Agriculture - Soil Conservation

EROSION CONTROL FACTORS AND THE UNIVERSAL SOIL LOSS EQUATION

Soil losses become severe when rolling areas are poorly managed.

Effective soil and crop management practices lend natural beauty to the landscape.

Erosion is the wearing away of the earth's surface by wind, water or other geological forces.

Vegetation has been important in protecting soils from excessive erosion.

The demands of American people today are such that the modern farmer has to cultivate the soil carefully and intensively. Most crop seeds are planted in loose, unprotected soil. This sets the stage for serious erosion losses, particularly on sloping land.

EROSION DAMAGE

When soils erode, plant nutrients (especially nitrogen and phosphorus) are lost with the soil. Since there is usually less phosphorus in the subsoil and it is less available to plants than phosphorus in the surface soil, the nutrient problem is intensified by erosion. Adding large amounts of organic matter and soil nutrients may be necessary in "reclaiming" severely eroded soils.

Another serious problem from erosion is the loss of the porous surface layer which contains organic matter and aggregated particles. This surface material makes soils easy to cultivate and more absorbent to rainfall. Subsoils are more difficult to manage and often produce unsatisfactory crop yields.

SOIL LOSS TOLERANCE

Since our purpose is to maintain a long-time productive agriculture, how much soil can we afford to lose? Some soil is lost even under the dense vegetation Mother Nature provided. However, under these conditions soil formation exceeded the rate of loss. We can be sure excessive soil loss under some conditions is more serious than under others. For instance, excessive erosion on a shallow soil 1 to 3 feet thick overlying bedrock will be more serious than the same losses on a deep loess (wind deposited) soil which is many feet thick. Soil loss tolerance can vary according to the type of soil and its many characteristics. In Iowa this variation will range from 1 to 5 tons per acre per year. These figures are supported by long and careful study of the problem (see table 1).

PREDICTING SOIL LOSSES

If we are to control excessive soil losses on our farms, we must have reliable guides for predicting soil losses under any combination of circumstances in any climatic area existing in the state.

Such a guide for use in conservation farm planning is now available for use by farmers and professional conservationists to determine soil losses

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from water erosion. This guide is the *universal soil loss equation.* The soil loss equation is based on scientific data collected by researchers over many years in Iowa and other states. Through its use it is possible to predict rainfall-erosion losses under different systems of land use and management. Such predictions furnish a sound basis for making shifts in land use and in selecting the right combination of conservation practices.

The first equation for predicting soil loss was developed in Iowa and put into use in 1946. Since that time the equation and supporting data have been refined and improved as more information became available. A major change was made in 1961 when the equation was revised and made usable throughout the United States. This background in development and especially the use of the equation on Iowa farms for more than 20 years has proven its value as a guide for making sound decisions concerning land use and conservation treatment.

TABLE 1. Annual Soil Loss Tolerance.

Soils over bedrock, sand or gravel	Soil Loss Tolerance	Examples [1]
15-30 inches deep	1 T/A	Dubuque silt loam
Soils over unconsolidated material		
Soils with very slowly permeable subsoils	2	Severely eroded Clarinda, Adair.
	3	Slightly to moderately eroded Clarinda, Adair
Soils with slowly permeable subsoils	4	Shelby, Sharpsburg
Soils with moderately permeable subsoils	5	Marshall, Tama

[1] For soil loss tolerance values for specific soils see table 5.

THE SOIL LOSS EQUATION

The soil loss equation reflects the influences of all the major factors known to influence rainfall erosion. The equation: A = RKLSCP.

- A is the average annual soil loss in tons per acre predicted by the equation.
- R is the rainfall factor.
- K is the soil erodibility factor.
- L is the length of slope factor.
- S is the steepness of slope factor.
- C is the cropping and management factor.
- P is the supporting conservation practice factor (terracing, strip cropping, contouring).

How these factors affect erosion and how numerical equivalents for them were established are discussed in the following sections.* A concluding section presents the necessary data in table form and shows how the equation can be used to resolve a typical farm erosion problem. Using the equation involves multiplying values determined for the various factors that influence soil loss to give a predicted average annual soil loss in tons per acre.

RAINFALL FACTOR – R

Research has shown that some rains are more erosive than others. They also occur in some areas of the country more often than in others. In Iowa, the total number of erosive rains increases as one travels from the northwest to the southeast. Numerical rainfall factors are assigned to the appropriate areas of the state; they range between 160 and 200 (see fig. 1). These factors reflect the average annual erosion-producing rainfall and thus represent the potential erosiveness of Iowa rains.

SOIL ERODIBILITY FACTOR – K

Some soils erode at a faster rate than others. Physical properties of the soil are mainly responsible for the differences. Some of the more important ones are: soil texture, size and stability of soil structure, soil permeability and infiltration, organic matter content and soil depth.

K factors for Iowa soils range from .17 to .49, see table 5. The values represent soil loss in tons per acre per unit of rainfall erosion index (R factor) from land with a 9 percent slope, 72.6 feet long under cultivated fallow. For example, a soil with a .32 K factor in an area with an R factor of 200 would have an average annual soil loss of 64 tons per acre (.32 x 200 = 64) when fallowed on a slope of 9 percent and 72.6 feet long.

The slope and fallow condition is an arbitrarily selected standard. It was selected because it represents the condition most commonly used in studies which supplied most of the measured soil loss data. With this standard as a starting point, soil loss from other conditions can be easily calculated.

SLOPE FACTORS – LS

Steep slopes lose more soil than gentle slopes. If the steepness of slope is doubled, the erosion hazard increases 2.5 times. If the length of a slope is doubled, the erosion hazard increases 1.5 times.

Knowing what the soil loss would be from an acre of continuous fallow as described under the K factor, one can develop a ratio for the LS factor

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and thus determine the amount of soil loss when the length and steepness of slope change to dimensions other than the standard: 9 percent slope, 72.6 feet long. Figure 2 gives LS ratios for all combinations of length and steepness of slopes. When conventional terrace systems are used, the length of slope factor is the horizontal distance between terraces.

CROPPING AND MANAGEMENT FACTOR — C

The C factor takes into consideration the combined effects of growing crops and cultural methods on soil loss in comparison to continuous fallow. To develop C factors for Iowa systems of farming, many items must be considered. Crops and their sequence, as well as crop yields, residues, and other cultural and management measures affect the value assigned to this factor. The C factor also involves consideration of the type of tillage operations that are performed, the time of year they are performed, and whether residues are turned under, left on the surface, mixed in the plow layer, or removed from the field.

The distribution of erosive rain storms during the average year is an important consideration in developing C factor values. Some crops that are planted early in the season have developed to the point that they may give good protection to the soil during the time of year when the erosive rains come. However, few crops are planted early enough to furnish such protection, therefore, the type of tillage performed or the placement of crop residues may need to be modified to reduce erosion.

In Iowa, the most erosive rains occur in May and June when the least amount of crop cover is growing on the land. However, when crops are grown in rotation, with good management of residues and with proper tillage, soil loss can be reduced to less than 10 percent of the loss expected from continuous fallow. This reflects the effect of cover. Thus, assigning a C factor of .13 to a cropping system means, in effect, that because of the cover only 13 percent as much soil loss is expected as would be expected if the land were in continuous fallow.

