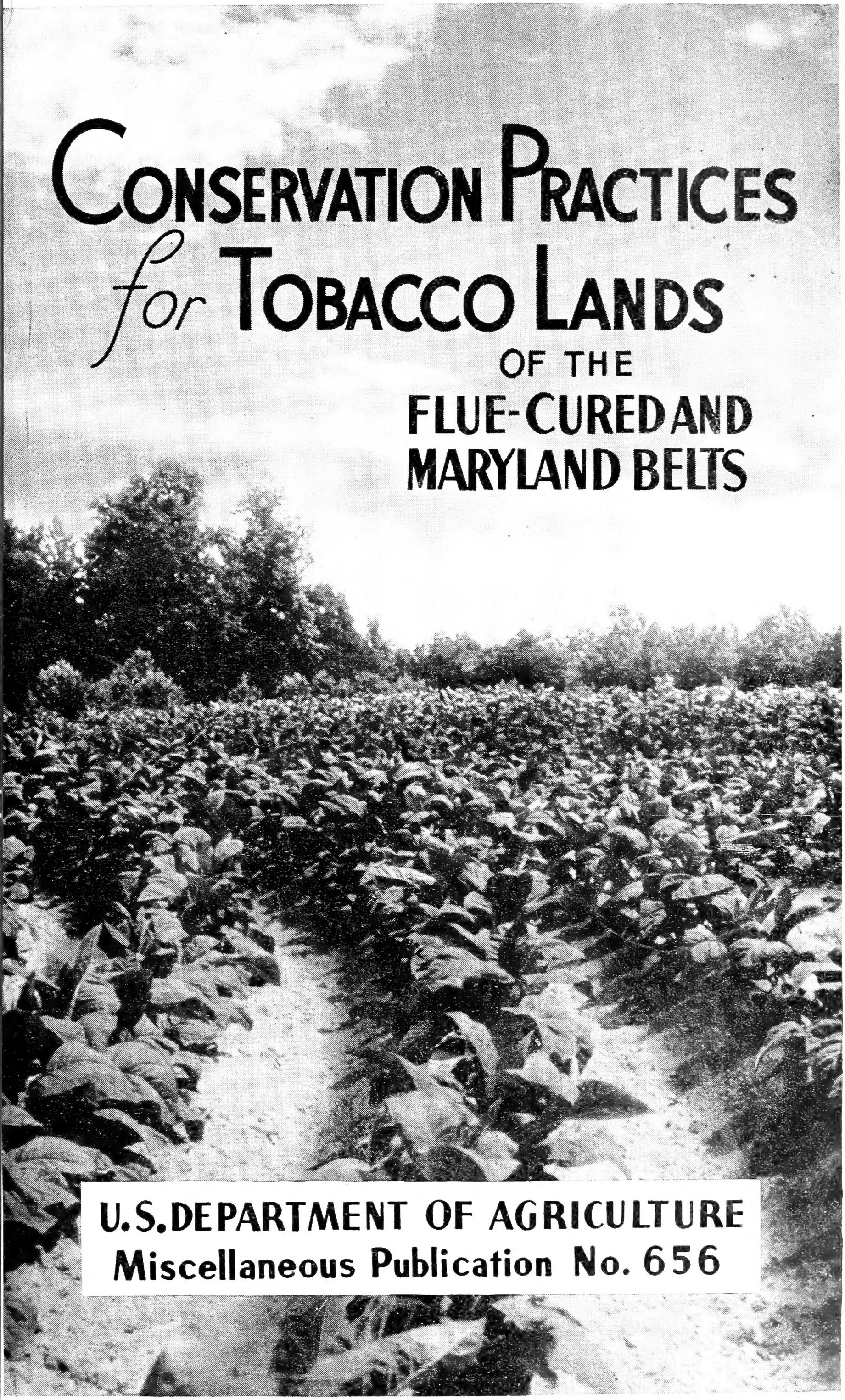
Conservation Practices for Tobacco Lands of the Flue-Cured and Maryland Belts



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PREFACE

Under present conditions, erosion is a serious menace to tobacco soils of the flue-cured and Maryland cigarette tobacco belts. While commercial tobacco culture in the United States began in Virginia and Maryland in the early 1600's, its prominence as a soil-depleting industry is an outgrowth of changed conditions occurring mostly in recent years.

In early times tobacco production in these areas was based solely upon the virgin fertility of newly cleared woodland soils. The fields were small. They were generally used for not more than three crops of tobacco—only so long as the native soil fertility would produce good crops of leaf. In some cases the land was then devoted to other crops, more often it was turned back to woods. Under these conditions of tobacco culture, soil erosion was held in bounds. Small fields, short use of the land in clean tillage, and the long accumulation of organic matter in the virgin soil contributed less to erosion than do modern methods of tobacco culture.

The demand for cigarette tobaccos has increased enormously during the past 30 years. With this demand has come greatly enlarged tobacco acreage and tremendously increased erosion hazard in the flue-cured and Maryland belts. The coarse tobacco that was grown on heavy-textured soil has been replaced by the cigarette type of tobacco that can be produced only on soils of light texture that are moderately low in soil fertility. Soils of this character erode easily when cultivated continuously under ordinary methods of farming. In the meantime, knowledge of how to sustain good crops of tobacco by the use of mineral fertilizer has made it less necessary to clear new land. It also tempts the grower to use his land for cultivated crops until organic matter and physical structure deteriorate to low levels. Thus the erosion resistance of the soil has declined and accelerated erosion of the topsoil has resulted.

This publication treats briefly of the nature and extent of erosion on these tobacco lands and gives some practical mechanical methods of soil protection, which safeguard the specific qualities of leaf demanded by the tobacco trade. Full use of these methods on the flue-cured and Maryland tobacco areas will go far towards protecting these lands against serious erosion loss. Additional agronomic information on improving the erosion resistance of these soils is also urgently needed—particularly as to crop rotations and such use of legumes as will maintain organic matter and physical structure while preserving the quality of cigarette tobacco required by the trade. However, we now have enough practical knowledge of erosion-control methods to justify a concerted attack upon the erosion problem. Such an attack, to be successful, will require the efforts of all agricultural workers and farmers in putting into practice the conservation measures that have proved most effective to date.

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Conservation Practices for Tobacco Lands of the Flue-Cured and Maryland Belts

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INTRODUCTION

Since the culture of tobacco was begun in Virginia and Maryland in the early 1600's this crop has been a principal source of revenue. It has long been a cornerstone in the economy of the southeastern and Maryland tobacco belts. Today, it sustains much of the agriculture, manufacture, and trade of this region.

The crop, however, along with other row crops grown in the area, has proved costly to the soil resources of the tobacco belts, and from this standpoint a critical stage has long since been reached. Much of our tobacco land has been exhausted and many of the once productive fields and larger land areas have become so eroded that they are no longer suitable for tobacco production (fig. 1). This is particularly true in the older and more rolling tobacco-growing counties of the flue-cured belt. The lower Piedmont, or middle belt, though not in quite as bad shape, is also suffering from serious erosion and has lost much of its topsoil. And even in the coastal plain area of the Maryland and flue-cured belts, galled spots and many eroded areas are evident.

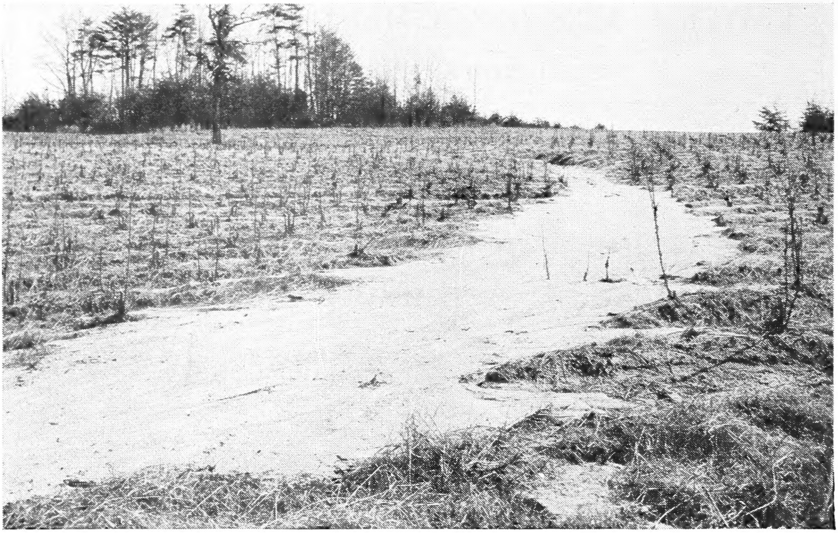

FIGURE 1.—Tobacco land in process of destruction by erosion. No protective or soil-conserving practices have been applied on this farm.

The extent of the past erosion over the Southeast is indicated by results of erosion surveys in two of the tobacco counties in Piedmont North Carolina (table 1). Here it was found that 28 percent of the land had lost more than 75 percent of its topsoil. An additional 54 percent of the land had lost an average of at least 50 percent of its topsoil. Thus, less than 20 percent of the land has as much as three-fourths of its original topsoil left.

As the depth of the topsoil decreases and the amount of clay in the top layer increases, the land tends to produce a heavier and less desirable type of tobacco. This relationship between the degree of erosion and the type of tobacco produced is probably reflected in the purchases from the 1947 crop of flue-cured tobacco made by the Flue-Cured Stabilization Corporation, and reported by the North Carolina Extension Service (*17*).[1] Approximately one-half of its total purchases consisted of the heavy-leaf grade, which is undersirable for cigarette use, and one-half of those heavy grades came from the old belt. Unless erosion is controlled over the tobacco area, more and more of the land will become unfit for tobacco growing.

What, then, are the reasons for this exploitation of our southern tobacco lands? Although many reasons contribute, a few may be mentioned which appear most important: (1) The maximum immediate return for each acre cultivated has been the first objective and has completely overshadowed any concern for the conservation of the land. Most tenant farmers, and many farm owners, are more concerned about the value of the crop than about the protection of the soil. (2) The average grower fails to realize the rate at which

[1] Italic numbers in parentheses refer to literature cited, p. 43.

his soil is being lost and is usually not aware that he has lost much until over half of the topsoil is gone. This is when his crop yields begin to drop rapidly. (3) Increased fertilization and better varieties tend to compensate for a limited period of time for the reduction in soil depth and in the soil's natural ability to grow crops. (4) The lack of information as to the effect of various tillage practices results in many practices that greatly increase the rate of erosion or that do not afford the protection which otherwise might be possible. These include such things as faulty row systems, weak rotations, and lack of proper land cover.

TABLE 1.—*Erosion in Rowan and part of Caswell Counties, N. C., as shown in conservation surveys by Soil Conservation Service*

Erosion	Total	
	Acres	*Percent*
+ Deposition	1, 463	8. 1
1 Slight	1, 866	10. 3
2 Moderate	9, 786	54. 0
3 Severe	5, 008	27. 6
4 Very severe	5	0
Total	18, 128	100. 0

It is an indictment of American agriculture that on most tobacco farms the same pattern of erosion has continued from colonial days. Washington, Jefferson, and Randolph, skillful farmers in their time, recognized the havoc of erosion on their lands. They taught and practiced soil conservation, but their warnings, with too few exceptions, have gone unheeded to the present time.

