wildlife plantings are made on a part of it. Both carpet and Bermuda grass are used for the pasture base, with perhaps greater use of carpet grass than elsewhere in the South. Such plants as Dallis grass, lespedeza, and hop and white clover are introduced later. All pastures, new and old, are fertilized and limed, and contour ridged or furrowed. The distance between ridges is 10 to 25 feet; that between furrows 5 to 7 feet. The spacing is determined by the degree of erosion, the steepness of the slope, and the soil type. On steeper slopes, moderately eroded land, and erodible soil types the closer spacings are used. After they are seeded, gullied places in pastures are mulched with forest litter, pine needles, cane pomace, or discarded hay.

Several tree species are planted, principally loblolly, shortleaf, slash, and longleaf pines, and black locust.

Plantings for wildlife are usually restricted to odd corners of farms and gullied areas. Privet hedge, bush lespedeza, coralberry, wild plum, Himalaya berry, and shrub dogwood are planted in the gullied areas, and mixtures of millet, common lespedeza, and *Lespedeza sericea* are sown in the odd corners.

Blacklands of Alabama and Mississippi

The black prairie begins in south-central Alabama and extends northwest, crossing into Mississippi near the center of the eastern boundary of that State and extending north almost to Tennessee. The first project area established by the Soil Conservation Service to serve the blacklands was centrally located at West Point, Miss., about 18 miles from the Alabama State line. Recently, another has been located near Marion, Ala.

The soils in the blacklands are heavy, lacking in humus, poorly drained, and highly susceptible to sheet washing. They take up water slowly, and much is lost as run-off. Soil losses have been greater in the blacklands than is realized. A survey of land conditions revealed that from a half to three-fourths of the topsoil had been removed from many fields by rain wash. The soils originally were dark in color, but now in many localities erosion has removed the surface layer, revealing a light-colored subsoil layer. However, throughout the area there is general lack of appreciation of the damage caused by unrestrained run-off which accounts for the infrequency of planned erosion-control measures. Farmers run their rows downhill because they desire quick drainage. Contour farming and terracing are rarely practiced. A grass-cotton-corn rotation is used, owing, however, to the peculiar growth habits of Johnson grass, now the natural vegetation of the blacklands. Johnson grass in cotton is an exceedingly troublesome weed; after 3 or 4 years in cultivation, cottonfields must be turned back to grass. But after 2 or 3 years in meadow or pasture Johnson grass roots come to the surface, and the field may again be planted to cotton or corn. An analysis of the agriculture within the project area showed that cotton occupied the land 6 years in 10, Johnson grass 3 years in 10, and corn once in about 10 years.

Farmers cooperating with the Service are introducing a definite crop rotation. They are using a 5-year rotation of 2 years of cotton, 2 years of Johnson grass for hay, and 1 year of corn. A winter cover and green-manure crop is planted sometime during the rotation, usually on land to be in corn the following year. Vetch and Austrian Winter peas do well.

Sloping fields are contour-farmed and strip-cropped. Slopes above 3 percent in grade also are terraced, although of necessity terraces are constructed on slopes of lesser grade where soil losses have been heavy. The higher parts of long slopes of lesser grade also are terraced.

Control strips are planted to feed and soil-improving crops: sorghum and cowpeas mixed, some cowpeas and soybeans alone, crotalaria, alfalfa, lespedeza, and sweetclover. Oats are planted in strips on the light-textured soils.

Johnson grass is not a good erosion-control plant under blackland conditions. It is coarse growing, and water riffles around and erodes the soil between the individual plants. Therefore even when a field is in hay the field is strip-cropped. Strips of alfalfa are planted on heavy Houston soils and well-drained Trinity soils, where this crop grows well; and on soils where they are adapted, lespedeza and sweetclover are used. Alfalfa strips are expected to stand 5 years. Strips of lespedeza and sweetclover stand for 2 years.

The width of the strips of close-growing crops is not less than 30 feet. The strips of row crops are 60 to 75 feet wide, the lesser width is applied to the more erodible soils and slopes.

The ease with which meadow becomes established, the moderate grade of the slopes, and general topography suggest the use of meadows as the most economical disposal system for terrace water. Johnson grass comes in quickly and naturally, but since this grass alone does not afford sufficient protection, the meadow is strengthened by the addition of other plants. When quick growth is wanted for immediate protection in outlet meadows, common lespedeza, Sudan grass, Dallis grass, black medic, or hop or white clover may be sown, the selection depending on the soil type.

Terrace-outlet channels are constructed on slopes above 4 percent. Bermuda grass is used in the channels. No satisfactory substitute has been found.

Probably slopes of more than 7 percent in the black prairie cannot be profitably cultivated for long. Such slopes at West Point, of which there are few, are taken out of cultivation, fertilized, and made into pasture or meadow. Much land of less than 7-percent slope is made into pasture. Whether a field is converted to pasture depends more on soil type and degree of erosion than on slope. The pastures consist of a Johnson grass base with clovers, Dallis grass, and lespedeza added. Pasture land that is not to be returned to cultivation is contour-ridged rather than terraced. Temporary pastures are terraced rather than contour-ridged. The ridges are spaced about 10 feet apart. The Nichols type of terrace is used on meadowland and temporary pasture, because mowers pass over this structure more easily than over the Mangum-type terrace and there is less interference with other machinery operations.

Both the modified Mangum and Nichols terraces are built in cultivated fields. All terraces are built with power machinery. Light equipment cannot operate efficiently in the black prairie. The soils are heavy and sticky, and the subsoils, especially, tend to roll.

Mississippi Loessial Area

East of the lower Mississippi flood plain there is a strip of land about 50 miles wide that, according to most geologists, was covered by a deposit of wind-blown soil during some remote period in the past. This deposit of loessial soil material extends from the mouth of the Ohio River to the lowlands along the Gulf of Mexico. The bluffs along the Mississippi, where the deposit of wind-blown soil is deepest, form its western boundary. East from the bluffs the soil deposit gradually grows thinner until it fades to a trace.