Factors have been developed for the most commonly used cropping systems in Iowa. They range from .03 for a cropping system using mostly grass to .5 for continuous row crops with residues removed, as given in tables 4 and 4a.

PRACTICES FACTOR — P

The P factor involves contouring, contour stripcropping and conventional terracing; it is the ratio of soil loss when a specific practice is used to that lost when up-and-down-hill operations are employed. The practice of plowing, cultivating and harvesting crops on the contour usually reduces erosion about 50 percent. As the slopes increase in steepness, contouring decreases in efficiency and effectiveness as an inhibitor of soil loss. Contouring factors range from .5 for the gentle slopes to .9 for the steepest slopes. Strip-cropping with alternating strips of meadow and grain crops is twice as effective as contouring. As the amount of meadow in strips declines, stripcropping becomes less effective as a method of reducing soil loss.

Conventional terraces have long been one of the most effective mechanical practices used in Iowa to reduce soil loss. The effect of conventional terrace systems in reducing soil loss is calculated by using a factor that reflects the reduction of long slopes into the short slopes that exist after the terraces are constructed. For conservation practice factors, see table 6.

The standard formula for conventional terrace layout is 0.7S + 2. This formula gives the vertical distance between terrace lines. Here, S is steepness of slope expressed in percent (feet of fall in 100 feet of horizontal distance). The horizontal distance between terraces can be determined by solving the following simple equation:

$$\frac{0.7S + 2}{S} \times 100 = \text{Horizontal distance between terraces.}$$

Example: If S = 8%; by substituting 8 for S in the formula we have

$$\frac{5.6 + 2}{8} \times 100 \text{ or } \frac{7.6}{8} \times 100 = 95 \text{ feet.}$$

Note that the horizontal distance between conventional terraces is never allowed to be shorter than 90 feet regardless of steepness of slope (see tables 3, 3a and 3b). This is to maintain reasonable efficiency with farm equipment.

IMPROVED TERRACE SYSTEM DESIGN

Terracing and terrace system design have gone through a long period of development in Iowa. Early terraces were closely spaced and created many point rows. Methods of construction (from the upper side) tended to create a steeper land slope over all. Well developed outlets (waterways) were needed, where level terraces were not adapted, to carry off excess water. Observations indicate that terraces will gradually "bench" over time from the normal movement of soil down the slope. This movement is caused by the effects of tillage, the downward flow of water and the forces of gravity.

Facing the problems inherent with conventional terrace systems mentioned above, plus the added difficulties of farming sharply curved and more closely spaced rows with large tillage machines, engineers have greatly improved terrace system design with "cut and fill" construction methods which allows terrace lines to be parallel and eliminates point rows and sharp curves. Further improvement has come, by permanently seeding the backslopes on terrace ridges. Pushing soil up hill to form the terrace ridges or excavating (borrowing) soil for the ridge from below rather than from the channel area above lessens the slope of the area between terraces rather than steepening it. Where excess water must be drained away, tile outlet systems with vertical intakes at needed points rather than grassed waterways are used. Terraces of this type, whether level where adapted or with tile outlets, are more widely spaced than conventional systems thereby protecting a greater acreage per unit of terrace. A "closed" system of this type confines soil movement to the benching effect which takes place over time between the terraces. The benching in itself increases farming efficiency and provides more favorable distribution of available moisture. These terrace systems are illustrated on page 5.

If you choose parallel-level terraces, where adapted, or parallel-push-up level or tile outlet grassed backslope terraces, where adapted, *the tables referred to earlier do not apply*. Since erosion is adequately controlled with these terrace systems, when properly maintained, regardless of slope or cropping sequence, there is no limitation on use of row-crops. (See tables 4, column C^6 and 4a, column C^7).

USING THE EQUATION

How the physical features of the land, climate, crops and the soil conservation practices affect soil loss has been discussed. By multiplying all the values assigned to factors that affect erosion, average annual soil loss can be predicted. In Jasper county, for example, where the rainfall factor is 180 and the soil has an erodibility factor of .32, a field with 8 percent slopes 400 feet long and under a corn-corn-oats-meadow rotation with good management and farmed on the contour would lose approximately 9 tons of soil per acre per year. The following shows how this is calculated:

Average annual soil loss per acre equals: R x K x LS x C x P.

The factor values for this example are determined as follows:

R = 180 from fig. 1.
K = .32 from table 5.
LS = 2.0 from fig. 2.

C = .13 from table 4a.
P = .6 from table 6.

180 x .32 x 2.0 x .13 x .6 = 8.99 tons per acre.

180 x .32 = 57.6 tons soil loss from a fallow acre on 72.6 feet long, 9 percent slopes.

57.6 x 2.0 = 115.2 tons soil loss from a fallow acre on 400 feet long, 8 percent slopes.

115.2 x .13 = 14.98 tons soil loss from RROM rotation on these slopes.

14.98 x .6 = 8.99 tons soil loss per acre when the field also is contoured.

If the rotation is changed and an additional year of meadow added (corn, corn, oats, meadow, meadow), the C factor would change from .13 to .10 and the soil loss would be reduced to 7 tons.

This is still more soil loss than can be tolerated from even the best of soils. If the field is terraced with conventional terraces, the 400-foot slopes would be divided into 95-foot lengths. This would change the LS ratio from 2.0 to .91 and the soil loss would be reduced to approximately 4 tons per acre (with RROM), an acceptable amount.

The equation is used to predict the average annual soil loss that might be expected over a period of years. There will be year-to-year fluctuations. Thus, the equation is used only as a guide in the development of conservation plans.

For easier use of the equation, tables are provided for predicting soil loss. From table 5 you can determine the K and T values for the major soils in Iowa. In tables 2, 2a, 2b, 3, 3a and 3b, soil loss has been calculated without the influence of growing crops. In other words, the soil loss depicted by the figures in those six tables is the loss from land in continuous fallow when all other conditions affecting erosion are constant. All the factors are multiplied together except the C-factor (A=RKLSP).

By selecting the proper factor from the table of crop management factors (table 4 or 4a) you need only to multiply the appropriate figure from table 2 or 3 series by the appropriate figure from table 4 or 4a and obtain the annual expected soil loss per acre.

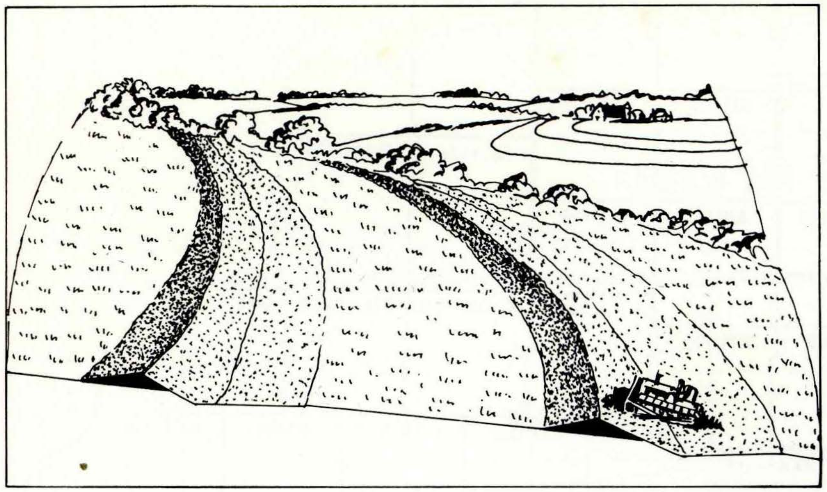
The use of table 4 or 4a depends upon the rainfall distribution area involved. These areas are shown in fig. 1. In area 13 use table 4, and in area 14 use table 4a.