Despite the present widespread exploitation of the flue-cured and Maryland areas, and notwithstanding apparent indifference to their past and present abuse, most of these tobacco lands can still be saved from destruction. Experiments conducted recently by the Soil Conservation Service, in cooperation with the North Carolina and Maryland experiment stations at Raleigh and Beltsville, furnish proof that these lands can be protected from erosion and their fertility maintained by the application of scientific soil-saving techniques. The following pages deal briefly with present erosion hazards on these tobacco soils and in more detail with the mechanical and vegetative methods that are proving most effective in protecting them from erosion and in maintaining their production.

EROSION HAZARDS ON TOBACCO LAND

Erosion is a serious problem on most tobacco soils in the flue-cured and Maryland tobacco-producing belts. Growth conditions required by the crop, high natural erodibility of the soils, topography, and seasonal rainfall pattern as well as farm practices all contribute to the erosion hazard.

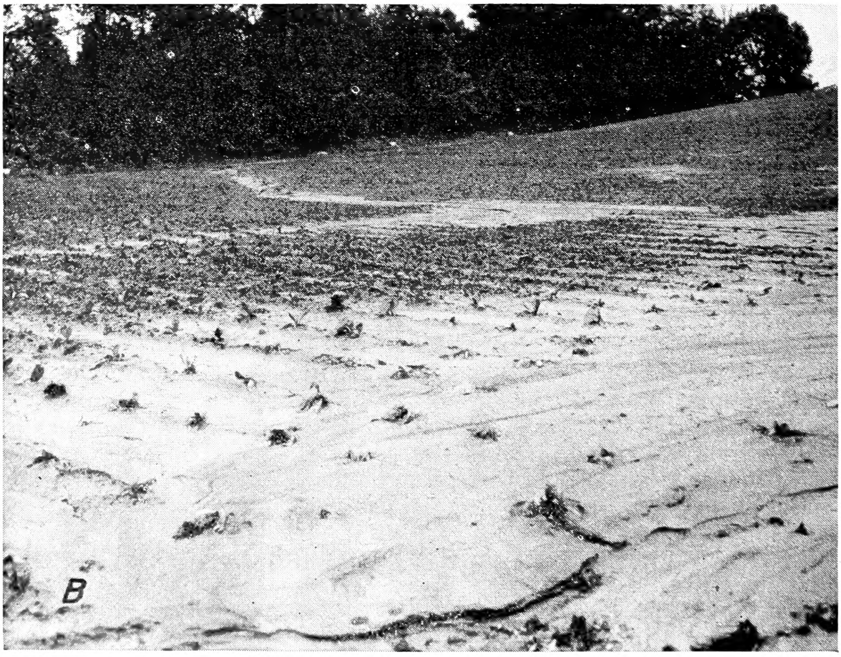

FIGURE 2.—Sheet erosion and the subsequent formation of rills and gullies have long been widely accepted as a necessary part of tobacco growing in the Southeast. *A*, Aerial view of eroded tobacco field in southern Maryland. *B*, Close-up of sheet erosion in the same vicinity.

Soils

Soil type is a dominant factor in the quality of tobacco. Garner (*9*) has pointed out that although the tobacco plant can be grown under a wide range of soil and climatic conditions, the production of each commercial type is definitely localized, owing primarily to the influences of climate and soil on the properties of the finished leaf. In the flue-cured and Maryland tobacco belts, the production of a normal yield of high-quality tobacco requires well-drained soils that are light in texture. In these belts tobacco crop yields are also dependent upon the quality and depth of topsoil. Favorable growth conditions require a topsoil of at least 6 to 8 inches depth.

These tobacco soils are naturally low in organic matter and their physical properties are such that they erode easily during intense summer rains. The character of erosion occurring on these tobacco soils is shown in figure 2. Observations on erosion in progress, such as represented in these pictures, may be made at almost any place in the flue-cured and Maryland tobacco belts.

The shallow phases of some of these sloping tobacco soils have slowly permeable subsoils near the surface (fig. 3). This condition limits the amount of rainfall that may be taken into the soil and increases the runoff and erosion hazard.

FIGURE 3.—This relatively flat tobacco field has been damaged by excess runoff due to slowly permeable subsoil.

Land Slope

The greatest single factor contributing to erosion on tobacco land is the slope of the fields on which tobacco is grown. Musgrave (*14*) points out that for a given soil type the erosion rate increases greatly with the steepness of slope. Except for parts of the Coastal Plain, most of the tobacco is grown on gently sloping to rolling land with some slopes of 15 to 20 percent. Relatively little of the good tobacco soil in these belts is flat enough to be unaffected by erosion.

Rainfall Pattern

With tobacco as with other row crops high-intensity rainfall is one of the principal causes of soil erosion (*2*, *5*, *8*, *14*). The distribution of intense rains is shown in relation to tobacco seasons in figure 4, *A*.

In the flue-cured and Maryland tobacco belts the erosion hazard is intensified because the tobacco-growing season occurs within the period of the year with highest rainfall intensity. High-intensity storms occur more frequently in June, July, and August than in any other months.

Results of experiments on cultivated tobacco land at Raleigh, N. C., show a significant relationship between season and erosion. Under the conditions of the studies at Raleigh about 80 percent of the erosion occurred in the 3 months of June, July, and August, whereas only 6 percent occurred in the 7-month period from September to March. Observations on many tobacco fields likewise indicate that most of the erosion losses take place during high-intensity rainstorms occurring in the 5-month tobacco season. Results obtained by others (*14*, *2*, *5*, *6*) show a similar relationship between summer rainfall and the erosion of farm land in widely different parts of the country.

The important relationship of seasonal rainfall to erosion is graphically ilustrated in figure 4, *B*, which serves to emphasize the following important points: The erosion hazard in tobacco fields reaches its peak during the 5-month period from April to August. This increased erosion hazard is due to the interlocking influences of the greater amount of rainfall, more intense rains, and increased disturbance of the soil by cultivation. From the time land is plowed in spring until the soil is again stabilized after the crop season, there is great need for intensifying the use of erosion-control practices.

EARLY STUDIES OF EROSION CONTROL ON TOBACCO LANDS

The serious nature and widespread extent of erosion on tobacco lands was recognized by conservationists early in the development of soil-conservation programs in the flue-cured and Maryland bright-tobacco belts. Immediate steps were taken to test and evaluate all standard soil-defense practices thought to be applicable to the soils in tobacco production.

Field trials were begun in 1937 in the flue-cured tobacco areas of Virginia and North Carolina. From 1937 to 1939 operations and research workers of the Soil Conservation Service, cooperating with the State experiment stations, carried out the studies on a large number of farmer-operated fields. These fields represented a wide variety of conditions under which tobacco was being grown. Land slopes

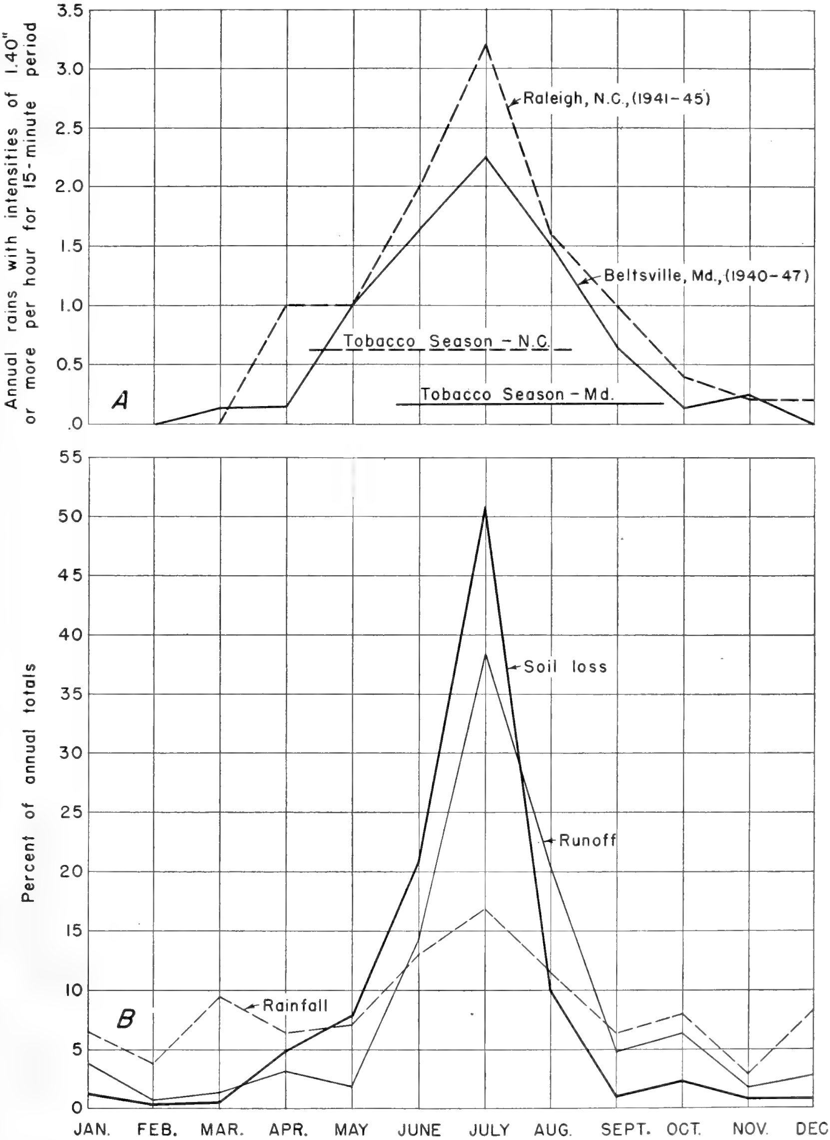

FIGURE 4.—*A*, Monthly distribution of high-intensity rains which lasted for 15 minutes or more as related to tobacco-growing seasons. *B*, Rainfall, runoff and soil loss by months at Raleigh, N. C., 1941–43. These experiments were on land protected over winter by cover crops, and the row grades ranged from contour to 30 inches per 100 feet.

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ranged from 2 percent to 18 percent, but were, for the most part, from 6 to 8 percent. Positive values were obtained from the use of a wide variety of well-known erosion-control practices on these tobacco lands. The studies also showed that no single practice when operated alone could be depended on to give adequate protection against erosion. In nearly all cases there was need for coordinated use of multiple practices. As the erosion hazard increased with the slope and with shallower soils, a greater number of practices was required.

In these early studies erosion-control practices found to have special value on tobacco lands included the following:

Sodded water diversion channels that were well protected on the uphill side by a grassed buffer strip 10 to 15 feet in width; channel-type terraces properly laid out with spacings, grades, and lengths adapted to topography, soil, and slope; well-developed and well-maintained grassed waterways capable of carrying off surplus rain water from crop rows, terraces, and fields; early fall seeding of winter cover crops on land that otherwise would remain bare over winter; crop rotations, and strip cropping that include a year or more of unbroken sod; vigorous sod-mixture growth in all field depressions that were not smoothed out by plowing or other methods.

Faulty Row Systems

These early studies also showed that much of the erosion occurring in tobacco fields was due to the row systems commonly used by farmers. Throughout the flue-cured areas tobacco is generally grown on strongly ridged rows. The desire of farmers in this area to provide free row drainage, particularly on slowly permeable soils, has caused them to lay out crop rows down slope or with excessive grades. This practice intensifies the effect of slope and greatly accelerates runoff and soil loss. Many farmers prefer straight rows and will take such row direction across fields as will give them the straightest rows. This usually results in excessive grades with serious erosion in some places and poor drainage in others.

