Solutions: Best Management Practices (BMPs)

Point sources of pollution were regulated through federal legislation (The Clean Water Act) in 1972. As a consequence, 60% to 80% of the pollution that now occurs in U.S. waters comes from NPSs (USEPA 1995). To reduce the impact of NPS pollution, changes in management must occur. Pollutants from NPSs can be controlled through the use of BMPs.

Best management practices are used to protect and conserve natural resources. Some BMPs are used to protect water resources, while other BMPs are implemented to protect wildlife habitat, both terrestrial and aquatic. Still other BMPs are utilized to protect land resources from degradation by wind, salt, and toxic levels of metals. By controlling pollutants derived from agricultural or urban sources, BMPs can reduce or prevent impacts to the physical and biological integrity of surface water, groundwater, and land resources.

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Best management practices can be either structural (waste lagoons, terraces, sediment basins, or fencing) or managerial (rotational grazing, nutrient management, or conservation tillage). Both types of BMPs require good management to effectively reduce agricultural NPS pollution.

Factors controlling BMP effectiveness

Best management practices are used to reduce the effects of all forms of pollutants. They use a variety of mechanisms that result in varying degrees of effectiveness. When selecting BMPs, you should use a systematic approach to ensure that the practice you select will solve your problem. The following questions can help you in the selection process:

1. *What pollutants are contributing to the problem?*
   Sediment, nutrients, bacteria, etc.
2. *Where are the pollutants being transported?*
   Surface water or groundwater
3. *How are the pollutants being delivered?*
   Availability, transport paths, in the water or on sediment

You also need to remember that the most effective plan will probably consist of several different BMPs that target different mechanisms. Some BMPs may solve a surface water quality problem but create a groundwater quality problem. This should be considered when the selection is being made rather than after a new problem arises. The BMPs for your operation should be designed (and the installation reviewed) by an expert trained in these systems. Finally, if a BMP is not economically feasible and well suited for the site, you probably should not use it. When selecting BMPs, consider all costs including effects on yield, production and machinery costs, labor and maintenance, and field conditions. Often a very effective BMP will rapidly become a problem if all of the costs are not considered before implementation.

All activities within a watershed affect NPS pollution, but control of soil erosion is probably the best opportunity for preventing pollution since sediment is not only a pollutant itself, but also carries nutrients and pesticides with it. While soil erosion is a natural process, it is accelerated by any activity that disturbs the soil surface. The amount of soil erosion that occurs is related to five factors: the rainfall and runoff, the soil erodibility, the slope length and

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steepness, the cropping and management of the soil, and any support practices that are implemented to prevent erosion. Man can do very little to change the rainfall a location receives and has little effect on the soil's natural properties that affect erosion. However, man can manage to reduce the impact of these factors. For example, increasing the amount of rainfall that goes into the soil (infiltration) is an indirect means of reducing erosion. Knowledge of rainfall patterns will also allow farmers to ensure that the soil is protected during the periods of the year when they receive the largest amounts of rainfall. Traditionally, farmers have controlled soil erosion through modifications in slope steepness and slope length and in cropping and management. Since the dawn of agriculture, man has known that longer, steeper slopes produce more soil erosion and has used methods such as the construction of levies and terraces to reduce slope length and steepness. More recently, practices such as strip cropping and vegetated waterway construction have been used to reduce runoff velocities and slope length. Crop canopy and surface cover or residue acts as a buffer between the soil surface and the raindrops, absorbing much of the rainfall energy and ultimately reducing soil erosion. Therefore, crops that produce more vegetative cover, have longer growing seasons, or produce a persistent residue will have less soil erosion. Any cropping system with less tillage or greater amounts of vegetative production, such as perennial systems, will result in less sediment leaving the field.

While most BMPs reduce soil erosion and transport, some BMPs use other mechanisms to reduce a pollutant's impact. Best management practices may be effective by addressing any of these three stages to the pollutant delivery process: availability, detachment, and transport. Availability is a measure of how much of a substance in the environment can become a pollutant. For example, an effective BMP for reducing the amount of animal waste entering surface water is to simply decrease the amount that you are land applying to an area so less waste is available. Once a substance is available; however, it must be detached from the target site to become a pollutant. Pollutants may be detached as individual particles in the water or attached to soil particles. If a pollutant is soluble, then detachment occurs when it is dissolved in water. For example, dry manure or litter applied to the surface is more easily detached than the same amount of liquid manure that has soaked into the soil. To become a pollutant, the element must travel from the point where it was applied to the surface water or groundwater. Surface runoff or infiltration often transports pollutants; however, this transport can often be reduced through BMPs. For example, using a filter strip to collect sediment before water enters a stream is an example of reducing the amount of pollutant transport.

BMP systems

The installation or use of one structural or management BMP is rarely sufficient to completely control the pollutant of concern. Combinations of BMPs that control the same pollutant are generally more effective than individual BMPs. These combinations, or systems, of BMPs can be specifically tailored for particular agricultural and environmental conditions, as well as for a particular pollutant (Osmond et al. 1995).

A BMP system is any combination of BMPs used together to comprehensively control a pollutant from the same source. When a pollutant originates from more than one source, a separate BMP system should be designed to reduce pollutant loss from each source. For example, if the problem is sediment from cropland, the BMP system to control field erosion would be different than if the sediment originated from cattle in the riparian buffer. To control sediment from livestock activities, fencing, revegetation of the riparian buffer, strategically located water troughs, and rotational grazing could be combined into a BMP system. The control of sediment from croplands could consist of many different techniques, including minimum tillage, strip cropping, field borders, and other practices.

An individual BMP can only control a pollutant at its source, during transport, or at the water's edge. A BMP system is generally more effective in controlling the pollutant since it can be used at two or more points in the pollutant delivery system. It can be designed to reduce N at the source and during transport, as well as to remediate the N at the water's edge. Nutrient and manure management should be used to minimize N additions to surface water and groundwater (source reduction) but maintain yields.

On average, only 40% to 60% of N fertilizer is used by crops (Gilliam et al. 1997). The remainder of the N becomes part of the soil organic matter, moves into the groundwater, denitrifies (becomes gaseous N_2), or runs off with surface water. Field borders can be used to slow runoff from the field, decreasing N transport by increasing N and water movement into the soil and increasing N absorption by the field border crop. Nitrogen that is not controlled by nutrient management and field borders can be intercepted and remediated by riparian buffers along the water resource. Nitrate-N (NO_3-N) associated with groundwater can be either denitrified by soil bacteria or absorbed by the riparian vegetation. Riparian vegetation can trap organic N attached to soil particles flowing overland. Used in conjunction as a system, these BMPs will reduce N loads into surface water and groundwater.

No single "ideal" BMP system can control a particular pollutant in all situations. Rather, the BMP system should be designed based on the

- Pollutant type, source, and cause;
- Agricultural, climatic, and environmental conditions;
- Farm operator's economic situation;
- System designer's experience; and
- Acceptability by the producer of the BMP components.

However, even properly designed BMP systems constitute only part of an effective land treatment strategy. For a land treatment strategy to be really effective, properly designed BMP systems must be placed in the correct locations in the watershed (critical areas) and the extent of land treatment must be sufficient to achieve water quality improvements (Line and Spooner 1995). Generally, 75% of the critical area must be treated with the appropriate BMP systems. If the problem derives from livestock, generally 100% of the critical area within the watershed must be treated with BMP systems (Meals 1993).

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