Let us check the preceding problem. From table 2a under the K-factor column for Tama soil (.32) and a slope length of 400 feet and 8 percent, we find a figure of 69.12 (tons). Multiply by .13 (C-factor) from table 4 and you will obtain 8.99 tons soil loss. If you use conventional terraces, find 31.45 (tons) from table 3a and multiply by .13 from table 4.

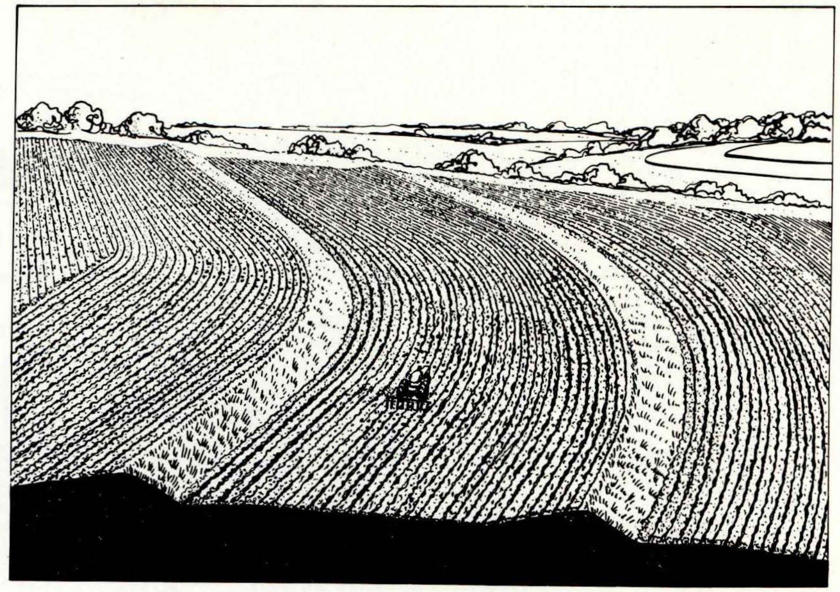
Remember, if you live in rainfall area 160, you will use tables 2b and 3b, depending on whether you choose contouring or conventional terracing as a conservation practice. In rainfall area 180, you would use tables 2a or 3a and in rainfall area 200, the appropriate tables would be 2 and 3.

Remember also to select the crop management table in accordance with where you live. For area 13, (western Iowa) use table 4 and for area 14 (eastern Iowa) use table 4a.

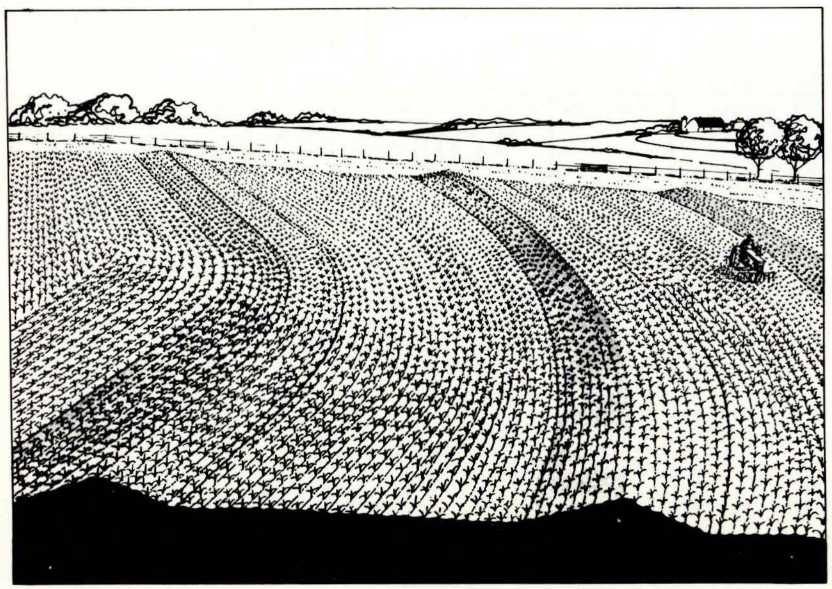
You are encouraged to use the tables rather than the longer method for calculating soil loss since the tables offer a rapid method for determining expected annual soil loss for any location in Iowa and for any set of conditions.



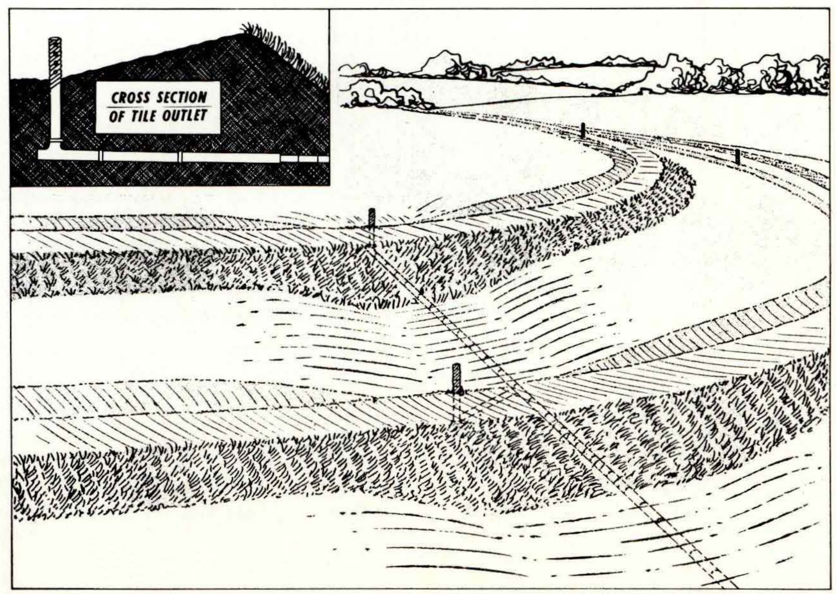
Construction technique—soil moved from lower side of ridge.



Grassed backslope parallel terraces.