In some tobacco areas, particularly in the flue-cured middle belt, crop rows are generally run straight across terraces (fig. 5). It was found that as a result of this practice excessive amounts of soil moved down the row middles and lodged in the terraces. The capacity of the terrace channels was also reduced by this practice and terrace maintenance was correspondingly increased.

Preliminary observations in the Maryland tobacco belt showed that farmers generally were using flat culture and straight rows without regard to slope (fig. 6). In this belt where there is somewhat larger acreage of tobacco soil available than is used every year, little effort had been made to protect tobacco fields against erosion other than by various crop rotations, winter cover crops, and land rest in weed growth.

RESEARCH ON CORRECTIVE MEASURES

Observation and knowledge of the widespread erosion resulting from the crop-row systems used by farmers of the flue-cured belt led in 1940 to specialized research on this and related phases of erosion.

FIGURE 5.—A tobacco field near Raleigh, N. C., with rows run up-and-down-hill across the terraces. The heavy loss of valuable topsoil was caused by one rain.

FIGURE 6.—Flat tobacco rows run straight up-and-down-hill are causing severe erosion and excessive runoff. The tobacco on the hillsides is suffering from a droughty condition while the tobacco in the bottom has been covered with silt or drowned.

The research has been planned and carried out cooperatively with the State experiment stations of Maryland and North Carolina. In Maryland, studies have been located at the Beltsville research center; in North Carolina, they have centered on the Soil Conservation Experiment Station near Raleigh. In both areas field trials and supplementary studies have been carried out on farmer-operated fields. The practical results of this research are presented and discussed in the following paragraphs.

Row Grades on Bright-Tobacco Soils

The principal experiment on row grades at the station near Raleigh, N. C., was conducted to determine the grade for tobacco rows that would result in effective row drainage, protection against soil loss, and good crop yields. Highly ridged crop rows were used with well-defined drainage channels between rows. Six variations of grade were tested, ranging by 6-inch intervals from 0 to 30 inches per 100 feet. The plots were laid out on typical bright-tobacco soil of Appling and Durham sandy loam with slopes ranging from 3 to 6 percent. Each plot was 16 feet wide. This allowed four tobacco rows, run lengthwise of the plot, with the center row middle on the designated grade. Tobacco was planted each year following a winter cover of rye or ryegrass. Cultural practices were similar to those usually followed by tobacco farmers of the area. Equipment was installed to measure both runoff and soil loss after each rain.

Supplementary velocity tests were also conducted while the row-grade experiment was in progress. One cubic foot of water per minute was run into the upper ends of the rows for a period of 30 minutes and the velocity measured. Results of the experiment, including runoff, velocity, and soil loss, are shown in figure 7.

Runoff almost doubled when the grade was increased from 0 to 6 inches per 100 feet. There was a further slight increase in runoff when the grade was increased to 12 inches. Increases in row grades above 12 inches, however, caused no significant increases in runoff. This means that runoff, or drainage, was adequate with as little as 6 to 12 inches fall per 100 feet. It means also that steeper grades, such as are frequently seen in many tobacco fields, are unnecessary for effective row drainage.

Soil loss, on the other hand, tended to increase rapidly with the grade and reached serious proportions with the 30-inch grade. Under the conditions of this experiment, an increase of 12 inches, or 1 percent, in row grade increased soil loss approximately 4 tons per acre. If the row grades had been extended to 6 or 8 percent, as is the case in many tobacco fields, it is obvious that the soil loss would have been tremendously increased.

Velocity of runoff water likewise increased with the grade and it may be seen in figure 8 that with the 30-inch grade the water was flowing about twice as fast as in the row with 6-inch grade. Apparently, this increase in velocity caused the increase in soil loss as total runoff was not greatly increased between the 6-inch and 30-inch grades.

The amount of row grade was usually indicated by the appearance of the row middles following rains. Rows on the contour and with 6-inch grade showed little evidence of velocity and soil movement.

The numerous small depressions along the row did not completely fill with moving soil but remained as miniature basins and helped retain part of the surface water. These miniature storage basins along the

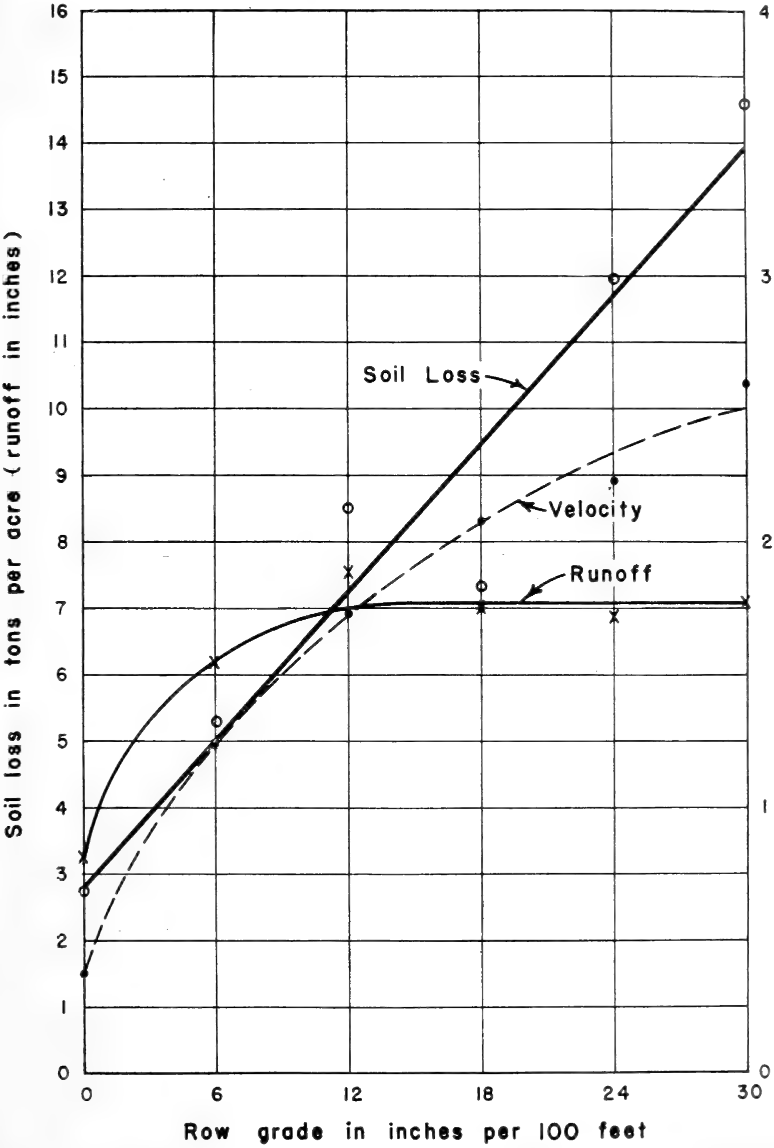

FIGURE 7.—Runoff, velocity, and soil loss from tobacco plots with different row grades, Raleigh, N. C., 1941–43. Row grades above 12 inches per 100 feet caused no increase in runoff but velocity and soil loss continued to increase.

row furrows apparently reduced runoff to some extent but never caused poor drainage because the extra water was absorbed quickly. As the grade of the row middles increased to 30 inches, these depressions usually filled with soil and the row middles became smooth channels.

As the grade increased the water flowed faster and moved more soil as indicated by the increasing amount of sand along each furrow. In this erosion process on sandy land the soil tends to separate. The silt and finer material stays in suspension and goes with the water, while the sand and coarser material moves along the channel floor where much of it is deposited in slight depressions as shown in figure 8.

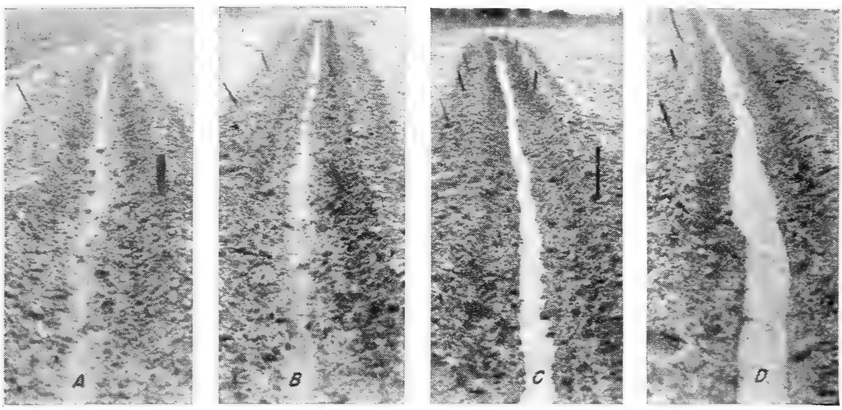

FIGURE 8.—Supplemental row-grade studies at the Soil Conservation Experiment Station near Raleigh, N. C., illustrate the effect of flowing water on row channels with different grades. Grades shown are (A) 6, (B) 18, (C) 30, and (D) 42 inches per 100 feet. Note that as the grade increases a greater amount of the fine material is washed away, leaving heavy sand particles in the bottom of the furrow. One cubic foot of water per minute entered the rows for 30 minutes.

In row-grade tobacco plots there was little evidence of scouring on the 30-inch grade, even though the rate of soil loss had greatly increased. This explains how much of our topsoil may be removed before farmers realize that erosion is taking place.

Row Grades on Maryland Tobacco Soils

The experiments with row grades in Maryland were mainly to test the yield and quality of tobacco grown on ridged rows laid out on different grades, and to evaluate the erosion-control features of this method of tobacco culture in the Maryland belt. On one area, ridge rows on contour and on 5-percent grade were tested in comparison with up-and-down-hill flat rows as checks. On another area 1-percent grade ridge rows were compared with up-and-down-hill flat rows. All grades for across-slope cultivation (contour, 1 percent, or 5 percent) were established by first laying out guide rows which were 11 full rows apart at the steepest part of the slope. Thus five full rows could be laid out above and below each guide line, and short rows were used to fill in any wide places that occurred. Continuous tobacco cropping with winter covers of wheat and vetch has been practiced on the areas used. The plots were laid out on a Sunnyside fine sandy loam soil, on slopes ranging from 8 to 14 percent. All treatments except row grade and tillage were the same.

In the first season all tobacco was planted on relatively flat rows and the plan was to gradually develop ridges on the across-slope crop rows with cultivation.

However, rains immediately following planting caused heavy soil losses from all plots. The plots cultivated across slope were severely damaged by cross washing and rilling. This thoroughly demonstrated the need for developing strong ridges before planting. Since this first season, all across-slope rows at Beltsville have been bedded before planting to leave a furrow 8 or 9 inches deep. This ridge row maintained during the tobacco-growing season has prevented cross wash in all except contour plots (fig. 9).

Where ridge rows on the contour were compared to flat rows up and down a 10-percent slope, heavy soil loss occurred on the up-and-downhill area during a severe rainstorm in July. Less than 7 tons per acre of soil were washed from the contoured area, whereas the rows that ran up-and-down-hill lost an estimated 70 tons per acre (fig. 10). Even with the best treatment more weight of soil than of tobacco was removed.

Rills measuring up to 8 inches in depth were eroded in the up-and-down-hill plots whereas the relatively slight erosion on the contour plot resulted from a break in the row system which affected only a small part of the plot. With the exception of the break in the contour area, practically no soil moved off the field. In the plot with 5-percent row grades, no cross wash occurred, but there was severe scouring between the rows resulting in deep V-shaped rills, increasing in depth toward the end of the rows.

