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Assessing Conservation Tillage With RUSLE

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Soil erosion has and continues to be a concern for USDA agencies and the public in general. Until recently, the concerns were addressed with the Universal Soil Loss Equation, USLE, (Wischmeier and Smith, 1978). However, USDA technicians have been concerned because the technology was recognized as being mature and inadequate for addressing modern farming practices such as conservation tillage.

A new erosion prediction technology, the Revised Universal Soil Loss Equation (RUSLE), has been developed and is in the process of being implemented by USDA. Of greatest importance is that RUSLE incorporates additional research developed subsequent to 1978, provides increased flexibility to model a wider range of systems, provides more accurate representation of current crops and farming practices, corrects errors in the USLE 1978 technology and has been computerized for rapid comparison of alternative land management scenarios.

RUSLE retains the same function of: A = R • K • LS • C • P. Where: A = average annual soil loss; R = rainfall-runoff erosivity factor; K = soil erodibility factor; LS = slope length and steepness factor; C = cover-management factor; and P = support practice factor.

Considerations For RUSLE Factors and Databases

Major changes in the individual factors of RUSLE involve:

R FACTOR: The R factor represents the hydrologic (weather) input that drives the sheet and rill erosion process. RUSLE includes greatly expanded isoerodent maps (maps of equal erosion hazard represented by R).

In the Western US, data from more that 1,000 locations were analyzed for the new map. In the areas where large R values are encountered with very flat slopes, the computer program reduces the R value to reflect raindrop impact on water ponded on the surface.

K FACTOR: The soil erodibility factor K is a measure of the inherent erodibility of a given soil with the standard condition for a "unit" plot maintained in continuous fallow. RUSLE retains the soil erodibility nomograph, the most commonly used tool for estimating K-values based on soil properties. It also reflects the seasonal variability of the soil that is related to freeze-thaw, soil moisture status during the year and other factors causing K to vary during the year. The short-term variability is weighted in proportion to percent of annual R for semi-monthly intervals.

L and S FACTORS: RUSLE uses four separate L-factors for length and the S-factor for the effect of slope steepness. They include a function of slope steepness, and a function of susceptability to rill relative to interrill erosion.

In most practical applications, a slope profile represented as a single plane or uniform slope can be a poor topographical representation. Complex slopes can now be described readily in RUSLE to provide an improved topographic representation.

C FACTOR: The cover-management factor is perhaps the most important RUSLE factor because it represents conditions that can be managed to reduce erosion. Values for C are a weighted average of soil loss ratios that represent the soil loss for a given condition at a given time to that from the "unit" plot. To compute C, individual soil loss ratios (for semi-monthly periods) are weighted according to the distribution of erosivity for corresponding periods.

RUSLE uses a subfactor relationship given by the equation: C = PLU • CC • SC • SR • SM. Where: PLU = prior land-use subfactor, CC = canopy subfactor, SC = surface cover subfactor, SR = surface roughness subfactor, and SM = soil moisture subfactor used in the Northwest Wheat and Range Region.

To implement these calculations, the CITYLIST, CROPLIST/ and OPLIST databases are used. Users must specify the crops in a rotation and the dates of operations such as tillage and harvest. RUSLE then computes soil loss ratios and average annual C-factors.

P FACTOR: This factor represents how surface conditions affect flow paths, flow hydraulics and thus erosion associated with supporting practices like contouring, strip cropping and terracing. For example, with contouring, tillage marks are credited with directing runoff around the slope at reduced grades. Slight grade changes can change runoff erosivity greatly.

In RUSLE, extensive data have been analyzed and the results interpreted to give factor values for contouring

Table 1. Soil loss estimates for three tillage systems for a corn-soybean rotation

System	R	K	LS	C	P	A
Conventional Till	180	0.28	0.95	0.29	1.0	14
Reduced Till	180	0.28	0.95	0.13	1.0	6
No-Till	180	0.28	0.95	0.026	1.0	1

and cross-slope farming as a function of ridge height, furrow grade and climatic erosivity. P-factor values for terracing account for grade along the terrace, while a broad array of stripcropping and buffer strip conditions are considered.

The RUSLE software uses three data bases to facilitate the calculations of soil loss: CITYLIST that contains the basic climate data; CROPLIST that lists fundamental information on vegetation; and OPLIST that contains basic information on soil disturbing practices. The three data bases are used in evaluating the RUSLE factor values and permit recalling the information for repeated calculations and locations.

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CITYLIST: In addition to station identifying information, the file includes mean monthly precipitation and temperature, 24 entries for semi-monthly percentage of the annual R factor, an individual storm energy-intensity factor having a frequency of occurrence of once in 10-years and the number of frost-free days per year.

CROPLIST: In addition to identification of the crop, the file includes crop yield, residue at harvest and decomposition parameters of above and below ground biomass, and residue weight per unit area at 30, 60, and 90 percent cover. The file also includes root mass in the upper 4 inches, percent canopy cover and fall height for water drops falling from the canopy, each at 15-day intervals.

OPLIST: The file reflects soil disturbing operations and includes tillage implement names as well as operations that affect crop growth, harvest, start of regrowth and disposition of residue. Included in the file is the percent of surface disturbed, random roughness after an operation, percent of mass or cover before an operation that is retained on the surface by weight or cover and depth of residue incorporation.

Once a RUSLE user has developed all of the information needed for a soil loss calculation, it can be stored in the computer for easy recovery. Some user expertise is required to select appropriate parameters values and/or modify existing databases, but running the software is easy. Training on using RUSLE is available from the Soil and Water Conservation Society in Ankeny, Iowa.

