Impact of Conservation Practices on Soil Erosion in Northeast Iowa (Region 3)

Bob Zhou, postdoctoral research associate
Matt Helmers, assistant professor
Mark Hanna, Extension agricultural engineer

Department of Agricultural and Biosystems Engineering, Iowa State University

Introduction

In Northeast Iowa, many soils are shallow in soil depth or have coarse sands and gravels, therefore are classified as fragile soils. Crop productivity will be adversely affected if excessive erosion has occurred on these soils. Soil erosion can be reduced by the implementation of various erosion control measures. The purpose of this study was to investigate the impact of conservation practices on soil erosion for a farm in Northeast Iowa.

Materials and Methods

The study site was located in Delaware County, Northeast Iowa, within the Buffalo Creek-Silver Creek Watershed (HUC 12). The size of the study area was about 280 acres. Slope ranges between 0.3% and 3.5% with the mean slope about 1.7%. Note that the slope range of the study area may not be truly representative of more steeply sloping areas in Northeast Iowa. Soil of the study site primarily consisted of Clyde silty clay loam (*Fine-loamy, mixed, superactive, mesic Typic Endoaquolls*).

Five tillage systems with a corn-soybean rotation were investigated: no-till, strip-till, disk-till, chisel-till, and conventional-till. No-till had no soil or crop residue disturbance except for that occurring during planting. Strip-till prepared narrow rows for seed bed after soybean harvest in the fall while no-till was used after corn harvest. Disk-till included a disking after corn harvest in the fall and field cultivating for both corn and soybean in the spring. Chisel-till consisted of stalk shredding and chisel operation after corn harvest in the fall and field cultivating for both corn and soybean in the spring before planting. Conventional-till consisted of shredding stalks and subsoiling after corn harvest, and disking and cultivating for corn and soybean in the spring. The impact of biomass removal rates after corn harvest on soil erosion was also investigated.

Total phosphorus (P_{sed}) bound to sediment was estimated by (Frere et al., 1980):

$$P_{sed} = P_{soil} \times W_{sed} \times W_{er}$$

Where P_{soil} is the total P content in 0-6 inch soil depth (530 ppm was used in this study, as estimated by Mallarino et al. (2002) for Iowa soil), W_{sed} is the sediment yield estimated from WEPP, and W_{er} is the enrichment ratio in WEPP.

The Water Erosion Prediction Project (WEPP) model was used to predict soil erosion rates under various scenarios. The topography of the study site was derived from the 30 m digital elevation data. Subwatersheds were delineated using the GeoWEPP (Figure 1), which has a geospatial interface for the WEPP. The weather data from the City of Oelwein in Fayette County was used to create the climate input file by the CLIGEN weather generator in the WEPP.

Results and Discussion

Mean annual surface runoff and sediment yield were lower in reduced tillage systems than in conventional tillage (Table 1). As a result, less sediment and nutrients/pollutants would be delivered to downstream water bodies. As expected, no-till had the lowest runoff and sediment yield among all the tillage types. While the difference of annual surface runoff was negligible among strip-till, disk-till, and chisel-till, the annual sediment yield had the order: chisel-till > disk-till > strip-till. The on-site soil loss was also reduced to a great extent under no-till practice when compared with conventional-till (Figure 2). The total amount of phosphorus loss, which was lost with sediment, was 0.26, 0.42, 0.81, 1.33 and 3.15 pounds/acre/year in no-till, strip-till, disk-till, chisel-till, and conventional-till, respectively (Table 1).

The simulation results showed that removing biomass after harvest would significantly increase soil erosion. For tillage systems with more field operations, even a small amount biomass removal would dramatically increase soil erosion. For example, the annual soil loss increased about 70% for disk-till at a 30% biomass removal rate (Table 2).

The impact of grassed waterways on reducing sediment yield was also investigated. Grassed waterways are strips of grass seeded in areas of cropland where water concentrates. Under conventional-tillage, the annual sediment yield when grassed waterways were adopted was only about one-fourth of the sediment yield in tilled waterways, which had the same field operations as other row-crop areas (Figure 3). Other tillage systems also showed a great reduction in sediment yield with grass waterways.

References

Frere, M.H., J.D. Ross, and L.J. Lane. 1980. The nutrient submodel. P.65-87. *In* W.Knisel (ed.) CREAMS: a field scale model for chemicals, runoff, and erosion from agricultural management systems. Vol.I Model documentation. USDA Conservation Research. Report 26. U.S. Gov. Print. Office, Washington, D.C.

