was grown on a fairly small acreage in hilly areas. Where it was felt that corn had to be grown it was kept out of the rotation as long as possible.

These points indicate that most farmers in the area were aware of the hazards in cultivating the highly erosive slopes. They tended to choose crops accordingly. On the other hand, erosion attributable to the tillage and harvesting methods of the time, like thorough plowing, cultivation and residue removal after harvesting were not fully understood.

Information on crop rotations varied considerably among the soil survey and other literature. Some sudies gave no information on the rotations follwed. However, one rotation commonly mentioned as widely practiced was one year of corn (C), followed by a year in oats or other small grain (G), followed by a year of meadow (M), with the meadow being seeded in with the oats, or CGM. A second fairly common rotation was CCGM.

Corn was seldom grown continuously and then only on the best land or on small tracts on hill farms. Several soil surveys indicated that systematic rotations were not commonly practiced, but the meaning of 'systematic' was unclear. Rotation meadow was usually cut for hay until turned under, but was sometimes used as green manure in years of abundant rain and other hay. Many farmers were said to feel from experience that long rotations involving meadow could not be carried out successfully. Hay was left in as long as possible as forage. Farmers preferred cash crops like tobacco and corn over hay.

Rotations involving corn were generally limited to the smoother lands and not put on the hilly sections because of the difficulty in cultivating steep slopes as well as their susceptibility to erosion. The somewhat uneven and scattered information on rotations common in MLRA 105 in the 1925-35 period leads one to conclude that the most common rotation involving corn was CGM (C=corn, G=any small grain, M=meadow). The Crawford County Soil Survey indicated that rotations on the relatively level valley soils frequently alternated corn only with meadow, such as CCMM or CCCMM. Corn was avoided on fairly sloping ridgelands, with small grains, mainly oats, alternated with meadow, as in GGM or GGMM.

There was evidence in some reports that the failure to follow crop rotations led to serious weed problems. Check-row planting of corn was practiced for weed control and improved water absorption, but the necessary partial cultivation with slope tended to aggravate erosion problems, especially during the early cultivations.

Soil Management Problems

Commercial fertilizers were not commonly regarded by farmers as being necessary for profitable production, and liming was not generally practiced. An important exception was Crawford County where limestone quarries were nearby and commercial fertilizer was used. Barnyard manure was generally considered the best fertilizer. It was valued as much for promoting good tilth as for maintaining fertility.

Crawford and Vernon Counties in Wisconsin had extensive acreages in tobacco. The manure was apparently used first on tobacco, a good cash crop, and then on corn, potatoes and vegetables, apparently in that order. The small grains and hay were seldom fertilized, except that manure was sometimes used to get legume hays started. Barnyard manure was almost the only fertilizer used in many areas, but there was also some turning under of green manures, including green rye, especially on sandy soils.

In Vernon and other counties alfalfa was appreciated as a crop, but because of the high price of seed and the liming and fertilizing requirements, alfalfa was not commonly grown at the time. Hay crops were usually left in as long as possible to provide forage.

Tillage and Crop Residue Practices

The sample and other counties were similar with regard to these practices. Tillage operations were generally thorough. This was partly attributed to the high price of land. This encouraged the intensive cultivation of any additional land purchased. The customary practice was to plow as much land as possible either in the late summer or fall. Corn land was plowed in the fall if the weather permitted, otherwise not until just before spring planting. Straight furrows were considered a source of pride and the mark of a good farmer.

When oats were to follow corn, about half the land planned for oats was plowed and the rest disked. Entire fields were plowed at the same time if possible, especially on the ridge farms. Plowing and subsequent cultivation with the slope caused tremendous losses of soil. The removal of crops and residues was common, leaving only stubbles. In the early years, however, even the burning of stubbles was common, because it was difficult to turn it under with the equipment of the time. Soil losses in the fall and from the spring snowmelt were very heavy, as the corn fields were nearly bare after being harvested for grain or shredded for stover.

Harvesting Methods for Corn: For corn the Censuses of Agriculture for 1925, 1930, and 1935 separately reported by counties the acres harvested for grain, those cut for silage or fodder, and those hogged off or with the standing crop grazed. The 1925-35 ten-year averages overall for the five sample counties were: 64 percent harvested for grain, 26 percent cut for silage or fodder, and 10 percent hogged off.

Harvesting of Small Grains: For small grains like oats, wheat, barley and rye, other than the acres occasionally cut early for hay, the common practice was to harvest for grain, and remove the straw, leaving only the stubble. Combines were not yet marketed in the area. The small grains were generally cut with binders, shocked, and centrally threshed, probably on a custom or cooperative basis, and most likely in the fields or near the buildings. The straw stacks may have been used directly or baled and then stored or sold. In any case, the fields were left as stubble and fall-plowed as soon as possible, if not already seeded to meadow.

Conservation Efforts

Common conservation techniques like contouring, terracing and strip cropping were seldom practiced in MLRA 105 prior to the establishment of Federal and State technical assistance and cost-sharing programs. However, it appears that farmers of the time generally did avoid cultivating their highly erodible land. Cropping patterns were determined largely by soil and slope conditions, within the needs of the farm for grain and forage crops. The soil survey reports for both Crawford and Trempealeau counties in Wisconsin indicate that there was little cultivation on slopes exceeding 14 percent. On the other hand, because of their tendency to lodge under excellent growing conditions, small grains like barley and oats were not commonly grown on the level well-drained soils.

Any alfalfa was usually grown on the best land. Alfalfa seed was costly and in most areas legumes were difficult to get properly established without the addition of lime and commercial fertilizer. The alfalfa also eliminated the possibility of corn on the field for a few years. This encouraged planting corn on the steeper slopes and on the same field for several years. Little attention was given slopes in laying out fields on almost all farms. Corn rows were typically the long way of the field, regardless of slope. Some farmers blocked open furrows with chunks of sod to keep water from following the furrows.

By present standards conservation measures of the time were limited both in scope and effectiveness. Some farmers planted grassed waterways, but they were too narrow to be fully effective. Deposits of silt in the grass soon formed a ridge and caused cutting along the sides. Some of the valley slopes were worked on the contour and in alternate strips of hay and grain crops. The strips were usually straight, though sometimes as close to the contour as possible without being laid out with an instrument. Attempts were also made to reduce soil loss by contour harrowing the fields seeded to grain, with the last cultivation made on the contour if possible.

The Coon Creek project report involving parts of Vernon, La Crosse and Monroe counties in Wisconsin relates that two farmers in the area had terraces. Both systems had been established with the help of the Extension Service. The terraces were small but effective and natural grass waterways were used for outlets. The value of terraces for erosion control was recognized by both the owners of these two farms and their neighbors.

In Crawford County to the south the Soils Department at the University of Wisconsin had constructed experimental 'Mangum' terraces on several fields in the county as active demonstrations. Their ridges were low and smooth enough for easy use of ordinary implements.

There were efforts to control gullies. Some farmers tried to divert water away from gullies by plowing furrows from the edge to each side. In a few cases small dams of loose rock, logs or lumber were constructed. They were generally ineffective because they did not catch the lip of the gully, and failed to stop its advance. To make small gullies crossable with implements, they were sometimes filled with straw, brush, manure, logs, or rocks and then the sides were plowed in.

Some gullies were caused by water from road ditches and culverts rather than by farming methods, especially where there was a drop to a nearby gully or lower land. To protect the road from undermining, the highway departments often used a metal flume to take and lower the water to a safe distance from the road. However, little attention was given to preventing erosion at the outlet of the flume and much soil was carried away by water from roadways.

Estimating Cropland Soil Erosion

Estimates in this study of expected average annual erosion rates on cropland involve, for 1930, 1982 and 1992, applications of the Universal Soil Loss Equation (USLE). Details of the USLE procedure are documented by Wischmeier and Smith, principally in their Agriculture Handbook No.537 on Predicting Rainfall Erosion Losses (Wischmeier and Smith,1978). Hereinafter this classic reference will be called Handbook 537. An earlier journal article by Wischmeier (1976) discusses the advantages and pitfalls in applying the method in particular kinds of problems.

The estimates of average annual erosion rates for 1982 and 1992 have been obtained directly from the 1992 National Resources Inventory (NRI) and to some extent from the 1982 NRI. These Inventories are completed at 5-year intervals by USDA's Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (USDA,1962,1971 and 1987).

The National Resources Inventories are a comprehensive source of national, regional, State and county-level data on such numerous variables as land ownership, land uses, management practices such as irrigation, as well as detailed information on water-related and wind-related soil erosion and associated treatment needs and practices. The NRI estimates for 1992 were based on observations at about 800 thousand randomly selected sample points located across the United States. Results are judged to be statistically reliable at a national level and for States, broad regions, and sub-State areas other than individual counties. National-level results for 1992 are summarized by Kellogg and associates (Kellogg, TeSelle and Goebel, 1994). A review of USDA's similar inventories and a detailed explanation of the sampling techniques employed in recent inventories is in another USDA report (Goebel, 1992). For our study area the NRI estimates for 1982 and 1992 are based on USLE factor values for 1,945 sample points within the five sampled counties, and for 12,057 sample points within all 28 counties predominantly in MLRA 105.

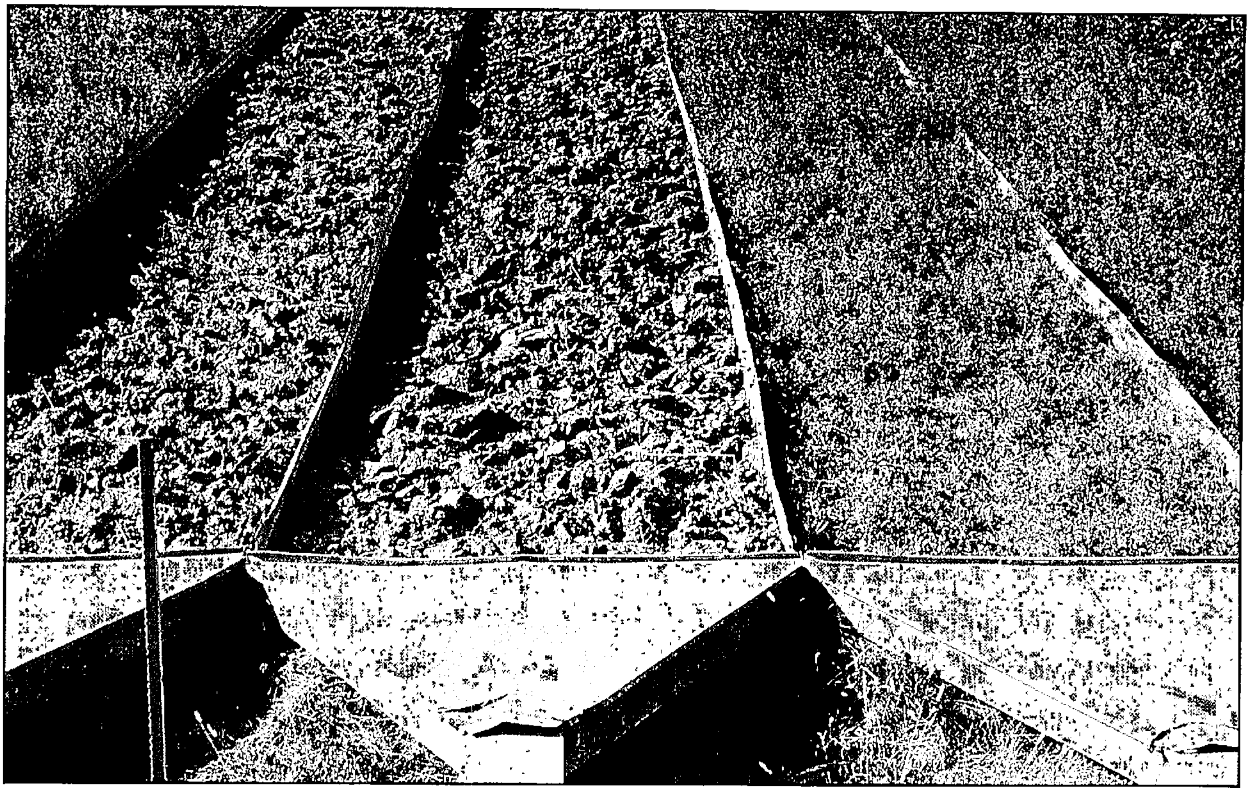
Some Prior Applications

Wischmeier and Smith pointed out that the reason for having a systematic method for estimating rates of soil loss, such as the USLE or suitable alternative methods, is to rationalize decisionmaking for conservation planning on a site basis. The method enables planners to predict the magnitude of erosion under different climatic and soil conditions as well as alternative cropping systems, management techniques, and conservation practices (Wischmeier and Smith,1978,p.3). The USLE is used to estimate water-related sheet and rill erosion. Estimates of wind-associated soil erosion and of gully erosion induced by concentrated water flow involve other factors and methods.