Sample Calculation

RUSLE allows the quick evaluation of a wide range of cropping alternatives, including unusual cropping systems that have never been evaluated in research trials. The following example illustrates how RUSLE can be used to evaluate alternative cropping systems.

The farm is located near Indianapolis, Indiana on a silt loam soil common to the area. The crops are a 125 bu./ac corn and a 35 bu./ac soybean rotation with no supporting practices. The slope is a typical complex slope that we divided in five segments for analysis in RUSLE.

Starting at the upper end of the slope, the segments are 50 ft., 3 percent; 25 ft., 5 percent; 75 ft., 8 percent; 30 ft., 5 percent; 60 ft., 3 percent in length and steepness respectively. The present "conventional" system includes a moldboard and a twisted shovel chisel plow for primary tillage. Secondary tillage involves a tandem disk and a field cultivator.

RUSLE computes a soil loss of 14 tons/ac/yr. for this system, much too large to be acceptable with a soil loss tolerance of 5 tons/ac/yr. or less.

An alternative would be a reduced till system using a chisel plow with straight points for primary tillage followed by a field cultivator for secondary tillage. No row cultivation is used to control weeds. The estimated soil loss for this system is 6 tons/ac/yr., much closer to the soil loss tolerance but still higher than desired.

The third alternative is a no-till system. The soil loss for this system is 1 ton/ac/yr., well below soil loss tolerance. ▲

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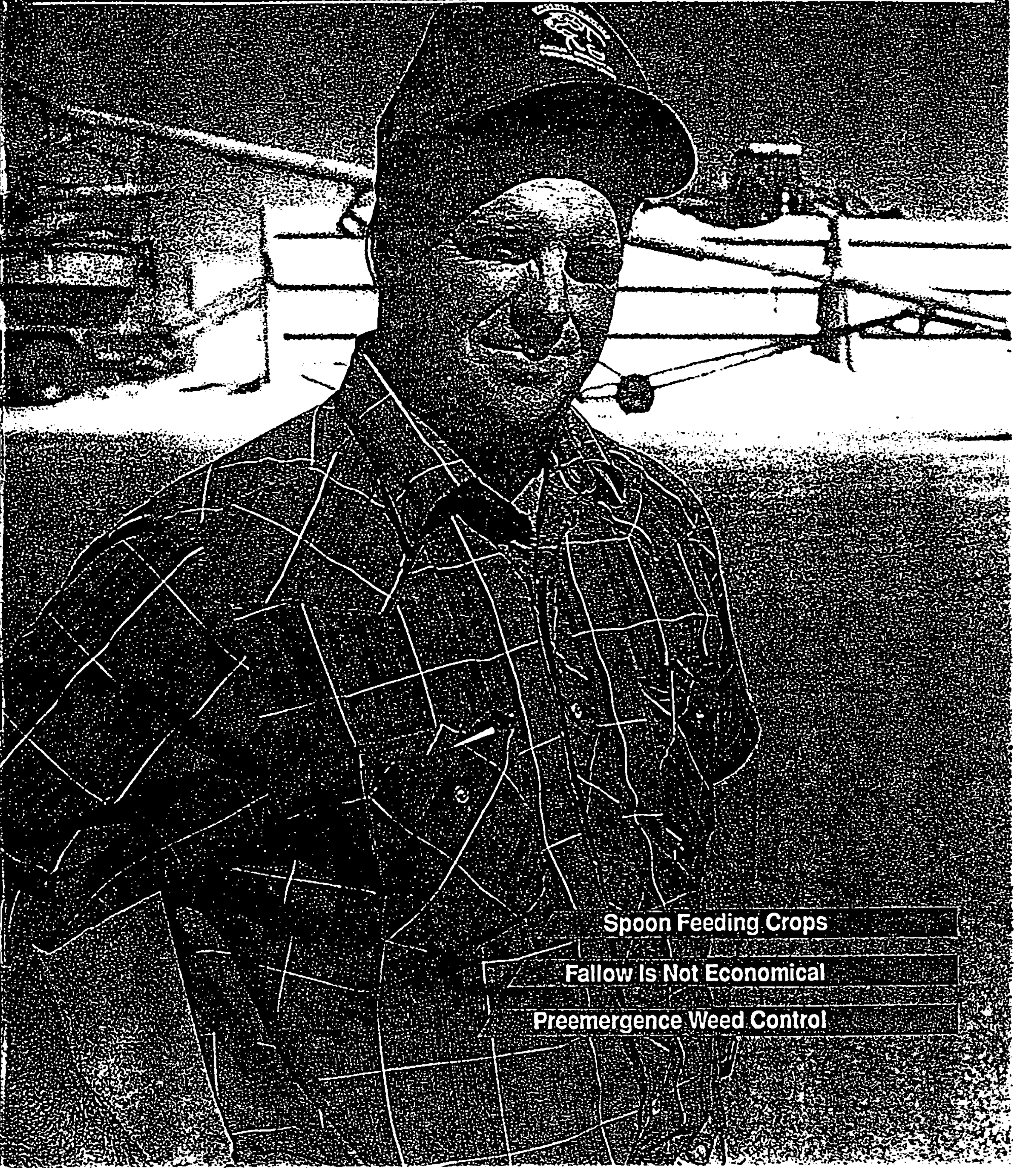

Spoon Feeding Crops

Fallow Is Not Economical

Preemergence Weed Control