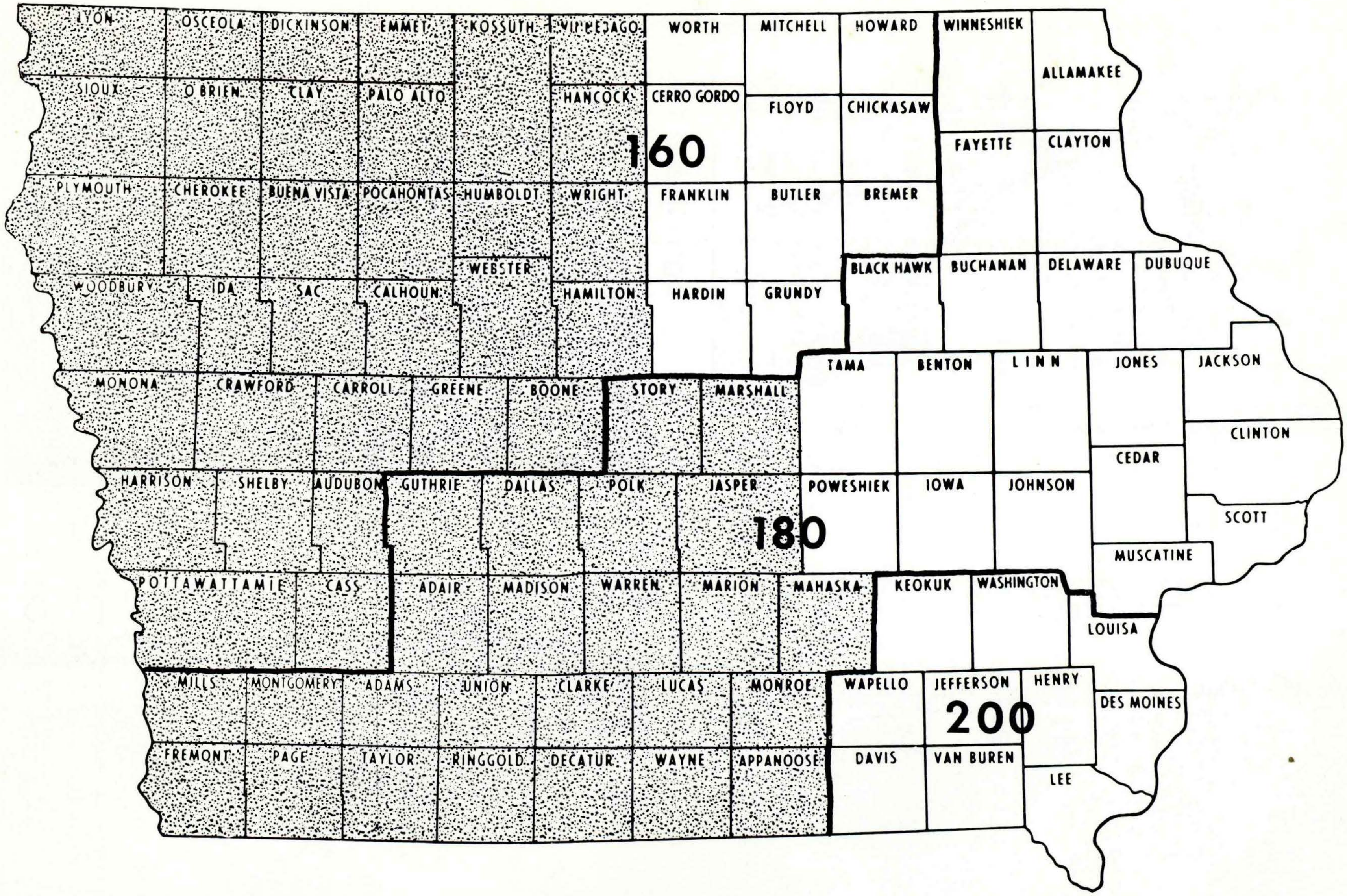
Broad base parallel terraces.



Terraces with tile outlets and grassed backslopes.

Photos courtesy SCS.

Fig. 1. Rainfall Factors for Counties in Iowa and Distribution of Rainfall by Areas.



Area 13
Area 14

The rainfall factors (160, 180, 200) reflect the *total number* of erosive rains during the year.

Areas 13 and 14 reflect differences in the *seasonal timing* of erosive rains during the year. Amount of erosion is influenced by these differences in rainfall distribution because of the effect of rain falling on soil with different stages of tillage and crop growth. In selecting C factors, note that separate tables are used for areas 13 and 14.

Fig. 2. Chart for adjusting plot soil loss to length and degree of slope.

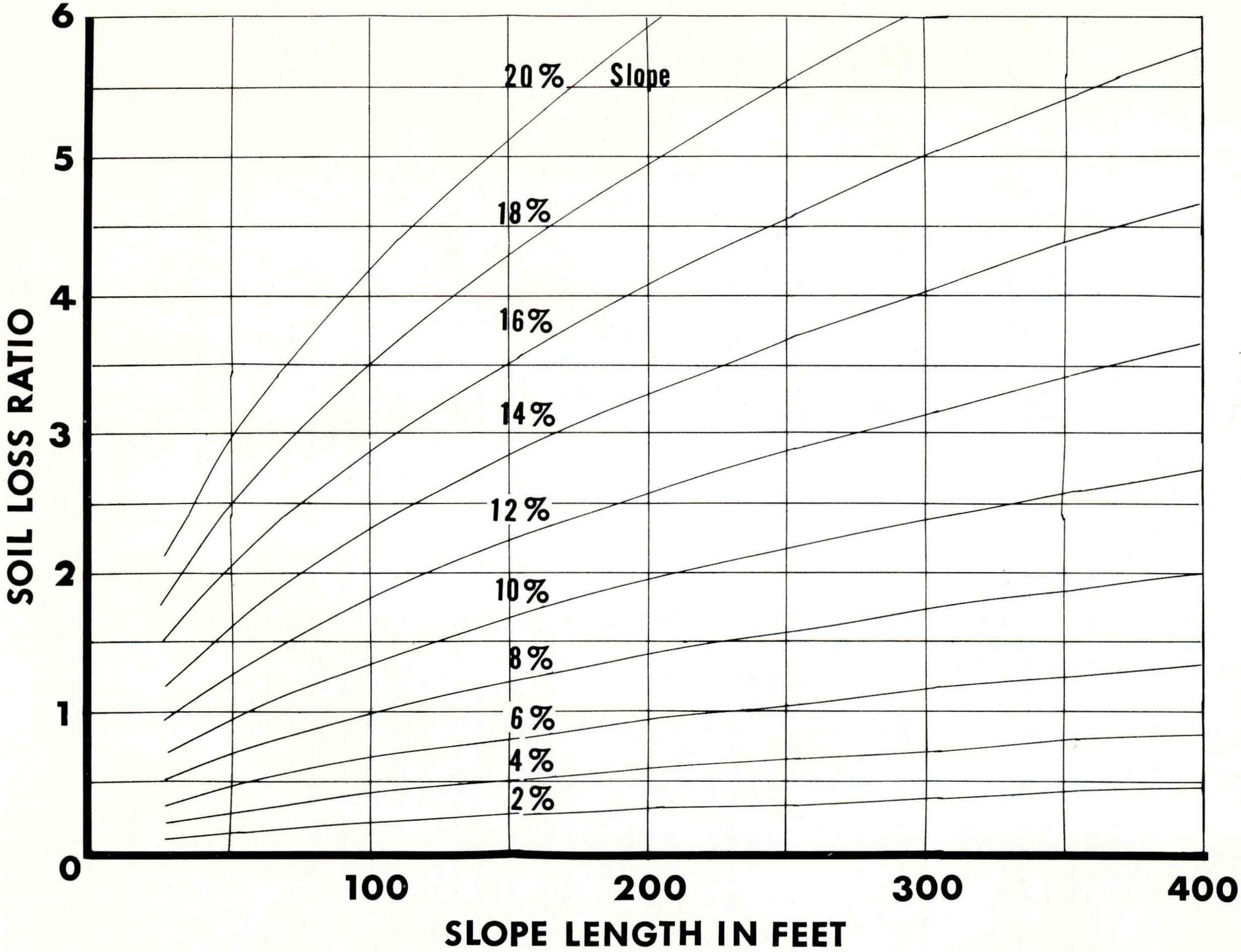


TABLE 2. Average Annual Soil Loss From Continuous Fallow
R = 200
RKLSP Values For Contouring*