Before the war between the States almost all of the loessial region was cultivated. The soil was highly prized for cotton. But wind-blown soil material is highly erodible. It washes and gullies easily. In cotton, the humus-filled topsoil washed away, and yields declined. The land then dropped out of cultivation until the humus content was built up by natural vegetation, when it was brought back into cultivation for a few years. This is the old farming system of cultivation and rest, which was tried and failed in the eastern Appalachian and piedmont country. In the Soil Conservation Service project area at Port Gibson, Miss., fields have been in and out of cultivation three and four times in the last 20 years. Up to 3 feet of soil has been lost during this brief period.

Little effort has been made in the past in the loessial area to hold the soil. Few fields have been terraced or contour-farmed; winter cover crops have been grown only a few years and only on a small part of the land.

When care is taken to preserve and replenish the supply of organic material, loessial soil responds unusually well to a vegetative program of erosion control. The loessial soil of the Mississippi Valley is productive and produces abundant vegetation quickly. Where winter cover crops have been grown the results have been uniformly good. Their strong growth provides excellent vegetative cover during the erosive periods in the winter and early spring. And, turned under, the organic matter and nitrogen provided by the legumes maintains a highly productive soil condition. On the Port Gibson project, winter cover crops, principally vetch and some Austrian Winter peas, are grown on a high percentage of the cultivated land.

All sloping land irregular in conformation owing to gullying, and all land sloping above 5 percent that is to remain in cultivation, is terraced on the project area at Port Gibson. Both the Mangum and Nichols types of terraces are built. The Mangum terraces are used on slopes up to 6 percent in grade, the Nichols type terraces on slopes above 6 percent. Terraces are made somewhat smaller than standard specifications require, for terraces having a base width of 15 to 18 feet have proved adequate in size for the smaller fields common to the loessial area. It has not been necessary to build many outlet channels at Port Gibson. Usually water may be turned into woods, pasture, or meadow. In instances where no other means of disposing of terrace water could be devised, outlet channels were constructed and sprig-sodded with Bermuda grass or seeded to carpet grass, hop and white clover, and lespedeza. Outlets prepared in the fall are seeded to Italian ryegrass or oats for winter protection in the first season. Outlet channels sloping more than 6 percent are sodded solidly with Bermuda grass.

Land sloping more than 2 percent, and all terraced land, is strip-cropped. To start the strip-cropping system a mixture of cowpeas and sorghum is planted in strips during the first summer season. This is followed by oats and lespedeza, the lespedeza standing for 2 years.

A minimum of one-fifth of the cultivated land is planted in close-growing crops in strips. In the Port Gibson area the average amount of land per farm in close-growing strip crops is 27 percent. Strips are not less than 30 feet wide and may have a width of as much as 60 feet. On terraced land the control strips are placed astride every second or third terrace, beginning at the upper side of the terrace and extending over the terrace and into the terrace interval the desired distance. On steeper slopes, where terraces are spaced more closely, the strips of close-growing crops are adjusted to every third terrace; on lesser slopes, to every second terrace.

Since the hill land is adapted to cotton production and the bottom land to corn, in much of the loessial area, the rotation employed in the interstrip section on uplands is cotton followed by a winter cover crop, and on the lower lands, corn followed by a winter cover crop. The location of the strips is moved from terrace to terrace at the end of each 2-year period. Since only about one-fifth of the land on most farms may be devoted profitably to lespedeza, under the present farming system, about 10 years must elapse before the rotation of cotton, oats, and lespedeza is completed.

Slopes of from 10 to 12 percent are devoted to meadow, continuous production of other close-growing crops, or pasture (fig. 33). Slopes of 12 percent and over either are made into pasture or planted to trees and shrubs, depending on the need of the farm for pasture and woodland. Kudzu is grown as a meadow crop on badly eroded land and thrives.

Newly made pastures are contour-ridged or furrowed, sprig-sodded with Bermuda grass, or seeded to carpet grass and overseeded with a pasture mixture consisting of common lespedeza, white Dutch and hop clovers, and Dallis grass. On thin land some carpet grass seed is added. Natural pastures usually contain more carpet grass than Bermuda grass. These pastures are contour-ridged or furrowed, and the disturbed areas seeded to the same mixture.

Pasture contours have proved popular with farmers at Port Gibson. They have not only improved pasture growth but, by holding the water back, have helped to make corn growing possible on lowlands which were flooded periodically before an erosion-control program was effected on the upland slopes.

Hardwoods grow unusually well in the Mississippi loessial area. An oak at Port Gibson attained a diameter of 30 inches in 27 years. Hardwoods are therefore planted on land retired permanently from cultivation. Red oak, white oak, ash, poplar, and, for fencepost stock, some black locusts are the species used.

FIGURE 33.—*This badly eroding field in the loessial area of Mississippi was retired to pasture. Contour ridges were constructed in December 1936. The field was then seeded to hop and white clover, lespedeza, and Dallis grass. This picture was taken 5 months later.*

Crowley's Ridge in Arkansas

West of the Mississippi River in east-central Arkansas there is a strip of loessial soil known as Crowley's Ridge. The ridge is deeply dissected by many ravines, and the fields consequently are small. They comprise only a few acres. It is not practical to terrace these small fields. They lie high above a stable grade, and water concentrated by terraces cannot be safely directed away without too great expense.

Only the very gently sloping land, the level fields, and some of the hilltops on the ridge are planted to row crops. On the project area near Forrest City the cultivated hilltops and the so-called upland bottoms are surrounded by border strips and strip-cropped. The edges of fields which break into a ravine are bordered with Bermuda sod and lespedeza.

The slopes and hilltops in the project area are used for pasture, permanent lespedeza meadow, or for woods. Hilltops are cultivated only on farms on which there are few upland bottoms. All pastures are contour-ridged or furrowed, sodded with Bermuda grass sod where the cover is sparse, overseeded, fertilized, and limed. Here, as in the loessial uplands of Mississippi, the more valuable kinds of hardwood trees grow rapidly, and woodland management offers an opportunity to secure permanent income from extensive areas of steeply sloping land.