This and other observations made during the course of this study showed rapid rates of soil destruction by both the up-and-downhill culture and the 5-percent ridge-row culture.

On land with 8- to 10-percent slope, ridged rows with 1-percent grade were compared with flat rows up and down hill. At the end of 7 years' cropping to tobacco, the depth of topsoil on the 1-percent grade-row area had remained relatively unchanged, whereas on the up-and-down-hill row area the soil surface on a plot 150 feet long had been lowered by approximately 6 inches. The loss of topsoil varied from approximately 1 inch at the upper half of the plot to about 10 inches at the lower half of the plot.

The Effect of Row Grade on Crop Yield

Early in the present studies it was recognized that ridge rows properly laid out across slope represented an effective measure for controlling erosion during the crop season. Accordingly, yield tests at the Raleigh station have dealt with tobacco grown on ridge rows with all conditions as nearly identical as possible, except row grades.

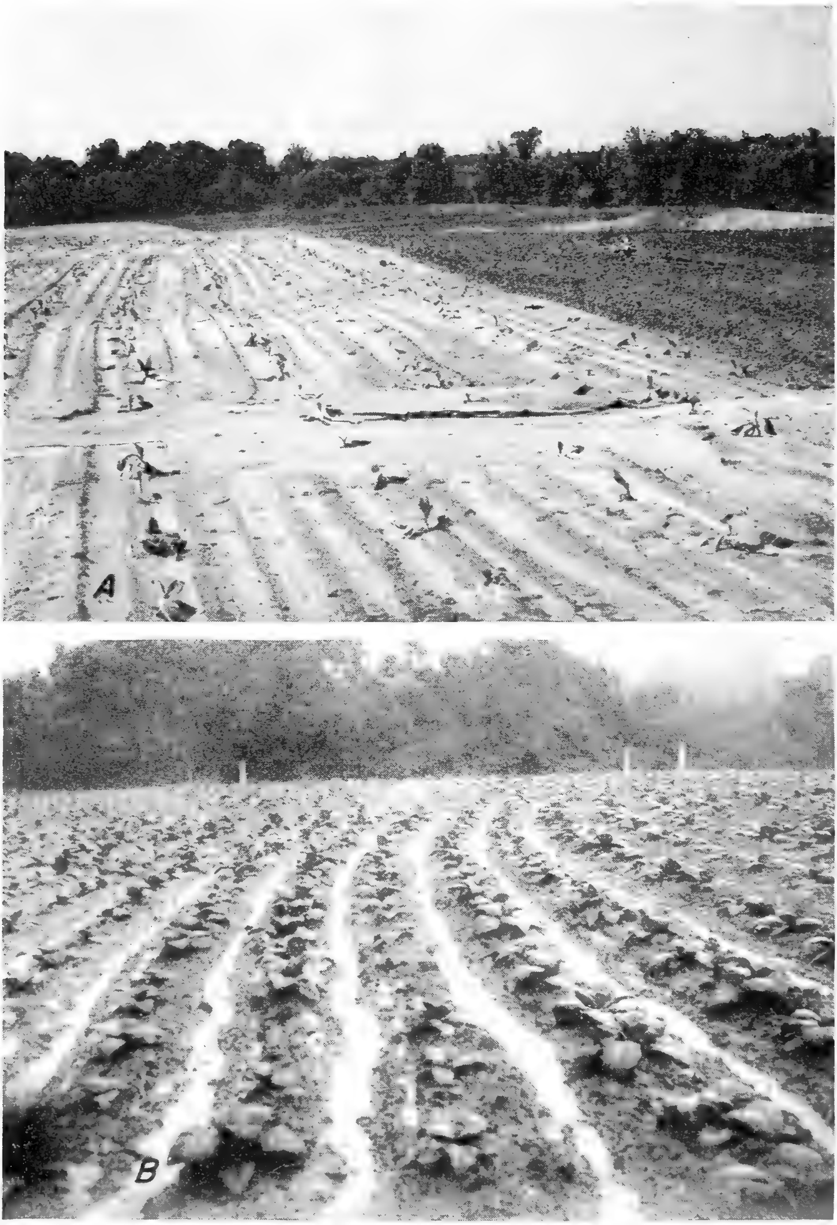

FIGURE 9.—*A*, Contour tobacco planted on flat rows has been damaged by one hard rain. Excess water will usually cause cross-wash damage in tobacco fields, unless directed to grassed waterways. *B*, Across-slope ridged rows with 1-percent grade shown here prevent cross washing during a heavy summer rain. They provide adequate low-velocity drainage.

The row grades were varied from contour to 30 inches or 2½ percent on relatively deep Appling and Durham sandy loam having 3- to 6-percent slope. Yield and value of the tobacco crops are shown in table 2.

FIGURE 10.—*A*, Contour-ridged tobacco following a heavy rainstorm. The row middle caught most of the heavy soil material. *B*, Up-and-down-hill flat tobacco rows following the same rain. Each row middle was severely rilled, exposing tobacco roots. This plot lost soil at the rate of approximately 70 tons per acre during this one rainstorm.

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The data presented in table 2 show that no significant differences were reflected in either yield or value of tobacco grown on these grades.

TABLE 2.—*Comparison of yield, price per pound, and value of flue-cured tobacco on row grades ranging from contour to 2½ percent, Raleigh, N. C., 1941–43*

Percent grade	Yield per acre	Price per pound	Value per acre
	Pounds	*Cents*	*Dollars*
0.0	867	37. 7	327
0.5	810	39. 8	322
1.0	838	39. 6	332
1.5	830	38. 8	322
2.0	837	39. 1	327
2.5	882	38. 7	341

While soil losses increased steadily with each increase in row grade as shown in figure 7, the maximum amount of 45 tons of soil lost during the 3-year period had no immediate effect on crop yield. This is highly significant since it indicates that serious damage from sheet erosion may occur before the signs are noticeable either in crop yields or on the soil surface.

Since ridge-row culture was not in use in the Maryland tobacco belt it was important to determine by the Beltsville studies if ridge-row culture would give satisfactory crop yields under Maryland conditions. The areas had been in unplowed weeds and grass for at least 6 years. This old sod was plowed for the first tobacco crop, and each succeeding tobacco crop followed a winter cover of wheat and vetch, planted as soon as possible after tobacco harvest. The land was fertilized for each tobacco crop with 1,000 pounds of 4–8–12 fertilizer per acre applied in the row. Crop yields and values are shown in table 3.

TABLE 3.—*Comparison of yield, price per pound, and value of tobacco produced on 1-percent grade ridge rows with that of tobacco produced on up-and-down-hill flat rows on 8- to 14-percent slopes, Beltsville, Md., 1940–46*

Treatment and increase	Yield per acre	Price per pound	Value per acre
	Pounds	*Cents*	*Dollars*
1-percent grade ridge row	1, 053	42. 4	446
Up-and-down-hill rows	928	39. 9	371
Increase in favor of 1-percent grade ridge	125	2. 5	75

Both yield and value of the crop were increased by ridge rows on a 1-percent grade compared with flat rows run up-and-down-hill. The records given in table 3 show an average annual increase of 125 pounds of tobacco per acre with an annual increase in value of $75. As pointed out previously the 1-percent grade ridge rows gave excellent erosion control whereas flat rows run up-and-down-hill caused heavy losses of soil.

Ridge rows on contour gave good tobacco yields and values but cross wash occurred during heavy rains. Erosion damage was severe on the 5-percent grade rows during two growing seasons resulting in droughty soil conditions and greatly reduced yields in the second year. During the next 2 years, the original area with 5-percent row grade was changed to contour ridge rows in order to evaluate the immediate residual effects of this soil loss. Yield results for the 4-year period are compared in table 4.

TABLE 4.—*Comparison of tobacco yields under contour and 5-percent grade ridge culture, showing residual effect of erosion caused by 2 seasons of 5-percent-grade rows, Beltsville, Md., 1940–43*

Plot	Treatment	Crop yield per acre			
		1940	1941	1942	1943
		Pounds	*Pounds*	*Pounds*	*Pounds*
A	Contour—4 years	1, 169	1, 137	1, 050	1, 204
B	5-percent grade—2 years	1, 141	686		
B	Contour—2 years			853	1, 090
	Yield increase due to continuous contour	28	451	197	114

Tobacco yields on the two areas were nearly equal the first year, indicating that the initial tobacco-yielding capacity of the 5-percent row area was not less than that of the contour area. The very wide difference in yields the second year shows the quick effects of erosion occurring on the 5-percent row area. Yield differences during the last 2 years of the study show some recovery of the eroded area, but during the last year there still remains a 10-percent yield reduction caused by erosion damage. These findings serve to illustrate the lasting effects of severe erosion on this tobacco soil, as well as the rapid occurrence of such damage when improper cultural practices are used.

During the period covered by these studies at Beltsville, tobacco yield and quality (as reflected by price) have varied according to the rainfall pattern that occurred in the growing season. These variations due to crop response to rainfall have been evident under both good and poor erosion-control practices. The favorable tobacco seasons had sparse to medium rainfall during the first 30 to 50 days after transplanting, followed by fairly abundant rainfall about 30 days before harvest. Unfavorable seasons had protracted rainy weather during the first part of the season, or rainfall was sparse during the last part of the season. The three types of rainfall patterns, in relation to

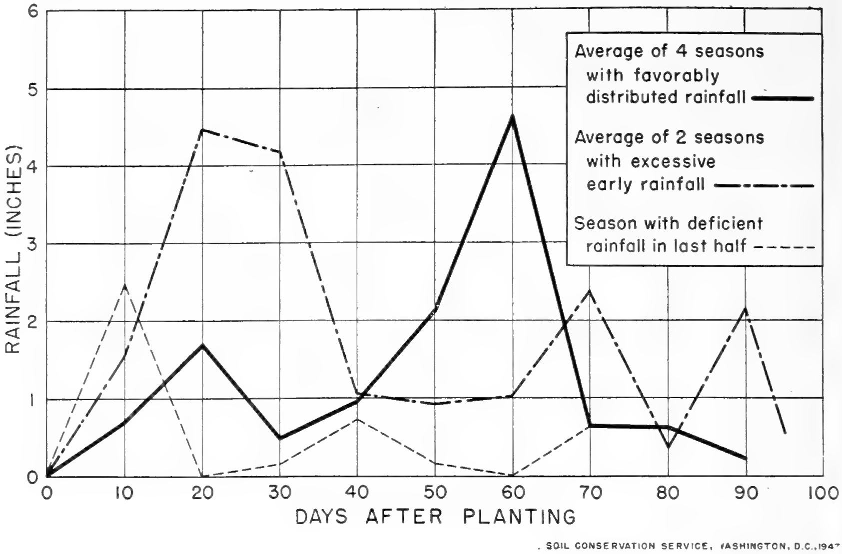

FIGURE 11.—Rainfall distribution patterns during favorable and unfavorable tobacco seasons, Beltsville, Md., 1940–46

tobacco production, occurring during the 7-year period, are shown in figure 11.

The tobacco crop values produced on 1-percent grade ridge rows and on flat rows run with the slope are compared in relation to rainfall distribution in table 5. These studies were conducted on Sunnyside fine sandy loam soil with slopes ranging from 8 to 10 percent.