Slope Length, feet	Per-cent	Soil Erodibility Factors - K Values .17	.20	.24	.28	.32	.37	.43	.49
200'	2	6.12	7.20	8.64	10.08	11.52	13.52	15.48	17.64
	4	10.2	12.00	14.40	16.80	19.2	22.2	25.8	29.4
	6	15.8	9.30	22.4	26.0	29.8	34.4	40.0	45.6
	8	28.56	33.60	40.32	47.04	53.76	62.16	72.24	82.32
	10	39.4	46.4	55.6	65.0	74.2	85.8	99.8	113.6
	12	52.4	61.6	74.0	86.2	98.6	114.0	132.4	151.0
	14	89.8	105.6	126.8	147.8	168.8	195.4	228.0	258.0
	16	111.6	131.2	157.4	183.6	210.0	242.0	282.0	322.0
	18	134.2	158.0	189.6	222.0	252.0	292.0	340.0	388.0
	20	181.6	214.0	256.0	298.0	342.0	396.0	460.0	524.0
	24	226.0	266.0	320.0	372.0	426.0	492.0	572.0	652.0
300'	2	8.16	9.60	11.52	13.44	15.36	17.76	20.6	23.6
	4	12.4	14.60	17.52	20.4	23.4	27.0	31.4	35.8
	6	19.88	23.4	28.0	32.2	37.4	43.2	50.4	57.4
	8	35.09	41.28	49.54	57.79	66.05	76.37	88.75	101.14
	10	49.0	57.6	69.2	80.6	92.2	106.6	123.8	141.0
	12	64.6	76.0	91.2	106.4	121.6	140.6	163.4	186.2
	14	109.4	128.8	154.6	180.4	204.0	238.0	276.0	316.0
	16	136.0	160.0	192.0	224.0	256.0	296.0	344.0	392.0
	18	165.8	195.2	234.0	274.0	312.0	362.0	420.0	478.0
	20	220.0	260.0	310.0	362.0	414.0	480.0	558.0	636.0
	24	282.0	330.0	398.0	464.0	530.0	612.0	712.0	812.0
400'	2	9.38	11.04	13.24	15.46	17.66	20.4	23.8	27.0
	4	14.28	16.80	20.2	23.4	26.8	31.0	36.2	41.0
	6	22.8	26.8	32.2	37.6	42.8	49.6	57.6	65.6
	8	40.80	48.00	57.60	67.20	76.80	88.80	103.20	117.60
	10	56.4	66.4	79.6	92.8	106.2	122.8	142.6	162.6
	12	74.8	88.0	105.6	123.2	140.8	162.8	189.2	216.0
	14	126.2	148.4	178.0	208.0	238.0	274.0	320.0	364.0
	16	158.4	186.4	224.0	260.0	298.0	344.0	400.0	456.0

*When *alternate strips* of legume-grass *meadows* are used in a contour strip cropping system, soil loss values for strip cropping may be obtained by multiplying the above contour figures by .5.

When *alternate strips* of close *growing* crops are used in the contour strip cropping system, soil loss values for strip cropping may be obtained by multiplying the above contour figures by .75.

To determine average annual soil loss when crops are grown on the land:
1. Select the soil loss from the table above for the existing conditions.
2. Multiply the soil loss by the rotation and management factor selected from table 4 or 4a.

TABLE 2a. Average Annual Soil Loss From Continuous Fallow
R = 180
RKLSP Values For Contouring*

Slope Length, feet	Per-cent	Soil Erodibility Factors - K Values .17	.20	.24	.28	.32	.37	.43	.49
200'	2	5.51	6.48	7.78	9.07	10.37	12.17	13.93	15.88
	4	9.18	10.8	13.0	15.1	17.28	20.0	23.2	26.46
	6	14.2	16.7	20.2	23.4	26.8	31.0	36.0	41.0
	8	25.70	30.24	36.29	42.34	48.38	55.94	65.02	74.09
	10	35.5	41.8	50.0	58.5	66.8	77.2	89.82	102.2
	12	47.2	55.4	66.6	77.6	88.7	102.6	119.2	135.9
	14	80.8	95.0	114.1	133.0	151.9	175.9	205.2	232.2
	16	100.4	118.1	141.7	165.2	189.0	217.8	253.8	289.8
	18	120.8	142.2	170.6	199.8	226.8	262.8	306.0	349.2
	20	163.4	192.6	230.4	268.2	307.8	356.4	414.0	471.6
	24	203.4	239.4	288.0	334.8	383.4	442.8	514.8	586.8
300'	2	7.34	8.64	10.37	12.10	13.82	15.98	18.54	21.24
	4	11.2	13.14	15.77	18.4	21.1	24.3	28.26	32.2
	6	17.9	21.1	25.2	29.0	33.7	38.9	45.4	51.7
	8	31.58	37.15	44.58	52.01	59.44	68.73	79.88	91.02
	10	44.1	51.8	62.3	72.5	83.0	95.9	111.4	126.9
	12	58.1	68.4	82.1	95.8	109.4	126.5	147.1	167.6
	14	98.5	115.9	139.1	162.4	183.6	214.2	248.4	284.4
	16	122.4	144.0	172.8	201.6	230.4	266.4	309.6	352.8
	18	149.2	175.7	210.6	246.6	280.8	325.8	378.0	430.2
	20	198.0	234.0	279.0	325.8	372.6	432.0	502.2	572.4
	24	253.8	297.0	358.2	417.6	477.0	550.8	640.8	730.8
400'	2	8.44	9.44	11.92	13.9	15.9	18.36	21.4	24.3
	4	12.9	15.12	18.2	21.1	24.1	27.9	32.6	36.9
	6	20.5	24.1	29.0	33.8	38.5	44.6	51.8	59.0
	8	36.72	43.20	51.84	60.48	69.12	79.92	92.88	105.84
	10	50.8	59.8	71.6	83.5	95.6	110.5	128.3	146.3
	12	67.3	79.2	95.0	110.9	126.7	146.5	170.3	194.4
	14	113.6	133.6	160.2	187.2	214.2	246.6	288.0	327.6
	16	142.6	167.8	201.6	234.0	268.2	309.6	360.0	410.4

*When *alternate strips* of legume-grass *meadows* are used on a contour strip cropping system, soil loss values for strip cropping may be obtained by multiplying the above contour figures by .5.