The streams from the ridge drain to the west and cut through broad, gently sloping second bottoms normally above overflow. The soils on these second bottoms are similar in character to those on the ridge, although here soils with compact and tight subsoils are much more extensive than on the ridge. They wash severely from the more sloping lands unless control measures are applied. Cotton and corn and a very little lespedeza are the principal crops grown. Farmers buy nearly all their hay.

Second-bottom land in the project area is strip-cropped. Strips planted in the fall are wheat, rye, or oats. In the spring the strips are overseeded with lespedeza. The lespedeza stands for 3 or 4 years. Then the strips are relocated. Sorghum and peas or Sudan grass are used in strips started in the summer. The strip-cropping plan is to alternate 25 feet of close-growing crop with 75 feet of row crop. Corn is interplanted with soybeans or cowpeas.

Upper Coastal Plain

The upper Coastal Plain is an area of sandy soils in eastern Texas, northwestern Louisiana, southeastern Oklahoma, and southern Arkansas. It is one of the older farming areas of the South, settled by pioneers of farming stock. The soil was never rich, even in the days before cash-crop farming. The organic layer under the hardwood and pine forests was scarcely 3 inches deep. Undoubtedly much of the forest land should never have been cleared for cultivation; and much of the land once cleared is no longer cultivated and should be returned to forest. But there are sizable tracts on the upper Coastal Plain where the soil is good and, when wisely handled, productive. Fields which retain some of their topsoil respond readily to good soil-management practices. Turning under two or three crops of cowpeas or winter legumes for green manure, for example, invariably improves the productiveness of the soil.

Cotton farming, which displaced the pioneer self-sufficient agriculture, quickly exhausted or stripped the organic layer of soil from the rolling lands, and for years cotton farming has been an unprofitable single enterprise. Although cotton promises to remain the principal cash crop, it is recognized that a reduction in the acreage of this crop must occur on most farms before a farmer can expect, by a system of crop rotation and farm reorganization, to build up and maintain the productiveness of his soil and reduce soil wastage.

The more successful farmers in the area have diversified their farming. Many now produce all of the feedstuff required by their work stock and a large part of the family supplies, which formerly were purchased with cash procured from the sale of cotton. However, these men are a minority. An agricultural extension agent in a northwestern Louisiana parish, surveying the local feedstuffs situation in March 1937, found that not more than 60 farmers in his parish had enough feed on hand to carry their work stock through the planting season. The cash outlay in this parish for feed totals more than $200,000 a year. A recent economic study of farm organization made by the Texas Agricultural Experiment Station for the upland Coastal Plain of that State reveals the benefits of diversification. Different combinations of cotton with tomatoes, sweetpotatoes, watermelons and peas, and dairying, yielded more net farm income than straight-cotton farming.

On most farms of the upper Coastal Plain it is necessary to carry out a complete reorganization of the cropping system in order to accomplish effective erosion control, in addition to making full use of such mechanical measures as terracing, contour farming, and contour ridging or furrowing of pastures. Less cotton and corn, but more of the close-growing feed crops are grown on farms so reorganized.

In project areas small grain has displaced part of the cotton and supplemented corn as a feed crop. Since average corn yields in many counties on the upper Coastal Plain do not exceed 10 bushels an acre, the small grains have produced, acre for acre, more feed than corn. Whole fields have been diverted from the production of row crops to meadowland and pasture. The effect of this shift in field use, together with a program of strip cropping, has been to provide, for the first time in many years, sufficient feed at least to carry work stock through the planting season. In many instances there has been a surplus of feed produced over the needs of the work stock. This surplus has not always been sold. A number of farmers have bought dairy cows, and they find that the monthly check received for a few cans of milk set on the road in the morning meets the operating expenses of the farm. Money from the sale of cotton is their profit. Several project areas, incidentally, are being served by new milk plants built since the local feed situation improved.

The eroded condition of most slopes and surface irregularities are such, on the upper Coastal Plain, that terracing is employed as a basic erosion-control measure on most upland fields. There are some slopes under 2- or 3-percent grade and of even conformation which do not require terraces; but these are relatively few. The modified Mangum and Nichols terraces are used. Terraces, in project areas, are constructed and spaced according to standard specifications for variable-grade structures, although in some sections where fields are small, as around Monticello, Ark., smaller terraces have proved dependable on fields of 4 or 5 acres. Before terraces are made, washes and gullies are plowed in to assure less concentration of water and clogging of the channels of terraces.

Elaborate plans for disposing of terrace water are seldom necessary. Even in sections most developed agriculturally less than half the land is cultivated. Under these conditions terrace water usually may be directed into a woods, a pasture, or a meadow. When it is necessary to provide outlet channels, these are strip-sodded when the grade is not more than about 4 percent and sodded solidly when the slope is steeper. Bermuda is the only dependable grass to use in most sections, although in localities where carpet grass grows well this grass has proved satisfactory.

All sloping fields, in project areas, whether terraced or not, are strip-cropped. The strips of close-growing crops occupy from a fourth to half of the field area. The proportion of the field devoted to close-growing crops is greater on the steeper slopes and in fields which have lost a good part of their topsoil.

Close-growing crops planted in summer strips are Sudan grass, redtop sorghum, or hegari, usually mixed with cowpeas. For fall and winter protection oats or rye or sometimes barley or wheat, often in combination with vetch, are grown in strips on soils suitable for small grains. Where the soil type is unsuited to small grains, the stubble from the summer strips is left standing to aid in erosion control during the winter season.

When strips are used with terraces, one or a combination of the methods shown in figures 14 to 19 are used. Newly made terraces are always protected during their first year by a close-growing crop, as shown in figure 14.

Lacking both mineral fertility and organic matter, soils of the upper Coastal Plain generally yield poorly. It is essential, therefore, in an erosion-control program depending mainly on vegetation, to improve soil fertility so that vegetation will grow strongly. As a first step a systematic rotation of crops is introduced. The crops are grown in such sequence that the soil is protected by a vegetative cover as much of the time as possible. A legume appears some time during the rotation and is turned under for green manure, to supply nitrogen as well as organic matter.

