THE BEAVER CREEK STORY

Beaver Creek watershed in West Tennessee covers about 95,000 acres and includes some of the Nation's most productive farmland and most highly erodable soils. A preliminary assessment of the Beaver Creek watershed, conducted by the Tennessee Department of Environment and Conservation, indicated that agricultural activity was degrading water quality. In 1989, the Tennessee Department of Agriculture (TDA) and the U.S. Geological Survey (USGS) began a cooperative study (1) to evaluate the effect of agricultural activities on water quality in the watershed and to determine the effectiveness of agricultural best management practices (BMPs) designed to improve water quality by reducing agricultural nonpoint-source (NPS) pollution.

The project gained momentum in 1990, when the Beaver Creek watershed was added to the U.S. Department of Agriculture's list of Hydrologic Unit Areas, qualifying it for educational, technical, and financial resources to improve water quality. A local coordinating committee was formed consisting of county, state, and federal agencies, and most importantly, local farmers. Each group had some responsibility for the Beaver Creek project, such as providing information about conservation methods, BMP implementation, or water quality evaluation.

The following questions were considered before coordinating the project:

- Where should the watershed be monitored for NPS pollution?
- What parameters should be monitored to measure NPS pollution?
- When is the most effective time to collect data that represents NPS pollution?
- What is the effect of implementing agricultural BMPs on water quality?

These questions have been answered. The results from these studies are summarized in this brochure.

WHERE TO MONITOR?

Agrichemical monitoring included testing the soils, ground water, and streams. Four farm sites ranging in size from 27 to 420 acres were monitored. Monitoring stations were operated downstream to gain a better understanding of the water chemistry as runoff moved from small ditches into larger streams and, eventually, to the outlet of the Beaver Creek watershed.

WHAT TO MONITOR?

Soil tests (subsurface sediment, surface sediments), pesticides were monitored to determine if they were getting into the stream. Pesticides and nutrients also can penetrate into the soil through agricultural migration in the soil was evaluated. Information, if ground water was affected, the biological health of the stream was measured by collecting and identifying aquatic organisms at numerous stream sites.

Information was needed to define the migration of agrichemicals in the soil and streams. The number of soil and water-quality samples was established from preliminary studies in order that adequate representation of the concentration and flow was obtained.

WHEN TO MONITOR?

Agrichemicals can be flushed from the fields during storm runoff. Thus, stream sampling took place during storm events. Soil and ground-water samples were collected in storm information to see if the agrichemicals moved downstream to the water table.

MONITORING ACTIVITIES

Soil Profile Within the Fields

Five soil samples were collected between two rows and two splits, sampling at a single location in the field (fig. 1). These soil samples were duplicated at several locations in the field to establish a representative distribution of pesticides over time and space. Samples were collected at different depths each time to determine if the pesticides were moving into the ground water.

SAMPLING LOCATIONS

Streams Draining the Fields

An optimal sampling strategy for characterizing chemicals and suspended sediment in agricultural runoff includes frequent sampling during stormflow and less frequent sampling after a storm and during periods of dry weather. A sampling interval equal to 5 percent of stormflow duration was determined to be adequate to characterize concentrations of constituents during stormflow with accuracy of less than 5 percent. Thus, for a stormflow duration of 100 and 200 minutes, the interval was 5 and 15 minutes, respectively.

The health of a stream is reflected by the number and type of benthos-swimming organisms that live in the stream (biomonitoring). Biomonitoring results varied slightly, depending on the sampling technique used. Potential biases resulting from the various sampling techniques were reduced by using different sampling techniques.

Soil and Ground-Water Results

No till farming techniques did not increase ground-water contamination in the Beaver Creek watershed. Elevated dispersion of aldicarb, a metabolite of aldicarb, and other aldicarb metabolites in the soil profile was negligible. The transport of aldicarb from a soil seed treatment was minimal in the contamination, and in the no-till fields. About 85 percent of the aldicarb was found within the first half foot below the soil seed. No residue was detected below 2.5 feet. The shallow depth of transport attributable to the low permeability of the soils, decreased amounts of rainfall, and high rainfall of summer and plant transpiration during the summer months.