When *alternate strips* of close *growing* crops are used in the contour strip cropping system, soil loss values for strip cropping may be obtained by multiplying the above contour figures by .75.

To determine average annual soil loss when crops are grown on the land:
1. Select the soil loss from the table above for the existing conditions.
2. Multiply the soil loss by the rotation and management factor selected from table 4 or 4a.

TABLE 2b. Average Annual Soil Loss From Continuous Fallow R = 160

RKLSP Values For Contouring*

Slope Length, feet	Per-cent	Soil Erodibility Factors - K Values .17	.20	.24		.32	.37	.43	.49
200'	2	4.90	5.76	6.91	8.06	9.22	10.82	12.38	14.11
	4	8.16	9.60	11.52	13.44	15.36	17.76	20.64	23.52
	6	12.64	14.88	17.92	20.80	23.84	27.52	32.00	36.48
	8	22.85	26.88	32.26	37.63	43.00	49.73	57.79	65.86
	10	31.5	37.1	44.5	52.0	59.4	68.6	79.8	90.0
	12	41.9	49.3	59.20	69.0	78.9	91.2	105.9	120.8
	14	71.8	84.5	101.4	118.2	135.0	156.3	182.4	206.4
	16	89.3	105.0	125.9	146.9	168.0	193.6	225.6	257.6
	18	107.4	126.4	151.7	177.6	201.6	233.6	272.0	310.4
	20	145.3	171.2	204.8	238.4	273.6	316.8	368.0	419.2
	24	180.8	212.8	256.0	297.6	340.8	393.6	457.6	521.6
300'	2	6.53	7.68	9.22	10.75	12.29	14.21	16.48	18.88
	4	9.92	11.68	14.02	16.32	18.72	21.60	25.12	28.64
	6	15.9	18.72	22.40	25.76	29.92	34.56	40.32	45.92
	8	28.07	33.02	39.63	46.23	52.84	61.09	71.00	80.91
	10	39.2	46.1	55.4	64.5	73.8	85.3	99.0	112.8
	12	51.7	60.8	73.0	85.1	97.3	112.5	130.7	149.0
	14	87.5	103.0	123.7	144.3	163.2	190.4	220.8	252.8
	16	108.8	128.0	153.6	179.2	204.8	236.8	275.2	313.6
	18	132.6	156.2	187.2	219.2	249.6	289.6	336.0	382.4
	20	176.0	208.0	248.0	289.6	331.2	384.0	446.4	508.8
	24	225.6	264.0	318.4	371.2	424.0	489.6	569.6	649.6
400'	2	7.50	8.83	10.59	12.37	14.13	16.32	19.04	21.6
	4	11.42	13.44	16.16	18.72	21.44	24.80	28.96	32.8
	6	18.2	21.4	25.8	30.1	34.2	39.7	46.1	52.5
	8	32.64	38.40	46.08	53.76	61.44	71.04	82.56	94.08
	10	45.1	53.1	63.7	74.2	85.0	98.2	114.1	130.1
	12	59.8	70.4	84.5	98.6	112.6	130.2	151.4	172.8
	14	100.9	118.7	142.4	166.4	190.4	219.2	256.0	291.2
	16	126.7	149.1	179.2	208.0	238.4	275.2	320.0	364.8

*When *alternate strips* of legume-grass *meadows* are used in a contour strip cropping system, soil loss values for strip cropping may be obtained by multiplying the above contour figures by .5.

When *alternate strips* of close *growing* crops are used in the contour strip cropping system, soil loss values for strip cropping may be obtained by multiplying the above contour figures by .75.

To determine average annual soil loss when crops are grown on the land:
1. Select the soil loss from the table above for the existing conditions.
2. Multiply the soil loss by the rotation and management factor selected from table 4 or 4a.

TABLE 3. Average Annual Soil Loss From Continuous Fallow R = 200

RKLSP Values for Conventional Terracing*

Slope Length, feet**	Per-cent	Soil Erodibility Factors - K Values .17	.20	.24	.28	.32	.37	.43	.49
170	2	5.51	6.48	7.78	9.07	10.37	11.99	13.93	15.88
137	3	5.95	7.00	8.40	9.80	11.20	12.95	15.05	17.15
120	4	7.31	8.60	10.32	12.04	13.76	15.91	18.49	21.07
110	5	9.18	10.80	12.96	15.12	17.28	19.98	23.22	26.46
103	6	11.05	13.00	15.60	18.20	20.80	24.05	27.95	31.85
99	7	13.26	15.60	18.72	21.84	24.96	28.86	33.54	38.22
95	8	18.56	21.84	26.21	30.58	34.94	40.40	46.96	53.51
92	9	21.83	25.68	30.82	35.95	41.09	47.51	55.21	62.92
90	10	24.89	29.28	35.14	40.99	46.85	54.17	62.95	71.74

Slope Length feet**	Per-cent	Soil Erodibility Factors - K Values .17	.20	.24	.28	.32	.37	.43	.49
90	11	28.97	34.08	40.90	47.71	54.53	63.05	73.27	83.50
90	12	33.05	38.88	46.66	54.43	62.21	71.93	83.59	95.26
90	14	56.30	66.24	79.49	92.74	105.98	122.54	142.42	162.29
90	16	69.90	82.24	98.69	115.14	131.58	152.14	176.82	201.49
90	18	84.86	99.84	119.81	139.78	159.74	184.70	214.66	244.61
90	20	114.14	134.28	161.14	187.99	214.85	248.42	288.70	328.99

*The values in tables 3, 3a and 3b are for terrace systems with vegetated outlets such as sod waterways. For push-up, grassed backslope parallel terrace systems which are either level or incorporate tile outlet systems, see footnote C6 under table 4 and C7 under table 4a.

**These slope lengths are the distances between conventional terraces when laid out according to the standard formula: vertical interval = 0.7S + 2. S is steepness of slope expressed in percent (feet of fall in 100 feet of horizontal distance). Thus, on a 10 percent slope the vertical distance between terraces is 0.7 x 10 + 2 = 9 feet.

To determine average annual soil loss when crops are grown on the land:
1. Select the soil loss from the table above for the existing conditions.
3. Multiply the soil loss by the rotation and management factor selected. from table 4 or 4a.

TABLE 3a. Average Annual Soil Loss From Continuous Fallow R = 180

RKLSP Values for Conventional Terracing*

Slope Length, feet**	Per-cent	Soil Erodibility Factors - K Values .17	.20	.24	.28	.32	.37	.43	.49
170	2	4.96	5.83	7.00	8.16	9.33	10.79	12.54	14.29
137	3	5.36	6.30	7.56	8.82	10.08	11.66	13.55	15.44
120	4	6.58	7.74	9.29	10.84	12.38	14.32	16.64	18.96
110	5	8.27	9.72	11.66	13.61	15.55	17.98	20.90	23.81
103	6	9.95	11.70	14.04	16.38	18.72	21.65	25.16	28.67
99	7	11.93	14.04	16.85	19.66	22.46	25.97	30.19	34.40
95	8	16.71	19.66	23.59	27.52	31.45	36.36	42.26	48.16
92	9	19.65	23.11	27.73	32.36	36.98	42.76	49.69	56.62
90	10	22.40	26.35	31.62	36.89	42.16	48.75	56.66	64.56
90	11	26.07	30.67	36.81	42.94	49.08	56.74	65.94	75.15
90	12	29.74	34.99	41.99	48.99	55.99	64.74	75.23	85.73
90	14	50.67	59.62	71.54	83.46	95.39	110.29	128.17	146.06
90	16	62.91	74.02	88.82	103.62	118.43	136.93	159.13	181.34
90	18	76.38	89.86	107.83	125.80	143.77	166.23	193.19	220.15
90	20	102.72	120.85	145.02	169.19	193.36	223.58	259.83	296.09

*The values in tables 3, 3a and 3b are for terrace systems with vegetated outlets such as sod waterways. For push-up, grassed backslope parallel terrace systems which are either level or incorporate tile outlet systems, see footnote C6 under table 4 and C7 under table 4a.

