Iowa Learning Farms

Building a Culture of Conservation

Farmer to Farmer: Iowan to Iowan

A Whole-Farm Approach

Impacts of historical land use changes

With the expansion and evolution of agriculture over the last 200 years, Iowa's landscape is the most altered of any in the nation. Climate, technology, economics, government policy, population and globalization have significantly changed the land use and management throughout the state. A significant portion of the land's topsoil has been lost to erosion which means the remaining topsoil is even more valuable and in need of conservation. This study investigates the impacts of historical land use and management changes on soil loss and water flow, as well as reports on the environmental benefits of implementing conservation practices such as no-till, strip-till, cover crops, grassed waterways, terraces and buffers on an Iowa farm in row-crop production.

Site description

The study site is located in Osceola Co., in the Tazewell Glacial Till soil region of northwest Iowa. The Tazewell region features predominantly Everly, Wilmonton and Letri soils which are moderately well, somewhat poorly and poorly drained soils, respectively. The 1,200 acre watershed (Figure 1) is dominated by Everly soils, has an average slope of 2.5%, and is a part of the larger HUC 8 Rock River watershed. This site was chosen because of the easy access to needed historical information from a landowner who has managed land in the watershed for over 50 years.

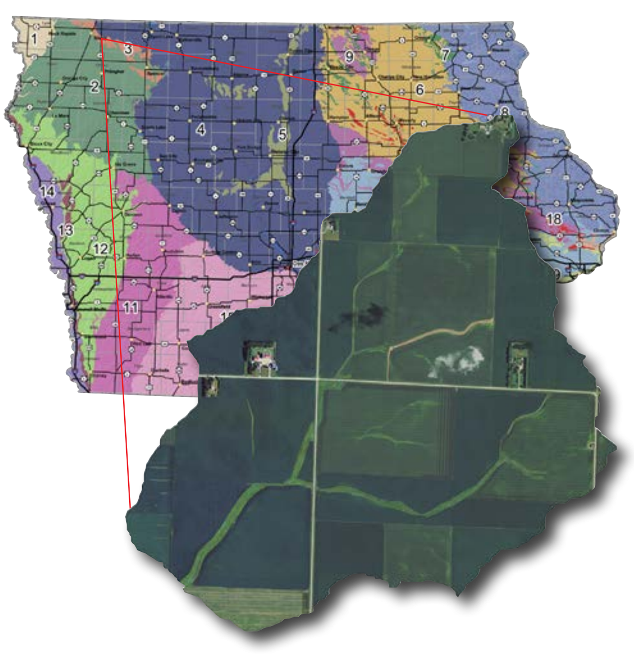


Figure 1. Study Site

Historical land use and management

U.S Census Bureau land use data from the 1930's, 1950's, 1970's and 2000's for Osceola County were applied to the watershed to reflect the use of crops grown across the county for those specific periods. Representative statistics were generated by averaging the data from at least two years in each the decades considered. The decades were chosen because they represent periods of significant agricultural changes.

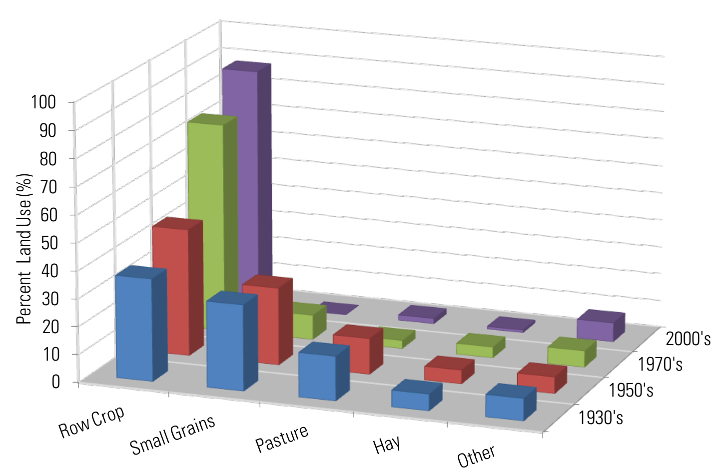
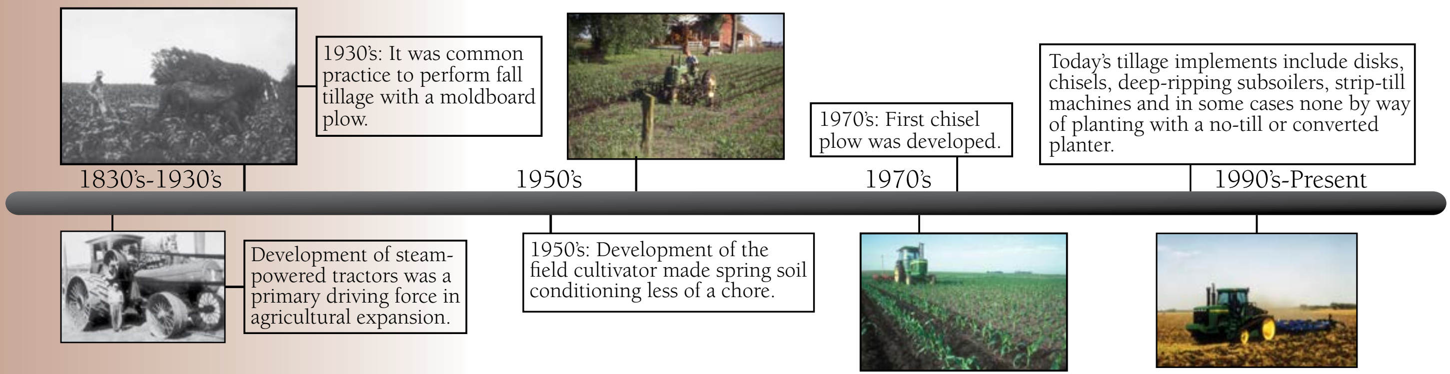


