

Agricultural Best Management Practices



for Protecting Water
Quality in Georgia

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FOREWORD

The Georgia Soil and Water Conservation Commission was formed to protect, conserve and improve the soil and water resources of the State of Georgia. The Commission's goal is to make Georgia a better place for its citizens through wise use and protection of basic soil and water resources and to achieve practical water quality goals, while maintaining a viable agriculture.

Contamination from agricultural practices may be causing certain streams to not support designated uses. Therefore, the agricultural community must be aware of practical and effective methods of controlling nonpoint source pollution (NPS). If the farming community does not participate in a voluntary program using Best Management Practices (BMPs), or if BMP efforts are not in full compliance, **then it can be expected that there will be additional calls for mandatory programs.**

The Conservation Commission and soil and water conservation districts are not regulatory or enforcement agencies. As part of an effort to promote voluntary water quality endeavors, the Commission has assembled the expertise and taken responsibility for producing Agricultural Best Management Practices for Protecting Water Quality. This publication is designed as a basic guide for anyone implementing agricultural best management practices to protect the state's waters. **"State Waters" includes any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells and other bodies of surface or subsurface water, natural or artificial lying within or forming a part of the boundaries of the state, which are not entirely confined and retained completely upon the property of a single individual, partnership or corporation.** The Commission is dedicated to working in a cooperative manner with all local, state and federal agencies, agribusiness and producer groups to employ the best technical expertise possible.

The Conservation Commission is the designated lead agency for protecting water quality from agricultural nonpoint source (NPS) pollution. Because of the impacts from agricultural NPS pollutants, the Commission developed this manual to aid the farming community in establishment of BMPs. The Commission is committed to improving water quality in Georgia's streams and water bodies by maintaining and protecting existing water quality and restoring or enhancing waters which are degraded in order to achieve the goals of the Clean Water Act.

Georgia's agricultural lands are varied. The diversity of the state's climate, soil, water and plant and animal resources require that landusers make site specific decisions for protecting the environment. Best Management Practices (BMPs) discussed herein are intended to provide several alternative practices that when used singularly, but generally in combination, provide protection to water.

The Conservation Commission accepts a responsibility to provide education and technical assistance to landowners, users, contractors and the general public to ensure that the stewardship principles incorporated in agricultural BMPs are understood and employed for maximum benefit to Georgia's land and people.

ii INTRODUCTION

The Federal Clean Water Act of 1987 established as a national policy “that programs for the control of nonpoint sources of pollution be developed and implemented by each state in an expeditious manner so as to enable the goals of the Act to be met through the control of both point and nonpoint sources of pollution.” Section 319 of the Clean Water Act focuses on nonpoint sources of water pollution.

Nonpoint source pollution can be described as any pollution whose specific point of generation and whose exact point of entry into a water course cannot be defined. Origins of these contaminants include percolation, seepage, and surface runoff from agricultural and silvicultural lands and from construction, mining and urban areas.

In addition to federal legislation, the Georgia General Assembly addresses nonpoint pollution through O.C.G.A. 12-2-8 in directing the promulgation of minimum standards and procedures for protection of natural resources, environment, and vital areas of the state.

Major improvements have been made to wastewater treatment systems from urban and industrial sources in Georgia in the past few years. Water quality in streams has improved significantly. However, as problems from these “point” sources diminish, decline or recede, more emphasis is placed on “nonpoint” sources. The major contributors to nonpoint water quality problems identified by the state are sediment from urban development and from nutrients, pesticides, bacteria, sediment and other pollutants which may originate from agricultural sources.

The term **BEST MANAGEMENT PRACTICE** (BMP) refers to a practice, or a combination of practices determined to be the most effective practical means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals.

This BMP manual was prepared to provide guidance for establishment of recognized agricultural BMPs and

to comply with Section 319 of the Federal Clean Water Act in maintaining water quality.

Agricultural enterprises should incorporate adequate measures to protect water quality. The most practical approach for reducing nonpoint source pollution is the use of preventive practices. The purpose of this handbook is to describe and recommend such practices for Georgia’s varied conditions. Sound natural resource planning must consider a wide variety of factors. Due to variability of climate, soils, topography and other factors, best management practices should be determined on a site by site basis.