Mallarino, A.P., B.M. Stewart, J.L. Baker, J.A. Downing, and J.E. Sawyer. 2002. Phosphorus indexing for cropland: overview and basic concepts of the Iowa phosphorus index. J. Soil Water Conserv. 57: 440-447.

Table 1. Simulation results of surface runoff, sediment yield, and phosphorus bound to sediment for different tillage systems in C-S system.

	No-till	Strip-till	Disk-till	Chisel-till	Conventional-till
Runoff (inch/year)	2.16	2.74	2.77	2.80	3.06
Sediment yield (tons/acre/year)	0.19	0.31	0.61	1.00	2.39
P on sediment (pounds/acre/year)	0.26	0.42	0.81	1.33	3.15

Table 2. Impact of biomass removal rate after corn harvest on sediment yield (tons/acre/year) for different tillage systems. Values in the bracket are the percentages of increase in soil loss compared with the control (without any biomass removal) for each tillage type.

	Biomass Removal Rate				
	0	30%	50%	70%	100%
No-till	0.19	0.19 (0.10%)	0.20 (4.6%)	0.21 (12.4%)	0.42 (121.8%)
Strip-till	0.31	0.32 (5.6%)	0.34 (11.6%)	0.39 (25.7%)	0.68 (118.1%)
Disk-till	0.61	1.07 (70.5%)	1.21 (92.9%)	1.40 (129.3%)	2.17 (255.6%)
Chisel-till	1.00	1.54 (55.3%)	1.69 (70.0%)	1.90 (91.6%)	2.46 (148.2%)
Conventional-till	2.39	2.97 (24.4%)	3.14 (31.3%)	3.37 (41.2%)	4.01 (68.1%)

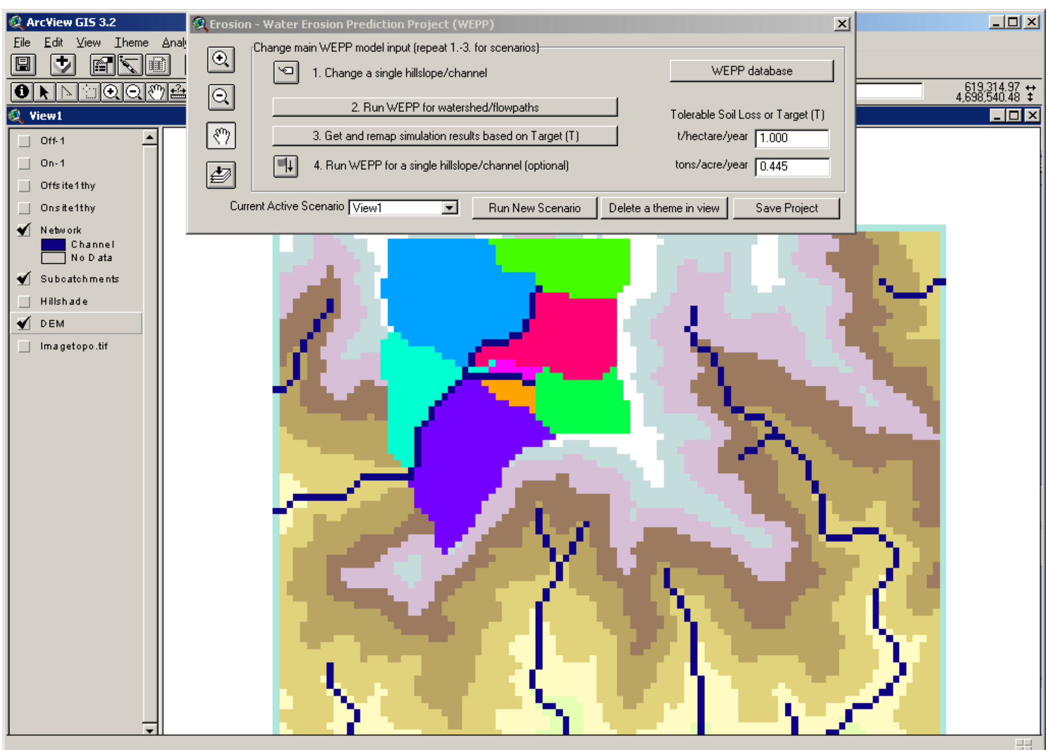
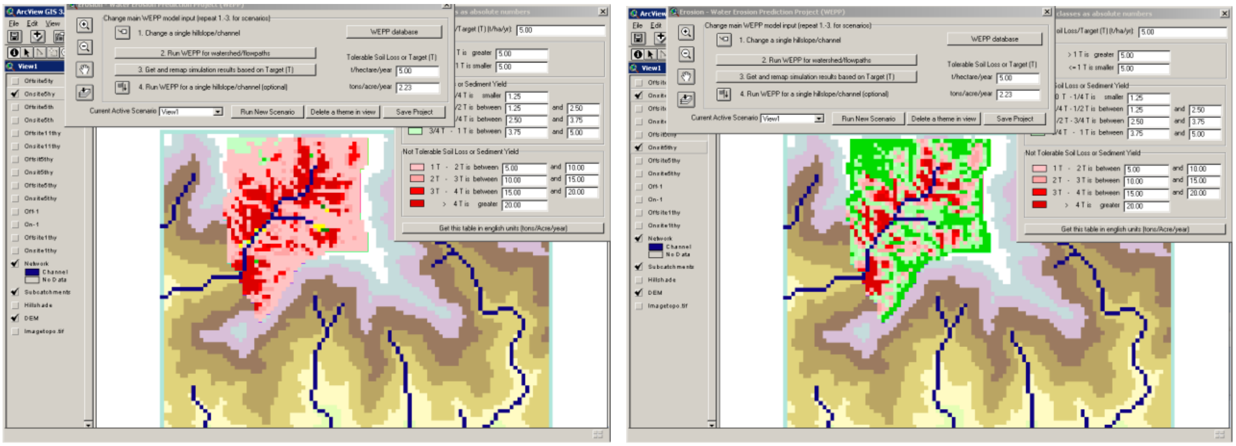