In 1986 the Economic Research Service completed a national-level analysis of the erosion-control costs and benefits of the USDA's Conservation Technical Assistance, Great Plains and Agricultural Conservation Programs (Strohbehn,1986). The physical measures of sheet and rill erosion were based on the USLE; data for wind erosion were based on methods developed by Chepil and associates at USDA's Wind Erosion Research Unit at Manhattan, Kansas (Lyles,1985).

An application of the USLE methodology in assessing the physical and economic impacts of alternative soil conservation practices and policy options for reducing soil losses to given tolerance levels, has been completed for eight representative farms in southeast Minnesota that happen to be in MLRA 105 (Padgitt,1980). Prospective erosion control benefits for 448 conservation plans in 30 sampled counties in Alabama, North Carolina, South Carolina and Tennessee were analyzed by Grubb and Tolley (1966), using a preliminary version of the USLE.

A previous interdisciplinary study for a watershed in the Missouri loessial region in western Iowa predated the availability of the USLE, but was based on a similar rational soil loss formula, called the "Browning Factors" (Schwab with others,p.122ff). The objective of the Iowa team study was to apply engineering and agronomic principles in reconciling the economic interests



Runoff check plots at the Upper Mississippi Valley Experiment Station, LaCrosse, Wisconsin. Information from such experiments was used to develop the Universal Soil Loss Equation. NRCS/USDA photo. (Wisconsin 76,351).

of farmers who controlled watershed uplands with the objectives and plans of other onsite or offsite public agencies affected by watershed land uses (Pavelis with others,1961).

The later work of Trimble and Lund in Wisconsin (1982) applied the USLE to determine changes between 1934 and 1975 in erosion, as well as the reductions in reservoir and valley sedimentation associated with land use and management practices in 10 sub-basins totaling about 8 thousand acres within the Coon Creek Basin. This is an area of 49,400 acres involving parts of La Crosse, Monroe and Vernon Counties. It was the first conservation demonstration project established by the Soil Conservation Service (USDA,1939 and Helms,1982a).[8]

[8] For the period 1934-1975 Trimble and Lund determined that there was an overall reduction of nearly 75 percent in the average annual erosion rate per acre in the 10 sub-basins they studied (Trimble and Lund,1982,p.10). They attributed the reductions to substantially decreased grazing of woodlands, more meadow in crop rotations, and the adoption of conservation practices, especially contour stripcropping.

Anticipating the Universal Soil Loss Equation

The serious soil erosion problems observed in the early 1930's were the result of several factors: (1) Crop selection and land use methods not consistent with the capabilities of soils to produce sustained yields; (2) soil management problems specific to the area and indirectly if not directly related to potential erosion; (3) the absence of regular crop rotations where needed; (4) the tillage and residue management practices followed; and (5) the absence of now generally recommended conservation practices.

The importance of these factors along with climatic considerations was aptly summarized by Perfect and Sheetz in their survey in the 1930's of conditions on the Farmersburg-McGregor Project in Clayton County, Iowa. The USLE embodies many of their concepts of how soil erosion can occur:

> "The factors contributing to erosion are climate, the nature of the soil, the slope of the land, the existing and former land uses, and the agricultural methods employed in the tillage of the soil. Of the various climatic factors, the amount and intensity of rainfall have the most effect on erosion.
>
> "There are three periods during the year in which erosion losses are extensive. The first comes with thawing snow in the early spring. Most of the snow that falls in the winter remains on the ground until the spring when it melts rapidly. As much of the ground is without any vegetative cover at this time, the loss of soil in the runoff water resulting from the melted snow is enormous. Heavy rains during the spring at the time of seedbed preparation remove large quantities of topsoil, as the soil is usually worked to such an extent that it is broken up into fine particles that are readily washed away.
>
> "The third critical period occurs in the summer following hot, dry weather during which the soils become almost powdery dry. Intense rains falling on the loose, dry topsoil wash away large amounts of the soil". (Perfect and Sheetz,1942,p.22).

Applying the USLE to 1930 Conditions

The Universal Soil Loss Equation (USLE) is grounded in many years of soil and water conservation research, being based on over 10,000 plot-years and 500 watershed-years of observations on precipitation, soil loss and related field and cropping situations (Meyer and Moldenhauer,1985). The equation first evaluates factors for rainfall and runoff (**R**); soil erodibility (**K**); slope length (**L**); slope steepness (**S**); cover and management (**C**); and supporting conservation practices (**P**). The estimated average annual erosion rate for a given cropping situation is then computed as:

A = R K L S C P

Definitions for each USLE variable are repeated from Wischmeier's and Smith's Handbook No. 537 (1978,p.4):

A is the computed soil loss per unit area, expressed in the units selected for **K** and for the period selected for **R.** In practice, these are usually so selected that they compute **A** in tons per acre per year, but other units can be selected.

R, the rainfall and runoff factor, is the number of rainfall erosion index units, plus a factor for runoff from snowmelt or applied water where significant.

K, the soil erodibility factor, is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as 72.6 feet in length and having a uniform slope of 9 percent, continuously in clean-tilled fallow.

L, the slope-length factor, is the ratio of soil loss from the field slope length to that from a 72.6-ft length under identical conditions.

S, the slope-steepness factor, is the ratio of soil loss from the field slope gradient to that from a 9-percent slope under otherwise identical conditions. In practice **L** and **S** can be combined as a single topographic factor **LS** (not a simple product).

C, the cover and management factor, is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow.

P, the support practice factor, is the ratio of soil loss with a support practice like contouring, stripcropping, or terracing to that with straight-row farming up and down the slope.

In the erosion analysis that follows it is assumed that conservation measures like terracing, contour farming and stripcropping were at best developmental in nature and not practiced widely enough in the sample counties or in the region to be assigned a factor value for **P** of less than 1 in the USLE, the value for straight row farming up and down the slope. While supporting tillage or other conservation practices had not yet been adopted on a significant scale, farmers were conservation-minded to the extent that, recognizing potential erosion hazards, crops were selected with reference to soil suitability and slope conditions.

Values of **R, K, L,** and **S** needed for the MLRA 105 analysis were provided by soil scientists from climatic and soils data. As noted above the factor **P** could be assigned a value of 1.

Regarding the cover and management factor **C**, the early soil surveys and Census reports were used to help identify the crops grown and/or the crop sequences likely followed on cropland soils in the five sample counties for the base year 1930. The distributions of crops and/or rotations across major soils used for crops in a given year or period were used to estimate average values for the cover-management factor **C**. Several kinds of specific information were needed to derive values for the **C** variable itself:

Possible Crop Sequences

According to soil survey reports and other publications for the period 1925-1935 about 17 primary crop rotations, excluding continuous cropping, were used in MLRA 105 in 1930. All were possible candidates for determining approximate values for the USLE factor **C** in the year 1930. They are listed with reference to the particular crops that may be involved:

Corn with small grains only (4): CG, CCG, CGG, CCGG

Corn with small grains and meadow (7): CGM, CCGM, CGGM, CGGMM, CCCGM, CGMM, CCCGMM

Corn with meadow only (3): CMM, CCMM, CCCMMM

Small grain with meadow only (3): GM, GGM, GGMM, and where:

C = Corn, including corn for grain, corn silage, and corn grazed;

G = Close-grown small grains, mostly oats but also wheat, barley, and rye;

M = Meadow, including clover-timothy mixes, clover alone, timothy alone, alfalfa, legume and grass seed crops, and annual legumes taken for hay.

Subsistence or cash row crops like potatoes, vegetables, and tobacco rotated with corn or small grains were also included for analysis. The tobacco likely received priority for applications of barnyard manure.

Crop Yield Levels

The acres in each principal crop for each sample county in 1930 have been compiled from the Census of Agriculture and other sources (table A-4). Yield levels (table A-5) for the base year 1930 were computed on an 'expected' basis, as 10-year averages from 1925-35. Annual data from State statistical offices were used if available, otherwise data were averaged from the Censuses of Agriculture for 1925,1930 and 1935, or from observations made in county soil surveys completed during the same period (table A-5). While yields from field to field doubtless varied, depending on soil productivity and the crop rotations, all are believed to fall within the range defined as Low

Productivity (LP) in Agriculture Handbook 537. In the rotations above, the greatest corn yield would be expected in the first year following meadow, the next highest in the second year following meadow, and lowest three or more years after meadow.

Tillage Systems

Modern conservation tillage technology did not exist in 1930. The moldboard plow was the primary tillage tool. In some cases where spring-planted crops followed corn, the land was disked to prepare the seedbed. Three general tillage alternatives were used at the time: (1) Fall moldboard plowing, with secondary tillage in spring, followed by seasonal cultivation as necessary for corn or other row crops; (2) spring moldboard plowing, secondary tillage and/or cultivation; and (3) spring disking.

Tillage systems for specific crops in 1930 involved various combinations of the three general types. Those chosen for this study appeared reasonable from the literature of the period and recollections of individuals familiar with agricultural methods of the time.

Selected 'C' factors for tillage options for each crop within rotations of varying length for Clayton County, Iowa as an example are given in table A-6. Note that the factors vary with the prior crop, the number of seasons a crop was continued, the time and method of tillage, and the method of harvesting as related to the amount of residue left in the field.

Crop Residues

Published sources indicated that removing crop residues for roughage or bedding, or by grazing, was a common but not universal practice in 1930. Five residue management situations were accordingly examined: (1) Harvest for grain, residue left and returned to the soil by moldboard plowing or disking; (2) Harvest for silage, remaining stubble returned to the soil by moldboard plowing or disking; (3) Harvest for grain, stover or straw removed for roughage or bedding; (4) Harvest for grain, residue grazed by hogs; and (5) Standing crop grazed by hogs.

Residue Management for Corn: In the case of corn, the 1925, 1930, and 1935 Censuses of Agriculture reported by counties the acres harvested for grain, those cut for silage or fodder, and those hogged off or left standing for grazing. For these three Census years an average of 64% of the corn in the five sample counties as a group was reported as being harvested for grain, 26% was reported taken for silage, and about 10% was reported grazed or hogged off. Because the Census reports were silent on whether crop residues were removed, some additional assumptions were necessary.

The cover-management factors for corn sequences in the USLE calculations represent average conditions. They assume that 50% of the corn was harvested for grain with residues left, 40% was harvested for silage (residue considered removed), and 10% was grazed, either as a standing crop or after harvest for grain. This implies partial removal of residues. For corn these weights further assume that residues were left for 80% of the corn harvested for grain, and removed for the remaining 20%. Residues were almost completely removed if the corn was taken for silage or if stover was removed after harvesting for grain. These percentages were used to obtain weighted mean 'C' values for corn sequences given in table A-6.

Residue Management for Small Grains: For small grains like oats, wheat, barley and rye, a single residue management option was assumed: " Harvest for grain, with straw removed after harvest, leaving only stubble". Because combines were not in use, straw was not distributed over the field. The grain was bound, shocked, and transported to a stationary threshing machine. Appropriate 'C' factors for small grain sequences have also been provided (table A-6).

Cropstage Dates

Data for planting and harvest dates, and dates of selected crop canopy levels, were available at the Midwest National Technical Center (MNTC) of USDA's Natural Resources Conservation Service (NRCS). These data were initially developed by Hayes about 1978, then updated and refined by Argabright and Lightle to reflect conditions of the 1980's and 1990's. Their estimates are adjusted to reflect 1930 conditions:

Cropstage F, Rough Fallow Period: MNTC dates were used with no change.

Cropstages SB, 1, and 2, Seedbed Establishment and Development: MNTC dates were adjusted to reflect slower canopy closure due to lower plant populations, wider rows, and lower biomass production associated with less fertilization and unimproved corn varieties.

Cropstage 3, Maturing Crop Period: Low canopy levels were assumed, to reflect the low productivity yield levels of table A-5. An 80-percent canopy cover was assumed, consistent with Low Productivity corn.

Cropstage 4, Stubble Period: Soil loss ratios for this period reflect the fact that removal of residues for roughage or bedding was a common practice in 1930. For those systems where the corn residues were left on the field, soil loss ratios were from Agriculture Handbook 537 for Cropstage 4L (residues left partially standing, not shredded or spread). This reflected field conditions following husking by hand or harvest with early mechanical pickers.