Most BMPs involve the application of sound conservation principles that not only minimize water pollution, but also meet the needs of the total ecosystem, that is the soil, water, air, plants and animals. The system of application should be ecologically sound and economically feasible.

While BMP is the terminology used for practices that maintain or improve water quality, the Soil Conservation Service uses the term “conservation practice” to identify rather specific practices that are comparable or somewhat similar to BMPs. The Commission relies heavily on SCS for technical guidance and, as such, many practices found in this BMP manual are based on SCS field office technical guides. Technical guides are the primary technical reference of SCS. They contain information about conservation of soil, water, air, and related plant and animal resources. Technical guides are localized so that they apply specifically to the geographic area for which they are prepared. Detailed standards and specifications have been developed and are maintained for almost 100 practices in Georgia. Some of these practices have been developed primarily to protect or improve water quality, and others are for soil protection or improvement and other purposes, but almost all of them affect water quality in some way.

A single BMP, or conservation practice, will prevent a specific water quality problem, but generally a combi-

nation of practices are needed. Simple problems may require a small number of practices, while complex problems may require a greater number of practices. The number of practices necessary to solve environmental problems should be determined after a thorough, on-site inventory and study of the problem. Since most problems have multiple solutions, options should be evaluated and the most feasible means selected.

The combination of conservation practices and management that, when installed, will permit sustained use of the natural resource is referred to as a resource management system (RMS). The Environmental Protection Agency uses the term "management measures" to distinguish the complete list of BMPs needed to protect or correct water quality impairment. Criteria for these conservation practices are on file in the Field Office Technical Guide in SCS offices located throughout the state.

It is recommended that those involved in carrying out agricultural activities voluntarily use the suggested BMPs. Additional, more detailed information about conservation practices is contained in the USDA-Soil Conservation Service Field Office Technical Guide (FOTG) for Georgia and US-EPA's Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Georgia Forestry Commission's Recommended Best Management Practices for Forestry In Georgia and The University of Georgia Cooperative Extension Service publications.

All BMPs require operation and management procedures to keep them functioning properly and to maintain them in an effective condition. Maintenance on some practices requires day to day attention, others less frequently, but almost all need special care during or following heavy rainfall events. All operation and maintenance procedures necessary for long term success of these practices may not be enumerated in this document, but field office technical guides in SCS offices and other documents are available that discuss additional details.

IV MANUSCRIPT REVIEW

The following agencies and organizations have provided a technical review of this manual:

- Georgia Association of Conservation District Supervisors
- Georgia Agribusiness Council
- Georgia Cattlemen's Association
- Georgia Conservancy
- Georgia Department of Agriculture
- Georgia Department of Natural Resources
- Georgia Environmental Protection Division
- Georgia Farm Bureau Federation
- Georgia Forestry Commission
- Georgia Pork Producers Association
- Georgia Soil and Water Conservation Commission
- Georgia Wildlife Federation
- USDA - Southeast Watershed Research Laboratory - ARS
- USDA - Southern Piedmont Conservation Research Center
- University of Georgia Agricultural Experiment Station
- University of Georgia Cooperative Extension Service
- US Environmental Protection Agency, Region IV
- USDA Agricultural Stabilization and Conservation Service
- USDA Farmers Home Administration
- USDA Soil Conservation Service

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CONSERVATION TILLAGE SYSTEMS

Many Georgia row crops, including cotton, can be produced using conservation tillage which is generally the most effective single practice for controlling erosion and sediment transport.



DESCRIPTION

Conservation tillage is a means of planting and culturing crops with a minimum disturbance of soil. When cover crop mulch or crop residues are used, it can be an effective, inexpensive means of obtaining good crop yields while protecting the soil from wind and water erosion and reducing soil moisture evaporation. Conservation tillage is defined by the Conservation Technology Information Center as any tillage method that leaves at least 30 percent of the soil surface covered with crop residue immediately after planting. The definition includes a range from no-till to the 30 percent minimum cover criteria.