Figure 1. Subwatersheds delineation in the GeoWEPP.



(a) (b)

Figure 2.On-site annual soil loss rate for (a) conventional-till and (b) no-till of the study area. Areas with red color indicated that the annual soil loss exceeded the target value, and areas with green color represented the areas with the annual soil loss below the target value. A target soil loss rate of 5 tons/ha/year was used for illustration in the figure.

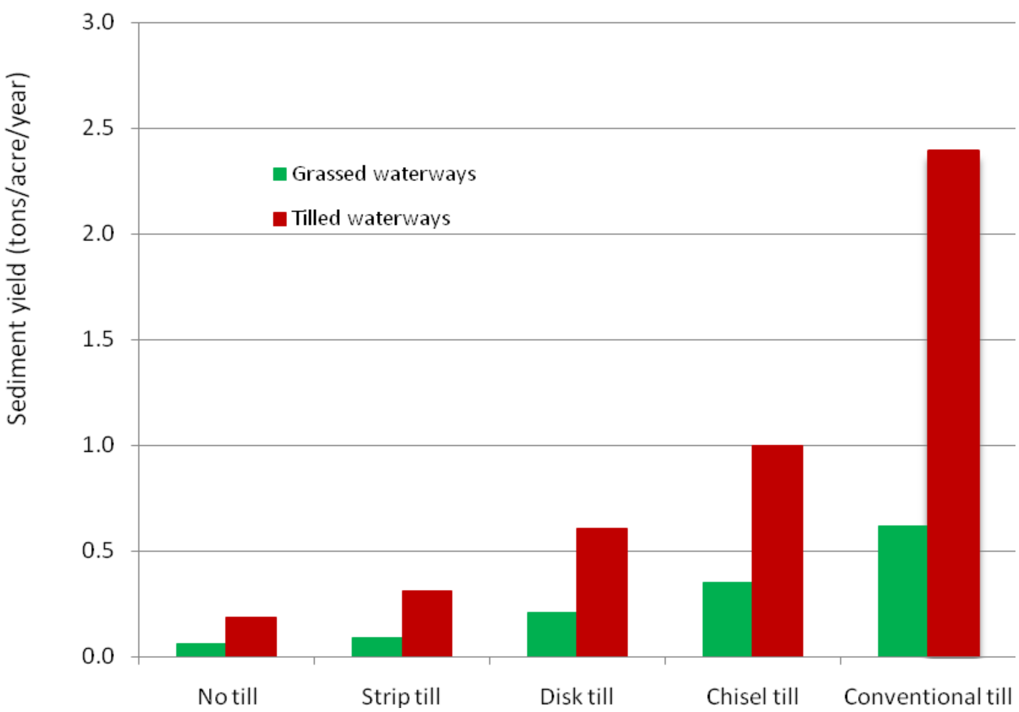


Figure 3. Comparison of grassed waterways and tilled waterways.