**These slope lengths are the distances between conventional terraces when laid out according to the standard formula: vertical interval = 0.7S + 2. S is steepness of slope expressed in percent (feet of fall in 100 feet of horizontal distance). Thus, on a 10 percent slope the vertical distance between terraces is 0.7 x 10 + 2 = 9 feet.

To determine average annual soil loss when crops are grown on the land:
1. Select the soil loss from the table above for the existing conditions.
3. Multiply the soil loss by the rotation and management factor selected. from table 4 or 4a.

TABLE 3b. Average Annual Soil Loss From Continuous Fallow
R = 160
RKLSP Values for Conventional Terracing*

Slope Length, feet**	Slope Per-cent	Soil Erodibility Factors - K Values .17	.20	.24	.28	.32	.37	.43	.49
170	2	4.41	5.18	6.22	7.26	8.29	9.59	11.15	12.70
137	3	4.76	5.60	6.72	7.84	8.96	10.36	12.04	13.72
120	4	5.85	6.88	8.26	9.63	11.00	12.73	14.79	16.86
110	5	7.34	8.64	10.37	12.10	13.82	15.98	18.58	21.17
103	6	8.84	10.40	12.48	14.56	16.64	19.24	22.36	25.48
99	7	10.61	12.48	14.98	17.47	19.97	23.09	26.83	30.58
95	8	14.85	17.47	20.97	24.46	27.96	32.32	37.56	42.81
92	9	17.46	20.54	24.65	28.76	32.87	38.00	44.17	50.33
90	10	19.91	23.42	28.11	32.79	37.48	43.33	50.36	57.39
90	11	23.17	27.26	32.72	38.17	43.62	50.44	58.62	66.80
90	12	26.44	31.10	37.32	43.55	49.77	57.54	66.87	76.20
90	14	45.04	52.99	63.59	74.19	84.79	98.04	113.93	129.83
90	16	55.92	65.79	78.95	92.11	105.27	121.72	141.45	161.19
90	18	67.89	79.87	95.85	111.82	127.80	147.76	171.72	195.69
90	20	91.31	107.42	128.91	150.39	171.88	198.73	230.96	263.19

*The values in tables 3, 3a and 3b are for terrace systems with vegetated outlets such as sod waterways. For push-up, grassed backslope parallel terrace systems which are either level or incorporate tile outlet systems, see footnote C6 under table 4 and C7 under table 4a.

**These slope lengths are the distances between conventional terraces when laid out according to the standard formula: vertical interval = 0.7S + 2. S is steepness of slope expressed in percent (feet of fall in 100 feet of horizontal distance). Thus, on a 10 percent slope the vertical distance between terraces is 0.7 x 10 + 2 = 9 feet.

To determine average annual soil loss when crops are grown on the land:

1. Select the soil loss from the table above for the existing conditions.
3. Multiply the soil loss by the rotation and management factor selected. from table 4 or 4a.

TABLE 4. Crop Management Factor Values For Rainfall Distribution Area 13
Ratio of Soil Loss from Cropping Systems to Soil Loss from Continuous Fallow

Management and Yield Levels*

Cropping System	C1			C2		C3		C4		C5			C6
Corn Yield, Bu.	40-59	60-74	75+	60-74	75+	60-74	75+	60-74	75+	40-59	60-74	75+	75+
Hay Yield, Tons	1-2	2-3	3-5	2-3	3-5	2-3	3-5	2-3	3-5	1-2	2-3	3-5	
Continuous Row Crop	.49	.45	.40	.50	.41	.54	.50	.60	.56	.40	.35	.25	Soil
RRROx	.36	.32	.29	.37	.31	.38	.33	.44	.41	.28	.24	.19	losses
RROx	.32	.28	.25	.33	.30	.33	.31	.38	.36	.24	.21	.17	controlled
ROx	.23	.20	.18	.24	.20	.23	.22	.27	.25	.17	.14	.12	See
RRROM	.25	.21	.19	.24	.20	.27	.24	.30	.26	.18	.15	.12	footnote
RROM	.19	.15	.13	.18	.15	.20	.18	.23	.20	.14	.11	.08	C6
RROMM	.15	.12	.10	.14	.10	.16	.12	.18	.16	.11	.080	.062	
RROMMM	.13	.10	.09	.12	.10	.13	.12	.15	.12	.094	.071	.052	
ROM	.11	.09	.064	.09	.076	.11	.091	.12	.10	.071	.054	.038	
ROMM	.084	.065	.049	.072	.058	.081	.069	.090	.078	.056	.041	.030	
ROMMM	.068	.052	.040	.058	.047	.066	.056	.073	.063	.045	.034	.025	
ROMMMM	.058	.044	.034	.049	.040	.055	.048	.062	.057	.039	.029	.021	

C1 = Spring plow for row crops. Residues left. Stalks disked and left on surface for small grain.
C2 = Fall plow for row crops. Residues left. Stalks disked and left on surface for small grain.
C3 = Spring plow for row crops. Residues removed. Small grain seeded in disked row stubble in spring.
C4 = Fall plow for row crops. Residues removed. Small grain seeded in disked row stubble in spring.
C5 = Wheel track plant for row crops. Residues left. Stalks disked and left on surface for small grain.
C6 = Push-up grassed backslope parallel terrace systems, of either the level type where adapted or with use of tile outlet systems. Soil movement is confined and utilized in terrace benching. Therefore, continuous row-cropping is feasible with spring or fall plowing and various cropping or residue management systems.

R = Row crops
O= Small grain
Ox = Small grain and green manure
M= Meadow

DATES USED:	Plow	Plant	Harvest
Row Crops	4/20 (11/1)	5/15	10/25
Small grain		4/5	7/15

*Legume-grass seedings and adequate fertility for each yield level are assumed. If grass is not included in the seeding use the next lower yield level to determine the "C" value of a given rotation.