The actual amount of tillage needed with conservation tillage varies with soil type and crop in Georgia. Summer crops need deep rooting to reduce drought stress. Sandy textured soils tend to form compacted soil layers 5 to 10 inches deep. The extent of this compaction is often enough to prevent deep rooting. Hence, some means of disrupting the hard pans are usually required for summer crops grown on these soils. In-row subsoilers on conservation tillage planters have proved to be especially valuable for summer crops like soybeans, cotton and corn grown on Southern Coastal Plain soils.

Mulch for conservation tillage may be obtained by (1) growing a cover crop (rye, oats, vetch, millet, etc.) and killing it with contact herbicide at or prior to the time for conservation tillage crop planting or (2) leaving old crop residue uniformly in place on the soil surface. A most common Georgia approach to conservation tillage is to grow a winter small grain, harvest it, spread the residue, then use special conservation tillage planters to plant directly into the small grain residue.

Although crop yields and erosion rates differ from field to field, a study conducted at the University of Georgia Experiment Station in Griffin, has shown conservation tillage to reduce surface soil temperature by as much as 30 degrees F and soil water runoff/erosion by as much as 95% over that of conventional tillage.

Wheat and rye are the most common cover crops used for conservation tillage in Georgia. They are easy to establish, easy to kill with contact herbicide and have little or no adverse effect on establishment of conservation till crops.

Planters for conservation tillage need to have (1) a special coulter for cutting through mulch, (2) in-row subsoiling capability if a summer crop and compacted

soils are involved, (3) special or double-disc openers for precision seed placement, and (4) special or narrow packer wheels for soil firming around seed, and proper equipment adjustment.

Successful conservation tillage may also require special herbicides and herbicide applicators for effective, economical weed control.

WATER QUALITY IMPACTS

Conservation tillage can be very effective for not only reducing soil erosion but also for improving water quality. Research studies show that conservation tillage reduces soil loss by 50 to 95%. The more the surface is covered, the greater the benefits. The reduction in soil movement greatly reduces pollution of streams and lakes from sediment nutrients and pesticides. The efficiency of conservation tillage for control of these substances when attached to soil is roughly proportional to soil saved.

With increased infiltration, there is an increased potential for negative impact on groundwater quality; however, an improved soil ecosystem can hasten the decomposition of pesticides, but nitrate-nitrogen movement to groundwater through worm holes and other macropores may be enhanced. Impacts on ground water quality should be assessed on a case by case basis.

PLANNING CONSIDERATIONS

Conservation tillage, in addition to controlling erosion, also provides savings of time, fuel, labor, and soil moisture. It often requires more timely and more intensive management for success than conventional tillage. With conservation tillage, crop sequence, soil texture, crop residues, weeds, lime-fertilizer practices and climate must be considered. Summer crops are generally better suited for conservation tillage than winter crops.

With heavy residues, well drained soils are generally better suited to conservation tillage than poorly drained soils, especially for early planted crops like corn. Poorly drained soils warm and dry slowly in the spring, thus nutrient availability (particularly phosphorus) and early plant growth can be reduced.

Piedmont soils tend to be better suited for conservation tillage than Coastal Plain soils. Conservation tillage is successful for the latter if in-row subsoiling is used to disrupt hard pans and good pest management practices are followed.

OPERATION AND MAINTENANCE

Some benefits of conservation tillage occur only after the system has been used for a number of years. Organic matter begins to accumulate and soil tilth improves over time.

Crop rotations are very important for conservation tillage systems. A cropping sequence should be planned to minimize weed, insect, and disease problems and to minimize agricultural chemical problems that may affect the following crop. Crop residue management or cover crops must be planned to maintain adequate ground cover for the following crop.

Soil should be tested regularly to determine need for nutrients.

CONTOUR FARMING AND TERRACING

Terraces and contour farming is a popular runoff control and sediment reduction practice in Georgia, especially in the coastal plain section of the state.



DESCRIPTION

Contour farming is farming “on, or near, the level,” across the slope rather than up and down the slope. Contour farming reduces soil erosion and increases infiltration.