Figure 1. Schematic of the soil sampling strategy.

Natural, nonbiological reactions appear to be the primary mechanism for degrading aldicarb and its metabolites in the soil profile. The calculated half-lives of aldicarb metabolites in the field were much less than those derived from laboratory experiments. In the laboratory, the toxic by-product of aldicarb can last almost 3 years, but in cotton fields, it degrades to nonoxic compounds in about 2 weeks.

Surface Water Results

Suspended sediment resulting from erosion is the major water-quality problem in the watershed. Runoff from 45-acre fields is cleaner than runoff from corn-soil fields. However, the slower water movement and storms are longer, organisms were not as affected by suspended sediments from the stream channel. BMP's to reduce sedimentation were more effective in the channelized channel; consequently, water sampled in the Beaver Creek watershed. Preliminary results from suspended sediment interactions with biological habitat and nonpoint nutrient inputs in the stream.

About 85 percent of the total nitrogen carried by storm runoff is organic nitrogen. About 75 percent of this organic nitrogen is flushed from the fields during late summer and early spring storms. Thus, BMP's that prevent field erosion during the non-growing season can help to reduce nitrogen runoff. Inorganic nitrogen (nitrate and nitrite) is only 50 percent of the total nitrogen runoff load. About 50 percent of the inorganic nitrogen is flushed from the fields during late spring storms. Only 10 percent of the nitrogen is flushed during the growing season probably because of assimilation and less precipitation.
The results of the Beaver Creek watershed study have increased the understanding of the effects of agriculture on water resources. Study results also demonstrated that BMP's do protect and improve water quality. This information can help water managers, farmers, and others to protect and improve the quality of the environment for future generations.

**Effectiveness of BMP's**

Prior to the implementation of BMP's at one of the farm study sites, some storms produced an average suspended-sediment concentration of 70,000 milligrams per liter (mg/L). After the implementation of BMP's, however, the average value never exceeded 7,000 mg/L, which is a tenfold reduction.

No-till crop production was the most effective BMP for conserving soil on the farm fields tested. Other studies have also found that no-till farming preserves the structure of the soil and retains the crop residues from the previous season.

A natural bottomland hardwood wetland and a constructed wetland were evaluated as instream resource-management systems. The wetlands improved water quality downstream by acting as a filter and extracting a significant amount of NPS pollution from the agricultural runoff. The constructed wetland reduced the nutrients, sediment, and pesticide load by approximately 50 to 90 percent over a 4-month period (fig. 2).

Streambanks tend to be more stable if vegetated with large trees rather than herbaceous plants; however, downcutting can still occur.

**Nitrogen Phosphorus Sediment Metolachlor Acifluorfen**

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Sediment</th>
<th>Metolachlor</th>
<th>Acifluorfen</th>
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<td>0.15</td>
<td>0.05</td>
<td>0.5</td>
<td>0.02</td>
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From 1991 to 1995, aldicarb and its metabolites (aldicarb sulfoxide and aldicarb sulfone) were detected in runoff from the farm fields with the highest concentrations measured during a storm event only hours after aldicarb was applied. This result demonstrates the importance of weather conditions and farming activities on agricultural runoff. No aldicarb was detected in storm-runoff samples collected a few weeks after application. However, the metabolites were detected as late as 76 days after an aldicarb application.

**REFERENCES**


Organizations involved in assessment studies in the Beaver Creek area:

- U.S. Department of Agriculture, Natural Resources Conservation Service
- Tennessee Department of Agriculture
- Tennessee Department of Environment and Conservation
- Shelby County Soil and Water Conservation District
- University of Tennessee Agricultural Extension Service
- The University of Memphis
- The University of Tennessee
- The Tennessee Soybean Promotion Board

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Further information can be obtained by contacting your County Extension Agent. An Extension Publication Catalog can be obtained by e-mailing: Sundra@AES.gw.utm.edu.

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- U.S. Geological Survey, Branch of Information Services
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