Farmers who depend on livestock for a part of their cash income, and not wholly on cotton, are able to employ longer rotations of a kind more satisfying for soil-improvement purposes. They can use rotations that cover 3 or 4 years, whereas farmers who depend on crops for their sole source of cash income can, at best, use only a 2-year rotation. Table 4 lists some of the crop-rotation systems being employed in the project areas of the Soil Conservation Service on the upper Coastal Plain.

Badly gullied fields, fields sloping more than 8 percent, and fields of less grade from which the greater part of the topsoil has been removed by erosion are converted into pastures or woods. Some fields are seeded to grasses for permanent meadow. In some sections bottom lands have been used for pasture and the uplands for the production of field crops. When danger from overflow is not great, part of the lowland pasture is plowed and planted to field crops and the sloping, eroding fields are planted to grass to offset the loss of lowland pasturage. In the project area at Nacogdoches, Tex., the land-use program on a number of farms has been reversed by this procedure. A combination of lowland and upland pastures provides a longer grazing season and better-quality pasturage.

TABLE 4.—*Crop rotations employed in erosion-control programs on farms on the upper Coastal Plain*

First year	Second year	Third year	Fourth year
Cotton or other cash crop followed by oats or oats and vetch.	Corn in 6-foot rows with cowpeas or velvetbeans planted in the middle.	....	....
Cotton or other cash crop followed by oats or oats and vetch.	½ corn and ½ sorghum........	Cowpeas.......	....
Cotton or other cash crop followed by oats or oats and vetch.	Corn in 6-foot rows with cowpeas or velvetbeans planted in the middle.	½ Sudan grass and ½ sorghum.	Cowpeas.

Pastures are established on suitable soil types by sodding with Bermuda grass and overseeding, principally, with hop and white clovers, bur-clovers, black medic, common lespedeza, and Dallis grass, according to local adaptability. Some of the lowland areas are sodded with carpet grass and overseeded. It is necessary to lime and fertilize most fields before pastures can be made. The amounts used depend on local requirements. Most of these soils are deficient in available phosphorus and require an application of some phosphatic fertilizer to insure success.

Contour ridges or furrows are constructed on many sloping pasture fields to retain moisture and lessen the rate of erosion until vegetation is dense enough to control soil washing. To establish and maintain pastures in good condition, pastures are mowed three or four times during the first season or two and less often in later years, to control weed and shrub growth.

In Arkansas the practice of sodding in strips has gained favor in areas where common lespedeza does well. Sodded strips 25 to 50 feet wide alternate with strips of equal width sown to common lespedeza. The strips are laid out on the contour. Eventually the Bermuda grass will spread across the strip of lespedeza. The strips of Bermuda grass meanwhile hold soil movement in check. The advantage of this method is its lesser cost.

Many slopes are retired to trees, particularly where there are fine sandy soils, which are not suitable for pasture. Plantings are mainly pines and locust. There is a general need for fence posts, and many of the smaller fields are planted to black locusts to meet this need. The pine plantings are interplanted with shrubs and hardwood trees which provide food and cover for wildlife.

The Blacklands of Texas

Seventy-five years ago the blacklands of Texas were prairie. Most of the old prairie sod was turned less than 50 years ago. Little land has been farmed more than 65 years.

The soils of the blacklands are highly erodible. They sheet-wash easily since the surface soils are naturally loose and granular and rest on heavy clay layers. Up to a certain point the soils absorb water fairly readily. As they become dry, they shrink and crack, and gullies often start from the crevices. As they become wet, the soils swell and seal, and water runs rapidly over the surface. Because of the topography of the area and the character of the soil, sheet erosion is far more serious in the blacklands than is gully erosion. Few farmers, the majority of whom are tenants, have made much effort to control soil washing. Indeed many of them are unaware of the extent of damage caused by erosion, although here and there telltale outcroppings of the underlying chalk and marl reveal that all of the topsoil has washed away. A survey of land conditions in blackland project and camp areas revealed that many fields had lost from 25 percent to as much as 75 percent of their topsoil. The survey, involving 280,000 acres, revealed that 12.5 percent of the land exhibited no erosion damage; 46 percent of the land had lost not more than one-fourth of the original topsoil; 26.8 percent had lost from a fourth to three-fourths of the topsoil; 12 percent had lost more than three-fourths of the topsoil and exhibited numerous gullies; and 2.7 percent of the land had lost all of its topsoil, and gullies had cut through the parent soil material.

Little of the blacklands is terraced; nearly all rows run downhill; for the most part, crops of the erosion-permitting kind are grown, and continuous cropping rather than rotation of crops is the rule.

Erosion-control treatments in the blacklands are determined largely by the degree of slope in the field and the severity of erosion. The various soil types, except in their shallow phases, are managed in very similar manner. There is little land that will not benefit from some protective practices. In project areas only land that slopes not more than 0.5 percent, which to the eye appears practically level, is neither strip-cropped nor terraced. Slopes of more than 0.5 percent are strip-cropped. On slopes of up to 3-percent grade, terraces are used with strips where the length of the slope is greater than 1,000 feet. On slopes of from 3- to 7-percent grade, terraces are used with strips where the length of slope is greater than 700 feet. However, all fields badly infected with root rot are terraced even when strip-cropped. Moderate slopes, even though short, are terraced if gullies have appeared in the field, or if half of the topsoil has been lost. Slopes of from 7 to 10 percent, if they are not to be retired to meadow or pasture are kept under a continuous cover of oats, wheat, or barley over winter, and the stubble is left standing for summer protection; or, half the slope is kept in winter cover followed by stubble and half under a summer cover of Sudan grass o sorghum, the winter and summer crops being planted in alternate strips 45 to 60 feet wide.

Because it is not a natural tree country, most land that is retired from row crops, owing to steepness of slope and eroded condition, either is kept permanently in sowed or drilled crops, or meadow or is made into pasture. It is practically impossible in the blacklands to grow row crops on slopes of more than 7 percent and effectively control erosion.