Cropland and Crop Classifications

These were developed in this study to help match the soils in each county by land use capability class/subclass (LCC) to cropping sequence groups. The major land capability classes I, II, III and IV are generally usable for cultivated crops, but Classes II, III, and IV may have limitations such as erosion hazards (subscript e), excess wetness (subscript w), soil limitations (subscript s), or climatic limitations (subscript c). The LCC classification was developed by the Natural Resources Conservation Service (formerly the Soil Conservation Service) of the U.S. Department of Agriculture (Klingebiel and Montgomery, 1961).

A first consideration was that the various crop rotations followed in 1930 were not uniformly distributed over the soil groups. Rotations having high values of **C** were assumed more likely followed on the better soils.[9] The rotations having lower C values were more likely followed on soils having greater erosion or other hazards and more limitations for production.

For example, we assumed that in 1925-35 the rotations involving minor row crops and intensive corn production (Crop Groups A and B) would have occurred mainly on the soils in land use capability subclasses I, IIe, and IIw. Group C sequences (generally two-crop small grain/meadow rotations), having intermediate values of '**C**' ,were assumed to occur mostly on were more likely to occur on soils in capability subclasses IVe, IIs, IIIs, and IVs. Three-crop corn/small grain/meadow rotations (Group D) were assigned to the capability subclass IIIe lands. Adjustments were made to this general pattern as needed to reconcile calculated crop acres with the reported Census data for 1930.

Approximating 'C' factors under conditions in 1930 required that the main crops grown and any rotations followed correspond well with the available croppable soils as well as with the number of acres of each crop grown in1930.

Crop acres as published in the 1930 Census of Agriculture were used as statistical controls. They are recorded for each sample county and crop in table A-4. They were matched to available cropland on the basis of land use capabilities. Four cropland/crop groups were defined:

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[9] This may appear contradictory in that, other factors equal, higher **C** values mean greater erosion, but recall that corn or other row crops were grown frequently on the better soils. This ordinarily involved moldboard plowing, clean cultivation and residue removal, all of which left the fields vulnerable to rapid snowmelt and rainfall erosion.

Table 4. Soils and crop groups by land use capabilities in sample counties in MLRA 105, 1930

Soil and Crop Groups	Clayton County, Iowa	Houston County, Minnesota	Winona County, Minnesota	Crawford County, Wisconsin	Vernon County, Wisconsin	Totals, 5 sample counties
Land Use Capability Classes and Subclasses, by Percent Used for Principal Crops[1]:						
Class I	90	65	70	90	60	76
Subclass IIe	90	65	70	90	60	71
Subclass IIw	90	44	45	60	35	50
Subclass IVe	60	35	45	36	30	35
Subclass IIs	60	35	45	36	35	48
Subclass IIIs	60	35	45	36	30	45
Subclass IVs	60	35	45	36	30	45
Subclass IIIe	81	45	61	65	46	64
County averages	79	47	62	45	39	55
Principal Crop Groups, by Land Use Capability Classes (data in acres)[2]:						
Crop Groups A and B:	58,000	43,800	79,700	10,3003	28,800	220,600
Class I, IIe	39,800	34,400	76,650	7,100	24,100	182,050
Subclass IIw	18,200	9,400	3,050	3,200	4,700	38,550
Crop Group C.	11,900	20,550	17,400	42,950	44,675	137,475
Subclasses IVe, IIs,	11,900	20,550	17,400	42,950	44,675	137,475
Crop Group D .	149,100	30,150	50,000	19,850	40,125	289,225
Subclass IIIe	149,100	30,150	50,000	19,850	40,125	289,225
All Groups/Uses,1930[3]	219,000	94,500	147,100	73,100	113,600	647,800
Vegetables	2,300	600	1,000	300	700	4,900
Irish potatoes	1,400	1,000	2,100	800	1,400	6,700
Tobacco	--	--	--	2,400	8,900	11,300
Corn	86,400	35,200	36,000	26,800	31,200	215,600
Small grains	75,500	35,800	74,600	26,100	47,800	259,800
Rotation meadow	53,400	21,900	33,400	16,700	23,600	149,000

[1] Percentages of total county acreages in given capability classes estimated as available for main crops in 1930.
[2] Acres have been estimated by applying the percentages above to all land in the given capability classes.[3] Crop acreages as reported in the 1930 Census of Agriculture and in some State crop reports for 1930.

Cropland Group AB

Cropland group AB was assumed suitable for A, minor row crops and B, relatively intensive or frequent corn production. Group AB included all Class I land and land use capability subclasses IIe and IIw. For example, in 1930 group AB included 58,000 acres in Clayton County, Iowa; 79,700 acres in Winona County, Minnesota; 28,800 acres in Vernon County, Wisconsin; and 220,600 acres in all five sample counties (table 4).

Group A--Minor Row Crops

Crop Group A included the minor row crops of Irish (white) potatoes, vegetables, and tobacco, assumed grown only on the best soils, with tobacco having first priority for the addition of barnyard manures. Of the five sample counties, for the most part tobacco was and is limited to Crawford and Vernon Counties in Wisconsin.

Again using Clayton County as an example, group A included the 2,300 acres vegetables and 1,400 acres of Irish potatoes, with half the acres in each alternated every other year with either corn or any small grain. This means that about 1,850 acres of corn and also 1,850 acres of small grains were estimated as rotated with the minor row crops in 1930, of which 1,150 acres were alternated with vegetables and 700 acres with potatoes. Details on such allocations are illustrated for Clayton County in table A-7. A total of 7,400 acres of the 58,000 acres of cultivatable cropland in capability class I and subclasses IIe and IIw in cropland group AB were required for the rotations involving vegetables and potatoes, leaving 50,600 acres available for rotations of corn with small grains or meadow.

Group B--Intensive Corn

Continuous corn was ruled out in the analysis. According to the literature of the period few farmers grew corn on the same land from year to year. On all soils continuous corn would seriously deplete the organic matter, especially considering that crop residues were normally removed. It is probable that farmers periodically put their best corn land into meadow or small grains.

For crop group B for all five sample counties, a standard set of three crop rotations was initially considered, the first being CCCMM, a rotation mentioned in the Crawford County, Wisconsin soil survey as common on valley lands. Two other rotations considered possible for Group B were CCCGM and CG. The three rotations were taken as initial candidates for allocating available cropland, other than that needed for Group A (potatoes, vegetables and tobacco), among corn, small grains. and meadow.

As crop groups A and B involve the same capability classes (class I, subclasses IIe and IIw), their crop allocations were combined as shown for Clayton County, Iowa in the first row of table A-7. The 58,000 acres in these soils were estimated to have included the 2,300 acres in vegetables and 1,400 acres in potatoes, plus 29,310 acres in corn, 20,670 acres in small grains, and 4,320 acres of rotation meadow.

Group C--Two-crop Small Grain/Meadow Rotations

Crop group C lands represented situations where steep slopes or other limitations such as shallow soils generally prohibited the culture of any corn, even that in rotation with meadow, recalling the earlier conclusion that few effective supporting conservation practices were in place in 1930. In the literature examined, one rotation prominently mentioned for this case was GGMM. Another was GGM. These were selected as starting points for reconstructing probable 1930 rotations involving only small grains with meadow.

Cropland group C restricted to small grains and meadow included land use capability subclasses IVe and IIs, IIIs, and IVs (table 4, table A-7). It included 11,900 acres for Clayton County, our example, and 137,475 acres for the five sample counties combined. Allocating all these soils in Clayton County to a GGM rotation, which apparently was the most common rotation followed throughout the five sample counties, indicates that there were about 7,933 acres in small grains and 3,967 acres in meadow.

Group D--Three-crop Corn/Small Grain/Meadow Rotations

Crop group D allowed a wider array of possible crop combinations and crop sequences, which also varied among the five sample counties. Group D involved only cropland in capability subclass IIIe---about 149,100 acres for Clayton County and 289,225 acres for the five counties (table 4). The leading three-crop rotation was CGM, as one year of corn followed by a year in oats or other small grain, followed by one year of clover or other meadow crop, but with it having been seeded in with the small grain nurse crop.

The CGM rotation was mentioned as frequently followed in nearly every soil survey or erosion report researched. Further, it seems to have had wide use throughout the region, given that it was a primary rotation tested against fallow on research plots at the Conservation Experiment Stations at Clarinda, Iowa; Bethany, Missouri; and La Crosse, Wisconsin.

In reviewing the history of the Clarinda Station, Browning recalled that the farm purchased for the Station site had been under cultivation for more than 75 years, was tenant-operated, and was generally in a run-down condition, with corn having been grown about 75 percent of the time, and with no sign of conservation practices that would help reduce soil and water losses (Browning,1948,p.12). In another report of the period Uhland indicated that for a three-year CGM rotation on Marshall silt loam soils at Clarinda, average annual runoff was only 31 percent that for continuous corn, and average annual soil losses were only 18 percent those for continuous corn (Uhland,1949,p.2).

The research farm at the La Crosse, Wisconsin Station had also been cultivated for about 75 years (Hays and others,1949,p.10). It too was unproductive and with no evident soil conserving practices. At Bethany, Missouri, an early analysis of erosion involved comparing continuous cropping to either corn, alfalfa, and blue grass against the 3-year rotation of CGM, so CGM was likely a very common rotation, or one considered by the researchers to be at least a minimal alternative to continuous cropping, or perhaps both (Smith and others,1945,p.53). Under continuous corn for 10 years on Shelby loam soils at Bethany, the measured soil loss averaged 50.9 tons/ac/yr. The measured loss for a CGM continued for 10 years was only 7.5 tons/ac/yr (Uhland,1949,p.2).

The CGM sequence was also a leading rotation studied for erosion control effects by Hays and Clark in another Wisconsin bulletin (1941). On these considerations several 3-crop rotations, all involving CGM, were first considered for each of the five counties in the erosion analysis for MLRA 105. The acreages assigned to each rotation in this group as in groups AB and C were adjusted where necessary to check with the crop acres officially reported in the 1930 Census of Agriculture. The shares of land in group D finally assigned to the various rotations are in parentheses:

<u>Clayton County, Iowa</u>: CGM (70%) and CCGM (30%)

<u>Houston County, Minnesota</u>: CGMM (20%), CCGM (30%), and CCGMM (50%)

<u>Winona County, Minnesota</u>: CGM (100%)

<u>Crawford County, Wisconsin</u>: CGM (100%)

<u>Vernon County, Wisconsin</u>: CGM (15%), CCGM (85%)

<u>Comment on Rotation Meadow:</u> The overall Census control acreages and the composition of meadow in each sample county in 1930 are in tables 4 and A-4. While the data on meadow involved five different types of vegetative cover (table A-4), the matching of cropland to the various crop rotations was only to the county totals for meadow. This implied that all meadow could be any grass or legume, or any mixture of the two.

Steps in Deriving USLE Erosion Rates for 1930

Carrying through the allocation procedures described to all five sample counties and arriving at USLE estimates of erosion losses on cultivated cropland involved five general steps. These could be followed in similar studies for other areas. The first four were critical in estimating the cover-management factor **C** with regard for crops grown, rotations possibly followed, and the tillage or residue management practices used.

Step 1-- Defining Crop and Rotation Groups: Match the soils in each county by land use capability class/subclass to cropping sequence groups. As indicated earlier the rotations having high values of **C** could be assumed more likely on the better soils, while rotations having lower **C** values were more likely to have been followed on soils having greater erosion hazards and more limitations for production.

We assumed that in the period 1925-35 the rotations involving minor row crops and intensive corn production (crop groups A and B) occurred mainly on the soils in land use capability subclasses I, IIe, and IIw. Group C sequences (two-crop small/grain/meadow rotations) were assigned mostly to capability subclasses IVe, IIs, IIIs, and IVs. Three-crop corn/small grain/meadow rotations (Group D) were assigned to the capability subclass IIIe lands.

Step 2--Estimating Available Cropland: Determine from modern soil surveys for Clayton and other sample counties (Kuehl,et.al.,1982) the total acres of each soil or land use capability class suitable and needed for the principal crops in each county.

Step 3--Estimating Principal Crops by Soils: Estimate the percent of each soil type or capability class devoted to the principal crops in 1930, and calculate corresponding acreages. Adjust the estimates as needed to balance the calculated acres to the acres of cropland reported in the 1930 Census of Agriculture. Completing steps 1, 2 and 3 produced the information in table 4.

