1982

G82-586 Effects of Agricultural Runoff on Nebraska Water Quality

Elbert C. Dickey
University of Nebraska at Lincoln, edickey1@unl.edu

Phillip Harlan
University of Nebraska at Lincoln

Don Vokal
University of Nebraska at Lincoln

C.J. Kisling-Crouch
University of Nebraska at Lincoln

G82-586-A

Effects of Agricultural Runoff on Nebraska Water Quality

This NebGuide discusses the effects of agricultural runoff on Nebraska water quality. Methods of controlling agricultural runoff are also examined.

Elbert Dickey, Extension Agricultural Engineer
Phillip Harlan, Extension Agronomist
Don Vokal, Extension Technologist, Agronomy
C.J. Kisling-Crouch, Technical Writer, Agricultural Engineering

---

The Federal Water Pollution Control Act Amendments of 1972 and the Clean Water Act of 1977 were written in response to a national concern for decreasing surface and groundwater quality. These laws set 1985 as a target date for eliminating pollutant discharges into navigable waters. An interim goal of the acts calls for "water quality which provides for the protection and propagation of fish, shell fish, and wildlife and provides for recreation in and on the water," where attainable, by July 1, 1983.

To accomplish these goals, each state was given the responsibility to develop a water quality management plan which identified problem areas and suggested possible solutions. Nebraska has prepared such a plan and has filed it with the Environmental Protection Agency.

To prepare Nebraska's Water Quality Management Plan, the Nebraska Natural Resources Commission sponsored public meetings and hearings for private citizens and members of organizations from across the state who were interested in this issue. Water quality data and pollution sources information were used at these planning meetings to identify eleven water quality problem areas:

1. Agricultural runoff.

2. Leaching of nitrates, pesticides and other chemicals into groundwater.
3. Improper operation and maintenance of waste water treatment plants and insufficient operator training.
4. Roadside erosion.
5. Stream bank erosion.
6. Irrigation returns flows.
7. Construction site runoff.
8. Urban runoff.
9. Residual waste disposal site contamination of surface and groundwater and land application of wastewater effluent and sludge.
10. Feedlots.
11. Septic tanks.

Although all of these problem areas are important, agricultural runoff and the resulting water quality problems are of greatest concern to Nebraska. Effective methods to alleviate these problems are also suggested in Nebraska's Water Quality Management Plan. These methods, called best management practices, are practical and manageable on a voluntary basis.

Agricultural Runoff

Agricultural runoff is excess water from rainfall and other precipitation that runs off the land. When uncontrolled, agricultural runoff removes topsoil, nutrients, pesticides, and organic materials and carries them to water bodies where they become pollutants. In Nebraska, the estimated average erosion rate is more than 140 million tons annually. By volume, sediment resulting from erosion is the nation's largest single water pollutant.

Erosion is the detachment of soil particles from clods and the soil surface. Most of this occurs during rain storms which can detach or loosen up to 100 tons of soil per acre in a severe storm. The detached soil can be transported by agricultural runoff which dislodges additional soil particles as it flows across unprotected soil surfaces. Heavier soil particles may settle out in bottomlands and on footslopes before reaching a body of water. This eroded soil can cover and destroy young plants and cause future drainage problems.

Sediment fills streams, rivers, reservoirs, lakes and roadside ditches, reducing their useful life. The once-productive soil then becomes a costly maintenance problem for taxpayers since the sediment must be removed to provide adequate water-carrying capacity and to prevent flood damage. In addition to loss of storage capacity, the sediment fills water bodies and can impair water quality. When runoff enters a water course, the lighter soil particles may remain in suspension and block sunlight vital to the growth of desirable, oxygen-producing plants living in the water. Sediment-darkened water also absorbs more heat from sunlight than clearer water, thus causing warming. The combination of warm and muddy water leads to the replacement of desirable fish species with less desirable types more tolerant to these conditions.