Terraces are of the modified Mangum type, broad enough to accommodate multiple-row machinery. The first 400 feet of terrace length is made level; after that the terrace is given grade which is increased at the end of each 400 feet of length. Terraces do not ordinarily exceed 2,000 feet in length. Terrace water is turned, whenever possible, onto meadows or pasture land. However, owing to the large proportion of cultivated land in the blacklands, it is necessary more frequently than elsewhere in the Cotton Belt to build outlet channels to carry terrace water to a stabilized grade. Bermuda grass and buffalo grass are used in outlet channels. Sometimes Bermuda grass is sodded in the bottoms and buffalo grass on the sides of the channel.

Infections of cotton root rot in fields greatly complicate the strip-cropping program in the blacklands. Root rot attacks all legumes as well as cotton. Only the grains and grasses are free from the ravages of this disease. Wherever root rot is prevalent the choice of crops used for control strips is limited to oats, wheat, barley, Sudan grass, the sorghums, and the meadow grasses. Hubam sweetclover, a recent introduction into the blacklands, is the most promising legume tried thus far in areas infected with root rot. When seeded in the fall or early spring it provides protection for the soil during the period of erosive spring rains. Oats is the most popular winter strip crop, especially in the northern half of the area. Toward the south oats do not always produce a grain crop and are harvested for hay when grown in strips. Many farmers in the project area at Lockhart, in the southern part of the blacklands, are substituting Hubam sweetclover for oats for winter control strips. Alfalfa and little bluestem (fig. 34) are planted in strips which are to stand for several years. The use of alfalfa is restricted to fields not infected with root rot disease. Little bluestem, which was one of the grasses prominent in the native cover, is popular for semipermanent strips on blackland project areas. Other grasses used for this purpose are big bluestem and, in a limited way, Indian grass.

The spacing of strips with respect to terraces is shown in figures 14 to 19.

Rotations are applied within the field on a strip-cropped farm. Fields, as such, are not rotated. Strips of row crops are planted between strips of close-growing crops, and these strips are moved up and down the slope from year to year to provide for a rotation of crops. A rotation, to improve the soil, should contain a legume; but the prevalence of root rot complicates cropping plans. Root rot is in its most active stage during the summer months. Its organism is less active during the winter and early spring months. In order to provide a

FIGURE 34.—*Meadow grasses are planted on strips that are to remain for several years. Little bluestem is planted on contour strips in the blacklands of Texas.*

rotation for soil improvement and protection and at the same time avoid root rot damage, it is therefore necessary to resort to winter or early spring seeded legumes. For this purpose, Hubam sweetclover has caught the fancy of the farmers in the project areas. Sorghums are frequently planted for green manure in place of legumes in root rot areas. Table 5 shows the rotation systems commonly used in blackland project areas.

TABLE 5.—*Rotation systems recommended for the blacklands of Texas*

First year	Second year	Third year	Fourth year
Cotton	Oats	Corn or sorghum	
Do	Corn	Hubam sweetclover	
Do	Oats	Corn or sorghum; Hubam sweetclover.	
Do	Corn or sorghum; oats	Cotton	Oats; corn or sorghum.

Established pastures sloping not more than 3 percent are mowed to control weeds, but no other protective measures are applied unless the sod is too thin to control erosion. Then the pasture is sodded by the furrow method, buffalo grass being used when available or Bermuda grass. Buffalo grass is preferred for the higher land; Bermuda for the lower. Other pasture plants are introduced by overseeding with Dallis and rescue grass, bur-clover, black medic, and annual yellow sweetclover. Land that slopes more than 3 percent and land newly made into pasture are contour-ridged or furrowed and mowed.

Active gullies on all pasture land are sloped and sodded; and brush interfering with the growth of the grasses is cleared from the field. Diversion terraces are constructed above gullied areas to carry the water away from the heads of active gullies.

The Grand Prairie of Texas

The Grand Prairie of Texas lies between the blacklands and the West Cross Timbers. The 7,000,000 acres in this section are devoted to grazing, livestock farming, and field crops. Cotton at one time occupied more than half of the land in cultivation, but in recent years the trend has been away from cotton toward increased production of feed crops and livestock, principally sheep, goats, and cattle. Owing to the growing importance of livestock in the farming sections of the Grand Prairie, it is now less difficult to adjust farming operations with a view to erosion control than it used to be when more cotton was grown. Most farmers want more improved pasture, and increasing numbers of livestock offer a certain outlet for the feed produced in erosion-control strips.

All cultivated fields are strip-cropped on farms cooperating with the Soil Conservation Service in the Grand Prairie. On slopes of up to 2 percent the strips of close-growing crops are 24 feet wide and alternate with 75 feet of erosion-permitting crops. On slopes from 2 to 5 percent the width of the strips is widened to 30 feet and the area in row crops reduced to 60 feet. A so-called "50–50 method" also is used. In this system half of the land is planted in close-growing crops and strips and half of the land in erosion-permitting crops in strips. The width of the strips is adjusted to the degree of slope and the degree of erosion in the field. Only moderate slopes, few of more than 4-percent grade, are cultivated. Many are long. On slopes of up to 2½ percent the strips are 100 to 120 feet wide. The width of the strips on slopes of 2½ to 3½ percent is 80 to 100 feet, and on slopes of more than 3½ percent the width is 60 feet. Of the two figures given for each slope classification, the lesser one is chosen when the field is more severely eroded; the larger one when there is little erosion.

For full protection much land on the Grand Prairie must also be terraced. Since all cultivated land is strip-cropped, only those slopes are terraced which are gullied, uneven in conformation, or badly sheet washed. On terraced land the strips extend from the middle of the terrace interval, over the terrace, to the middle of the adjacent terrace interval. With this method only half of the terrace interval is planted to a row crop each season. The other half is protected from washing by close-growing vegetation.

Oats are the principal feed crop grown in the strips in the winter. Whenever oats cannot be seeded in the fall, spring wheat is planted, unless the spring season is too wet; then the strips are seeded to millet. The oats are followed by a row crop, usually about 3 acres of cotton to 2 acres of corn, although the proportion of cotton is sometimes greater.