TABLE 4a. Crop Management Factors For Rainfall Distribution Area 14
Ratio of Soil Loss from Cropping Systems to Loss from Continuous Fallow

Management and Yield Levels*

Cropping System	C1			C2			C3		C4		C5		C6		C7
Corn Yield, Bu.	40-59	60-74	75+	40-59	60-74	75+	60-74	75+	60-74	75+	60-74	75+	60-74	75+	75+
Hay Yield, Tons	1-2	2-3	3-5	1-2	2-3	3-5	2-3	3-5	2-3	3-5	2-3	3-5	2-3	3-5	
Continuous Row Crop	.47	.43	.38	.47	.43	.38	.49	.43	.49	.43	.55	.52	.32	.26	Soil
RRROx	.35	.31	.28	.37	.32	.31	.36	.33	.38	.34	.38	.35	.22	.19	losses
RR0x	.31	.27	.24	.33	.29	.27	.32	.29	.34	.31	.33	.31	.19	.17	controlled
R0x	.23	.19	.17	.26	.22	.20	.23	.21	.27	.24	.24	.23	.14	.12	
RRROM	.25	.20	.175	.245	.21	.19	.24	.20	.25	.21	.28	.26	.14	.12	See
RROM	.19	.15	.13	.19	.16	.14	.18	.14	.20	.15	.21	.19	.10	.09	footnote
RRWM											.17	.15			C[7]
RROMM	.15	.12	.10	.156	.13	.11	.14	.11	.16	.12	.17	.15	.08	.07	
RRWMM											.14	.12			
RROMMM	.127	.10	.086	.131	.108	.093	.119	.091	.13	.10	.14	.13	.07	.06	
RRWMMM											.118	.10			
ROM	.11	.083	.061	.126	.10	.08	.104	.073	.13	.10	.115	.098	.055	.042	
RWM											.094	.071			
ROMM	.083	.063	.047	.096	.077	.062	.079	.056	.098	.074	.088	.075	.042	.032	
RWMM											.071	.054			
ROMMM	.067	.051	.038	.078	.063	.050	.064	.046	.080	.060	.071	.061	.035	.026	
RWMMM											.058	.044			
ROMMMM	.057	.043	.032	.066	.053	.042	.054	.039	.067	.051	.059	.051	.029	.023	

C[1] = Spring plow for row crops. Residue left overwinter. Small grain residue left on surface.

C[2] = Spring plow for row crops. Residue left overwinter. Spring plow for small grain.

C[3] = Fall plow for row crops. Row crop and small grain residues left.

C[4] = Fall plow for both row crop and small grains. All residue left.

C[5] = Spring plow for row crops. Corn removed for silage. Plowed for wheat 9/15 and planted 9/25, or small grain spring seeded.

C[6] = Row crop wheel-track planted. Residue left. Small grain residue left on surface.

C[7] = Push-up grassed backslope parallel terrace systems, of either the level type where adapted or with use of tile outlet systems. Soil movement is confined and utilized in terrace benching. Therefore, continuous row-cropping is feasible with spring or fall plowing and various cropping or residue management systems.

R = Row crops
O= Small grain
Ox = Small grain and green manure
M = Meadow
W = Wheat

DATES USED:

	Plow	Plant	Harvest
Row crops	4/20, 10/20	5/15	10/20
Small grain (oats)	4/1	4/10	7/15
Winter wheat	9/15	9/25	

*Legume-grass seeding and adequate fertility for each yield level are assumed. If grass is not included in the seeding use the next lower yield level to determine the "C" value of a given rotation.

TABLE 5. Soil Erodibility "K" Values and Annual Loss Tolerance "T" Values

Soil Number	Name	"K" Value	"T" Value[a] Degree of Erosion 1	2	3
			(tons per acre)		
192	Adair clay loam	.43	3	3	2
93	Adair-Shelby complex	.43	4	4	3
793	Bertrand silt loam	.37	4	4	3
3	Castana silt loam	.32	5	5	4
222	Clarinda silty clay loam	.49	3	3	2
138	Clarion loam	.32	4	4	3
80	Clinton silt loam	.37	4	4	3
174	Dickinson loam	.28	3	3	2
175	Dickinson fine sandy loam	.24	3	3	2
377	Dinsdale silty clay loam	.32	4	4	3
204	Dodgeville (Ashdale) silt loam (30 to 50" to limestone)	.32	3	3	2
162	Downs silt loam	.32	4	4	3
183	Dubuque silt loam (15 to 30" to limestone)	.37	2	2	1
182	Dubuque (Palsgrove) silt loam (30 to 50" to limestone)	.37	3	3	2
163	Fayette silt loam	.37	4	4	3
198	Floyd loam and silt loam	.32	4	4	3
310	Galva silty clay loam	.32	5	5	4
313	Gosport silt loam	.49	3	3	2
364	Grundy silty clay loam	.37	4	4	3
41	Hagener loamy fine sand	.17	5	5	5
2	Hamburg silt loam	.32	5	5	5
1	Ida silt loam	.32	5	5	5
8	Judson silty clay loam	.32	5	5	4
395	Kenyon loam	.32	4	4	3
50	Kenyon sandy loam	.32	4	4	3
76	Ladoga silt loam	.37	4	4	3
65	Lindley loam	.43	3	3	2
280	Mahaska silty clay loam	.37	4	4	3
9	Marshall silty clay loam	.32	5	5	4
10	Monona silt loam	.32	5	5	4
410	Moody silty clay loam	.32	5	5	4
119	Muscatine silty clay loam	.32	5	5	4
55	Nicollet loam	.32	4	4	3
12	Napier silt loam	.32	5	5	4
273	Olmitz loam	.32	5	5	4
281	Otley silty clay loam	.37	4	4	3
131	Pershing silt loam	.43	3	3	2
61	Philby loam	.32	4	4	3
91	Primghar silty clay loam	.32	5	5	4
77	Sac silty clay loam	.32	4	4	3
312	Seymour silt loam	.43	3	3	2
370	Sharpsburg silty clay loam	.37	4	4	3
24	Shelby loam, clay loam, silty clay loam	.37	4	4	3
33	Steinauer loam	.32	4	4	3
62	Storden loam	.32	4	4	3
120	Tama silty clay loam	.32	5	5	4
176	Waukegan loam, shallow[b]	.28	2	2	1
177	Waukegan loam, moderately deep[c]	.32	3	3	2
178	Waukegan loam, deep[d]	.32	4	4	3
132	Weller silt loam	.43	3	3	2

[a] T value is soil loss tolerance. It is the amount of soil that can be lost in tons per acre per year and still maintain a high level of productivity over an indefinite period of time.

[b] Shallow: 15 to 18 inches to sand or gravel.

[c] Moderately deep: 24 to 30 inches to sand or gravel.

[d] Deep: 36 to 42 inches to sand or gravel.

TABLE 6. Conservation Practice Factors - "P" Values

Percent Slope	Practice Factor Values: *Contouring or Conventional Terracing	Stripcropping (Alternate meadows)	Stripcropping (Alternate close grown crops)
1.1 - 2.0	.60	.30	.45
2.1 - 7.0	.50	.25	.40
7.1 - 12.0	.60	.30	.45
12.1 - 18.0	.80	.40	.60
18.1 - 24.0	.90	.45	.70

*Certain chemical herbicides now widely used to inhibit the growth of grassy weeds in row crops are creating difficulties in the maintenance of grassed waterways and grassed terrace outlets. The hazard is related both to direct application through failure to shut off application equipment when crossing waterways and to water run-off from fields where these chemicals have been applied.

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