EROSION PREDICTION
INTRODUCTION

This section contains information on predicting soil erosion rates in New York State. The Revised Universal Soil-Loss Equation (RUSLE) and the Wind Erosion Equation (WEQ) are used to compute erosion rates. The erosion prediction models are empirical equations derived and tested by research. Both models are used to estimate the rate that soil is moving on critical areas of the landscape and are used as guides in the choice of conservation practices that will control erosion. In addition, information on estimating soil loss from gullies streambanks and roadbanks is also presented.

WATER EROSION

FORMS OF WATER EROSION

Forms of soil erosion by water include sheet and rill, ephemeral gully, classical gully, and streambank. Each succeeding type is associated with the progressive concentration of runoff water into channels as it moves downslope. Sheet erosion, sometimes referred to as interrill erosion, is the detachment of soil particles by raindrop impact and the removal of thin layers of soil from the land surface by the action of rainfall and runoff. Rill erosion is the formation of small, generally parallel channels formed by runoff water. Rills usually do not re-occur in the same place. Ephemeral gullies are concentrated flow channels formed when rills converge to form shallow channels. They are alternately filled with soil by tillage operations and re-formed in the same general location by subsequent runoff events. Classical gullies are also concentrated flow channels formed when rills converge. These are well defined, permanent incised drainageways that cannot be crossed by ordinary farming operations. Other forms of erosion that are related to soil erosion by water include stream channel and geologic. Stream channel erosion refers to the degradation of channels and waterways. Geologic erosion refers to long-term erosion effects, as opposed to accelerated erosion events discussed in the Subpart. No reliable methods exist for predicting the rate of ephemeral gully, classical gully, stream channel, or geologic erosion. The remainder of this part deals only with prediction and control of sheet and rill erosion.

THE WATER EROSION PROCESS

The processes of sheet and rill erosion are detachment, transport, and deposition of soil particles caused by raindrop impact and surface runoff.

Detachment is the removal of particles from the soil mass and is expressed in units, such as tons per acre. When soil particles are removed from the mass, they are referred to as sediment. The movement of sediment downslope is sediment transport. A measure of sediment transport is sediment load. Sediment load on a slope increases with distance downslope as long as detachment is occurring. That is, detachment adds to the sediment load.

Where runoff is slowed at the base of a slope or by dense vegetation, deposition occurs, which is the transfer of sediment from the sediment load to the soil mass. That is, deposition removes sediment from the sediment load, and accumulates on the soil surface.

Two types of deposition, remote and local occur. Remote deposition occurs some distance away from the origin of the sediment. Deposition at the toe of a concave slope, on the uphill side of vegetative strips, and in terrace channels are examples of remote deposition. Local deposition is where sediment is deposited near, within several inches, of where it is detached. Deposition in microdepressions and in low gradient furrows are examples of local deposition.

HOW, WHY, AND BY WHOM WATER EROSION IS ESTIMATED

NRCS estimates soil erosion by water as part of its technical assistance to land users. In conservation planning, erosion estimates are made for an existing management system and compared with alternative systems and with soil loss tolerance, T, values.

In addition, soil loss estimates are used to inventory natural resources, evaluate the effectiveness of conservation programs and land treatment, and estimate sediment production from fields that might become sediment yield in watersheds.

Since March 1995, NRCS adopted RUSLE as the official tool for predicting soil erosion by water. NRCS continues to use the Revised Universal Soil Loss Equation (USLE) for certain provisions of Farm Bill programs and for the NRCS National Resources Inventory (NRI).

PRINCIPLES OF WATER EROSION CONTROL

The principle factors that influence soil erosion by water are:

- Climate,
- Soil properties,
- Topography,

- Vegetative cover, and
- Conservation practices.