The data in table 5 show that the 1-percent grade ridge rows produced better crop values under all rainfall conditions that occurred during the experiment. The increase amounted to $32 per acre in the years when crop production was reduced by excessive rainfall early in the season, $97 per acre in the good crop years, and $71 per acre in the year which was dry during the last part of the season.

Direct comparisons of crop yields on ridge rows and flat rows on the same row grade have not been made with tobacco, owing to limited facilities for handling the crop. However, such comparisons were made with corn at Beltsville in 1944, on a field of Sassafras fine sandy loam with a slope of 6 percent. The fertilizer was mixed into the soil with a light disking. The rows were laid out on a 1-percent grade and three replications were used. In the ridged treatment corn was planted on ridged rows and worked twice with a middlebuster, whereas in the flat treatment the corn was planted flat and cultivated twice with a 5-tooth cultivator which left the land flat. Comparative yields are shown in table 6.

Throughout the growing season the corn on the ridge rows showed better growth than corn planted flat with the same 1-percent row grade. The ridge rows increased the corn yield by 25 percent. Similar results have been obtained in other years with corn and lima beans.

Table 5.—*Tobacco crop values produced on 1-percent-grade ridge rows compared to flat rows with the slope during seasons of favorable and unfavorable rainfall distribution*

Type of season	Year	Rainfall during tobacco season	Value of crop per acre		Increase from ridge row per acre
			1-percent grade ridge	Flat cultivated with slope	
		Inches	*Dollars*	*Dollars*	*Dollars*
Favorably distributed rainfall	1941	14. 61	518	421	97
	1942	15. 36			
	1944	10. 34			
	1946	7. 49			
Average		11. 95			
Excess rainfall in early season	1940	16. 49	368	336	32
	1945	20. 61			
Average		18. 55			
Too dry in last part of season	1943	4. 17	312	241	71
Average value of crop			446	371	75

Table 6.—*Shelled corn yields from corn grown flat compared with corn grown on ridges, Beltsville, Md., 1944*

Treatment	Corn yield per acre			
	Replication 1	Replication 2	Replication 3	Average
	Bushels	*Bushels*	*Bushels*	*Bushels*
Flat culture	50. 4	51. 8	39. 0	47. 1
Ridge-row culture	63. 4	61. 9	62. 6	62. 6
Difference favoring ridge row	13. 0	10. 1	23. 6	15. 5

Row-Grade-Slope Relationships

Where fields are terraced, it is the common practice to use the terraces as guides for crop rows. When crop rows are laid out parallel to either terrace, on land with varying slope the rows fail to maintain the grade of the guide terrace.

The difference in elevation between two terraces draining in the same direction is practically the same throughout their length, but the width of area between the terraces may vary widely, depending on the variation in the slope of the land. Thus terraces converge or close in when draining toward a steeper slope and conversely they diverge or spread out when draining toward a more gradual slope. This change in slope and in width between terraces affects the grade and direction of drainage in crop rows which parallel either terrace as illustrated in figure 12. This diagram represents two terraces with a vertical interval (a difference in elevation) of 3 feet and shows the grades and direction of drainage for every fifth row beginning with the guide terrace.

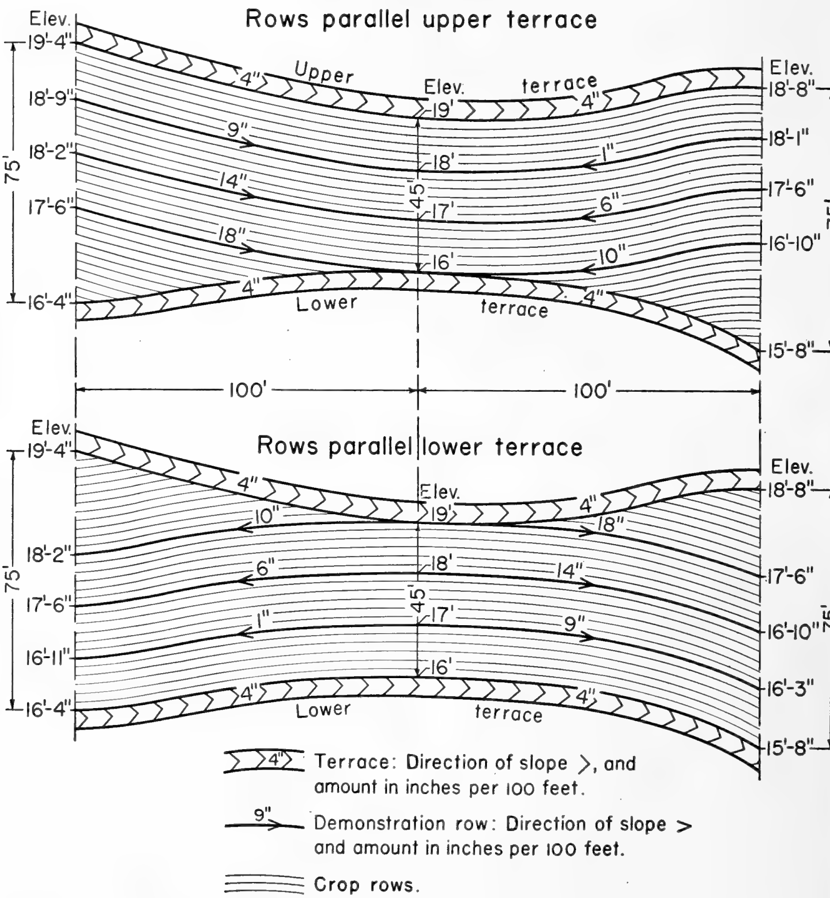

FIGURE 12.—Diagram of two terraces with assumed elevations showing how slope changes affect row grades. In the upper diagram, all rows parallel the upper terrace, while the lower diagram shows this same area with all rows paralleling the bottom terrace.

The facts illustrated may be summarized briefly as follows:

1. Rows which run parallel with the upper terrace, as in the conventional method, will drain toward the terrace outlet (right side of diagram) if the area between terraces is narrowing. These rows will

FIGURE 13.—*A*, Failure of contour tobacco rows during heavy summer storm. Adequate terracing with correct row grades would have eliminated this cross wash. *B*, Area of drowned tobacco caused by excess water in low spots even though rows were run straight up-and-down-hill across terraces.

quickly reverse and drain in the opposite direction where the area between terraces begins to widen.

2. When laid out parallel with the lower terrace, rows in widening sections will drain toward the outlet but will reverse and run in the opposite direction in narrowing sections. In either case there is a characteristic failure of crop rows to drain properly when laid out parallel to either terrace. This failure of tobacco rows to carry off their own water results in ponding and row breakage during heavy summer rainstorms (fig. 13, *A*). In case of ponding, the tobacco plants may be severely damaged by drowning (fig. 13, *B*). Serious breaks across the rows cause heavy soil loss, silting of terraces and waterways, and frequent breakage in the terrace below.

IMPROVED ROW SYSTEM

The best erosion-control measure for land in tobacco is a good row lay-out in which the rows act as miniature terraces and drain all the way through to the outlet with a moderate but continuous grade.

An improved method for obtaining this row lay-out has been developed by the Soil Conservation Service and is commonly designated the "string method." This method takes advantage of the effect of change of slope on grade of row as illustrated in figure 12. It corrects the faults of conventional methods and provides continuous row drainage throughout the terrace interval (the land area between terraces).

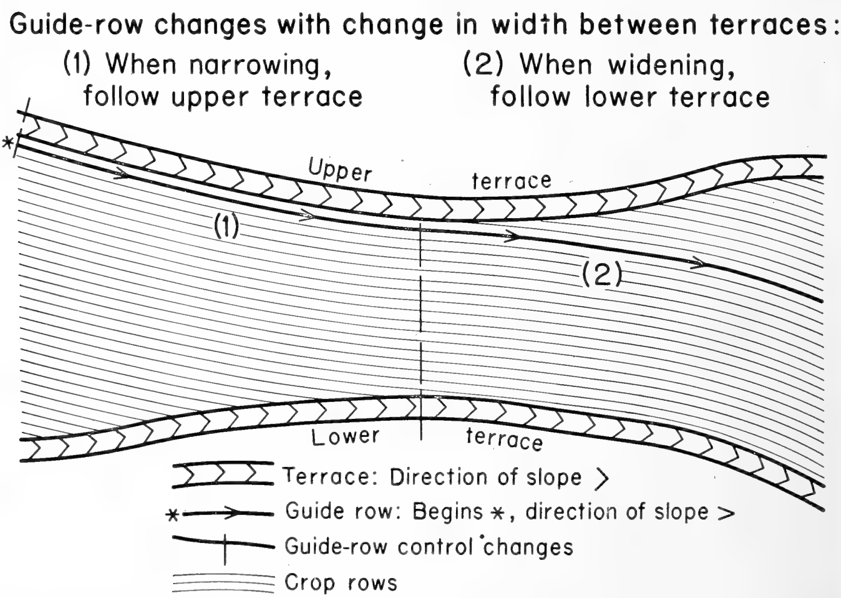

FIGURE 14.—A terrace interval, showing the guide row laid out by the "string method." Beginning at the higher end, the interval between the terraces first narrows and then widens as it approaches the outlet (right side of diagram). Note that in the narrowing section the guide row parallels the upper terrace and that it parallels the lower terrace in the widening section.

In the string method all rows located in intervals or sections that narrow toward the outlet are laid out parallel with the upper terrace; those rows in sections which widen toward the outlet are laid out parallel with the lower terrace (fig. 14).

The String Method

In the string method a guide row is first laid out for each interval between terraces, and all other rows parallel this guide row. The method of laying out the guide row is described in the following paragraphs.

The diagram in figure 14 shows a terrace interval which requires a single guide row. This covers the normal changes in terrace widths; namely the narrowing and widening sections between terraces which drain in the same direction.

1. Starting point: The guide row is started directly below the highest point in the upper terrace. It should be the first row below the terrace at this point.

2. Guide row crew: The guide row is laid out by a crew of three men, using a ball of twine and stakes. One man follows the channel of the upper terrace and holds the ball of twine. Another man takes the end of the string and moves along the channel of the lower terrace. The middle man holds the string at the point where the guide row is to begin and holds this point on the string throughout the entire operation (fig. 15). The string line should always be kept perpendicular

Figure 15.—Establishing the guide row between two terraces, by the "string method."

to the terrace which is being used as a guide at that particular moment.

3. Laying out the guide row: As the crew moves toward the terrace outlet, the middle man, in locating the guide row will parallel first one terrace and then the other. The middle man must be sure to keep the same length of string between himself and the man in the terrace which is being followed at that particular time. As the guide row is established, stakes should be set at convenient intervals to mark its location.

When the area between the terraces is narrowing, the guide row parallels the upper terrace. Therefore, the string between the middle man and the man in the upper terrace is kept the same length, and the lower man must take up the slack as it occurs in the string. When the lower man feels the string begin to tighten, it indicates that the area between the terraces is beginning to widen. From this point, the guide row must parallel the lower terrace, so the string between the middle man and the man in the lower terrace is kept the same length, while the man in the upper terrace lets out string as required. When the upper man feels the string begin to slacken, it means the area is beginning to narrow again and that the guide row should begin to parallel the upper terrace once more.

When there is no change in the length of string, it indicates that the terraces are parallel. Through a section of this sort the guide row will have the same grade as the terrace. If this section is of considerable length some additional grade will be needed. Some type of level will be helpful in obtaining an adequate grade. Twelve inches per 100 feet will give a 1-percent grade, which is generally considered to be sufficient. In short intervals the additional grade can be estimated by the middle man without danger of serious error.