Figure 2. Historical land use data for Osceola County, IA.

The landowner supplied information on past and present management practices. This included detailed information about tillage passes, specific implements and attachments used, timing of planting, cultivating and harvesting, as well as any crop rotations in place. These data were then used in generating land use and management profiles to be implemented in a computer model (WEPP) capable of predicting soil erosion and water losses.



Model assignments and results

The study area was broken into individual subcatchments (Figure 3) to which individual WEPP management profiles were assigned proportionally to reflect county-wide percent land use and most probable locations where past management practices would have been implemented (determined via aerial photographs from each period). A pre-plow scenario, in which the land use was 100% tallgrass prairie, was modeled to provide a baseline for natural erosion and water loss rates before the development of modern production agriculture in the watershed. Numerical results for each time period are presented in Table 1. Results are presented visually in Figures 3 and 4.

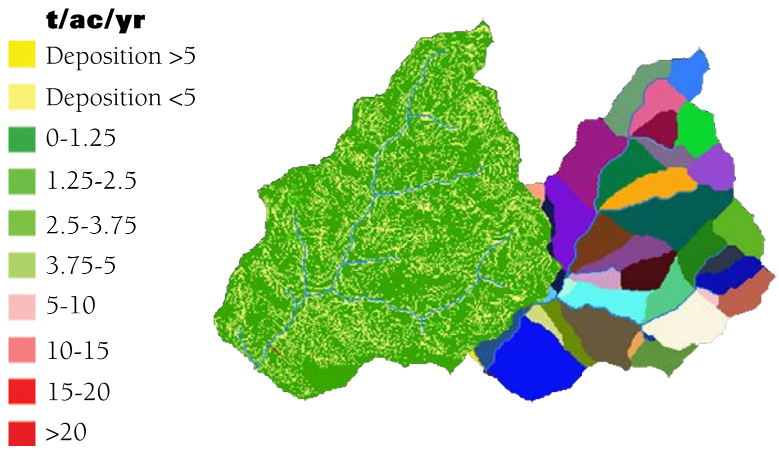


Figure 3. Subcatchments (right) and pre-plow soil erosion with tallgrass prairie (left).

WEPP, the soil erosion model

The Water Erosion Prediction Project (WEPP) model is a computer simulation that can predict soil erosion by water from hillslopes and small watersheds at the field scale. This model was used to estimate the annual sediment yield over 10 year periods using climate, topography, crop management, soil type, and watershed characteristics. Climate information was generated for the site using 100 years of meteorological data at the nearest weather station to the site located in Sibley, IA.

Water discharge

Results indicate water discharge from the watershed outlet has increased over time (Table 1). Lower water discharge during the pre-plow period is a direct reflection of the type of vegetation present as perennial native grasses and forbs uptake significantly greater amounts of water than most annual crops. Increases in water discharge over time are likely the result of expanding row-crop production and decreased use of crop rotations as areas formerly used for growing small grains, pasture and hay were converted to crops like corn and soybeans (Figure 2).