Climate and soil properties are conditions of the site and are not modified by ordinary management measures. Conservation treatment primarily involves manipulation of vegetative cover, modification of topography, and manipulation of soil conditions in the tillage zone. The greatest deterrent to soil erosion by water is vegetative cover, living or dead, on the soil surface. Cover and cultural practices influence both the detachment of soil particles and their transport. Growing plants and plant residue absorb the energy of raindrops, decrease the velocity of runoff water, and help create soil conditions that resist erosion. Cultural practices that affect vegetative cover includes crop rotations, cover crops, management of crop residue, and tillage practices.

REVISED UNIVERSAL LOSS EQUATION

INTRODUCTION

The following discussion and other information concerning the RUSLE equation may be found at http://www.sedlab.olemiss.edu/rusle . In addition, readers are encouraged to consult the NRCS National Agronomy Manual (NAM). It can be found at ftp://ftp.ftw.nrcs.usda.gov/pub/Nat_Agron_Manual/NAM_finaldraft.pdf . You will need the free Adobe® reader software to read this file. You may download this software from http://www.adobe.com/products/acrobat/readstep2.html .

This section describes the use of the Revised Universal Soil Loss Equation (RUSLE). The RUSLE is a management tool for estimating sheet and rill erosion from rainfall in New York. The equation may be used for estimations from cropland, pasture land, woodland, idle land, and, in some cases, urban areas. It quantifies the effects of natural factors, cultural, management, and cropping practices on soil loss. The Natural Resources Conservation Service has determined allowable soil loss for the soil types (map units) found in New York. These tolerable (T) annual figures are based on empirical data for maintaining long term economic productivity and resource sustainability. Values for allowable soil loss for different soil types may be found in Section II of the Field Office Technical Guide (FOTG). The use of the T value requires a fairly comprehensive analysis of all the soil and field conditions. A completely effective erosion control system is one where: (1) the necessary water control practices are planned and installed and (2) the soil loss is reduced to or is less than the tolerable soil loss. In addition to sheet and rill erosion, soil loss from gullies, and similar concentrated flow areas must be addressed. The method for assessment of concentrated flow sources is presented later in this section.

GENERAL DISCUSSION

RUSLE TECHNOLOGY FOR NEW YORK

The procedure for estimating soil loss is essentially the same as for USLE. Use published values from lookup tables and charts, multiply the factors and the resultant number (A) is in tons per acre per year.

$A = R \cdot K \cdot (LS) \cdot C \cdot P$

When (A) is computed, compare the value with acceptable soil loss values "T" to determine soil erosion control practices needed. The new "T" values are maximum allowable soil losses in tons per acre per year.

New Rainfall Factors "R" values are printed. Each county has a single R value to use.

Soil erodibility factors vary depending on climatic zones. An average annual "K" value is used. New York has three climatic zones: (climatic zone 112 is divided in two sections)--112 Southern and Eastern, and 112 Lake Ontario and 114B for the lower Hudson River Valley, NYC and Long Island counties. Old "K" values are provided for each soil in New York. Use appropriate climatic zone table to determine new RUSLE "K" values.

The "LS" factor has been expanded to four tables - 1) Cropland; 2) Pasture; 3) Construction and Mining Sites; and 4) Thawing Soils. Only the first three are applicable in New York. "Thawing soils" is intended for use in the Northwestern part of the United States. Interpolate as necessary to estimate usable values.

The cropping or cover "C" factors for use in New York are based on crop rotation files developed for New York and utilizing existing data bases. "C" factors differ by climatic zones. To facilitate developing look-up tables, only one weather station's (Binghamton) data was used for climatic zone 112; factors for 114B were developed for potatoes using the Bridgehampton, Long Island weather station. The balance of the "C" factors for climatic zone 114B were adopted from New Jersey without modification. Some tables have RUSLE file names with the "C" factor. These are for NRCS State Office use and future RUSLE computer versions. Additional "C" factors will be derived as needed.

By definition, the support practice ("P") in RUSLE is the ratio of soil loss with a specific support practice to the corresponding loss with up and down slope tillage. The supporting practice ("P") procedure is all new and one must follow the instructions within

RUSLE "P" section of RUSLE FOTG information. Examples are provided to assist in providing adequate guidelines for use.