Step 4--Matching Crops and Rotations to Soils: Estimate the percentage of each soil or capability class devoted to each crop rotation. Distribute accordingly the acres for each crop given in table 4. Adjust the rotation acres as needed to balance to the 1930 reported acres of each crop. Such adjustments could involve: (a) changes in the relative percent of the various rotations, or (b) alternative rotations.

Step 5--Other Factors and Calculations: To this point the acres in each combination of soils and rotations were determined and the USLE factors **K**, **L**, **S**, and **C** could be assigned to each rotation and cropping sequence. Values of the rainfall and runoff factor **R** for each county were taken from Agriculture Handbook No. 537.

Soil scientists provided values for **K, L,** and **S** from soils data. Values for **K, L,** and **S** depend on the characteristics of the soil map units which comprise each soil group.

Values for the cover-management factor **C** in the USLE, for the various crop rotations and management systems, were provided by agronomists. Appendix table A-6 is an abridged list of **C** values for cropping sequences applicable to this study for MLRA 105.

Supporting conservation practices such as contour farming and terraces were not in general use in 1930. Therefore, for the purposes of this study, the support practice factor **P** was assumed to have a constant value of 1.0. The final calculations are then--

(a) **R** x **K** x **LS** x **C** x **P** = average annual gross erosion rate, in tons per acre per year

(b) Average annual soil loss per acre x acres = total average annual soil loss in tons per acre for each combination of soils and rotations;

(c) The sum of soil losses for all the combinations in step (b) = average annual soil loss, in tons per year, for the total cropland acres in the county or other area concerned.

Steps 1 to 5 were repeated for each sample county. Consolidated results for the five sample counties are in table 5. A weighted average annual soil loss rate of 14.9 tons/ac/yr under 1930 conditions was thus determined for the five sample counties as a group. This was the rate compared with the average annual erosion rate of 5.5 tons/ac/yr expected under 1992 conditions for the same group of five counties as estimated in the 1992 National Resources Inventory.

Erosion in Sample Counties, 1930, 1982 and 1992

Some brief background may be helpful here. The physical significance of soil loss is determined by the extent to which soil productivity in source areas is impaired and the landscape damaged from gullies, as well as the fate of any soil removed--whether it may be redeposited downfield, or transported to become accumulated or suspended sediment in other areas, structures or water courses. The relationships involved have recently been examined by Beach (1994) in three Minnesota basins within MLRA 105.

The complex processes were described earlier by Trimble and Lund in their research in the Coon Creek Basin:

> ". . . . . material eroded from upland slopes has three immediate routes: It can be deposited within the basin either as colluvium or as alluvium, or it can be transported directly out of the basin to provide immediate sediment yield. Material deposited as colluvium can later be dissected and then redeposited as colluvium or alluvium, or it can be moved out of the basin. Alluvium can be eroded from the channel or floodplain and then transported from the basin, or it too can be redeposited farther downstream as alluvium" (Trimble and Lund,1982,p.6).

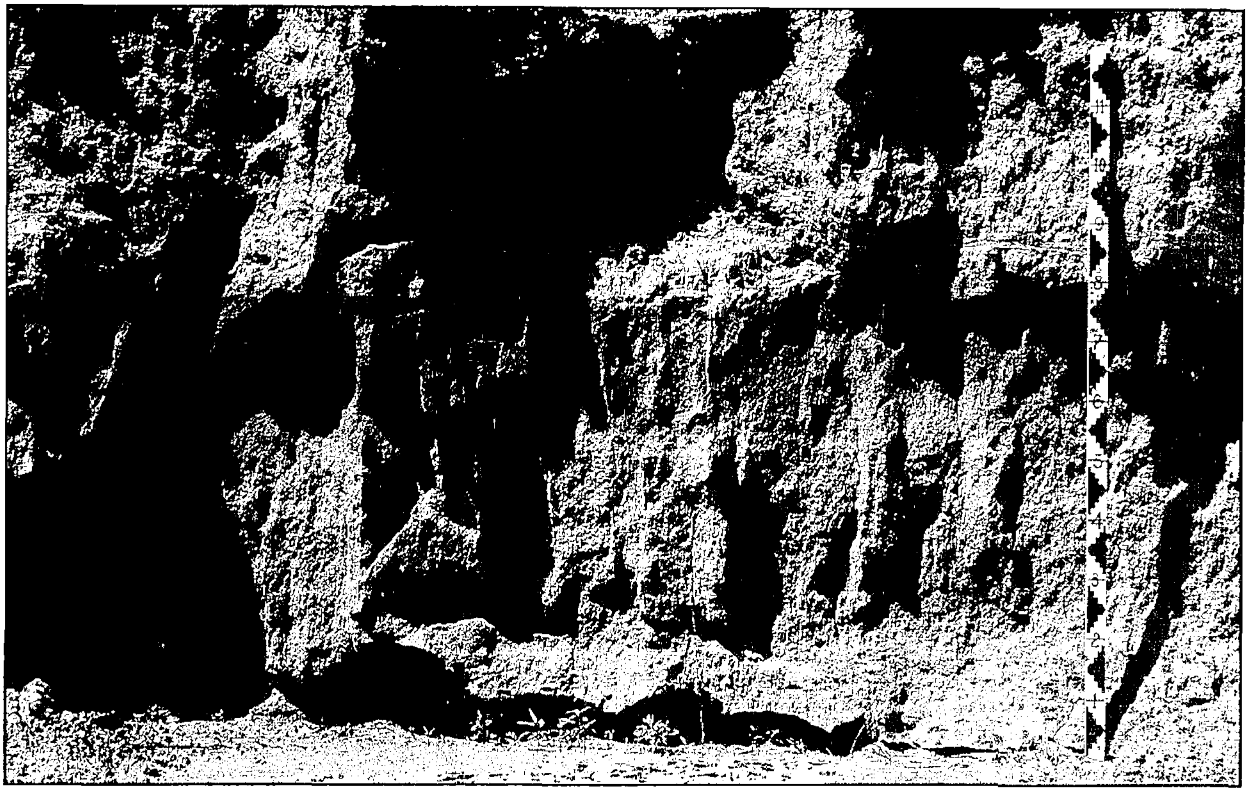
The economic consequences have similar dimensions. They include the cost of lost production potential in source areas and the costs associated with unnecessarily cleaning ditches or replacing roads, bridges and other structures. These rather ordinary and traditional economic costs become mingled with broad ecological implications for economic institutions and the natural environment. Preserving the beauty of rural areas, maintaining water quality, and assuring adequate current farm income while assuring a productive agriculture for future generations are all laudable goals. They argue for evaluation and balance within an ecological framework.

Comparisons in this study of cropland soil erosion between 1930, 1982 and 1992 in MLRA 105, an area of about 18,860 square miles (12+ million acres) and involving the major parts of 28 counties in four States, were limited to 'gross' soil erosion or on site displacement. The physical or socioeconomic consequences in the two periods are not examined, although they are reflected qualitatively in the gross rates for the area in principal crops.

Also evaluated were productivity-decreasing or 'excess' rates of erosion. The excess rate is defined as the gross rate of detachment in source areas, in tons per acre per year, less the rate 'T' at which losses could occur without impairing long term productivity and without applying additional fertilizers or other soil additives.

Information on cropland areas and acres of principal crops planted in 1930 and 1992 were available from the Census of Agriculture, supplemented where necessary from historical files in State statistical offices. Similar though not completely parallel information on cropland uses for 1992 is provided in the 1992 National Resources Inventory (NRI). The NRI estimates are derived from a point sampling procedure. Erosion rate estimates along with their estimated sampling error margins were provided for this study by the Natural Resources Inventory Division of the NRCS.

There are also margins for errors in Census data. These vary with the item being reported and the area covered. If obtained by a sampling procedure the Census estimate carries a sampling error plus a nonrespondent error. If the item is considered 'full-count' or required of all farms, it carries a nonrespondent but no sampling error. All the cropland and crop data accessed from the Census for this analysis are full-count items. The 1992 and other recent Census reports contain this information for most reporting items and counties. By special arrangements Census staff have provided relative errors for estimates made in 1974 of the broad item 'total harvested cropland' for each of the 28 counties in MLRA 105. On their recommendation, relative errors for 1974 are used in lieu of nonavailable similarly derived estimates of error in the 1930 data on total harvested cropland.



Silt deposition upon original flood plain soil, Vernon, Wisconsin. NRCS/USDA photo (Wisconsin 1-61).

It would also be possible to calculate gross erosion in 1992 using NRI as well as Census estimates of cropland acreages. The NRI and Census acreages differ considerably for pasture, woodland and other noncrop uses (table A-10). For cropland in general (item C) the two sets of estimates are fairly comparable if all counties in MLRA 105 are combined. For the area actually in principal crops as the primary concern in our analysis, the NRI estimate for the five sample counties, plus or minus its margin of error, brackets the Census figure. But because the NRI and Census estimates for the area in principal crops differ rather widely for the region and the Census data have smaller relative errors, the Census area estimates were used in computing gross erosion for the sample counties and the region.

Cropland Erosion Rates

Applying the crop allocation and USLE procedures described earlier, erosion rates on cropland in 1930 were developed by three crop groups for each of the five sampled counties and then combined as weighted averages for each cropland/crop group in the entire sample. Reviewing briefly, the areas in cropland/crop group AB were allocated first to subsistence or minor cash row crops like potatoes, vegetables and any tobacco. The remaining AB land was considered available for relatively frequent corn in association with some small grains and rotation meadow. Crop group AB includes land use capability class I, and subclasses IIe and IIw. The group included about 220.6 thousand acres or 34 percent of the cropland used for principal crops in 1930. The top section of table 4 shows the percentage of each land use capability subclass suitable for crops in each sample county. The controlling or officially reported crop acreages for 1930 are listed in the bottom section.

Crop group C includes lands in capability subclasses IIs, IIIs, IVs and IVe. In 1930 group C accounted for about 137.5 thousand acres or 21 percent of the area in principal crops (table 4). This group was generally restricted to small grains and meadow. Group D includes all subclass IIIe land. It involved 289.2 thousand acres or 45 percent of the 647.3 thousand acres used for principal crops in the five sample counties in 1930. These is the area where most of the corn was likely grown, in various combinations with small grains and meadow.

The detailed assignments for 1930 of crops and rotations among the land use capability and crop groups of table 4 are illustrated for one county (Clayton County, Iowa) in table A-7.

Sample County Results

Besides Clayton County the sample counties included Houston and Winona Counties in Minnesota, and Crawford and Vernon Counties in Wisconsin. Expected average annual USLE soil erosion rates under 1930 conditions were computed for each designated soil or soil complex (soil map unit) classified as to land use capability in each of the five sample counties, considering further the crop sequences and rotations fitted to each mapping unit. Sets of USLE calculations were made for 437 map units, ranging from 81 map units for Winona County, Minnesota to 102 map units for Vernon County, Wisconsin (table 5).

For the five sample counties, the complete process required 1,590 USLE computations of erosion rates per acre and gross erosion (rate times acres), a pair for each considered rotation within each map unit within each land use capability subclass within each of the three crop groups AB, C and D, for each sample county. The number of USLE computations required varied from 254 for Houston County, Minnesota to 409 for Vernon County, Wisconsin.

Weighted average USLE soil loss rates for 1930 were then obtained for the various land use capability subclasses and crop groups. The erosion rates per soil mapping unit were estimated as the simple average of the USLE rates for each of 1 to 7 rotations considered relevant to the various (437) map units.

The results of this process were then pooled for the five sample counties (table 5). Expected annual erosion rates under 1930 conditions were generally highest for crop groups C and D. The estimated USLE erosion rates for 1930 were greatest for the capability subclasses where susceptibility to erosion was the main limitation (IIe, IIIe, and IVe), regardless of whether these areas were used for row crops or small grain rotations with meadow.

Under the distributions of various soils and crops grown in 1930, the average erosion rate on cropland in principal crops ranged from 9.1 tons/ac/yr in Winona County, Minnesota to 22.4 tons/ac/yr in Crawford County, Wisconsin. The estimated mean across all soils and crops in the five sample counties was 14.9 tons/ac/yr. The standard error of the mean for the 437-member series of USLE rates for each differentiated soil map unit in the area in 1930 was about 0.5 ton/ac/yr, for a relative error of 3.5 percent (table 5).