It is seldom necessary to build terrace-outlet channels on Grand Prairie farms. From these moderate slopes it is nearly always possible to turn terrace water into a pasture or meadow. On many farms a pasture field is extended along the edge of the cultivated field from which terrace water is to be discharged. When meadows are seeded down to a mixture containing four or five grasses the vegetation soon becomes sufficiently dense to resist the washing effect of concentrated terrace water. Little bluestem is the principal grass used. Big bluestem, Indian grass, and switchgrass are commonly added to the mixture. A little Dallis grass is included for seepy areas where the soil stays wet most of the year.

At Gatesville, the location of one of the C. C. C. camps doing soil conservation work, Hubam sweetclover (fig. 35) was introduced on one farm 7 or 8 years ago. The Hubam sweetclover reseeds itself and appears with oats. The oats are threshed. The straw, which is mixed with the volunteer sweetclover, is feed of good quality. The owner of this farm states that the productivity of his soil is constantly improving from the use of the legume and manure from his livestock. He is supplying Hubam sweetclover seed to other farmers who are seeding it with oats in erosion-control strips. Although cotton root rot is not considered so destructive as in the blacklands, in wet years the disease causes sufficient trouble to make the growing of legumes other than Hubam sweetclover unattractive. Usually the Hubam sweetclover may be harvested before root rot is noticeable.

Figure 35.—Hubam sweetclover, an annual white sweetclover, is becoming popular among farmers in project and camp areas in the blackland and Grand Prairie sections of Texas.

Fields retired to pasture are sodded with Bermuda grass or buffalo grass. The buffalo grass, when available, is preferred for the higher land. The chunks of sod are dropped about 6 feet apart in furrows. Before being sodded, all fields to be made into pasture are contour-ridged. The ridges are spaced about 12 feet apart. Since most farmers keep sheep or goats, there is usually little weed trouble in established pastures. Farmers who do not have sheep or goats mow their pastures two or three times a season. Gullies are plowed in, and the banks are seeded to grasses and sodded.

The West Cross Timbers

The West Cross Timbers of Texas lie between the Grand Prairie and the Rolling Plains. They comprise some 7,000,000 acres of originally timbered land broken by small prairies. The native trees are post, live, and blackjack oaks, and other hardwoods, all of small size, except along the streams. On the prairies, needlegrass and buffalo, mesquite, and little bluestem grasses grew among scattered mesquite trees. Much of the area is too rough and rolling for crop production, and farming is restricted to the comparatively smooth, moderate slopes. These slopes were broken primarily to produce cotton, which originally occupied fully two-thirds of the cultivated fields. But in recent years, owing to declining yields and prices, the farming trend has been away from cotton toward diversified farming and livestock. Yet cotton remains the principal cash crop.

The soils in the West Cross Timbers appear to be especially susceptible to rapid erosion. When unrestrained by vegetation, run-off quickly cuts gullies that run the length of even moderate slopes in a short time. In the project area near Dublin, which is representative of the farming land in the West Cross Timbers, few fields sloping more than 5 percent have remained in cultivation (fig. 36). Farmers had, so to speak, followed their topsoil downhill, converting the steeper slopes to pasture, or, as happened in many instances, abandoned the land. A careful soil conservation survey of 80,096 acres in project and camp areas revealed that of the land still remaining in cultivation, 17 percent is bottom land and is not eroding; 50 percent has lost less than 25 percent of the original topsoil; 29 percent has lost 25 to 75 percent of the original topsoil and is gullied; and the rest is ready for retirement. The present pastures and woods that at one time were cultivated also exhibit similar conditions of erosion.

Crops are restricted, in project and camp areas in the West Cross Timbers section, to land that slopes not more than 5 percent. The control practices used are determined by the degree of slope and erosion and, to an unusual extent, by the soil type.

On land that slopes not more than 1 percent and shows no apparent erosion, control of soil washing is effected by contour farming and by including a green-manure crop in the rotation to maintain the content of organic material in the soil. But slopes of greater degree, which are losing material quantities of topsoil, require further protective measures.

Terraces are not used alone to control erosion. All terraced land is strip-cropped. Terraces have been employed for a number of years in the West Cross Timbers section, but erosion has been severe nevertheless. Unusually violent and sometimes prolonged storms occur, and unless terraces are supported by other control measures, they frequently fail. In 1936 a rainfall of 9 to 12 inches in 6 consecutive days ending with a 3-inch rain in 45 minutes broke every terrace that had not been protected by a strip of Sudan grass. The strip-cropped terraces did not fail. The terraces recommended are the broad-base, variable-grade type with a maximum channel grade of 3 inches in 100 feet toward the lower end of the terrace.

Strip crops are used on all eroding slopes. Where gullies are few and small and a fair proportion of the topsoil remains in the field, a strip-crop rotation without terraces is employed on the shorter slopes. The upper ends of slopes more than 500 feet long also are terraced. Where there are more than two or three gullies on an acre, even very moderate slopes are terraced.

Where the field does not need to be terraced, the width of the area in erosion-permitting crops on slopes of up to 2 percent is held to 75 feet. The width of the strips of close-growing crops is 24 feet, or two rounds of a 6-foot drill. The width of the strips in close-growing crops is increased to 30 feet on unterraced slopes of more than 2-percent slope, and the width of the area in erosion-permitting crops is reduced to 60 feet.

The strip-crop arrangement employed with terraces is one of the five methods shown in figures 14 to 19. Before the terraced field is strip-cropped, the small gullies are plowed in and seeded to close-growing crops.

The crops on trial in erosion-control strips for spring and summer protection are redtop sorghum, Sudan grass, hegari, cowpeas, or combinations of these crops in drills or close rows. For fall and winter protection, the crops on trial are oats, rye, barley, wheat, sweetclover, vetch or a combination of oats and sweetclover, or oats and vetch. It has not yet been determined which of these crops or combinations of crops will prove most suitable for the area.

