Best Management Practices for Row-Crop Agriculture

BEST MANAGEMENT PRACTICES

FOR POLLUTION CONTROL

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BEST MANAGEMENT PRACTICES FOR ROW–CROP AGRICULTURE

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by
Rolland Z. Wheaton
Visiting Professor
and
Edward B. Hale
Extension Specialist

Department of Agricultural Engineering
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

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Introduction

Increased public concern about water quality and the need to clean up the nation's lakes and streams resulted in the passage of PL 92-500 (the Federal Water Pollution Control Act Amendments of 1972) and the Clean Water Act of 1977. Section 208 requires planning for the control of both point and nonpoint sources of pollution. (The planning activities are described more fully in the publication entitled "Best Management Practices in Agriculture and Forestry", publication 4 WCB 1, January 1980).

Crop Production and Water Quality

Pollution resulting from cropping activities is classified as nonpoint. Nonpoint pollution usually results from rainfall or snow melt. Thus, it is evident that most pollution from agricultural fields is the result of erosion and runoff.

The major contaminants in the runoff are sediment, nutrients, pesticides, organic materials, and sometimes disease producing organisms. Of these, sediment is by far the largest volume of material. Also, most of the phosphate and pesticides which come from agriculture are associated with the sediment.

This suggests that one way to obtain a major improvement in the quality of agricultural runoff is to control erosion. However, not all eroded soil reaches the State's waters and not all water pollutants are the result of erosion. Row-crop land is particularly subject to soil erosion, Fig (1). To understand how erosion occurs, the process and factors which affect it will be examined.

Erosion Sedimentation Process

The erosion sedimentation process consists of three separate parts.

1. Detachment of the soil particle
2. Transport of the soil particle
3. Sedimentation or settling out of the particles

These three steps may occur several times between the original detachment and when the particle reaches the stream or lake.

High intensity rainfall causes most of the soil erosion. Normally these intense rains occur in the spring or summer. But, the sediment transport of major rivers occurs during the high flow periods, especially the first high flow following the low flows of late summer and fall. For smaller streams or rivers, the sediment load may or may not be in phase with the erosion in the field.

Factors Which Influence Erosion

The **rainfall characteristic** has a major effect on soil erosion. Two inches of rain received in several hours may produce very little erosion, but 2 inches in one-half hour will likely produce considerable erosion. The quantity of rainfall is important, but the intensity of the rainfall has a more significant effect on the amount of the soil erosion. The energy of the falling raindrop detaches soil particles, making them available for transport. Therefore, protection of the soil surface from the falling raindrop will reduce erosion. Cover is one of the more effective methods of erosion control.

Runoff starts as the rainfall exceeds the intake rate of the soil, and the small surface depressions are filled. It may begin as uniform sheet flow, but it soon concentrates into small rivulets resulting in small rills being eroded. If the small flows are not controlled, they will combine, eventually producing gullies. Also as the flow in the channels increases, the velocity increases and the ability of the water to detach and transport soil particles increases rapidly. Techniques which reduce the quantity and the velocity of the water will reduce erosion. This is the basis of many structural and some tillage and management methods of erosion control.

Soil type and physical conditions influence the amount of erosion resulting from a storm. Some soils have a great deal of resistance to erosion while others are very easily detached and transported. Good soil structure is important for erosion resistance. Excess tillage and poor cultural practices can destroy the soil structure.

Figure 1. Erosion of Rowcrop Land

The soil type cannot be changed but good cultural practices which assist in forming the best possible structure will increase the soil's resistance to erosion.

Soil cover is an effective method of reducing soil erosion. Growing plant canopies and mulches provide effective cover. Tillage and cultural methods should be practiced which will keep good cover on the soil for as long as possible. Besides absorbing the energy of the raindrops, cover increases the soil intake rate, reduces the velocity of runoff, and has a beneficial effect on the soil structure.

Slope length and steepness influence the erosion rate. The longer the slope, the greater will be the quantity of runoff water. Larger quantities of water have higher velocity and concentrate into definite flow patterns. Both factors increase the potential for erosion. The steeper the slope, the more rapid will be the rate of runoff and thus erosion.