Remember these points: (*a*) The upper man never takes up string, he gives it out in widening sections; (*b*) the lower man never gives out string, he takes it up in narrowing sections; (*c*) the middle man holds the same point on the string throughout the entire operation.[2]

Adapting the String Method to Different Terrace Patterns

1. Where terraces drain in both directions: When terraces drain both ways, the guide row is laid out first in one direction and then the other from the starting point (fig. 16, *A*). In this case the guide row starts from the highest point on the top terrace.

2. Secondary guide rows: Where the first guide row empties in the lower terrace, it becomes necessary to establish a secondary guide row above the first (fig. 16, *B*). To do this, the middle man moves

[2] Two slightly different procedures in laying out the guide row have been found satisfactory. Where only one man is familiar with the system, he may take the middle position and determine by the string which terrace he is to follow. He gives out string on the upper side when following the lower terrace. He takes up string on the lower side when following the upper terrace. With this method two strings have been found more handy, one for the upper side and one for the lower, with surplus length on the upper side to allow for the widening sections.

Where only two men are available, the wide and narrow points of the interval are first located and marked. The man marking off the guide row parallels the proper terrace by having man number two in the upper terrace when the interval is closing. This man shifts to the lower terrace when the interval widens.

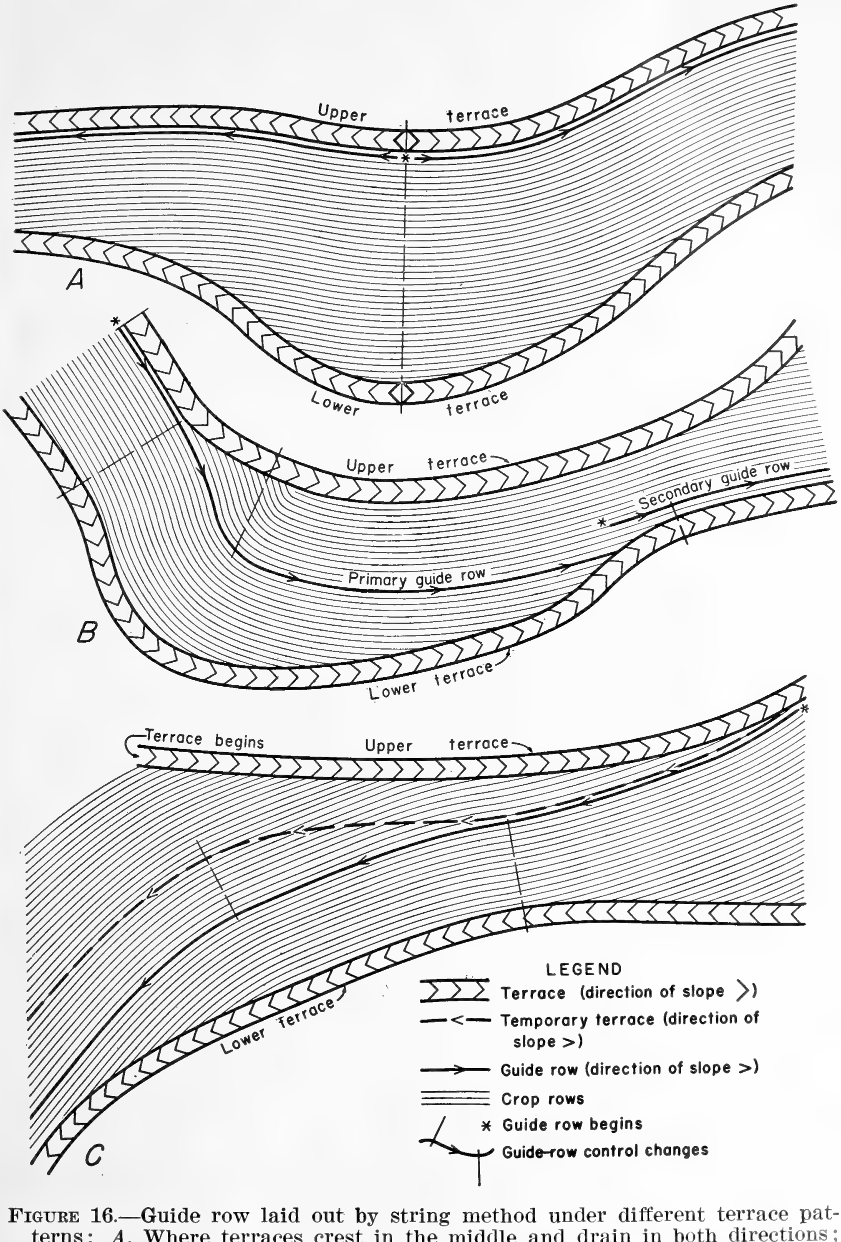

FIGURE 16.—Guide row laid out by string method under different terrace patterns: *A*, Where terraces crest in the middle and drain in both directions; *B*, where terraces are crooked and secondary guide row is needed; *C*, where terraces drain in opposite directions.

FIGURE 17.—Special attention should be given low places in tobacco fields. Lack of adequate grade in these tobacco rows has caused serious damage.

up the hill several row widths and starts a new guide row. From this point, the procedure is the same as with the first guide row.

3. Where terraces drain in opposite directions: Occasionally one terrace drains in one direction while the one above or below drains in the opposite direction. Where this occurs, rows can be laid out so as to flow in either direction. If row drainage in the same direction as the lower terrace is desired a temporary terrace line, draining in that direction, should be staked out near the upper terrace (fig. 16, C). On the other hand, if row drainage in the same direction as the upper terrace is desired, then stake out a temporary terrace line—draining in that direction—along the lower part of the interval, and lay out the guide row between this and the upper terrace. In both cases additional fall can be given if needed.

4. When more grade is needed: Frequently, areas are encountered where additional row grade will be necessary to provide row drainage. These areas can be low spots, humps, or sections between parallel terraces as mentioned previously. They should be crossed by gradually dropping the guide row downhill without use of the string. The use of some type of level will be helpful though not necessary in laying out the guide rows through such areas where extra fall is desired. Sighting back with the eye will usually show whether or not sufficient fall has been secured. It is important that special attention be given such places in order to provide adequate grade if the row system is to function properly, otherwise a break may occur as shown in figure 17.

5. Where rows empty into drainageways: It is necessary to provide free drainage of crop rows into drainageways to avoid having breaks near the row ends. This may be accomplished by turning the ends of the rows slightly downhill where necessary.

FIGURE 18.—All rows follow the guide row in completing the system. *A*, A furrow along the stake line is the first row laid out. Then the row marker follows this row. *B*, Bedding out tobacco rows following the row marker. Fertilizer will be drilled into these middles and the rows rebedded shortly before planting time.

6. Completing the system: The guide rows are the only crop rows that are staked out. After these have been correctly located, the rows in the remainder of the interval, both above and below the guide, are marked off parallel to the guide row (fig. 18).

On moderate slopes and, with well-built terraces, point rows beginning on the upper side of the terrace interval may extend over the terrace ridge, thus using the channel as a turn row. Care should be exercised, however, in cultivating across the terrace ridge so that the channel capacity is maintained.

On steeper land or with smaller terraces the crop rows should not cross the terrace ridge but should end just below the ridge. Three or more rows may then be run lengthwise the terrace ridge, if desired. In this case a narrow turn row may be left below these rows.

This system of row lay-out appears to be adapted to any sloping, terraced fields of moderate uniformity where frequent breaks or field irregularities do not interfere. It is especially suited to bright tobacco and other row-crop fields where free drainage is necessary (fig. 19).

The row system just described was first used in the Soil Conservation Service demonstration project area near Danville, Va., beginning in 1937. Following these first trials it has been used on numerous tobacco farms as well as at the Soil Conservation Experiment Station near Raleigh, N. C. Surveys have been made to determine the result-

FIGURE 19.—A well-planned tobacco field in southern Maryland, which includes terraces, grassed terrace outlets, and ridged rows. The guide rows in this field were located by the string method to give effective erosion control and adequate drainage.

ing row grades and the relationship between the row grades and terrace grades. These studies showed that under many conditions this row system served as an effective conservation practice, as each row carried its own water on a moderate grade. When properly laid out the row grades will slightly exceed the terrace grades. Under the conditions found on the experiment station fields, the average row grade was approximately 6 inches more per 100 feet than the terrace grade. This increase is determined by variation in slope and terrace spacing.

For several years this new system has been laid out on fields of farmers in cooperating soil conservation districts. It has proved effective in both the flue-cured and Maryland tobacco belts and is used extensively in some of the flue-cured areas. Results of its use have been watched closely with reference to its effects on soil loss, row drainage, and the growth of the tobacco. Farmer reaction has also been carefully considered and has been favorable. In addition to reduced soil loss and improved drainage, farmers generally report a more uniform growth of tobacco.

TERRACES ON TOBACCO FIELDS

In this bulletin terraces are considered chiefly on the basis of their relation to the improved row system on tobacco land. Specifications on terrace design, construction, maintenance, and use on agricultural land may be found in other publications (*11, 19*).

The studies on tobacco land indicate that a basic water-disposal system of terraces and waterways is essential before the improved row system can be generally applied. The use of terraces, in relation to the improved row system, may be summarized as follows:

1. The improved row system can, if necessary, be used on land which is already terraced. However, the row system is greatly affected by the terrace lay-out and the best results may be expected when the terraces are planned and constructed to facilitate use of the row system.
2. Terrace grades should be held to a practical minimum on fields with appreciable slope variations, because of their effect on row grade. For the same reason they may be increased somewhat on fields with uniform slope where terraces tend to run parallel.
3. Grades from 3 to 6 inches per 100 feet are satisfactory for most conditions. Terrace spacing should also be held to a practical minimum because wide spacing increases row grade and the volume of water to be handled.
4. The top terrace should be located as high up the slope as the available outlet will permit. This will reduce the land area above the top terrace which is usually a special problem in laying out rows since there is no upper guide.
5. In planning the terrace system on tobacco fields the length of terrace flowing in one direction should be held to a minimum by cresting terraces on the ridges and using all well-defined draws as outlets. This tends to shorten the rows and to straighten out the curves in both terraces and rows.

6. Smoothing of old gullies and the land surface before terrace construction is desirable on many tobacco fields. This will give broader bends in the terraces and rows which is especially desirable.

Terrace Outlets

Erosion control on tobacco lands in the Maryland and flue-cured belts is increased by the maximum use of terrace outlets. This is due to the high natural erosion hazard on these lands as well as to demands of the crop for well-drained soil throughout its growth. In other respects terrace outlet specifications for these lands are not different than those for other farm land in the areas. Detailed information on terrace outlets and waterways has been published by the United States Department of Agriculture (*11*) and by the North Carolina Extension Service (*6*).

