Impact of Conservation Practices on Soil Erosion in Northwest Iowa (Region 1)

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Introduction

While the importance of conservation practices on soil erosion control has been widely recognized, the increased demand for corn by ethanol producers and the recent sharp rise of the agricultural products' market stimulated more tillage as well as corn acres in Iowa. The objective of this study was to investigate the impact of conservation practices on soil erosion for a farm in Northwest Iowa, and identify the most effective practices.

Materials and Methods

A cooperative farm in Clay County was selected for this study, within the Elk Creek-Little Sioux River Watershed (HUC 12). The mean slope of this 180-acre study area was about 2.6%, ranging between 0.4% and 11.7%. Note that the slope range of the study area may not be truly representative of more steeply sloping areas in Northwest Iowa. The predominant soil present in the site was Clarion Loam (*Fine-loamy, mixed, superactive, mesic Typic Hapludolls*).

Soil erosion was investigated for five tillage types with a corn-soybean rotation. No-till had no soil or crop residue disturbance except for that occurring during planting. Strip-till only 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 cultivation 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 (0, 30%, 50%, 70%, and 100%) 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.

Surface runoff and sediment yield for the entire study area were estimated using the Water Erosion Prediction Project (WEPP) model over a 30-year period. The topographic inputs for WEPP were 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 climate data was generated by the CLIGEN weather generator in WEPP, based on the weather station in Sioux Rapids, Buena Vista County, Iowa.

Results and Discussion

The average annual sediment yield of the entire area ranged from 0.43 to 4.20 tons/acre for the five tillage systems. As expected, no-till had the lowest sediment yield, while conventional-till had the highest (Table 1). The on-site soil loss rate was also reduced under no-till system in comparison with conventional-till (Figure 2).

Likewise, the surface runoff amount also decreased in reduced tillage systems in comparison with conventional-till. The total amount of phosphorus loss that was bound to sediment, was 0.72, 0.98, 2.48, 3.48, and 7.05 pounds/acre/year for no-till, strip-till, disk-till, chisel-till and conventional-till, respectively.

The biomass removal rate after harvest had a significant impact on soil erosion. Less residue cover over the soil surface led to a higher soil erosion rate (Table 2). For tillage systems with a smaller number of field operations, such as no-till and strip-till, only a slight increase in sediment yield was observed at relatively low biomass removal rates. However, much more severe soil erosion occurred when the biomass removal rate exceeded 70%. For disk-till, a 30% biomass removal rate caused a 47% increase in annual sediment yield.

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. They are often graded and shaped to form a smooth, bowl-shaped channel. Implementation of grassed waterways could reduce sediment yield to a great extent regardless of the tillage system (Figure 3). The benefit is most significant for conventional-tillage. The annual sediment yield dropped from 4.2 to 1.2 tons/acre when grassed waterways were implemented, in comparison with the tilled waterways, which had the same field operations as other row-crop areas.

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)	2.24	2.49	2.61	2.86	3.16
Sediment yield (tons/acre/year)	0.43	0.58	1.48	2.07	4.20
P on sediment (pounds/acre/year)	0.72	0.98	2.48	3.48	7.05

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 increases 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	0.43	0.46 (7.1%)	0.49 (13.9%)	0.59 (37.8%)	1.11 (159.8%)
Strip-till	0.58	0.62 (9.1%)	0.67 (17.5%)	0.76 (33.4%)	1.27 (123.7%)
Disk-till	1.48	2.17 (47.2%)	2.40 (62.9%)	2.77 (88.1%)	3.95 (168.1%)
Chisel-till	2.07	2.84 (38.0%)	3.08 (49.6%)	3.43 (66.4%)	4.32 (109.6%)
Conventional-till	4.20	5.03 (20.0%)	5.27 (25.7%)	5.63 (34.2%)	6.81 (62.4%)