RUSLE BACKGROUND HISTORY

Efforts to predict soil erosion by water started in the 1930's. Cook (1936) identified the major variables that affect erosion by water. Zingg (1940) published the first equation for calculating field soil loss. Smith and Whitt (1947) presented an erosion-estimating equation that included most of the factors present in modern soil loss equations. The Musgrave equation (Musgrave 1947) was a soil loss equation developed for farm planning. Finally, an effort was initiated to develop a national equation from the various state and regional equations that existed in the 1950's. In 1954, the Agricultural Research Service (ARS) established the National Runoff and Soil Loss Data Center at Purdue University in West Lafayette, Indiana, to consolidate all available erosion data. Using the data assembled at the Data Center, Wischmeier and Smith (1965) developed the Universal Soil Loss Equation (USLE). The USLE was a consolidation of several regional soil loss equations, and was based on summarizing and statistical analyses of more than 10,000 plot-years of basic runoff and soil loss data from 49 U.S. locations (Agriculture Handbook 703, 1997; Wischmeier and Smith 1965, 1978).

The USLE was designed to provide a convenient working tool for conservationists. It quantifies soil erosion as a product of six factors representing rainfall and runoff erosivity, soil erodibility, slope length, slope steepness, cover-management practices, and supporting practices. The USLE was revised in the 1990's. However, by legislative decree the NRCS continues to use the Revised Universal Soil Loss Equation (USLE) for certain provisions of Farm Bill programs and for the NRCS National Resources Inventory (NRI).

Since March 1995, the Revised Universal Soil Loss Equation (RUSLE) has been used by the NRCS to estimate soil loss by water (Agriculture Handbook 703.). RUSLE predicts long-term average annual soil loss from sheet and rill erosion. RUSLE is an update of the Universal Soil Loss Equation (USLE) as described in Agriculture Handbook 537 (Wischmeier and Smith 1978). RUSLE utilizes a computer program to facilitate the calculations. RUSLE technology reflects the analysis of research data that were unavailable when Agricultural Handbook 282 (Wischmeier and Smith 1965) and Agriculture Handbook 537 were completed.

The RUSLE is a management tool used to estimate soil loss by sheet and rill erosion on cropland, pasture land, woodland, idle land, and, in some instances, urban areas. The equation quantifies the effects of natural factors, cultural, management, and cropping practices in soil loss. The NRCS has determined allowable soil loss from slopes for various soil types. The loss tolerance for any specific soil can range from 2 to 5 tons per acre per year. The use of T for erosion control requires a comprehensive analysis of all the soil and field conditions. A completely effective erosion control system is one where: (1) the soil loss is reduced to or is less than the tolerable soil loss and (2) the necessary water control practices are planned and installed. Also, bear in mind that while soil erosion control practices benefit long term soil quality and productivity, there are also beneficial effects on water, air, plant, animal and related human resources.

The larger the value of any of the factors in the equation, the greater is the indicated potential soil erosion. The value of K, the soil erodibility factor, and R the rainfall factor, are beyond the control of land managers.

The values of K reflect the effects of soil particle size, gradation of particle sizes, soil structure, permeability and organic matter content as related to soil particle detachment and transportation. Little can be done to these factors on a farm field except to increase the organic matter content. Even this is questionable on a very large scale. The values of R are determined from the rainfall characteristics of the region which is beyond practical control. The remainder of the factors, L, S, (LS), C, and P, however, may be controlled to a greater or lesser extent.

By using the RUSLE, numerous crop and tillage alternatives can be developed for a particular field or farm. These alternatives can be compared on the basis of predicted soil loss. They can also be evaluated for effectiveness using T. This allows the landowner to select his/her system based on the effectiveness to reduce soil loss, system feasibility, and economics.