Our experience shows that the following points should be stressed on these tobacco lands: (1) All pronounced drainageways occurring in the tobacco fields should be treated and maintained as terrace outlets or waterways. (2) Additional outlets should be constructed when the length of crop row drains much in excess of 600 feet in one direction. Careful planning in order to utilize the natural drainageways will often eliminate the need for constructing supplemental terrace outlets. (3) The outlets should be fully planned and developed before the terrace system is built. (4) The channels should be smooth and have adequate width to permit mowing and proper care. Where the width is sufficient these outlets can be profitably used for hay, and such use generally encourages good management. (5) The sides of the

Figure 20.—An excellent vegetated outlet in a natural field drainageway, which carries water from the rows and terraces on both sides. This outlet produces a good crop of hay.

outlets should extend back far enough so that drainage from row ends will flow over a sod strip to enter the main channel. (6) The outlet needs to be kept seeded, fertilized, and repaired at all times to assure a dense growth of protective vegetation (fig. 20). (7) The best plants for protecting outlets will vary considerably with soil, climate, and other factors so that no individual plant or combination of plants can be recommended for all situations. The advice of local soil conservationists or agronomists on the plants to use in outlets should be obtained.

Secondary Waterways in Tobacco Fields

The over-all water disposal system is provided by the network of terraces and terrace outlets discussed in the preceding paragraphs. In many tobacco fields small depressions resulting from erosion may occur across terrace intervals. Whenever practicable these should be filled in before the terraces are built, so that continuously drained crop rows may be extended across them. However, where such depressions have not been eliminated and are sharp enough to cause row breakage they should be kept in permanent vegetation and used as waterways for the crop rows that otherwise cross them. Once these waterways are well stabilized with vegetation they should be skipped in plowing and cultivating operations. When these waterways finally become filled by cultural practices they can be planted to tobacco like the rest of the field.

CULTURAL PRACTICES UNDER THE IMPROVED ROW SYSTEM ON TOBACCO LAND

Cultural practices under the improved row system can be the same as under any other method of row lay-out in common use. Cultivation will be as easy as with any contour pattern. The effectiveness of the system, however, depends on the combination of ridge-row cultivation and a moderate but continuous row grade, which enables each row to carry its own water without overtopping.

In the flue-cured belt the various steps of the tillage procedure generally followed are briefly as follows: Following initial land preparation, rows are marked off and opened with a single-hoe type of plow. Fertilizer is drilled into this furrow and mixed with the soil after which the rows are listed to cover the fertilizer and to form a ridge for planting (fig. 21, *A*). The balk middles are thrown to the ridge either before or after planting. Plants are set on these ridges by hand or by machine. The first cultivation, followed by a hoeing immediately around the plant, leaves the ground surface almost flat again and is sometimes followed by a shovel plow along the middles to open a well-defined furrow. Later cultivations work the soil toward the row and gradually build up a definite ridge.

Some farmers use a cultivator for the second and third cultivation, while others use a Stonewall plow, sometimes called a cotton plow, with adjustable wings and sweeps. The last cultivation tends to leave the ridge reasonably broad and as high as possible. A one-horse turnplow with the larger size moldboard, and sometimes with an added sweep, is ordinarily used for this laying-by and may be followed by some type of sweep along the middles (fig. 21, *B*).

FIGURE 21.—*A*, Planting tobacco on a low ridge in the flue-cured belt. *B*, Cultivation to clean out the rows and build up the ridges.

FIGURE 22.—On this southern Maryland farm both the planting and cultivation of tobacco is done by machinery. *A*, Planting tobacco on ridged rows with a two-row tractor planter on the H. W. Townshend farm. *B*, Cultivating ridged tobacco with two-row tractor cultivator proved satisfactory on this farm.

Tobacco over most of the bright belt is planted between May 1 and 20, and by the end of the first month the first three or four cultivations usually have developed sufficient ridge for each row to carry its own water. The hard summer rains, which constitute the greatest erosion hazard usually come after these ridges have been developed. This protection is provided at the time it is most needed. Occasionally heavy rains come while the crop rows are too low to be effective, in which case they may do serious damage. To guard against this it is advisable to leave a well-defined furrow after each cultivation.

In the Maryland belt current practices included neither the ridge row culture nor controlled row grades. The problem here was to provide both drainage and protection from erosion. Results cited previously in this buletin show that ridge rows with moderate grades benefit both crop and land as compared with customary farm practices in this tobacco belt. The tobacco planting dates in this belt come during the period of high erosion hazard. Thus, it is important to prepare high ridges before the crop is planted. In the Maryland belt both horse-drawn and tractor equipment have been tested in the ridge-row culture of tobacco. Land preparation has included plowing, disking, and harrowing in the same way as for flat cultivation.

With horse-drawn equipment, rows are laid out with a fertilizer distributor provided with a set of small disk hillers to cover the fertilizer and produce a small row ridge. A one-horse middle-buster is then run once or twice between each pair of rows. This leaves channels about 10 inches deep. The crop is then planted by hand or with a single-row planter. The crop is cultivated either by the middle-buster alone or with an ordinary cultivator followed by the middle-buster. The

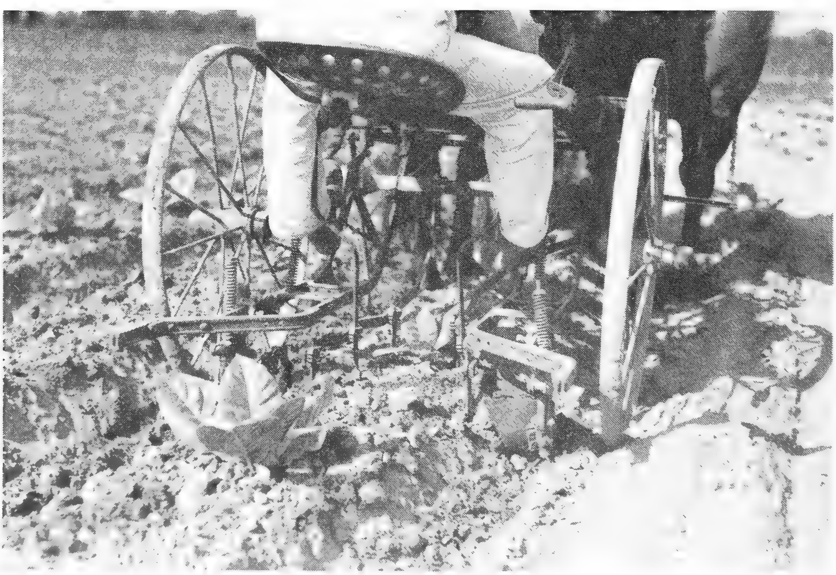

FIGURE 23.—Operating a low-saddle tobacco hoe mounted behind a one-row horse-drawn cultivator. Note that the grass and weeds have been controlled around the individual tobacco plants by opening and closing the weeding cultivators.

cultivator is used if the ground surface becomes crusted or grassy. Either a one-horse or a two-horse cultivator may be used. Hand-hoe weeding where necessary consists of scraping off the narrow strip of crusted soil along the top of the ridge and about the plants. Somewhat less hand work is usually required to weed ridge rows than flat rows.

With tractor equipment the fertilizer is broadcast and lightly disked or harrowed. The rows are then laid out and ridged in one operation with a two- or three-row middle-buster. The crop is planted with a two-row planter (fig. 22, *A*). Cultivation is with a two-row cultivator with ridging equipment (fig. 22, *B*).

Low-saddle tobacco hoes, similar to those used in Pennsylvania tobacco, can be mounted behind the tractor or riding horse-drawn cultivator and the cultivating and weeding accomplished in one operation. One man drives the team or tractor and another operates the hoe over each row, opening and closing the weeding cultivators around the individual tobacco plants. Very little hand hoeing is necessary with this type of cultivation and weeding (fig. 23).

The row channels must always be left clean to avoid impounding water. This is very important with any type of ridge-row cultivation.

TOBACCO LAND ROTATIONS

From the standpoint of erosion control on tobacco lands, benefits may be expected from rotations that include sod crops. The residual effect of sod materially reduces erosion occurring with row crops that follow the sod (*2*, *5*). Increases in the yields of many types of row crops following a sod in rotations have also been generally shown (*18*).

Good yields of high-quality tobacco have generally been obtained on newly cleared land or on land which has been occupied for a time by native weeds or sod (*13*, *15*). Tests at Marlboro, Md., (*3*, *4*) have also shown that rotations including 2 years of red clover or weeds gave better tobacco crop values than continuous tobacco culture with winter covers. Rotations on tobacco land may also be required as a means of controlling certain tobacco diseases (*8*).

The following rotations are commonly practiced by farmers in the flue-cured and Maryland tobacco belts:

The Flue-Cured Area

1. Tobacco, small grain, red top (*Agrostis alba*). This is used either as a 2- or 3-year rotation.

2. Tobacco, small grain, lespedeza 1 or 2 years, corn or other row crop, followed by a nonlegume winter cover. This is used as a 3- or 4-year rotation especially where diseases necessitate including other crops.

3. Tobacco followed by a legume winter cover, cotton or corn, followed by a nonlegume winter cover, such as rye or other small grain or ryegrass. In this rotation the legume precedes the cotton or corn while the nonlegume precedes the tobacco.

4. Tobacco each year followed by a winter cover such as rye or ryegrass.

The Maryland Area

1. Tobacco, small grain followed by grass and lespedeza or clover. This is used as a 3- or 4-year rotation.
2. Tobacco every other year followed by a winter cover of vetch and small grain which is permitted to mature and fall on the ground during the summer.
3. Tobacco every year with a winter cover of small grain, or small grain-vetch mixtures.

Rotations as followed on tobacco land have developed largely as a result of farm practice and have not been based, to any great extent, on experimental data. They are relatively weak from the standpoint of soil protection and from the economic returns from the other crops grown in the rotation with tobacco. In many cases they do not make adequate contribution to the yield and quality of the tobacco.

The proper use of rotations on tobacco land is an unsolved problem. The serious nature and extent of erosion on these lands justifies further concerted research efforts to develop crop rotations which give maximum protection to the soil and additional income while safeguarding the tobacco crop quality. Important considerations include:

1. Sod crops, the residual effects of which greatly increase the resistance of soil to erosion.
2. Crop sequences which maintain high quality in the tobacco crop.
3. Management of crop residues to control nitrogen release during the tobacco year.
4. Crop plants that will yield satisfactory profits when grown on tobacco soil.

WINTER COVER CROPS AND EROSION LOSSES

Winter cover crops have been generally recommended for winter protection and as a source of organic material for soil improvement. They are known to reduce erosion on many soil types, particularly on the heavier types (*4, 5*). In studies at Statesville on Cecil sandy clay loam they reduced erosion to less than one-half that where none was turned under.

At the Raleigh station the effect of winter covers was studied on the sandier soils under tobacco culture. Rye and ryegrass seeded as winter covers with and without additional nitrogen at seeding time, were compared with no winter cover. All plots were laid out so as to have a row grade of 18 inches per 100 feet and ridge cultivation was followed.

Soil loss measurements over a 4-year period showed an annual decrease in soil loss of 6 percent for ryegrass and 14 percent for rye, when compared with that from tobacco following no winter cover. Adding 24 pounds of nitrogen per acre at seeding increased these effects to 48 percent for ryegrass and 18 percent for rye.

If these cover-crop and residue effects are considered on a seasonal basis the benefits are much better understood. Seasonal soil losses from rye, nitrated rye, and no cover are shown in figure 24. First it was found that there was very little erosion during the winter months, from November through March, either with or without winter cover.

Any benefits resulting from their use came after they were turned under, usually from April through June, which is the period of cultivation. The benefits of nitrated ryegrass lasted through July because of its resistance to decomposition. The turf of ryegrass was such that land preparation for tobacco was difficult.