Nutrients and pesticides that may be present in agricultural runoff also cause serious problems. The direct effect on the producer is the economic losses connected with removing these materials. In addition, nutrients derived from soil, commercial fertilizers or animal manure may cause excessive algal growths in ponds and lakes. These growths filter out and absorb sunlight, and release offensive odors and toxicants.

The effects of pesticides on water quality can be dramatic in terms of aquatic life. These substances are

as toxic in the water as they are on the field and may affect a wide variety of aquatic organisms. If contacted or ingested in sufficient quantity, pesticides pose a health hazard to all forms of life. Water supplies can be jeopardized by the presence of pesticide or algal growths, and purification expenses must be endured by the producer as well as other users.

Best Management Practice for Controlling Agricultural Runoff

Best management practices are solutions used to reduce water quality problems caused by agricultural runoff. These are considered the most practical and effective methods for meeting water quality goals. Best management practices must keep pollutants out of the water while remaining cost-effective, especially since Nebraska's water quality management plan is voluntary. Some best management practices require construction and are relatively permanent while others, such as conservation tillage, require changes in management techniques.

Conservation Tillage

Conservation tillage is an effective and inexpensive method of controlling erosion. Tillage systems such as till plant, chisel, disk, and no-till can be classified as conservation tillage systems providing that a 20 to 30 percent residue cover remains on the soil surface after planting. These residues protect the soil during the critical erosion period from seedbed preparation to crop canopy establishment. Residue dissipates raindrop impact and reduces the movement of soil. Of the conservation tillage systems available, no-till provides the best erosion control since it leaves the maximum amount of residue on the soil surface. Recent Nebraska research indicates that the no-till system can reduce potential soil losses by 90 percent of that which occurs with the moldboard plow system (*Figure 1*).

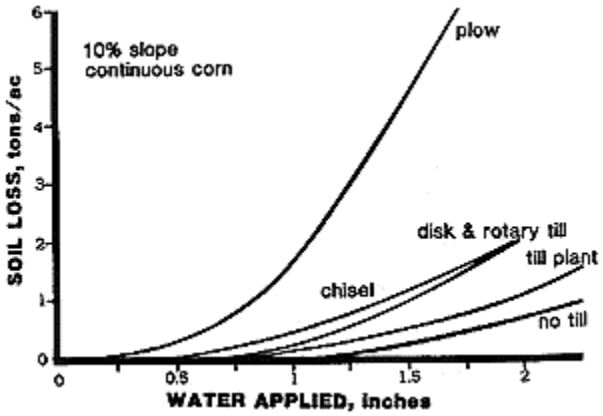

Figure 1. Measured soil losses from various tillage systems evaluated at the University of Nebraska Northeast Station near Concord. The rainfall application rate was 2.5 inches per hour.

Moisture conservation is an additional benefit of conservation tillage systems. The residue slows the runoff rate, thus allowing more time for infiltration. The mulch created by the residue also reduces moisture losses caused by evaporation. Increased production yields can be obtained in low rainfall areas or during dry years because of the additional moisture present. However, in some years and on some soils, the increased soil moisture and crop residue may delay planting because of slow soil drying and warm-up.

Conservation tillage offers substantial fuel and labor savings as well as moisture conservation and erosion control. When compared to the moldboard plow system, no-till can save as much as 70 percent in fuel and more than 50 percent in labor. By reducing the number of operations, other conservation tillage systems can also realize a portion of these savings.

Contour Farming

Contour farming decreases erosion by creating furrows around rather than up-and-down the hills. Crops planted up-and-down hill form natural channels that concentrate the runoff and accelerate soil erosion. On steeper slopes, the damage caused by up-and-down hill farming can be even greater because of the

increased velocity of the water. Contour farming interrupts these channels and reduces soil loss. Furrows around the hill also act as small dams or terraces and hold water, allowing more time for infiltration. Even with the moldboard plow system, farming on the contour can potentially reduce soil losses by 50 percent as compared to up-and-down hill plowing.