Usually it is not practical to grade the land for slope control. But tillage operations which go across the slope rather than up and down channel the runoff water across the slope, in effect reducing the slope steepness. Structural practices such as diversions and terraces reduce the effective slope length. Contouring and cross slope tillage have some of the same effects.

Cropping practices affect soil erosion. The benefits of cover and cross-slope tillage have been referred to. If the crop protects the soil during the more intense storms it will be especially beneficial. A good stand of grass or hay is one of the best covers.

A crop which produces considerable organic material will provide good protection, especially if this is left on the surface or only partially worked into the soil. In this manner, a corn stalk residue is superior to the residue from soybeans for protection of the soil following harvest. Good cropping and tillage practices are an excellent means of protecting the soil.

Conservation measures can be designed and installed for soil erosion control. These range from the structural measures of terraces, diversions, and waterways to contour tillage, strip cropping, and filter strips. They are effective by controlling the runoff water. Usually structural conservation measures need to be combined with cropping and tillage practices to be most successful. Table 1 lists these factors which influence erosion.

From this discussion it is evident that the practical approach to reduction of nonpoint pollution is the prevention approach.

TABLE 1.
Factors which influence the erosion process and the possibility of their control or modifications.

Factor	Potential for Control
Rainfall Intensity	Uncontrollable
Rainfall Amount	Uncontrollable
Soil Type	Uncontrollable
Soil Physical Condition	Controllable
Surface Roughness	Controllable
Cover	Controllable
Length of Slope	Controllable
Steepness of Slope	Control very difficult

Benefits of Erosion Control

Erosion control has many benefits to society and to the farmer. The social benefits will be observed as improved water quality resulting in increased beneficial use of the state's lakes and streams. Erosion control will reduce the sediment, nutrients, and pesticides in the water. Water supplies, fisheries, and recreational uses will expand.

The farmer will see the benefits of improved soil fertility and physical condition and crop production. Also, good management of livestock wastes, chemical fertilizers and pesticides should improve yields. It is the objective of the plan to assist agriculture in meeting the requirements of the Clean Water Act of protecting and improving the water quality while maintaining agricultural productivity.

Best Management Practices

BMPs are structural or management practices that can be used to reduce conditions which degrade the quality of the ground or surface waters. For purposes of this publication, the BMPs listed in the Agricultural Handbook, Planning Bulletin 316, that are applicable for the reduction of erosion and related pollutants, will be divided into the following three categories:

1. Structural measures
2. Conservation tillage and cultural practices management
3. Land use changes

The practices and numbers are taken directly from the Handbook which gives additional details about each practice and where it is applicable.

1. Structural Measures

   1.11 Diversion
   1.28 Terrace
   1.30 Waterway or Outlet

   1.15 Grade Stabilization Structure
   1.25 Streambank Protection
   1.10 Debris Basin
   1.22 Pond
   1.31 Sediment and Water Control Basin

   1.01 Access Road
   1.12 Fencing

2. Tillage and Cultural Practices

   In addition to those practices listed under Sediment and Erosion Control, several BMPs listed in the section on Animal Waste and Fertilizer Control and the section on Pesticides and Other Toxic Substances Control are applicable to row crop agriculture.

   1.03 Conservation Cropping System
   1.17 Minimum Tillage
   1.02 Chiseling and Subsoiling

   1.05 Contour Farming
   1.24 Row Arrangement
   1.26 Stripcropping

   1.07 Cover and Green Manure Crops
   1.09 Crop Residue Use
   1.18 Mulching

   1.14 Filter Strips
   1.16 Irrigation Water Management
   1.19 Pasture and Hayland Management
   1.20 Pasture and Hayland Planting

   2.17 Soil Testing and Plant Analysis
   2.03 Timing and Methods of Application of Animal Wastes
   2.14 Waste Utilization and Disposal
   2.18 Proper Fertilizer Application
   2.19 Slow Release Fertilizers

   3.02 Applicator Certification
   3.01 Alternative Pest Control Methods
   3.03 Determination of Optimum Pest Control Methods