Table 6 compares cropping patterns and erosion conditions between 1930 and 1992 in the five sample counties. Erosion rates in 1930 ranged from 8.5 tons/ac/yr on the best soils used for row crops (crop group AB) to 18.4 tons/ac/yr on crop group C, as the vulnerable soils generally restricted to small grains or meadow. Rates were nearly as high (18.2 tons/ac/yr) for crop group D, as the capability class IIIe land used for various corn/small-grain/meadow rotations. Group D accounted for about 54 percent of the gross soil loss in the five counties but for 45 percent of all land in row crops, small grains or meadow. This appears to be the case even though a substantially lower share (36 percent) of cropland group D land was devoted to row crops than was the land in cropland group AB (56 percent). Rates of soil loss under 1982 and 1992 conditions across all row crops, small grains and rotation meadow for the sample counties were accessed from the National Resources Inventory. The NRI estimates for 1982 and 1992 are based on USLE factor values for 1,945 NRI sample points in the five counties, or for 16.1 percent of the 12,057 sample points for all of the 28 counties predominantly in MLRA 105.[10] For example, for 1992 the estimated overall rate for the principal crops was 5.5 tons/ac/yr. This was about 63 percent less than the 14.9 tons/ac/yr for 1930 (table 6).

Between 1930 and 1992 the area in meadow in the five sample counties rose by 68 percent, increasing to 33 from 23 percent of the land in principal crop uses. The large reduction in the

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[10] Interestingly, the 1930 Census of Agriculture indicates that 647 thousand acres (also 16.4 percent) of the 3.9 million acres of the land in principal crops in the region, for which USLE erosion rates were reconstructed, were in the five sample counties. The percentage for 1992 was virtually the same--at 16.5 percent. This indicates not only that the five sample counties were and are quite representative of all 28 counties in the region but also that the net result of land use shifts since 1930 has been to make the land use pattern of the region relatively homogeneous.

erosion rate between 1930 and 1992 occurred despite large absolute and relative increases in row crops (216 thousand acres or 91 percent). The gain in row crops was achieved by expanding (by 14 percent) the total area suitable for all crops, by greatly reducing (by 80 percent) the area in oats and other small grains, and by applying recommended soil conservation measures.

Table 7 sums up the sample county analysis for 1930 and 1992. The respective erosion rates applied to the total areas in principal crops indicate that gross erosion in the five-county sample was reduced by between 45 and 67 percent between 1930 and 1992. The mid-value or 'average' reduction would be 57 percent. Expressing the reduction as a range emphasizes that such estimates are subject to error. Interval rather than single-valued estimates also give policymakers a better basis for evaluating the effectiveness of conservation programs and for justifying the additional measures needed to bring erosion losses down to acceptable levels.

Erosion in MLRA 105, 1930, 1982 and 1992

Extending the results from the sample county analysis to all of MLRA 105 was the final step in the procedure. The complete land use and crop production profiles developed earlier from the Census of Agriculture and other sources simplified the regional analysis, as the land use patterns and the acres in each principal crop in 1930 and 1992 were then known quite accurately, for the region as well as the counties sampled. The four sets of information needed for comparing cropland erosion for the region in 1930 and 1992 were: (1) Crop uses in 1992; (2) crop uses in 1930; (3) erosion rates per acre in 1992; and (4) the erosion rates per acre for the region in 1930. Set (4) was the 'unknown' to be determined, from available data on cropland use and the erosion rates estimated for the sample counties in 1930.

Regional Cropland Uses

The proportions of cropland used for row crops, small grains and rotation meadow in 1992 and in 1930 were nearly the same for the 28 counties in MLRA 105 combined as for the five sample counties (figure 4). Details are in table 6 for the sample counties and in table A-8 for the region. In the region row crops went from 31 percent of the area in the main crops in 1930 to 61 percent in 1992. The proportion in small grains went from 41 percent down to 6 percent.

Table 5. Soil loss rates by crop groups and land use capability subclasses, sample counties, 1930

Crop groups and LCC[1]	Share of total crop land	Clayton County Iowa	Houston County Minnesota	Winona County Minnesota	Crawford County Wisconsin	Vernon County Wisconsin	Average for five counties
	Percent	Estimated soil loss rate in 1930, tons/ac/yr					
Group AB	34.1	8.2	9.4	7.7	8.0	9.9	8.5
Class I	3.3	3.0	3.0	3.6	3.6	3.4	3.3
Sc IIe	24.8	11.0	11.4	8.4	10.5	11.9	10.0
Sc IIw	6.0	6.2	3.4	2.8	4.6	2.9	4.7
Group C	21.4	9.1	21.4	19.1	22.0	16.1	18.5
Sc IVe	19.6	14.8	22.5	22.5	23.1	16.2	20.1
Sc IIs	0.7	0.7	1.0	0.9	1.0	0.8	0.8
SC IIIs	0.4	0.7	1.5	0.9	1.1	0.5	0.9
SC IVs	0.7	2.6	1.6	1.4	2.1	0.8	2.2
Group D	44.5	20.1	15.3	7.8	30.8	19.9	18.2
SC IIIe	44.5	20.1	15.3	7.8	30.8	19.9	18.2
Totals or averages	100.0[1]	16.3	13.9	9.1	22.4	15.9	14.9
Pct. Error[2]	--	8.3%	8.5%	8.4%	7.0%	5.8%	3.5%
Map symbols[3]	--	84	74	81	96	102	437

1. First column adds to 100 per cent. Total area for all groups, crops and land use capability classes: 647,300 acres.
2. Standard error of estimate as percent of the estimated mean soil loss rate for the county.
3. Number of different soils or soil complexes on modern soil maps for which erosion rates were estimated from the USLE. Where multiple rotations were considered for a given map symbol, the mean of their USLE rates was assigned to the symbol involved.

Table 6. Principal cropland uses and soil erosion in 1930 and 1992 in five sample counties in MLRA 105*

Cropland and groups	Share of crop acres	Cropland in group	Soil loss rate per acre[4]	Gross soil loss per year	Distribution of crops by groups		
					Row crops	Small grains	Meadow
	Percent	1,000 ac	Tons/ac/yr	1,000 tons	1,000 ac	1,000 ac	1,000 ac
Principal Crops, 1930 total	100	647	14.9	9,654	238	259	150
			(Percent)	(100)	(37)	(40)	(23)
AB: Minor row crops/intensive corn[1]	34	220	8.5	1,871	125	76	19
			(Percent)	(20)	(56)	(35)	(9)
C: Small grains/meadow[2]	21	138	18.4	2,534	9	80	49
			(Percent)	(26)	(7)	(36)	(57)
D: Corn/small grains/meadow[3]	45	289	18.2	5,249	104	103	82
			(Percent)	(54)	(36)	(36)	(28)
Principal Crops, 1992 total	100	756	5.5	4,172	454	51	251
			(Percent)	100	(61)	(6)	(33)
Increase or decrease, 1930-1992	--	109	9.4	5,482	216	-209	102
	(Pct. change)	(14)	(63)	(57)	(91)	(-80)	(68)

* Sample counties: Clayton County, Iowa; Houston and Winona Counties, Minnesota; Crawford and Vernon Counties, Wisconsin.

[1] Group AB includes potatoes, vegetables or tobacco rotated with corn or small grains, with the remaining land devoted to frequent corn, with some small grains or meadow. Group AB includes areas in land use capability Class I and subclasses IIe and IIw.
[2] Group C generally restricted to small grain and meadow cropping. Group C includes areas in land use capability subclasses IIs, IIIs, IVs and IVe.
[3] Group D includes rotations including corn, small grains and meadow, all on capability subclass IIIe land.
[4] Soil loss rates for 1930 evaluated by crops grown on the land use capability classes indicated. Soil loss rate for 1992 is for all crop groups combined, from USDA's 1992 National Resources Inventory.

Table 7. Cropland erosion in 1930 and 1992 for five sample counties in MLRA 105

Items	Item	Units	1930	1992	Percent change, 1930-1992
1. Principal crops (Census)	Estimate	1,000 ac	647.0	756.1	17
	(Error)	(1,000 ac)	(13.5)	(18.1)	--
2. USLE erosion rate (NRI)	Estimate	Tons/ac/yr	14.9	5.5	-63
	(Error)	Tons/ac/yr	(1.0)	(0.8)	--
3. Gross erosion, average/yr	Estimate	1,000 tons	9,654	4,172	-57
	(Error)	(1,000 tons)	(848)	(704)	--
4. Lower limit, erosion/yr	Estimate	1,000 tons	8,806	3,468	* -45
Upper limit, erosion/yr	Estimate	1,000 tons	10,502	4,876	** -67

Sample counties: Clayton (Iowa), Houston and Winona (Minnesota), Crawford and Vernon (Wisconsin).
Item Explanations:

Item 1. Area estimates from the 1930 and 1992 Censuses of Agriculture. For Census acres, margins of error in constructing the 95-percent confidence interval refer to nonrespondent error for all cropland harvested, a full- count item. All error margins refer to the 95-percent confidence interval.

Item 2. Erosion rates derived from the Universal Soil Loss Equation (USLE). For 1930 the rates are reconstructed from factors for rainfall, soil erodibility, field slope and length, cropping patterns, tillage practices, and residue management practices for 437 different soils or soil complexes in five sample counties. Error margins for erosion rates per acre in 1930 based on the standard error of this 437-member series of estimated USLE erosion rates. USLE erosion rates for 1992, with their margins of error for constructing 95-percent confidence intervals, from USDA's 1992 National Resources Inventory.

Item 3. Average gross erosion per year estimated as the mid-value of the lower and upper limits in item 4. This may not be the same as the simple product of items 1 and 2.

Item 4. The lower limit of the 95-percent confidence interval for gross erosion per year is the product of [crop acres less its margin of error] times [the erosion rate less its margin of error]. The upper limit is the product of [crop acres plus its margin of error] times [the erosion rate plus its margin of error].

* The single asterisk identifies, at a 95-percent confidence level, the minimum percentage reduction in gross erosion between 1930 and 1992. It is obtained by subtracting 100 from the upper limit for 1992 taken as a percentage of the lower limit of estimated erosion in 1930.

** Identifies the maximum percentage reduction in gross erosion between 1930 and 1992. It is obtained by subtracting 100 from the lower limit for 1992 as a percentage of the upper limit of erosion in 1930.

The share for meadow, which had become mostly alfalfa by 1992, rose from 28 percent of all land in principal crops in 1930 to 33 percent in1992. Between 1930 and 1992 the total area in row crops had increased by 91 percent in the sample counties. The increase for the entire region was 131 percent. This indicates that the use of land for corn and soybeans has intensified more in the 23 counties not sampled than in the five counties sampled. It also implies that between 1930 and 1992 the rate of erosion on cropland was reduced less in the nonsampled than in the five sampled counties. This was the case.

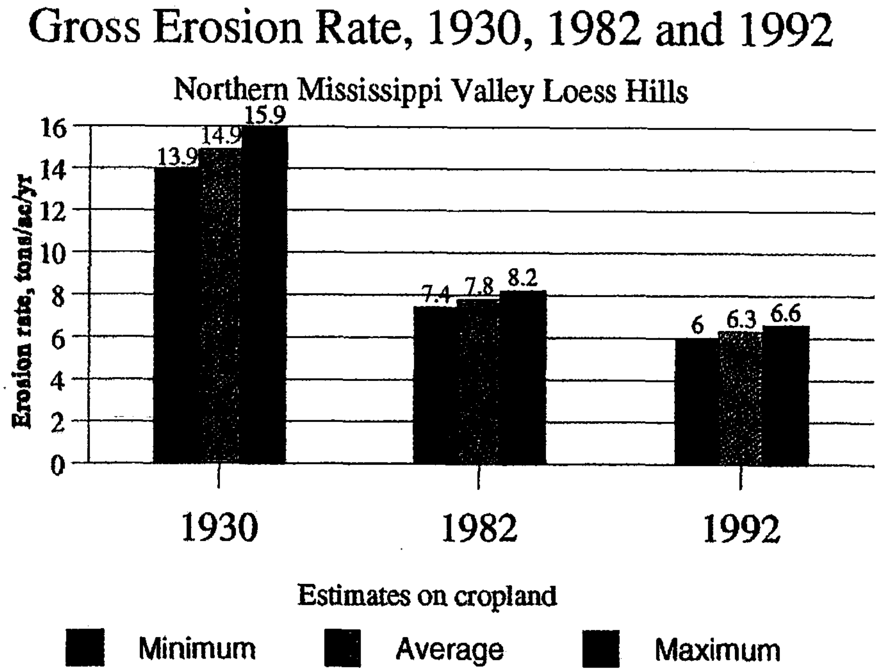
To explain, it is reasonable to assume that the average 1930 erosion rate for the sample counties (14.9 tons/ac/yr) was a good approximation of the 1930 rate for the nonsampled counties, as the typography, soil types, rainfall, and general land uses patterns were similar in the two areas. According to the National Resources Inventory (NRI) the average USLE rate for 1992 in the nonsampled counties was about 6.7 tons/ac/yr versus the 5.5 tons/ac/yr for the sampled counties. Between 1930 and 1992 the rate of soil loss for cropland was reduced by 55 percent in the 23 counties not sampled but by 63 percent in the five counties sampled.