Seeding winter covers actually increased soil loss during the period of land preparation, seeding, and early growth in September and October. Serious erosion at this time frequently occurs in fall-seeded fields

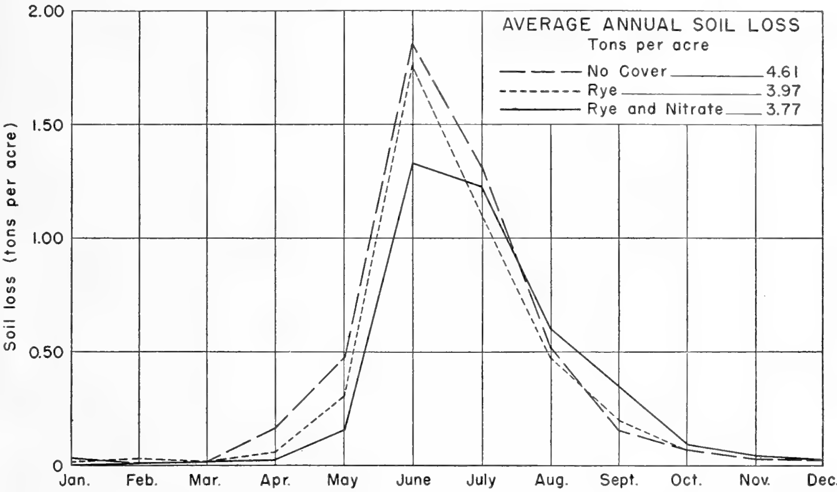

FIGURE 24.—Seasonal soil losses from tobacco plots with no winter cover, compared with soil losses on plots with rye and nitrated rye winter covers. All tobacco grown on 1½-percent grade ridge rows, Raleigh, N. C., 1944–47.

over the tobacco belts. This fall hazard tended to offset some of the benefits occurring during the spring and summer.

Benefits from these cover crops in erosion control seemed to be determined by (1) the amount of growth produced, (2) the amount of residue remaining on or near the surface, (3) the resistance of these residues to decomposition. Adding nitrogen to stimulate the growth of rye and ryegrass increased the beneficial effects of both cover crops. Thus it is apparent that when cover crops are used they should be seeded early and fertilized as much as necessary to secure adequate growth.

Tobacco yields and values from these plots are shown in table 7.

Tobacco yields were increased when a sufficient amount of readily decomposable cover-crop material was turned under, as in the case of nitrated rye. A sparse growth of cover, as with the no-nitrate rye, had little effect on the following tobacco crop. Material that decomposed slowly, as did nitrated ryegrass, also had little effect on yield.

In the studies of erosion-control practices for tobacco land at Beltsville, winter cover-crop mixtures of wheat and hairy vetch were used.

TABLE 7.—*Average yield, price and value of tobacco following no winter cover compared to tobacco following fertilized and unfertilized winter covers. (All tobacco grown on 1½-percent grade ridge rows, Raleigh, N. C., 1942–47.)*

Treatment	Yield per acre	Price per pound	Crop value per acre
	Pounds	*Cents*	*Dollars*
No cover	1, 062	45	477
Rye	1, 060	45	473
Rye and nitrate	1, 166	43	504
Ryegrass	1, 120	45	504
Ryegrass and nitrate	1, 057	46	486

The soil was naturally low in organic matter. To increase the amount of organic amendment, and to secure maximum erosion control, the cover crop was permitted to grow until the wheat reached the early bloom stage. This cover-crop residue was resistant to quick decomposition as evidenced by the wheat crowns and stems that were abundant in and on the soil at tobacco harvest time. Tobacco yields and values under this method of handling the cover crop have been good.

Since this method of cover-cropping is not commonly practiced by farmers, a supplemental experiment was carried out to compare early and late-season turning of winter covers. The early turning was done on April 11 when the covers were in a succulent green-manure stage. Late turning was done on May 17 when the nonlegumes were well-stemmed and beginning to bloom. The covers tested were wheat, rye, ryegrass and hairy vetch and each of the three nonlegumes in mixture with vetch. Two replications were used except in case of the check plot. The land treatment began with the fall seeding of cover crops. Two cover crops and one crop of tobacco were grown in preparation for the experiment. The cover crops were seeded during the last half of September in each year. Seeding rates were: Vetch, 40 pounds; rye and wheat, 5 pecks; and ryegrass, 4 pecks per acre. The test crop of tobacco in 1946 was planted June 4 and harvested from August 21 to September 10 as the crops on the various treatments matured. Results of this experiment are shown in table 8.

Statistical analysis of the data presented in table 8 showed significant differences due to treatments as follows: (1) the vetch alone and in mixtures increased the tobacco yield and total crop value. (2) Late turning increased yield where vetch was contained in the cover crop and decreased yield when vetch was not in the cover crop. (3) The nonlegumes (wheat-rye-ryegrass) with or without vetch increased the tobacco price per pound over the check and vetch alone. (4) Ryegrass alone, and land with no cover, gave lower crop value than that with wheat or rye alone.

Practical results of the studies at Beltsville on winter cover crops and their application to erosion control for Maryland tobacco land may be summarized as follows:

TABLE 8.—*Tobacco yield, price per pound, and per-acre value as affected by early and late turning of various cover crops, Beltsville, Md., 1946*

Covers	Yield per acre		Price per pound		Value per acre	
	Early [1]	Late [2]	Early	Late	Early	Late
	Pounds	*Pounds*	*Cents*	*Cents*	*Dollars*	*Dollars*
None	1, 273	1, 132	41. 3	38. 4	511	432
Nonlegumes:						
Wheat	1, 415	1, 251	42. 8	46. 3	608	581
Rye	1, 300	1, 398	45. 1	42. 1	587	586
Ryegrass	1, 253	1, 146	40. 1	41. 0	503	480
Average	1, 322	1, 265	42. 7	43. 1	566	549
Vetch	2, 018	2, 224	40. 2	37. 2	805	828
Mixtures:						
Wheat-vetch	1, 728	1, 828	47. 3	45. 4	820	825
Rye-vetch	1, 905	2, 094	44. 7	42. 3	855	885
Ryegrass-vetch	1, 751	2, 296	44. 3	44. 4	774	1, 022
Average	1, 795	2, 072	45. 4	44. 0	816	910
Grand average	1, 580	1, 671	43. 2	42. 1	683	705

[1] Turned Apr. 11.
[2] Turned May 17.

1. During the period 1940 to 1946 where the land was protected over winter by a cover crop of wheat and vetch, and during the summer by a 1-percent grade ridged row, seven successive tobacco crops were grown without evidence of decrease in either yield or value of the crop. The land used in this experiment had remained in natural sod for at least 6 years before it was first plowed for tobacco. This suggests that where good erosion control is practiced, land plowed out of sod may be used to grow several successive tobacco crops without causing decrease in crop value.

2. The detailed studies on winter cover crops carried out in 1946 indicate that better crop returns may be expected when the winter cover contains vetch in mixture with wheat, rye, or ryegrass than when vetch or any one of the nonlegumes is used alone. In all cases except ryegrass alone the use of winter covers gave substantial increases in the tobacco crop returns. Late turning of the cover crops containing vetch gave much the highest tobacco returns followed in order by early turning and late turning of the nonlegumes without vetch. The early-turned residues quickly disappeared, whereas in case of late turning a considerable amount of the nonlegume crowns and stems were still visible in and on the soil at tobacco harvest time. Since the effect of crop residues in decreasing erosion is known to be increased with their resistance to rapid decomposition these studies suggest late turning of the vetch-nonlegume covers as a means for increasing both crop value and erosion control.

Seeding Winter Cover Over Ridged Rows

Frequently, serious erosion occurs during the fall after the land has been smoothed for the seeding of winter cover, even after a good row system has furnished effective erosion control during the summer. Field trials and experimental studies have shown that much of this trouble can be avoided (fig. 25). Winter cover can readily be

Figure 25.—A winter cover seeded over the tobacco row beds without flattening them. *A*, Seeding has just been completed with the grain drill following the rows. *B*, A portion of the same field about 2 months later after the cover had become established.

seeded over the old tobacco ridges and their effectiveness carried through the winter. A satisfactory seedbed can be made with only slight preparation, such as a very light disking or harrowing which does not level the land. Retaining the row ridges will have the further advantage of carrying the row pattern through until the next

FIGURE 26.—Cover crops seeded early furnish effective cover. *A*, Cover seeded in early September gives ample protection. *B*, Cover seeded in October leaves land bare and unprotected in the spring.

spring if tobacco is to follow the next year. In this case the land can be broken by simply reversing the beds—a practice followed by many farmers in the flue-cured belt.

Early seeding of winter covers and sufficient fertilization adds greatly to their value. Seedings that do not make adequate growth may be useless in controlling erosion. In many cases late land preparation for seeding winter covers may cause more erosion than if the area had been left undisturbed. Dense lush growth of winter covers will give good protection from erosion and tend to increase crop yields the next summer (fig. 26).

THE USE OF MULCH

Tests of straw mulch in Maryland proved that mulch was the most effective method of erosion control on areas that are too steep or irregular for the more usual and less costly methods of control.

The value of tobacco grown on up-and-down-hill rows mulched before transplanting with 4 to 6 tons of straw is compared in table 9 with the value of tobacco grown on ridged rows with 1-percent grade.

It can be seen that the mulch treatment gave good crop values in the favorable tobacco seasons and in the excessively dry season. In the seasons with excessive early rainfall, however, yields were depressed on the mulched land. Average crop value for the 7-year period was slightly better for the graded rows. Recent tests have indicated, however, that growing conditions of mulched tobacco may be improved by some subsurface tillage after protracted rainy weather. Further studies on this phase of the problem and on eco-

Table 9.—*Effect of straw mulch on the value of tobacco during seasons with favorable and unfavorable rainfall. The effect of mulching ridged up-and-down-hill rows is compared with unmulched ridged rows with 1-percent grade.*

Type of season	Years	Rainfall	Value of crop per acre	
			1-percent grade	Mulch
		Inches	*Dollars*	*Dollars*
Favorably distributed rainfall	1941	14. 61	518	538
	1942	15. 36		
	1944	10. 34		
	1946	7. 49		
Average		11. 95		
Excess rainfall early in season	1940	16. 49	368	230
	1945	20. 61		
Average		18. 55		
Too dry during last part of season	1943	4. 17	312	363
Average return from crop			446	425

nomical methods of applying mulch are needed before the practice can be recommended for general use by farmers.

CONCLUSION

Although erosion is by no means limited to tobacco soils, these soils in the flue-cured and Maryland tobacco belts are among those most endangered by water erosion. To arrest erosion and adopt a course of land management which will hold future soil losses to a minimum will require concerted effort of all concerned—the farmers, the tobacco trade, soil conservation districts, and all State and Federal agencies. This publication points the way to such a course by citing some of the most successful methods developed in a brief period of research.

The limited extent of research reported here cannot solve the problem. Neither can it be solved until all agricultural workers and farmers become sufficiently conservation-minded to recognize that protection of the soil against erosion is a primary requirement for continued profitable production of tobacco as well as other crops. Also, it must be borne in mind that on land areas affected by water erosion the cost of soil protection mounts with the steepness of slope when soil-depleting crops such as tobacco are grown.

The following points are urged:

Promote the growing of tobacco only on those lands where adequate provisions are made to safeguard the soil against erosion.

Start now to promote the full use of the erosion-control practices that are known to be effective on tobacco land.

Recognize the defects and shortcomings in present knowledge of erosion control on these tobacco lands; then promote and support the efforts needed to improve the practices.

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