   3.06 Proper Application of Pesticides
   3.04 Prevention of Overtreatment
   3.05 Prevention of Water Source Contamination

   3.07 Cleaning Pesticide Application Equipment
   3.08 Disposal of Unused Pesticides
   3.09 Disposal of Pesticide Containers
   3.10 Proper Storage of Pesticides

3. Land Use Changes

   1.08 Critical Area Planting
   1.13 Field Windbreaks
   1.14 Filter Strips
   1.20 Pasture and Hayland Planting

In comparing these categories it will be noted that the **structural measures** usually have higher initial costs, but have lower annual costs. They require proper design and construction and have a degree of permanency. They may require some limited land use changes, but are most likely to require changes in tillage or management techniques, for example, a row direction change. Structural measures can be a very effective means of water quality improvement and they may allow continuation of a more intense cropping practice than would be possible without them. They are effective in controlling erosion by controlling the quantity and velocity of runoff.

The **conservation tillage and cultural practice management group** will have low initial cost, but have higher annual cost in the form of dependence on the farm operator for changes in operation and management. Some of the tillage systems may have lower annual machinery costs than those that are now used. But they require a change in the operation, management, and often a change in machinery. Therefore, they may be slow in acceptance. This group is effective in controlling erosion through protection of the soil surface from raindrops, by improving the soil structure and infiltration rate and by reducing runoff velocity. The management and wise use of the nutrients and chemicals will maintain their benefits, may reduce the quantities needed, and will result in reduced pollution.

Land use changes will be needed where some combination of the other practices does not do an adequate job of erosion control or where a change in land use is a more practical solution. For the cash corn-soybean operator, this may mean dedication of small areas or strips to permanent vegetation. If livestock are involved, some fields may be placed in permanent pasture haycrops or rotations.

How BMPs are Selected

The selection of BMPs for water quality improvement is specific to the problem and to the individual operation. Working with the owner or operator, the planner will review the problems, the soils, the farm operation and present conservation practices to determine which BMPs can be applied to meet the water quality objectives.

Most plans will consist of several BMPs combined into a farm conservation system.

In some cases, alternative plans may be developed for review and selection. Some group projects may be desirable for the best solution. For example, a grassed waterway might need to be constructed which will serve more than one farm.

Examples of BMPs

How a Best Management Plan might be developed will be shown by considering alternative plans for a farm in the central Piedmont area. To simplify the example, a single 20 acre field will be used. The soil type is a Cecil sandy clay loam, with a 400 ft. long 6% slope. Continuous corn is grown with the residue removed. Up and downhill conventional tillage is practiced (Figure 2). Field observation shows that the runoff is filtered through 300 feet of woods reducing the sediment and nutrient load before it reaches the stream.

Figure 2 Excessive Erosion Resulting from Up and Downhill Cultivation

Using the universal soil loss equation and SCS technical guides, the average annual soil loss as presently farmed is calculated to be 30 tons per acre. The allowable soil loss (T value) for Cecil sandy clay loam is 4 tons per acre. The present soil loss is excessive. Farming could not be continued for any extended period of time at this soil loss rate.

Alternative No. 1 assumes chisel plowing with corn residue left in the field (Figure 3). Minimum tillage is used but rows are not on the contour. This would reduce the soil loss to 15 tons per acre, a significant reduction but inadequate to maintain productivity (T value) or water quality. See the note on contouring with alternative no. 4.

Figure 3 Corn Residue Protecting the Soil

Alternative No. 2 uses contour strip cropping with alternate strips in grass, rotating between the strips every two years (Figure 4). Conventional tillage is practiced on the contour. The soil loss is reduced to 2 tons per acre, a very acceptable level but this alternative reduces the corn land 50% and requires that there be a use for the hay or grass.

Figure 4 Contour Strip Cropping

Alternative No. 3 uses a parallel terrace system; corn residue is left and conventional tillage operations are practiced on the contour (Figure 5). A terrace spacing of 84 feet is needed. Soil loss from this system is approximately 6 tons per acre. This is an inadequate reduction in soil loss but because the runoff is filtered through the woods, water quality is probably adequate.