The RUSLE is also used in determining the need for cropland treatment to reduce the slope length. In New York, many slope lengths are generally less than 300 feet so the use of cropland terraces and diversions is generally not reflected by using the RUSLE. However, these practices are justified in the planning process when they are needed to control erosive concentrated surface flows. This justification is a reflection of experience and professional judgement by the planner. Factors entering into the decision to use cropland terraces, diversions and even grassed waterways include: cropping system intensity, adherence or lack of adherence to the contour, soil depth and productivity, as well as the extent of tillage or no-till planting combined with crop residue management.

Occasionally, small portions of fields identified during the planning process cannot be completely treated to meet all the RUSLE criteria due to topography or physical limitations. In these situations, when watercourses or sensitive areas are located down slope, either off site protection from siltation must be provided or additional land treatment must be utilized to minimize siltation. Such practices as crop residue management and the use of cover crops may compensate for the lack of other treatment.

Even when meeting "T", cropland immediately upslope (above) watercourses or sensitive areas may require additional treatment during periods of low residue or crop cover. This is especially true during the part of a crop sequence when crops with high "C" values are utilized. This additional treatment could include the use and management of crop residues, cover crops, intercropping or by providing for a natural or seeded filter strip between the cropland and the watercourse or other sensitive area.

In summary, the RUSLE is an important tool in developing conservation plans that limit soil loss to an acceptable level when considering long-term soil productivity. However, from a water quality perspective, small parts of fields that cannot be treated to meet "T" or that are upslope from watercourses or critical areas, may require additional treatment. The use of cover crops, management of crop residues or the use of natural or seeded filter strips may be needed to assure protection of the water course or sensitive area from siltation or other forms of pollution from overland flow.

By using the RUSLE, numerous crop and tillage alternatives can be developed for a particular field or farm. These alternatives can be compared on the basis of predicted soil loss. They can also be evaluated for effectiveness using T. This allows the landowner to select his/her system based on the effectiveness to reduce soil loss, system feasibility, and economics.

RUSLE Definition and Explanation

RUSLE estimates average annual soil loss, expressed as mass per unit area per year, which is defined as the amount of sediment delivered from the slope length assumed in the RUSLE computation. RUSLE uses U.S. customary units and computes soil loss in units of tons/acre/year. RUSLE is a sediment yield equation that describes sediment yield at the end of the RUSLE slope length. RUSLE uses a particular set of definitions and observance of these definitions is critical to getting accurate results.

The *RUSLE slope length* is defined according to the problem being addressed. The typical application for RUSLE is development of a conservation plan to protect the eroding portion of a landscape from being excessively degraded by soil erosion, that is, to protect the soil as a resource. In this application, slope length is defined as the distance from the origin of overland flow along the flow path to the point where deposition begins to occur on concave slopes or to a concentrated flow channel. In some cases, the slope can flatten to cause deposition and then become steeper so that erosion occurs on the lower portion of the slope. Slope length passes through the depositional area when soil loss is being estimated on the lower portion of this slope.

Another application of RUSLE is to estimate the amount of sediment leaving a landscape that may cause off-site damages such as sedimentation in a road drainage ditch. In this case, the slope length is the distance from the origin of overland flow through depositional overland flow areas to the first “concentrated flow” area that collects the overland flow to the point that the runoff can no longer be considered overland flow. Consideration outside of RUSLE must be given to deposition that occurs in concentrated flow areas, except terrace and diversion channels that are considered by RUSLE, to fully estimate sediment yield from a landscape area.

RUSLE also computes soil loss for individual slope segments. These soil loss values represent net sediment production for those segments, which is the net between detachment and deposition within the segment.

Detachment is the removal of soil particles from the soil mass, which adds sediment to the sediment load being transported downslope. *Deposition* is the transfer of sediment from the sediment load back to the soil mass. *Local deposition* is the deposition of sediment very near to the point where the sediment was detached. Deposition of sediment eroded from soil clods (peds) in nearby depressions formed by the clods is an example of local deposition. *Remote deposition* is the deposition of sediment far from its point of origin such as deposition in a terrace channel or on the toe of a concave slope.