The area in rotation meadow in the region increased by about 36 percent between 1930 and 1992. Nearly 33 percent of the cropland in the region as well as in the five sample counties is in alfalfa each year. Because alfalfa is normally left in for a longer period than other legumes, this implies that, where practiced, crop rotations now involve at least several years of meadow. The most common rotation in 1930 was corn for a year, followed by a year in oats or other small grains, then followed by only one or two years of hay meadow, usually clover or a clover/timothy mix.

Approximating Regional Erosion in 1930

Extrapolating to a regional level the cropland erosion rates for 1930 for the five sample counties first considered that any erosion rates computed from the USLE were themselves sample estimates of the erosion rates occurring in 1930 across all 28 counties mostly within MLRA 105. In this case all of MLRA 105 and minor sections in contiguous MLRA's were viewed as the'population' for which erosion in 1930 was to be estimated from information about the sample. Although the five sample counties were not randomly chosen in a strict sense, they were an unbiased selection. All of the 28 counties in the region were presumed to have had an equal chance of having a soil or erosion survey reports completed during the decade 1925-1935. The availability of a soil survey report for this period was the main criterion for choosing which counties to sample.The status of soil surveys for all 28 counties principally in the region is shown in figure 1.

Figure 5



In each of the sample counties USLE erosion rates were computed at the level of each relevant rotation within each soil map unit, with each mapping unit in turn identified as to land use capability class and subclass. The rotations and crops were distributed accordingly. A total of 437 differentiated map units grouped into the eight capability classes, were required in deriving a weighted average USLE soil loss rate 'A' in tons/ac/yr as of 1930 for each sample county and then for the five counties combined (table 5).[11] This value for 'A', 14.9 tons/ac/yr, is an 'estimate' for the Northern Mississippi Valley Loess Hills of the average annual erosion rate occurring under 1930 conditions.

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[11] Note in tables 7 and 8 that for 1992 the mean estimates and error margins differ between the sample counties and the MLRA 105 region. This is because the analysis for 1930 was confined to five counties representing the entire region, whereas for 1982 and 1992 it was possible to rely on the National Resources Inventory estimates of USLE erosion rates and their respective margins for error. These were separately available for the five sample counties, the 23 nonsampled counties and then for all 28 counties predominantly in the region.

Results of the analysis of erosion conditions in 1992 versus 1930 for the Northern Mississippi Valley Loess Hills are given for the five sample counties in table 7 and then for all 28 counties in the region in table 8, which also includes comparable data for 1982. For 1930 the mean estimate for the sample counties for the gross USLE rate of erosion per acre (14.9 tons/ac/yr), as well as the margin of error in this rate (1.0 ton/ac/yr), were considered to be estimates for the region as well as for the sample counties.

Some overall results of the comparison of erosion conditions for the Northern Mississippi Valley Loess Hills in 1982 and 1992 versus 1930 are graphed in figures 5, 6 and 7. Gross USLE erosion rates per acre are compared in figure 5. The center bar denotes the mean estimated rate, while the minimum and maximum bars denote the lower and upper limits, respectively, of the 95-percent confidence interval for the estimated erosion rate.[12]

The gross quantities of erosion and quantities exceeding **T** are shown in figure 6. Figure 7 shows the minimum, average, and maximum estimates of the gross quantities of erosion occurring on cropland. These estimates are also for the 95-percent confidence interval.

Figure 8 compares selected items between 1930 and 1992 for the sample counties and the entire region in terms of their amounts in 1992 relative to 1930.

Summing up the essential results: Under conditions in 1992 the average annual erosion rate per acre of the land in principal crops in the Northern Mississippi Valley Loess Hills (MLRA 105) was only 42 percent of the rate estimated for 1930, and the total amount of soil being displaced on cropland in 1992 was only 49 percent of the amount displaced in 1930. These reductions were achieved despite the area used for row crops, small grains or rotation meadow in 1992 being 16 percent greater than in 1930, while the area in row crops alone was 2.3 times the area in row cropsin 1930. The chart also indicates that between 1930 and 1992 the area in row crops in the 23 counties not sampled had expanded more than in the five counties sampled.

The respective per-acre erosion rates for 1930, 1982 and 1992 are multiplied by the acreages in principal crops for the entire region (table 8). Between 1930 and 1992 there was a drop of 58 percent in the erosion rate, from 14.9 tons/ac/yr down to 6.3 tons/ac/yr. At a 95-percent level of confidence, it can be stated that reducing the gross erosion rate to 6.3 tons/ac/yr in 1992 translated into a reduction between 1930 and 1992 of between 42 and 58 percent in the amount of gross erosion

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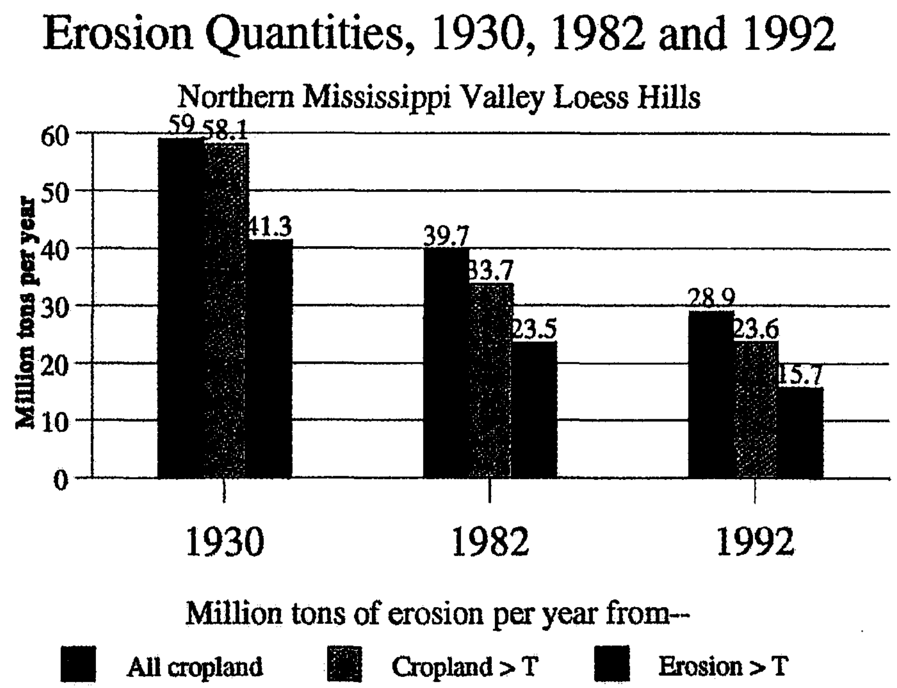
[12] The error margins given are for the 95-percent confidence interval. Divide the margins of error by 1.96 to obtain standard errors of the estimated mean erosion rates and total quantities for the years 1930, 1982 and 1992.

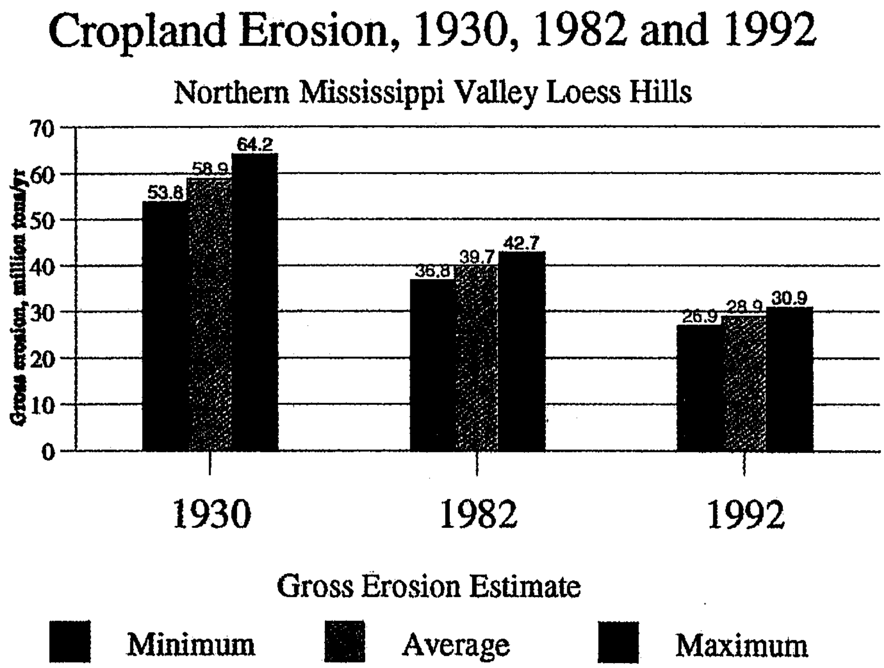
Figure 6



occurring on the land used for principal crops, for an average or mid-value reduction of 51 percent. Expressing the changes in terms of confidence intervals allows for errors inherent in the estimates of crop acreages as well as in erosion rates per acre. Between 1930 and 1992 the 'average' reduction in gross erosion per acre was 58 percent. Gross erosion had been reduced by about 33 percent between 1930 and 1982. By 1992 the gross erosion occurring in 1982 had been further reduced, by about 27 percent.

In 1930 between 54 and 64 million tons of soil per year were being displaced by erosion (figure 7 and table 8). By 1992 this had been reduced to between 27 and 31 million tons per year. The mid-value or 'average' displacement was slightly under 29 million tons in 1992 compared to nearly 59 million tons per year in 1930. Note that the mid-value is the simple average of the computed lower and upper limits of the 95-percent confidence interval. Its margin of error is half the difference between the upper and lower estimate limits.

Figure 7

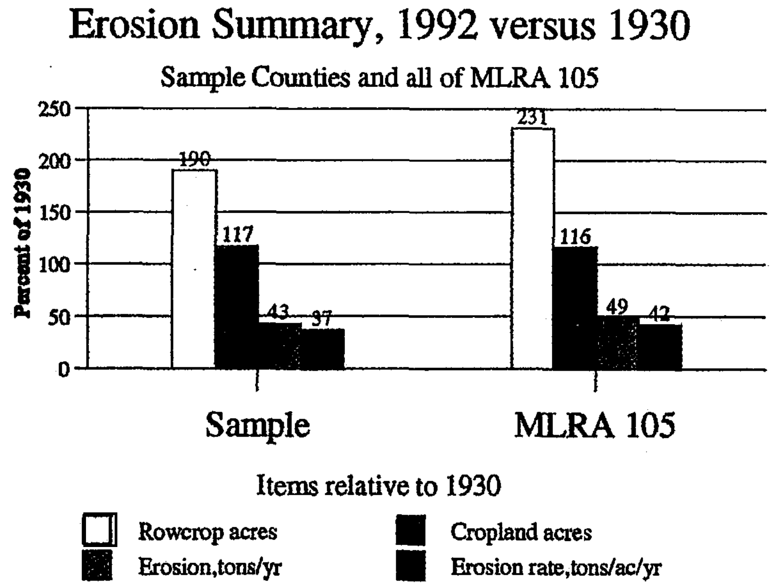


Productivity-Decreasing Erosion

The erosion analysis for MLRA 105 also examined the extent to which erosion in the three periods 1930, 1982 and 1992 could be considered to adversely affect long-term soil productivity. While any erosion is generally undesirable and regarded as 'excessive', excess erosion from a productivity standpoint was evaluated in this study as the amount by which gross erosion rates per acre exceeded allowable tolerances. The 'excess' rate of erosion was defined as the gross rate of displacement less the rate that can occur without an appreciable loss in soil productivity, and without applying substitute nutrients or other soil additives. For the five sample counties predominantly in MLRA 105, this tolerance or 'T' value varied between 3 and 5 tons/ac/yr, according to particular soils.