As an aid in maintaining productivity, it is planned to rotate crops regularly so that all of the land in strips will be benefited by turning under a legume sometime during the strip rotation.

Several rotation systems, 2 or 3 years in length, are being employed in the Dublin project area. The rotation that seems adapted to most farms is cotton followed by a winter cover crop the first year and grain sorghum or corn interplanted with summer legumes followed by a winter cover crop the second year. The selection of the winter cover crop depends largely on the soil type; and weather often determines its use. The cover crops are grazed in the winter and turned under for green manure later. Corn and grain sorghums are planted in rows 6 feet apart, the summer legumes being interplanted as soon after the crop

Figure 36.—*Soils in the West Cross Timbers section appear to be especially susceptible to erosion. They wash badly during violent rainstorms. Little land sloping more than 5 percent remains in cultivation.*

is well started as moisture conditions permit. The winter cover crops used are oats or rye alone or with annual sweetclover or vetch.

Cultivated land which has lost more than three-fourths of the topsoil, and slopes too steep or too badly gullied for further cultivation are made into pastures or, sometimes, farm woods. There is greater need for pastures. Therefore most fields of any slope that are retired from cultivation are contour-ridged or furrowed and sodded. The contour ridges are spaced about 12 feet apart.

Buffalo grass, which is native to the country, and Bermuda grass are used for pasture development in new pastures and in old pastures where the stand of grass is poor. One of the several sodding methods is employed. Before being sodded, the gullies are plowed in and seeded to vegetation that provides temporary cover quickly. When the work is done in the fall, Italian ryegrass or sweetclover is used; when the work is done in the spring, little bluestem.

When newly made pastures are overseeded with mixtures of grasses and clovers to improve the quality of the pasturage, for the most part seeds of such plants as rescue grass, Italian ryegrass, bur-clover, black medic, and Dallis grass are used. Seed is broadcast in the spring or fall or sometimes is mixed with a load of damp manure and spread, and covered lightly by a harrow, disk, or drag.

While the old pastures are being built up and new pastures are being made, supplemental feed is provided by temporary pastures—oats with sweetclover or vetch in the winter and Sudan grass with cowpeas in the summer. The strip-cropping program provides further feed supplies for pasture relief. After pastures have been established and fenced, livestock is moved from one to another in rotation, to permit the pasture plants to regain strength and reseed after being grazed. Mixed grazing with cattle, sheep, and goats is practiced on many pastures in the project area, not only to make most efficient use of the available pasturage but to keep down weeds and shrubs. When pastures in this section are not grazed by sheep or goats it is necessary to mow to prevent weeds from shading and destroying the desirable pasture plants.

Southern Oklahoma

Erosion damage in Oklahoma is widespread. According to one survey 84 percent of the cultivated land suffers from some form of accelerated erosion. In southern Oklahoma, where cotton is the leading cash crop, sheet and gully erosion are noticeable on practically all sloping land. Many of the steeper slopes long since have dropped out of cultivation. In some localities little land sloping more than 6 to 8 percent is now cropped.

The predominance of row crops in the cropping systems and the character of the rainfall stand out as the principal causes of rapid erosion rates on cultivated land in Oklahoma. The rainfall in the cotton-growing sections of the State while not frequently excessive in any season, is often intense. It is not uncommon for an inch of rain to fall in 10 minutes; and in the spring months rains of several hours duration not infrequently deliver 4 or 5 inches of water on land while it is without vegetative protection. Although many of the eroding fields in southern Oklahoma now are terraced, in other respects the farming systems employed are not greatly different from those introduced by the pioneer settlers. There are about 16 million acres in cultivation in the State; yet until recently less than half a million acres were planted annually to soil-building crops.

Growing soil-depleting and erosion-permitting crops continuously caused crop yields to decline and led to the abandonment of large acreages of land (fig. 37). A recent agronomic report states that crop yields have dropped 40 to 60 percent in central and eastern Oklahoma on land that has not known 30 harvests. Tests of samples of cultivated soils show declines of 25 to 50 percent and more in the supply of organic material and nitrogen since the land was first cultivated.

It is agreed that definite crop rotations containing soil-building and soil-holding crops must replace continuous row-crop farming if the productive life of southern Oklahoma soils is to be prolonged. In project areas the Soil Conservation Service recommends growing cotton and other row crops in regular sequence with legumes and other close-growing crops, as a first step in an erosion-control program. The usual cotton-and-corn cropping plan of southeastern Oklahoma, for example, is modified to include summer and winter legumes. Cowpeas or mung beans are planted in alternate rows, or in alternate pairs of rows, with corn; and row crops are followed by a winter legume such as vetch or a mixture of a winter legume and small grain. Some of the rotations recommended for use in project areas in southern Oklahoma are listed in table 6. In all of these rotations soil-building and soil-holding crops appear more frequently than in the cropping systems most commonly employed. They all furnish vegetative cover for the land during a part of the rotation period.

Table 6.—*Some crop rotations employed in erosion-control programs on cotton farms in Oklahoma.*

First year	Second year	Third year	Fourth year	Fifth year
Cotton	Vetch [1]	Cotton	Wheat, rye, Italian ryegrass, or winter oats.	Cotton.
Do	Corn or sorghum with summer legumes.	Small grain	Cotton	Corn or sorghum with summer legumes.
Do	Sweetclover	Sweetclover	Oats	Cotton.
Do	Oats	Sudan grass	Summer legumes	Corn.
Do	Oats; sweetclover	Sweetclover	Grain sorghum	Cotton.
Do	do	do	Wheat	Do.

[1] When vetch follows cotton it is planted in the cotton middles and plowed under the next spring. The vetch may be followed by a close-growing crop such as Sudan grass for hay or pasture.