Sediment load is a measure of the amount of sediment being transported downslope. *Sediment yield*, as used by RUSLE, is the sediment load at the end of the slope length, at the outlet of terrace or diversion channels, or sediment basins that are considered by RUSLE.

THE RUSLE EQUATION

RUSLE is an index method having factors that represent how climate, soil, topography, and land use affect rill and inter-rill (**<u>not</u>** gullies or classic gullies as concentrated flow channels) soil erosion caused by raindrop impact and surface runoff. In general, erosion depends on the:

- Amount and intensity of rainfall and runoff,
- Protection provided to the soil by land use against the direct forces of raindrop impact and surface runoff,
- Susceptibility of soil to erosion as a function of intrinsic soil properties and soil properties modified by land use, and
- Topography of the landscape as described by slope length, steepness, and shape.

These influences are described in RUSLE with the equation:

A = R K L S C P; where:

- A = average annual soil loss,
- K = soil erodibility factor,
- L = slope length factor,
- S = slope steepness factor,
- C = cover-management factor, and
- P = supporting practices factor.

A soil loss (erosion rate) in tons per acre per year is computed by substituting values for each RUSLE factor to represent conditions at a specific site.

RUSLE is a "lumped" process-type model based on the analysis of a large mass of experimental data and equations based on fundamental erosion processes where experimental data are inadequate to define RUSLE factor values. Rather than explicitly representing the fundamental processes of detachment, deposition, and transport by rainfall and runoff, RUSLE represents the effects of these processes on soil loss.

The RK product in RUSLE is an estimate of soil loss from unit plot conditions. These two factors have dimensions and units, whereas the other RUSLE factors are dimensionless relative to unit plot conditions. A *unit plot* is 72.6 ft long with a 9 percent slope; is maintained in continuous fallow; is tilled up and down hill according to a particular sequence of operations much like those used in clean-tilled row crops; and is cultivated periodically to break the crust that forms from rainfall and to control weeds. The soil surface is left relatively smooth and free of ridges after the last tillage operation in the sequence.

RUSLE FACTOR DEFINITIONS

R FACTOR:

The R factor represents the erosivity of the climate at a particular location. An average annual value of R is determined from historical weather records and is the average annual sum of the erosivity of individual storms. The erosivity of an individual storm is computed as the product of the storm's total energy, which is closely related to storm amount, and the storm's maximum 30-minute intensity. Erosivity range from less than 8 (U.S. customary units) in the western U.S. to about 700 for New Orleans, Louisiana. All other factors being the same, soil loss potential is 100 times greater at New Orleans, Louisiana than at Las Vegas, Nevada.

Maps of R-values have been computed from historical weather records and have been plotted onto maps and placed in databases used by RUSLE.

K FACTOR:

The K factor is an empirical measure of soil erodibility as affected by intrinsic soil properties. Erosion measurements based on unit plot conditions are used to experimentally determine values for K.

The factor K is a measure of soil erodibility under this standard condition. Land use, such as incorporation of organic material into the soil, affects soil erodibility, but such effects are considered in the C factor. The K factor is influenced by the:

- Potential for detachment of the soil,
- Infiltration
- Runoff, and
- Transportability of the sediment eroded from the soil.

The main soil properties affecting K are soil texture, including the amount of fine sand in addition to the usual sand, silt, and clay percentage used to describe soil texture, organic matter, structure, and permeability of the soil profile. In general terms, clay soils have a low K value because these soils are resistant to detachment. Sandy soils have low K values because these soils have high infiltration rates and reduced runoff, and sediment eroded from these soils is not easily transported. Silt loam soils have moderate to high K values because soil particles are moderate to easily detached, infiltration is moderate to low producing moderate to high runoff, and the sediment is moderate to easily transported. Silt soils have the highest K values because these soils readily crust producing high runoff rates and amounts. Also, soil particles are easily detached from these soils, and the resulting sediment is easily transported.