Sediment discharge and delivery

Sediment discharge during the pre-plow period was substantially lower than all other periods, due to the combination of reduced overland flow/surface runoff through increased infiltration by native plants and having vegetative coverage year round. While tillage practices may have been more aggressive in the 1930's and '50's, the 1970's saw further expansion of row crops, resulting declines in pasture and small grains, and fewer crop rotations. The management system in place today has reduced sediment discharge and sediment delivery per unit area of the field compared to other periods with row crops. However, as shown in Figure 4, there are still several specific areas of concern which could be losing soil at rates up to over 20 tons per acre per year, with over 2,000 tons of soil being exported from the watershed annually. Average rates for topsoil formation are less than 1 t/ac/yr and results indicate this watershed is losing soil at an unsustainable rate. Areas most at risk are those where water tends to flow in concentrated channels and in areas with maximum slopes ranging from 5 to 13.5 percent.

Average annual rainfall 29.1in/yr	Pre-plow	1930's	1950's	1970's	2000's
Results below are averages for a 10 year simulation					
Water discharge per unit area (in/ac/yr)	2.85	4.32	4.31	4.82	4.94
Sediment discharge from outlet (t/yr)	274	3128	4540	5559	2002
Sediment delivery per unit area (t/ac/yr)	0.24	2.63	3.80	4.65	1.66

Table 1. Numeric model results from the watershed of interest.

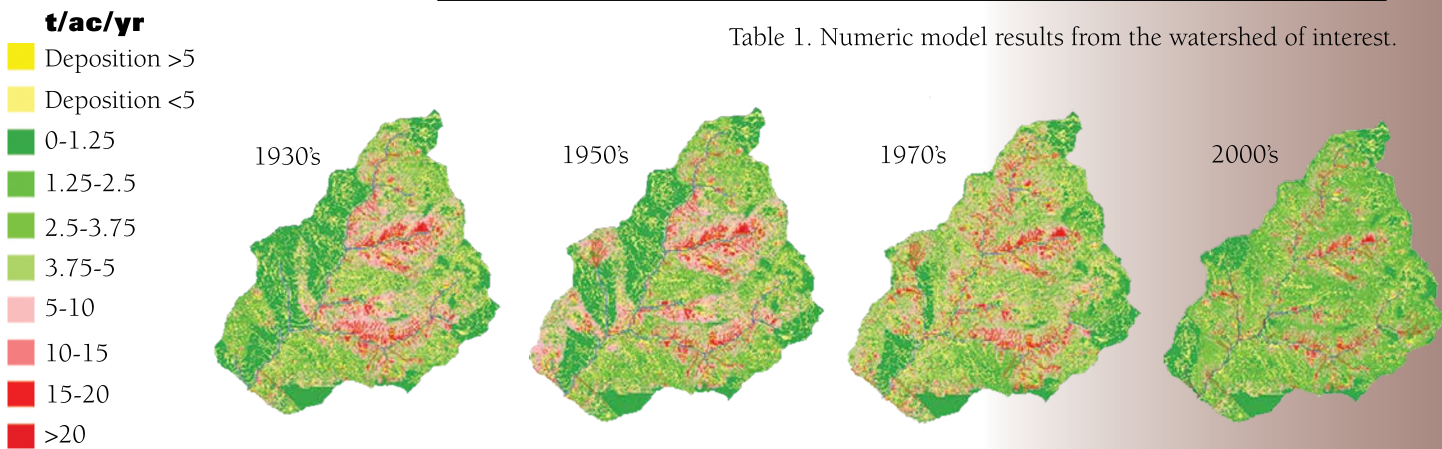


Figure 4. Visual model results for specified periods of interest.

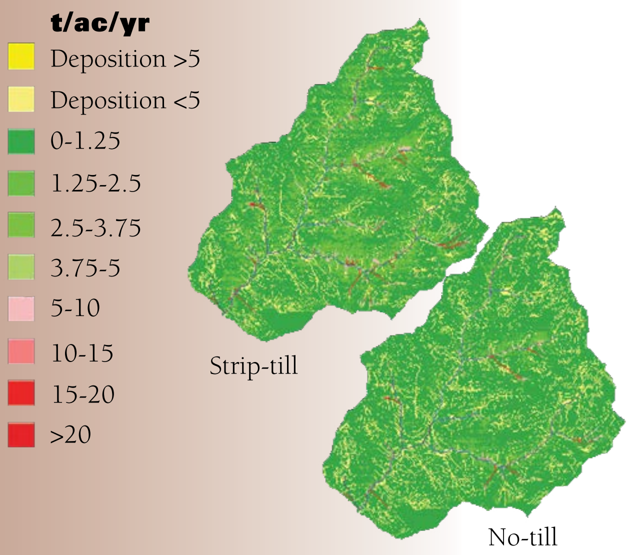
A perspective for the future

While farming practices today are doing a much better job of reducing soil erosion and increasing water infiltration, there is less topsoil available. The land continues to lose soil faster than it can be regenerated. Utilizing a whole-farm approach is key to moving toward improved soil and water quality while sustaining profitable and environmentally responsible farming operations.