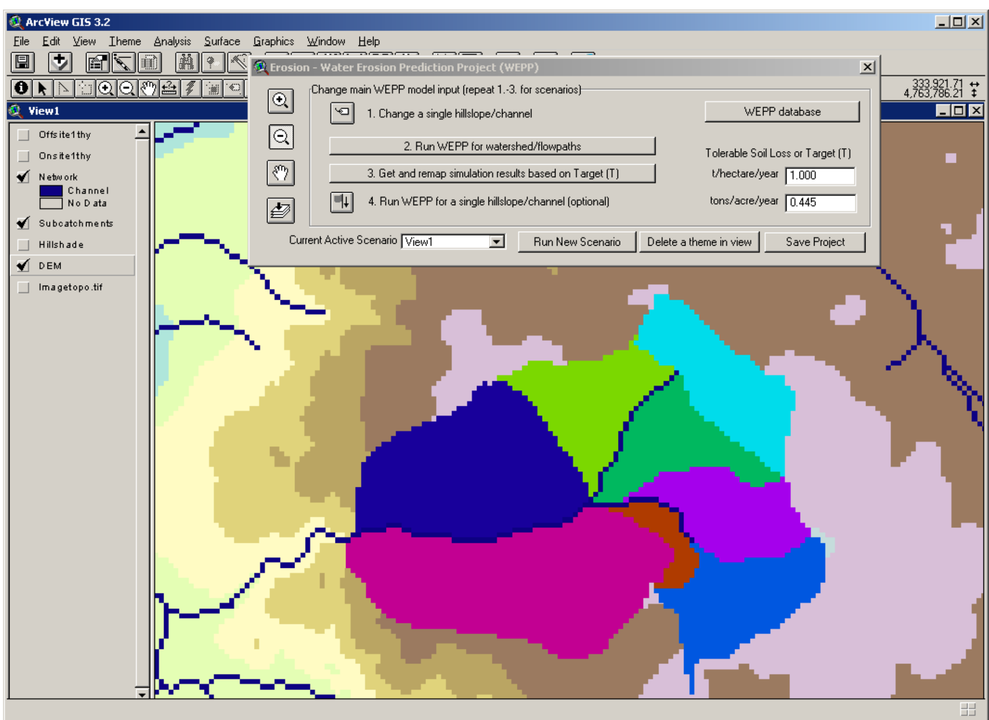
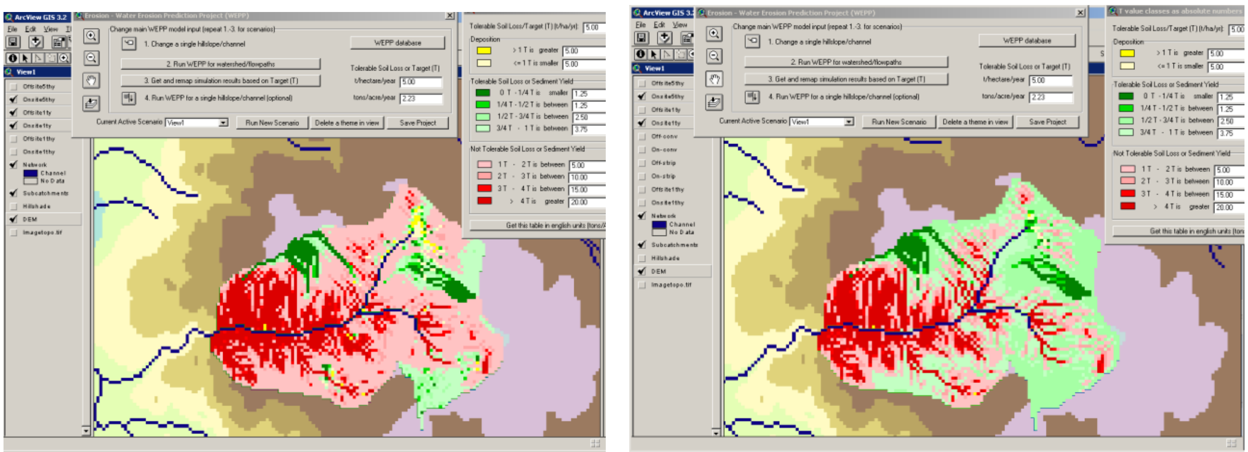


Figure 1. Subwatersheds delineation in the GeoWEPP.



(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.

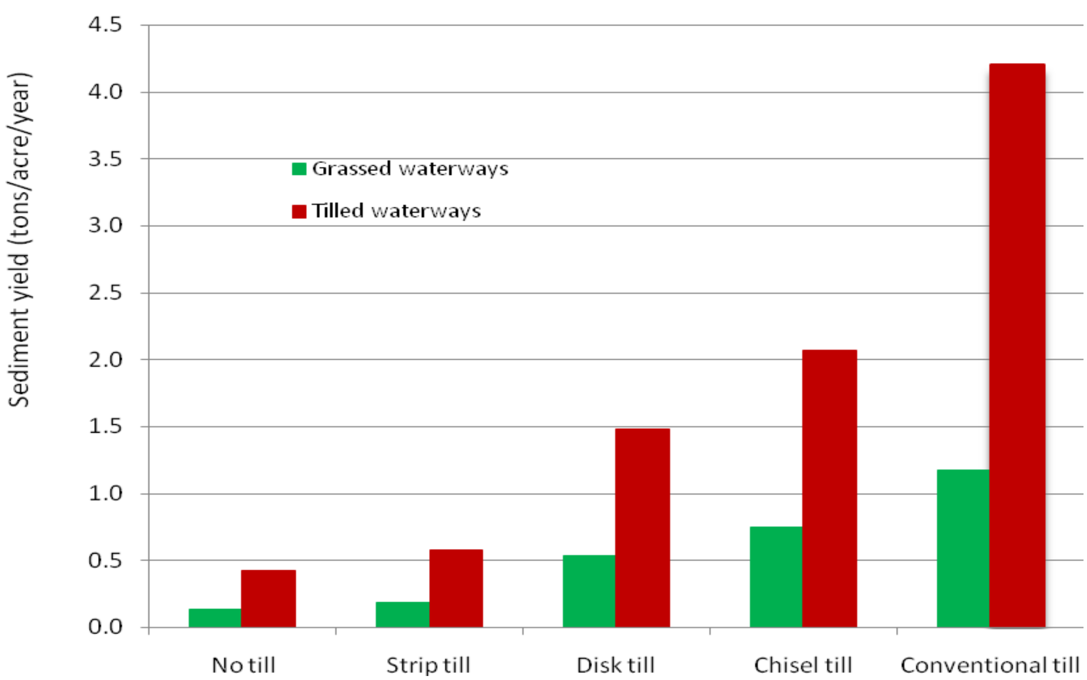


Figure 3. Comparison of grassed waterways and tilled waterways.