This mixture of effects illustrates that K is empirical. It is not a soil property, but is defined by RUSLE definitions. The definition for K, and for all RUSLE factors as well, must be carefully observed to achieve accurate results. For example, using K to account for reduced soil loss from incorporation of manure is not proper and produces incorrect results.

LS FACTOR:

The L and S factors jointly represent the effect of slope length, steepness, and shape on sediment production. RUSLE represents the combined effects of rill and inter-rill erosion. Rill erosion is primarily caused by *surface runoff* and increases in a downslope direction because runoff velocity also increases in the downslope direction. Inter-rill erosion is caused primarily by *raindrop impact* and is uniform along a slope. Therefore, the L factor is greater for those conditions where rill erosion tends to be greater than inter-rill erosion.

Erosion increases with slope steepness, but in contrast to the L factor for the effects of slope length, RUSLE makes no differentiation between rill and inter-rill erosion in the S factor that computes the effect of slope steepness on soil loss.

Slope shape is a variation of slope steepness along the slope. Slope steepness and position along the slope interact to greatly affect erosion. Soil loss is greatest for convex slopes that are steep near the end of the slope length where runoff rate is greatest and least for concave slopes where the steep section is at upper end of the slope where runoff rate is least.

The LS factor is a measure of sediment production. Deposition can occur on concave slopes where transport capacity of the runoff is reduced as the slope flattens. This deposition and its effect on sediment yield from the slope is considered in the supporting practices P factor.

NOTE: Determination of the L and S factors can be very difficult even for well trained conservation planners, agronomists engineers, or third party technical service providers (TSP). The factors have significant impact on the predicted soil loss. As such, professionals must carefully measure the on-site conditions that best represent the field conditions. Anyone using the RUSLE independently should have adequate field training in the determination of the L and S factor values.

C FACTOR:

The C factor for the effects of cover-management, along with the P factor, is one of the most important factors in RUSLE because it represents the effect of land use on erosion. It is the single factor most easily changed and is the factor most often considered in developing a conservation plan. For example, the C factor describes the effects of differences between vegetation communities, tillage systems, and addition of mulches.

The C factor is influenced by:

- *Canopy* (cover above but not in contact with the soil surface),
- G*round cover* (cover directly in contact with the soil surface),
- S*urface roughness*, *time since last mechanical disturbance*, *amount of live and dead roots in the soil*, and
- *Organic material that has been incorporated into the soil.*

These variables change through the year as plants grow and senesce, the soil is disturbed, material is added to the soil surface, and plant material is removed. The C factor is an average annual value for soil loss ratio, weighted according to the variation of rainfall erosivity over the year.

The average annual distribution of erosivity during a year varies greatly with location. In the United States, erosivity is nearly uniform throughout the year in the mid-south region, is concentrated in the late spring in the western cornbelt, and is concentrated in late fall and early winter in the Pacific coast and Northeast regions. Soil resources in all of these areas also experience significant runoff and sedimentation from intense, short duration (thunder) storms during the growing season.

The selection of numerous management techniques that affect the C value affords the planner an almost unlimited selection of management alternatives that can be incorporated into cropping systems. However, operator limitations including (1) management abilities or constraints; (2) acceptance of new technology; and (3) equipment availability may significantly limit viable alternatives. In addition to soil Loss, the planner must keep in mind integrated crop management techniques as they relate to integrated pest management and nutrient management. Examples include the use of specific crop sequences to avoid specific weed, disease or insect problems; the use of cover crops for fall applied manure and the consideration of tillage methods and utilization of nutrients from manure.

The *soil loss ratio* is the ratio of soil loss from a given land use to that from the unit plot at a given time. RUSLE computes soil loss ratio values as they change through time with each half-month period. It uses equations for subfactors related to canopy, ground cover, roughness of the soil surface, time since last mechanical disturbance, amount of live and dead roots in the upper soil layer, amount of organic material incorporated into the soil, and antecedent soil moisture in the Northwest Wheat and Range Region.