Taking a whole-farm approach to conservation means:

- Implementing crop rotations which help alleviate pressures from disease and pests, ensure effective nutrient uptake with cropping schedules, preserve soil fertility and use disease-resistant cultivars to reduce chemical usage.
- Balancing crop nutrition through routine soil testing, recycling of nutrients present in crop residues, and planting winter cover crops.
- Increasing residue through strip-tillage or no-tillage practices to reduce soil erosion, slow the flow of water, build soil organic matter, and increase water holding capacity.
- Using integrated pest management, monitoring levels for appropriate selection and scaling of pesticide use, and improving habitat for increased natural levels of biological control.
- Promoting a diverse landscape through strategic placement of perennial vegetation including grassed waterways, buffers, filter strips and terraces which serve to reduce/mitigate soil and nutrient losses, promote predator/prey interactions for natural pest control, and increase wildlife habitat.
- Utilizing new technologies that assist in accurate placement and timing of fertilizers, reduced cultivation, and efficient energy consumption.

How would results differ if row crop land was converted to strip-till or no-till?



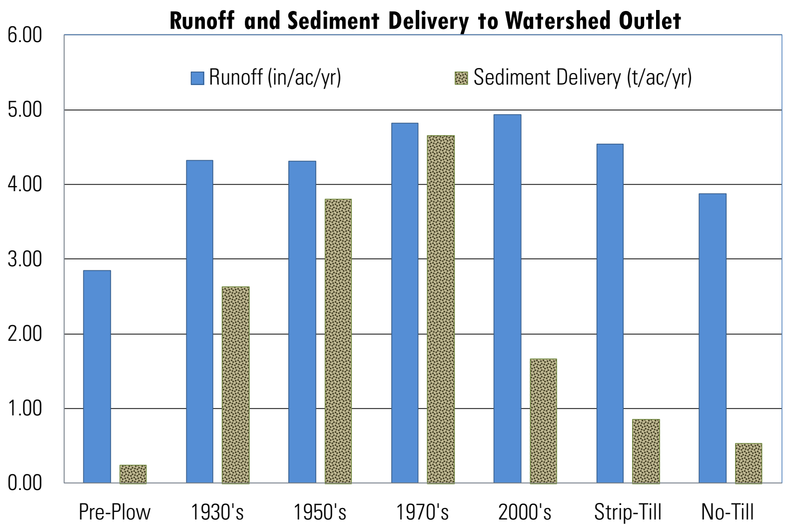


Figure 5. Visual results from conversion to strip-till and no-till (left).

Figure 6. Runoff and sediment delivery to the watershed outlet under differing historical and theoretical land use and management scenarios (right).

Agricultural land use in this small Iowa watershed is currently 90%. Although rainfall patterns, topography, soils and management practices differ widely across the state, the results of this modeling study provide insight to the benefits of implementing conservation practices such as strip-till and no-till into row-crop production systems. As seen in Figure 5, sediment delivery per unit area would be reduced in many parts of the watershed through these reduced tillage systems and could average 0.85 t/ac/yr for strip-till, and 0.53 t/ac/yr for a no-till system. Overall sediment discharge from the outlet could be reduced to 1,041 t/yr and 611 t/yr for strip-till and no-till systems, respectively. As compared to the 2000's management, sediment delivery and discharge could be nearly 50% less for strip-till and 70% less for no-till, while runoff could be 8% and 22% less for the two systems, respectively. In a time of increasing weather extremes, strip-till and no-till systems can greatly reduce annual runoff volumes and increase water holding capacity.

Furthermore, while not modeled in this study, the use of grassed waterways, terraces, stream buffers, perennial filter strips and cover crops also significantly impact soil and water quality and greatly improve the long-term sustainability of the land. Through implementation of a suite of conservation practices, producers can improve soil and water quality while maintaining a profitable and resilient farming operation for generations to come.

Look for our next two installations of "A Whole Farm Approach" which will study sites in Northeast and Southeast Iowa.

For more information

Contact the Iowa Learning Farms for more information about water quality modeling.

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