Under Oklahoma conditions, a good cropping system is but a starting point in a soil-improvement program. Other measures and practices must be employed to arrest soil movement while the soil is being improved by the addition of organic material and mineral elements. In project areas contour farming, strip cropping, and terracing are the measures used in conjunction with improved

FIGURE 37.—*Growing soil-depleting crops continuously has caused crop yields to decline and has led to the abandonment of large acreages of land.*

crop rotations to hold soil in the field. All sloping land on farms under agreement, whether or not it is terraced, is farmed on the contour. The strip-cropping plans best adapted to this area are those shown in figures 14, 15, and 18. The crop planted in the control strips may be a small grain, a winter legume, Sudan grass, sweetclover, or other close-growing feed or forage crop.

There is little land in cultivation in southern Oklahoma that does not require the protection of terraces. Some slopes of less than 2 percent are sufficiently uniform and, owing to soil type, are sufficiently resistant to erosion to require only contour farming and strip-crop rotations as protective measures. In general, however, all slopes of from 2 to 8 percent that are to remain in cultivation are terraced. Owing to the erodible nature of most of the soils, slopes of more than 8 percent can seldom be kept safely in cultivation. Such slopes are planted to permanent vegetation such as grass or trees in project areas.

Production of row crops is usually restricted to land sloping not more than 6 percent. Terraced slopes of 6 to 8 percent that are to remain in cultivation are generally seeded to small grains and meadow crops which provide close-growing cover.

Water from terraces on farms under agreement is never turned into roadside ditches unless such ditches are fully protected by vegetation or vegetation and structures. It is generally turned into pasture fields, woodlands, meadows, or, in some instances, wide grassed ravines. When it is necessary to build outlet channels to carry water to a natural drainageway, these are sodded. Bermuda grass is used for this purpose in the cotton sections of Oklahoma; run-off from 100 acres of terraced land has been handled satisfactorily by established Bermuda grass channels. In instances where the soil type, slope, and quantity of water to be discharged are unfavorable to the growth of vegetation, structures are placed across the channel at regular intervals to protect the terrace-water disposal system; and where overfalls occur in the drainageway, one or two structures of a permanent type are used to drop the water to a stabilized grade and to protect the vegetated channel above. Such structures are made of loose rock, masonry, brick, or concrete.

Cultivated fields that are to be converted into pastures and pastures that are eroding are contour-ridged and sprig-sodded with Bermuda grass along the contours. To aid the spread of grass between ridges, several furrows are plowed each year toward the original ridge from each side. In 2 or 3 years under this treatment a pasture may become completely sodded if the ridges are not more than 20 feet apart. Without such treatment the Bermuda grass will not spread past the barrier of weeds and other vegetation which appear in the intervals between ridges. Pastures which have a fair cover of sod, however, are contour-furrowed and not contour-ridged.

A supplementary pasture program is devised for farms under agreement to provide relief for permanent pastures. Temporary pastures are provided for the period when permanent pastures should be protected from grazing. Good temporary pastures in the winter and spring permit a farmer to defer grazing of his permanent pastures until the grass has made good growth. Temporary summer pasture gives relief during drought periods and permits permanent pastures to reseed. The small grains, Italian ryegrass (fig. 38), and winter legumes are used to provide temporary pasture in the winter and spring; Sudan grass and, on soils well supplied with lime and phosphorus, sweetclover are used to provide temporary summer pastures.

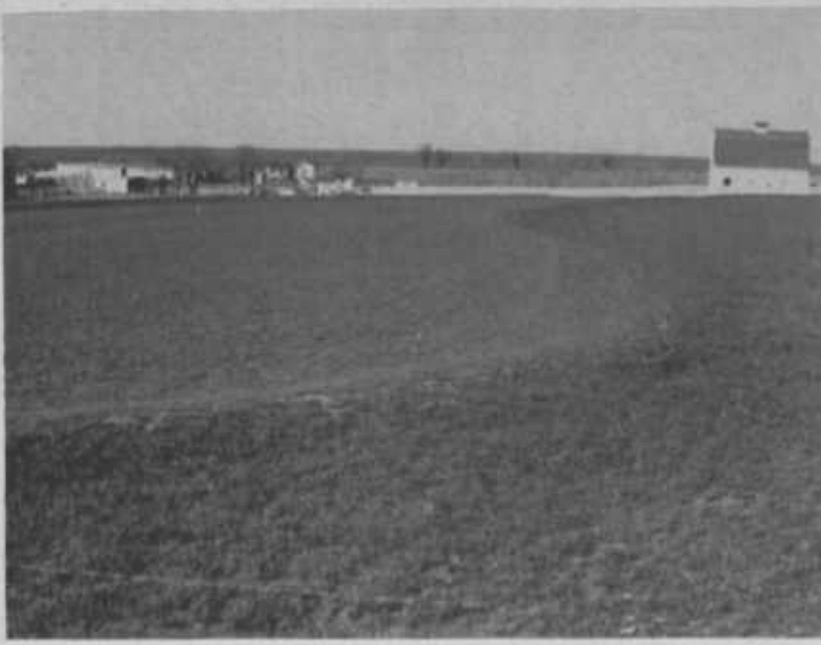

FIGURE 38.—*In southern Oklahoma, Italian ryegrass is used as a winter cover crop to protect the soil and provide winter pasturage.*

Burning weedy pastures, a general custom in southern Oklahoma, kills many desirable plants, destroys seeds of valuable species, and causes increased weed growth by eliminating competition from desirable plants. All of these effects of burning increase the erosion hazard. In project areas weeds are controlled by proper grazing methods and mowing, without the ill effects which follow burning (fig. 39). After weeds have become troublesome, mowing is perhaps the best method of destroying them. If the weeds are cut at the blooming stage, when the food reserves in the roots are lowest, one or two mowings a season are usually sufficient.

In project areas diversion ditches or terraces are constructed above gullied areas to carry water away from the heads of gullies that are cutting back into good land. Planting Bermuda grass and other vegetation in the gullies and placing inexpensive dams of rock and brush across their bottoms hasten stabilization. The larger gullies are fenced to keep out livestock.

FIGURE 39.—*If a pasture field is protected from overgrazing and burning, native grasses will return, unless the field is too badly damaged by erosion. This Oklahoma pasture, once annually burned and overgrazed, is now properly managed. Native grasses, principally the little and big bluestems, now provide full soil protection.*

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