P FACTOR:

The supporting practice P factor describes the effects of practices such as contouring, strip cropping, concave slopes, terraces, diversions, sediment basins, grass hedges, silt fences, straw bales, and subsurface drainage. These practices are applied to support the basic cultural practices used to control erosion, such as vegetation, management system, and mulch additions that are represented by the C factor. Supporting practices typically affect erosion by redirecting runoff around the slope to a safe outlet so that it has less erosivity or slowing the runoff to cause deposition such as concave slopes or barriers like vegetative strips and terraces. The major factors considered in estimating a P factor value include runoff rate as a function of location, soil, and management practice; erosivity and transport capacity of the runoff as affected by slope steepness and hydraulic roughness of the surface; and sediment size and density (USDA-ARS 2001).

LIMITATIONS OF THE RUSLE TECHNOLOGY

The term *Universal* distinguishes the USLE and RUSLE from State and regionally based models that preceded them. However, the use of the USLE and RUSLE is limited to situations where factors can be accurately evaluated and to conditions for which they can be reliably applied (Wischmeier 1978; Agriculture Handbook 703, 1997).

RUSLE predicts long-term average annual soil loss carried by runoff from specific field slopes under specified cover and management systems. It is substantially less accurate for the prediction of specific erosion events associated with single storms and short-term random fluctuations.

RUSLE also estimates sediment yield for eroded soil leaving the end of a slope with certain support practices. It does not predict sediment yield for the amount of sediment that is delivered to a point in a watershed, such as the edge of a field, that is remote from the origin of the detached soil particles. Nor does RUSLE predict erosion that occurs in concentrated flow channels.

DATA NEEDED TO SUPPORT RUSLE

RUSLE uses soil erodibility, K, values from the NASIS Soils Database. Climatic data is obtained from National Weather Service weather stations with reliable long-term data. State and area agronomists have developed cover and management factor, C, values for common cropping systems.

The crop database in the RUSLE program contains plant growth and residue production parameters. These variables for key crops are listed in Chapter 7 of Agriculture Handbook 703. Values for many of these parameters are available in a database for a variety of plants. A user interface, the Crop Parameter Intelligent Data System (CPIDS) (Deer-Ascough et. al. 1995), allows the user to search the data base. The USDA, ARS, National Soil Erosion Research Laboratory, West Lafayette, Indiana, maintains CPIDS.

Development and maintenance of data bases used by NRCS in erosion prediction models are the responsibility of NRCS agronomists at the State and National levels. Refer to Part 509 of the National Agronomy for more detailed information on data base management and instructions. The NRCS National Agronomist maintains a data base management plan that identifies the process of developing and maintaining databases needed to support RUSLE. Data bases for some States are available in electronic format on the Fort Worth server.

TOOLS FOR USING RUSLE

The NRCS in New York has developed climatic maps for New York State. These contain data to sufficient detail that is desired when applying RUSLE to specific field situations. These resources are found in the "Maps" portion of Section I of the FOTG.

Soil erodibility factor, K, values for RUSLE are available in the NASIS Soils Database and in other soil databases and tables. In areas of the United States where K values are adjusted to account for seasonal variability, (Agriculture Handbook 703) tables are available in State offices that show how the values are rounded to the nearest class and subclass. For slope length and steepness, L and S, table options are available in RUSLE. LS values can be obtained from tables 4-1 to 4-4 in Agriculture Handbook 703. The RUSLE computer program also calculates LS factor values for both uniform and complex slopes.