Estimates for excess erosion in 1982 and 1992 were accessed from the National Resources Inventory (NRI). For 1930 the estimates were obtained by first examining gross soil displacement for each of the 437 soil mapping units found in the five sample counties, then converting these to gross rates of displacement per acre, and then subtracting the appropriate T-values per acre as recorded in current soil surveys or field technical guides. Any positive balances per acre were multiplied by the acres in each mapping designation, and then aggregated by land use capability

Figure 8



subclasses within each cropland/crop group for each sample county, thus obtaining overall rates per acre of erosion in excess of assigned T values.

The results of the analysis of erosion rates and volumes greater than **T** for 1930 are given in table 9 for each of the eight land use capability subclasses and the three major cropland/crop groups defined for each sample county. The rates greater than **T** are averaged across all subclasses and crop groups in the counties but across only the cropland that was eroding at gross rates greater than **T** in 1930. The overall rate in excess of **T** in 1930 for the five sample counties (11.9 tons/ac/yr) and its corresponding gross USLE rate per acre for the individual areas eroding at rates greater than **T** (16.7 tons/ac/yr) were extrapolated to the region in calculating total amounts of gross as well as productivity-decreasing erosion.

By 1992 the <u>cropland area</u> eroding at rates greater than **T** and losing productivity in 1930 had been reduced by nearly 50 percent (table 10). The improvement between 1930 and 1982 was about 34 percent, with a further gain of 22 percent between 1982 and 1992.

By 1992 the <u>total amount</u> of erosion on the cropland eroding at a rate in excess of **T** in 1930 had been reduced by 59 percent, and by 30 percent less than in 1982. The yearly soil losses that can be associated with declining soil productivity in MLRA 105 amounted to over 41 million tons in 1930, 23.5 million tons in 1982, and 15.7 million tons in 1992, which was about 62 percent less than in 1930. These gains have additional significance when considering that the assigned **T**values were less than 5 tons/ac/yr for about 36 percent of the lands in MLRA 105 that were eroding at rates greater than 'T' in 1992. A T-value of 5 tons/ac/yr is frequently cited as the tolerance appropriate for most loessial soils in the Midwest.[13]

Soil displacement expressed in inches of surface soil removed per year or over extended periods was the measure commonly employed in early studies of erosion processes. In some respects it is easier to visualize than the weight displaced. At the risk of appearing overly precise an illustration can be given. Using a weight of 142 tons per acre-inch of soil as an approximate conversion constant (Uhlman,1949,p.2), total erosion per acre (16.7 tons/ac/yr) on the cropland eroding in excess of T in 1930 was equivalent to 0.12 inches (3 mm) per year. The excess or productivity-decreasing erosion rate in 1930 (11.9 tons/ac/yr) would amount to 0.08 inches (2.1 mm) per year. By 1992 total soil displacement had been reduced to 13.4 tons/ac/yr, equivalent to 0.09 in/yr (2.4 mm/yr). The portion associated with the gradual loss of productivity (8.9 tons/ac/yr) was equivalent 0.06 in/yr (1.6 mm/yr).

The increments of soil removed in a given year may be hardly if at all noticeable but they assume major importance if continued. A gross erosion rate of 16.7 tons/ac/yr (0.111 in/yr) continued over 25 years amounts to nearly 3 inches of topsoil displaced, or to nearly 6 inches if continued for 50 years. An average gross rate in 1930 in Crawford County, Wisconsin, one of the sample counties, on vulnerable capability subclass IIIe land containing various soil series and used for corn in a three-year rotation with small grains (CCG), was estimated at 30.7 tons/ac/yr (0.2 in/yr), equivalent to 5.4 inches of topsoil removed over a 25-year period, and to nearly 11 inches over a 50-year period.

Figure 6 relates three measures of aggregate annual erosion on cropland in 1930, 1982, and 1992: (1) Gross erosion occurring on all cropland: (2) gross erosion occurring on the cropland eroding at rates greater than T; and (3) the amount of this excess erosion occurring on the area included in (2). Between 1930 and 1992 all erosion on all cropland fell by 51 percent, or from 59

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[13] In discussing the present work at a June 1995 Symposium on 20th Century Farm Policies, Pierre Crosson of Resources for the Future, Inc. suggested that the T-value concept may not be a reliable basis on which to associate productivity declines with gross erosion rates. Even on relatively deep loessial soils farmers have substituted fertilizers, etc. to compensate for fertility losses in upper soil horizons, and have shifted to reduced tillage to minimize current erosion and help restore previous losses of organic matter. In essence the concept was more relevant to conditions in the area in the 1930s than presently, and also presently if topsoils are shallow. The loess mantle in the Northern Mississippi Valley Loess Hills (MLRA 105), for example, is relatively thin compared to, say, that of the Iowa and Missouri Deep Loess Hills (MLRA 107).

to about 29 million tons per year. That on the cropland that had been eroding at rates greater than T in 1930 fell by 40 percent. The tons of erosion causing productivity to decline was reduced by 62 percent between 1930 and 1992, or from about 41 down to 16 million tons per year.

The essential results of this study have been illustrated in figure 8: Under conditions in 1992 the average annual erosion rate per acre of the land in principal crops in the Northern Mississippi Valley Loess Hills (MLRA 105) was only 42 percent of the rate we estimated for 1930, and the total amount of soil being displaced on cropland in 1992 was only 49 percent of the amount displaced in 1930. These reductions were achieved despite the area used for row crops, small grains or rotation meadow in 1992 being 16 percent greater than in 1930, while the area in row crops alone was 2.3 times the area in row crops in 1930.

Conservation in MLRA 105

The reductions summarized in figure 8 occurred despite the area in corn or other row crops in 1992 being about 2.3 times what it was in 1930. It appears that private and public conservation efforts have had definitely reduced soil erosion in MLRA 105 because, with other factors considered equal, erosion losses increase with the area devoted to row crop production, as opposed to small grains or hay crops.

Onfarm Conservation Practices

Data for on-farm conservation efforts in the Northern Mississippi Valley Loess Hills region for the period 1980 to 1994 are graphed in figure 9. Some details on conservation practices from the NRI's for 1982, 1987, and 1992 are in table 11. The significant reductions in erosion were not accomplished by using land resources less intensively, as by leaving land in small grains or permanent hay meadow instead of growing more row crops. They were the result of less intensive tillage and a more intensive application of capital to land, represented by the cost of installing on-farm conservation measures and investing in watershed protection and development projects.

According to the 1992 NRI, stripcropping and/or terraces were in place on 1.3 million acres of cropland, of which 130 thousand acres were terraced (figure 7). Terracing has increased about 2 percent annually since 1982 and stripcropping at a slightly lower rate. Also, while reduced tillage can require substantial capital investments in specialized new equipment like no-till planters and involve higher herbicide costs, its soil and water conservation benefits are also substantial.

Table 8. Cropland erosion in 1930, 1982 and 1992 in 28 counties predominantly in the Northern Mississippi Valley Loess Hills (MLRA 105)

Items	Units	1930	1982	1992	Percent changes		
					1930-82	1930-92	1982-92
1. Principal crops	1,000 ac	3,952	5,090	4,583	29	16	-10
(Error margin)	1,000 ac	(83.4)	(107)	(105)	--	--	--
2. USLE erosion rate/yr	Tons/ac	14.9	7.8	6.3	-48	-58	-19
(Error margin)	Tons/ac	(1.0)	(0.4)	(0.3)	--	--	--
3. Gross erosion per yr	1,000 tons	58,967	39,749	28,904	-33	-51	-27
(Error margin)	1,000 tons	(5,194)	(2,949)	(2,036)	--	--	--
4. Lower limit, erosion/yr	1,000 tons	53,773	36,800	26,868	* -22	*-42	* -16
Upper limit, erosion/yr	1,000 tons	64,162	42,697	30,940	** -42	** -58	** -37

Item Explanations:

Item 1. Area estimates from the 1930 and 1992 Censuses of Agriculture. For Census acres, margins of error in constructing the 95-percent confidence interval refer to nonrespondent error for all cropland harvested, a full-count item. Owing to ambiguities in the published relative standard errors for harvested cropland in 1982, the Census Bureau suggested using for 1982 the more accurate relative errors as published for 1992. All error margins in the table refer to the 95-percent confidence interval.

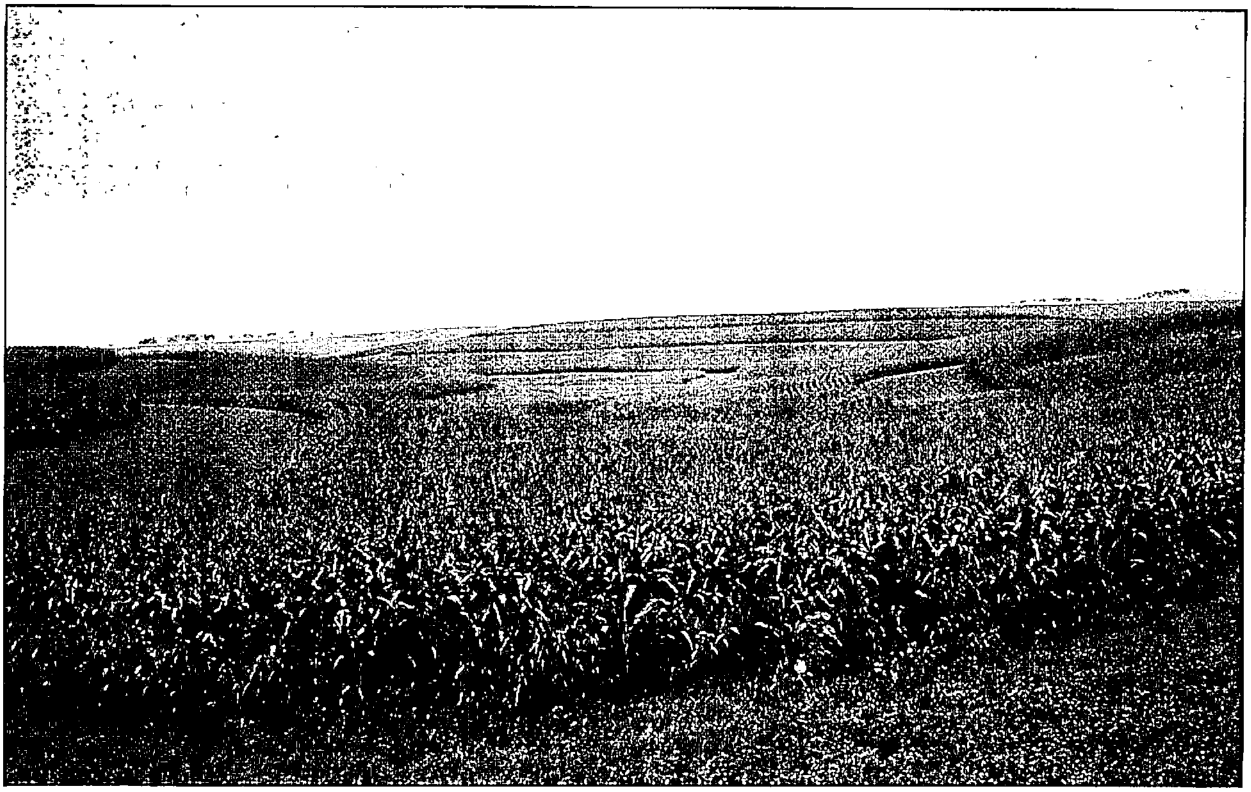
Item 2. Erosion rates derived from the Universal Soil Loss Equation (USLE). For 1930 the rates are developed from factors for rainfall, soil erodibility, field slope and length, cropping patterns, tillage practices, and residue management practices for 437 soils or soil complexes in five sample counties. Error margins for erosion rates per acre in 1930 based on the standard error of this 437-member series of estimated USLE erosion rates. USLE erosion rates for 1982 and 1992, with their margins of error for constructing 95-percent confidence intervals, from USDA's 1992 National Resources Inventory.

Item 3. Average gross erosion per year estimated as the mid-value of the lower and upper limits in item 4. This may not be the same as the simple product of items 1 and 2.

Item 4. The lower limit of the 95-percent confidence interval for gross erosion per year is the product of [crop acres less its margin of error] times [the erosion rate less its margin of error]. The upper limit is the product of [crop acres plus its margin of error] times [the erosion rate plus its margin of error].

* The single asterisks identify, at a 95-percent confidence level, the minimum percentage reductions in estimated gross erosion between 1930 and 1982, then between 1930 and 1992, and then between 1982 and 1992. They are obtained by subtracting 100 from the upper limit for 1992 taken as a percentage of the lower limit of estimated erosion for 1930, or for 1982 if the comparison is between 1982 and 1992.