Crop Rotation and Strip Cropping

Crop rotations that include small grains or other cover crops create a vegetative cover which protects the soil surface from erosion. Certain cover crops, such as grasses, can create a vegetative filter which removes sediment and slows the rate of runoff. Sod or legume cover crops aid in improved soil structure because of their root systems. This improved soil structure also decreases the rate of runoff and the amount of erosion.

Strip cropping is a series of alternate strips of crops laid out so that all tillage and crop management practices are performed across the slope or on the contour. This system functions most effectively when strips of small grains or close-growing perennial grasses and legumes are alternated with row crops. When planted on the contour, these strips create a vegetative filter and can reduce soil erosion losses considerably.

Terraces

Terraces reduce soil erosion by breaking a long slope into several short sections. This reduces the speed of runoff and the amount of sediment that can be transported. Runoff collected in the terrace channel can be stored for infiltration or safely diverted by grassed waterways or tile outlets to lower ground. Considerations for terrace construction include suitable terrain, soil characteristics, annual precipitation, and construction and maintenance costs.

The two basic terrace layouts are contour and parallel. On irregular or slightly sloping ground with shallow topsoil and unproductive subsoil, contour terracing may be advantageous. These terraces are built to follow the land's contour with only a minimal amount of soil excavation. Because of construction techniques, contour terraces are generally less expensive to build than parallel terraces. Parallel terraces, laid out equidistant from each other, avoid the problem of point rows commonly associated with contour terraces. Although somewhat more expensive to construct, parallel terraces systems are easier to farm with large equipment.

To ensure that terraces reduce erosion, runoff must be safely carried to locations below them. Tile outlets can be used in terrain that is too steep for successful use of grass waterways. These outlets have an advantage over grass waterways in that they are easy to maintain and do not remove land from production. Grass waterways, however, are less expensive to construct.

Grassed Waterways

Used alone or as outlets for terraces or other diversion structures, grassed waterways provide for the controlled release of runoff water along natural drainage ways. They are constructed by grading and shaping the drainage way so as to reduce the erosive force of runoff water. Grasses that tolerate running water are planted to diminish the water's force, anchor and protect the soil, and filter out sediment.

Grassed waterways allow the producer to cross the natural drainage ways in the field with equipment. This saves time spent on avoiding deep gullies or repairing damage caused by unrestricted runoff. They also make excellent boundaries between crops, provide nesting cover for wildlife, and may be

judiciously used for grazing or hay production.

The cost of installing grassed waterways depends on the degree and length of slope, the amount of erosion repair and grading needed, and the difficulty encountered in establishing adequate grass cover. To stimulate new growth and control weeds, mow and rake waterways several times a season. Remove accumulations of sediment to avoid smothering vegetation and restricting the capacity of the waterway. Never use the waterway as a lane or stock trail, especially in wet weather.

Ponds and Debris Basins

Runoff water can be slowed down or stopped by ponds, basins and similar structures before it has a chance to reach erosive velocity. The water can then be stored and released in a controlled manner. Ponds or debris basins can be constructed by building a dam across a natural or manmade drainage way, by excavating a pit in the drainage way or by diverting water into a natural or man-made depression. Some water-holding structures may be used specifically as catch basins to trap the sediment in impounded water. Structures that hold and control the release of potentially erosive runoff play a vital role in reducing soil losses and improving water quality.

Ponds should be fenced to limit access by livestock in order to avoid further degradation of water quality. Establish the vegetative cover of grasses as soon as possible following construction to protect the pond and to reduce erosion of the banks and dam. Since ponds collect and trap sediment from agricultural runoff, they eventually lose their water storing capacity. Careful management and the use of practices such as conservation tillage, terraces, and grassed waterways can increase the useful life of ponds by preventing undue amounts of sediment from reaching them.

Water quality problems resulting from agricultural runoff can be reduced by adopting and implementing best management practices. These practices, used alone or in combination, are considered the most practical and effective methods for meeting water quality goals. The process of their selection involves several factors since they must keep pollutants out of the water while remaining cost- effective.

File G586 under: WATER RESOURCE MANAGEMENT
A-7, Water Quality
Issued January 1982; 15,000 printed.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Elbert C. Dickey, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.