RELATION OF SOIL EROSION CONTROL TO THE RUSLE FACTORS

In conservation planning, the cover and management factor, C, and the support practices factor, P, can be manipulated in RUSLE to develop alternatives for erosion reduction. In addition, where slope length is reduced with some terrace and diversion systems, the slope length and steepness factor, LS, will be reduced. Using RUSLE technology, estimates of erosion reduction are illustrated in the subfactors of factor C. Benefits to erosion control are achieved in the:

- Prior land use subfactor by increasing the mass of roots and buried residue and increasing periods since soil disturbance,
- Canopy cover subfactor by increasing the canopy cover of the field area and low raindrop fall
- height from the canopy,
- Surface cover subfactor by increasing the ground over of plant residue, and by permanent cover such as rock fragments,
- Surface roughness subfactor by increasing the random surface roughness that ponds water, and thereby reduces the erosive effect of raindrops and traps sediment, and
- Soil moisture subfactor by growing moisture-depleting crops. This benefit is only applied in RUSLE in the Northwest Wheat and Range Region of the western United States. It is not applicable in New York even during prolonged drought periods.

When support practices are applied, they become integral parts of a resource management system for controlling soil erosion by water. Contour farming, contour stripcropping, and conservation buffers form ridges on or near the contour that slow runoff and trap sediment. Terraces and diversions intercept concentrated runoff flow and, in many cases, shortens the length of slope.

Some erosion control practices, such as grassed waterways and water control structures, do not substantially reduce sheet and rill erosion. While these can be effective erosion control practices in a resource management system, they are not a part of the soil loss reduction that is estimated by RUSLE.

RUSLE ASSOCIATED TILLAGE AND FIELD CROPS DEFINITIONS

Refer to National and/or State NRCS standard and specifications of conservation practices to obtain the proper P factor for a particular type of tillage.

CONVENTIONAL TILLAGE SPRING PLOW AND DISK

Refers to traditional tillage commonly using a moldboard plow in the spring where less than 10 percent residue remains after planting.

FALL CONVENTIONAL TILLAGE

Similar to above except carried out in the fall.

REDUCED TILLAGE

Defined as any planting system where a minimum of 30 percent surface cover by prior plant residues remains after planting. All conservation tillage would be either reduced or no-till. However, all reduced or no till may not qualify as conservation tillage.

Consideration of the use of manure as a substitute for crop residues must be carefully evaluated. Manure will only be effective when it contains a high amount of straw or other long stemmed or coarse bedding material. This recommendation must be consistent with guidelines in the nutrient management specification and the manure management manual, and should be included in the farm nutrient management plan. Considerations should include the economics of nutrients lost due to fall or winter applications as well as the environmental aspects of spreading on bare soils over winter.

Many charts and figures have been developed to reflect the amount of residues left or buried by different tillage methods and operations. Basically, a disk will bury residue and a chisel can bury or actually pull residue to the surface. Many variables exist when applying these charts. Depth, speed, and sequence of operations are particularly important. The use of a chisel followed by a heavy disk will leave little residue. Chiseling followed by a field cultivating or shallow chiseling followed by a light shallow disking would leave more residue. Many specific management tips on residue are included in the brochure entitled, "Reap Profits With Residue." It is advisable to develop C factors based on observed residue amounts or on a level of residue that is needed. A concept that should be considered is that, in most situations, 50 percent surface residue is achievable only with good management, and that a no-till planter or drill is needed to plant into this residue. Continuous no-till systems, especially with crop rotation, can increase surface residue amounts significantly when compared to a cropping system in which conventional or chisel tillage is used.

NO TILL

The soil surface is left undisturbed from harvest to planting. Planting operations are carried out without any prior tillage. Percentage of residue remaining will be dependent on the total volume of residue left and the distribution of that residue.

COVER CROP

As used in the charts, this refers to interseeding of a winter grain or other plant species prior to crop harvest so that the cover is established by the time of harvest. The result is to provide more winter protection for erosion control and enhance uptake of nutrients not utilized by the harvested crop.

Some considerations for conservation planning include:

A. Residue Equivalents

One pound of fine stemmed residue is equivalent to two pounds of corn residue.

B. Residues That Decompose Over Winter

The result is an average loss of approximately 15 percent. The higher losses are found in the warmer parts of the state.