Figure 5 Parallel Terrace System

Alternative No. 4 is a combination of Nos. 1 and 3. It uses parallel terraces, residue is left, chisel plow and minimum tillage planting are practiced. All operations are on the contour. With the terrace spaced at 100 feet the soil loss is reduced to approximately 4 tons per acre. This is an acceptable level, both in terms of soil loss and water quality, but has the inconvenience and the cost of a terrace system. Note: Contouring without terraces or strip cropping is not an acceptable practice on a 400 foot long 6% slope.

Alternative No. 5 is a no-till operation (Figure 6). Continuous corn is planted in small

Figure 6 No-Till Soybeans Planted in Small Grain Residue

grain residue of at least two tons per acre. The average annual soil loss is 3 tons per acre, an acceptable level. The no-till operation requires greater chemical use, increasing the potential for chemical loss. It also requires a change in equipment from that now being used.

In the examples above, alternatives Nos. 2, 4, and 5 are acceptable in terms of water quality and soil erosion. It now becomes a matter of selecting which system is best suited to the needs of the farm operation, is practical for the soils and the operator, and is economically sound. It should not be assumed that these five alternatives are the only possibilities. They are given only as examples of the application of BMPs to reach an objective.

Where Is Assistance Available?

Many local, state and federal agencies are cooperating in providing assistance to the landowner in developing and implementing a water quality improvement plan. The State Water Control Board has overall responsibility for water quality planning and implementation in Virginia. The management of the agricultural portion of this plan has been delegated to the Soil and Water Conservation Commission with the Soil and Water Conservation districts assuming the leadership role at the local level.

Information about water quality planning and techniques which may be used is available from the local office of the Cooperative Extension Service. The Soil and Water Conservation District Office and the Soil Conservation Service Office can provide information. These offices also have available many publications on individual practices which will be of value to the farm operator.

Technical assistance for planning and implementation of BMPs is available from the Soil Conservation Service through the local Soil and Water Conservation District.

Financial assistance to aid in the implementation of BMPs is available through the several federal programs. This assistance is available through the Agricultural Stabilization and Conservation office. Other state and federal programs may become available in the future.

Summary

The intent of most BMPs is to decrease the generation of pollutants rather than treat what is produced. They must be properly planned, designed and installed. But the concern of and good management by the farm operator will be necessary for a reduction of agricultural nonpoint pollution to become a reality.

Other Publications of Interest

Listed below are some of the many publications available from the local Extension and Soil Conservation Service offices which give more specific information about some of the BMPs. Both offices have many other publications of interest to the producer.

Available from Extension Offices

Soil — Virginia's Basic Natural Resource, Publication 504, 1972.

Soil Acidity: Nature — Causes — Affects — Remedy, Publication 490, 1972.

Lime for Acid Soils — What to Use and How to Apply, Publication 405, 1970.

Fertilizer Recommendations for Agronomic Crops in Virginia, MA-25, 1977.

Use of Manures in Crop Production, MA-208, 1977.

Nitrogen Inhibitors and Their Affect on Nitrogen Losses from Soil, MA-195, 1976.

No-tillage Corn, Publication 342, 1970.

Soybean No-till Guide, MA-188, 1975.

Response of Corn and Soybeans to Under-row Ripping, ME-115, 1978.

Reseeding Clover and Grasses with Minimum Tillage, MA-196, 1977.

Suggestions for Seed Bed Preparation for Small Land Owners, ME-75, 1972.

No-tillage Machinery and Seed Bed Requirements, Publication 419, 1971.

Rope Wick Herbicide Applicator, ME-118, 1979.

Sprayer Calibration, ME-45, 1968.

Available from SCS Offices

Soil Erosion — The Work of Uncontrolled Waters, AIB-260, 1971.

Sediment — Its Filling Harbors, Lakes and Roadside Ditches, AIB-325, 1967.

How to Control a Gulley, FB-2171, 1973.

Maintaining Water Courses, L-562, 1975.

Grassed-Waterways in Soil Conservations, L-477, 1960.

Farming Terraced Land, L-335, 1974.

Mulch Tillage in Modern Farming, L-554, 1971.