** The double asterisks identify, at a 95-percent confidence level, the maximum percentage reduction in estimated gross erosion between 1930 and 1982, then between 1930 and 1992, and then between 1982 and 1992. They are obtained by subtracting 100 from the lower limit for 1992 taken as a percentage of the upper limit of estimated erosion for 1930, or for 1982 if the comparison is between 1982 and 1992.

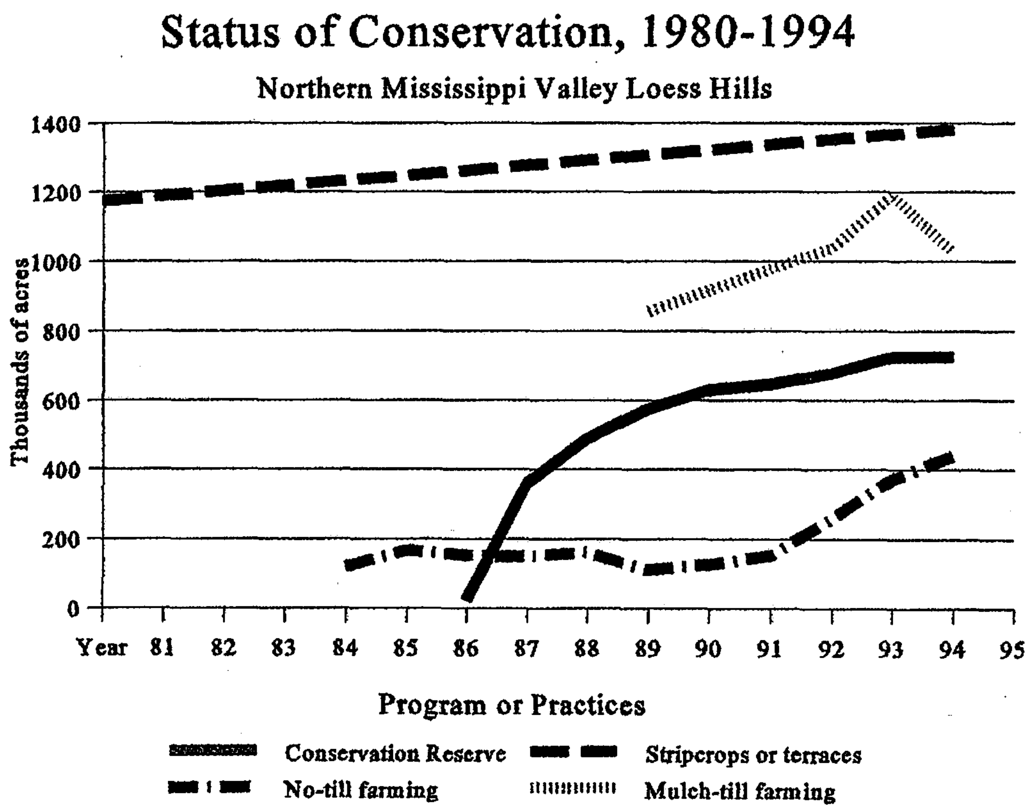


Buffer strips of permanent brome grass with continuous corn is now a common conservation practice; northeast of Elkader, Iowa. Photo by Douglas Helms, NRCS/USDA. August 1995.

The observed trend for contour stripcropping and terracing is sketched in connecting the three available estimates from the National Resources Inventory---for 1982, 1987 and 1992 (table 11). Thre three estimates lie on a nearly straight line. In 1992 these measures were in place on 1.3 million acres of cropland, of which 130 thousand acres were terraced. According to the NRI, terracing has increased about 2 percent annually since 1982 and stripcropping at a lower rate.

While reflecting an overall intensity of conservation activity, the acreages in table 11 for conservation measures on cropland, grazing and woodlands include some double counting, as up to three practices could have been recorded for an NRI sample point or its immediate vicinity. According to Consolidated Federal Funds Report (CFFR) data obtained from the Bureau of the Census, Federal cost shares paid under the Agricultural Conservation Program (ACP) in the five sample counties ranged around $120,000 per county per year over the period 1983-1992 (USDC,1994c). The CFFR figure is adjusted to1992 price levels. The average for all 28 counties in MLRA 105 was $123,000 per county per year, indicating that the level of participation in the ACP was somewhat lower in the five counties sampled than in the 23 counties not sampled.Other related research indicates that, including installation and maintenance costs, farmers in Iowa, Minnesota

Figure 9



and Wisconsin pay an average of 52 percent of the total cost of onfarm conservation practices. State and local agencies cover 8 percent, for a nonfederal total of 60 percent and a Federal share of 40 percent (Pavelis,1985,p.22). Federal shares divided by 0.40 give an estimate of the total investment in onfarm conservation practices made in MLRA 105 in the ten years 1983-92. The total in 1992 dollars comes to $86.1 million for the ten years, of which $44.8 million was paid by farmers, and about $41.3 million by Federal,State and local agencies.

Conservation Tillage

Some time plots for conservation tillage are shown in figure 9. Conservation tillage is gaining rapidly in the sample counties and the general region.[14] Residues from high-yielding corn

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[14] Data on conservation tillage in figure 9 were compiled for MLRA 105 by Carmen Sandretto of the Economic Research Service, USDA.

shield the soil surface from impact and runoff, including rapid snowmelt, in the same manner as permanent vegetative cover.[15] Retaining heavy residues on the soil surface from present high-yielding corn is not only effective in controlling erosion and can also help restore the humus content and productivity lost from previous erosion.

As of 1994, no-till farming as the most effective and clearly defined form of conservation tillage had been adopted on about 440,000 acres (12 percent) of the land planted to row crops or small grains, compared to none in 1930 and only 3 percent in 1984, when special records on the practice were first compiled. The practice has consistently increased since 1984 according to the Conservation Technology Information Center (CTIC), a clearinghouse for information on conservation tillage supported by USDA and other Federal agencies. Also, in 1994 mulch or ridge tillage was practiced on just over a million additional acres (26 percent) of the acres in planted crops. Including all variations, the CTIC data indicate that some form of reduced tillage was practiced in the region on nearly 40 percent of the area planted to row crops or small grains in 1994.

The National Resources Inventory (NRI) also provides some estimates of additional conservation treatments needed on cropland, pastureland, and woodlands in MLRA 105. These estimates are given in table A-9. Including all variations, the CTIC data indicate that in 1994 some form of reduced tillage was practiced on nearly 40 percent of the area planted to row crops or small grains.

Conservation Reserve and Diversion Programs

In the 1992 Census of Agriculture, about 66,000 acres of the croppable land (less than 1 percent) in the region were reported as being in various set-aside or similar short-term diversion programs of USDA. These programs are apart from the Conservation Reserve Program (CRP), which aims to retire highly erodible cropland from production through long-term (10-year) contracts with landowners. Contract files indicate that a cumulative total of nearly 726,000 acres in the

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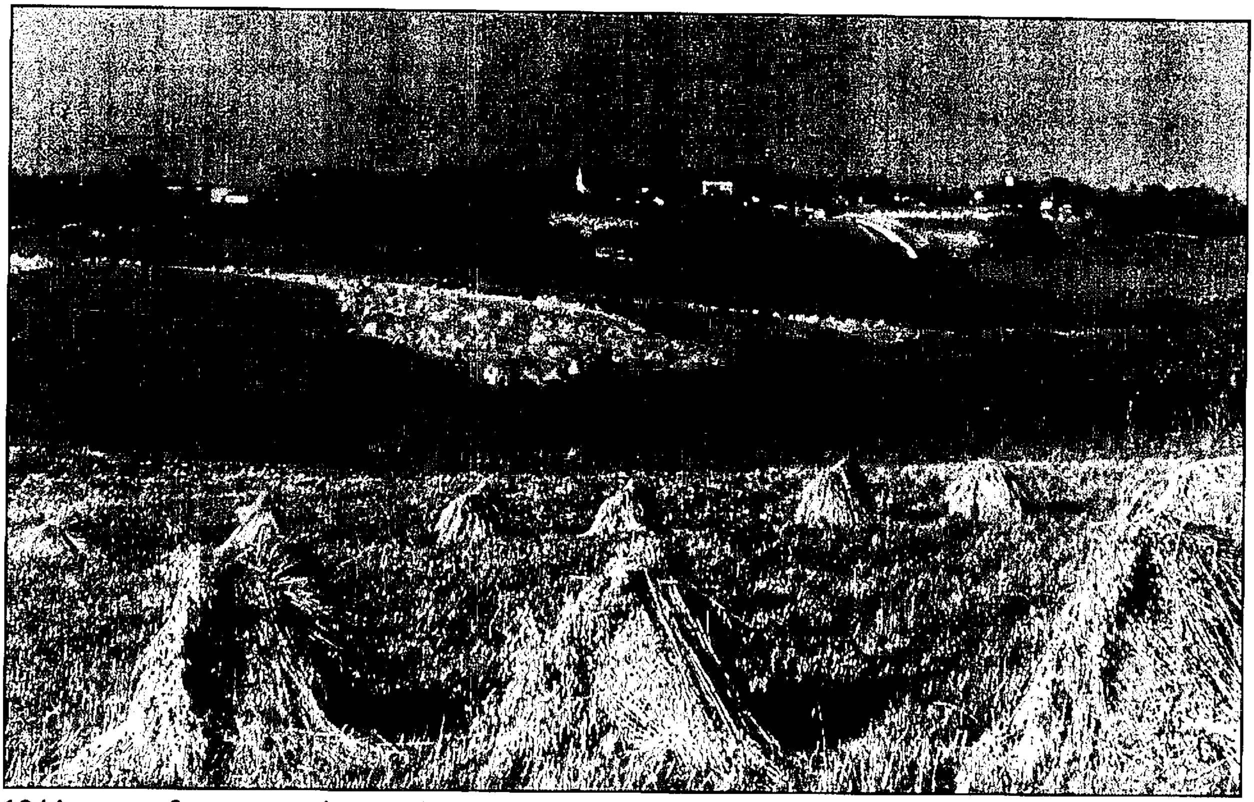
[15] On this point Uhland describes counts made at Bethany, Missouri of the number of water drops falling 30 centimeters required to disperse a soil aggregate about the size of a pea and wash it through a 20-mesh screen. Only 6.2 drops of water falling 30 centimeters were required to entirely disperse an average aggregate from soil that had been cropped annually to corn. This was contrasted to a requirement of 37.7 drops to disperse aggregates taken from first-year meadow, 41.2 drops for aggregates after two years of meadow, and 40.2 drops for aggregates taken from land that had been in alfalfa for 13 years (Uhland,1949,p.2).

Table 9. Soil loss rates in excess of 'T' by crop groups and land use capability subclasses for sample counties, 1930

Crop groups and LCC[1]	Clayton County Iowa	Houston County Minnesota	Winona County Minnesota	Crawford County Wisconsin	Vernon County Wisconsin	Average for all counties	Cropland eroding above 'T'
	Estimated excess rates of soil loss in 1930, tons/ac/yr						Percent
Group AB	5.9	6.8	4.7	5.7	7.3	5.8	69.0
Class I	0.5	0.6	1.0	0.3	0	0.9	12.3
Sc IIe	6.1	6.9	0	5.7	7.3	6.0	87.9
Sc IIw	5.6	1.0	0.4	4.8	0	5.0	22.3
Group C	11.2	17.7	18.2	18.8	11.9	15.8	91.4
Sc IVe	11.3	17.8	18.3	18.8	11.9	15.8	99.7
Sc IIs	0	0	0	0	0	0	0
SC IIIs	0	0	0	0.3	0	0.3	0.3
SC IVs	0	0	0	1.7	0	1.7	1.7
Group D	15.2	10.6	3.3	25.9	15.4	13.5	99.0
SC IIIe	15.2	10.6	3.3	26.0	15.4	13.4	99.0
All groups	13.2	10.8	5.8	19.6	12.3	11.9	87.2[1]

[1] Total cropland area for all groups, crops and land use capability classes in 1930 was 647,300 acres; cropland area eroding in excess of 'T' in 1930 is estimated at 564,462 acres.



1944 scene of contour stripcropping system on the Workler Brothers farm. Garnavillo, Iowa is in the background. National Archives photo. (Iowa 1194).

1995 repeat photo: Stripcropping is no longer practiced but contour farming is still used with conservation tillage. Photo by Douglas Helms, NRCS/USDA. August 1995.