A terrace is an earthen embankment that is constructed on the contour or across a slope to intercept runoff. There are two general types of terraces. Gradient terraces have a somewhat uniform slope down the channel to divert the runoff to a suitable outlet such as a grassed waterway or an underground outlet. Parallel terraces also divert runoff, but slope is variable so that terraces are spaced at a uniform distance apart to facilitate farming operations.

Terraces will permit the use of more intensive cropping systems while reducing soil erosion. In addition to providing erosion control and water quality benefits, a terrace can be an effective moisture conservation practice to increase crop production.

WATER QUALITY IMPACTS

Contour farming can be effective at reducing erosion when rows are planted on ridges, especially on gently sloping fields. It reduces the amount of sediment and attached pesticides and nutrients entering surface waters. Contour farming can reduce erosion rates by 5 to 30 percent in Georgia, depending on slope of land and row ridge height. Tables showing estimated effects are in SCS technical guides.

Nutrient and pesticide management should be used along with contouring to reduce the availability of those materials for leaching.

When properly designed, installed, and maintained, terraces and contour farming can be very effective at reducing erosion and trapping sediment. These characteristics improve water quality by preventing sediment and attached nutrients and pesticides from leaving the field.

Because contour farming increases the amount of infiltration, the potential for leaching of agricultural chemicals to ground water is increased. On more permeable soils, terraces can increase the amount of infiltration significantly. Terraces that concentrate

pollutants and promote infiltration in a limited area would have the highest risk of leaching chemicals.

PLANNING CONSIDERATIONS

Contour farming is most suitable on uniformly sloping fields. Fields with slopes that break in many different directions are not practical for contour farming. Along with contouring and terracing other practices such as conservation tillage, nutrient management, and pesticide management should also be considered to reduce potential pollution.

Terraces are best suited to uniform, gently to moderately sloping fields (2 to 6 percent slope) that have erosion problems. They work best in fields with deep soils. Terraces are not recommended on fields with very stony, steep, sandy or shallow soils. They are also not recommended for fields with very irregular topography and short slopes. These conditions result in layouts that would not be practical to farm with modern farming equipment because it is difficult to keep the terraces parallel.

Terraces are relatively expensive to install and require a substantial amount of time to design and construct. As fields become steeper, more, and larger terraces are required and the cost increases accordingly. Because of the high construction costs, cost-sharing programs encourage farmers to install this practice.

OPERATION AND MAINTENANCE

Maintain terraces to their original designed grade. When used in clean tillage systems, soil on both sides of the terrace should be turned toward the terrace crest with a plow or other implement at least every two years. Less frequent maintenance is usually required in field with conservation tillage systems. Care should be exercised to ensure that the terrace spacing is not altered.

Remove sediment accumulations in the storage area of underground outlet terraces. Outlets must be maintained in good condition and trash around the outlet must be removed after each storm event.

All tillage, planting and harvesting operations must be parallel with the terraces.

Contour lines on fields that are not terraced must be maintained. Permanent, narrow grass strips can be used as a marker for contour lines.

5 STRIPCROPPING

Stripcropping systems reduce sediment movement, add variety to the landscape and provide a diversity of food and cover for wildlife.



DESCRIPTION

Stripcropping involves planting crops in a systematic arrangement of straight or contoured strips to reduce wind or water erosion. The crops are arranged so that a strip of sod or close growing crop is alternated with a strip of row crop.

WATER QUALITY BENEFITS

Contour stripcropping on 2 to 7 percent slopes can reduce erosion by as much as 75% compared to farming up and down the hill. Stripcropping can also be used to effectively control wind erosion on cropland. In addition to controlling erosion, rotating crops in stripcropping systems can reduce insect, nematode, and weed problems, thus reducing the amount of pesticides that are needed.

PLANNING CONSIDERATIONS

When stripcropping is combined with contouring, another practice such as a grassed waterway, terrace, or diversion should be used to dispose of runoff. The width of contour strips are determined by the land slope, crops grown and machinery widths, but usually are spaced from 90 to 110 feet apart. Steep slopes may require closer spacing. All tillage and planting of crops should be parallel to the strip boundaries. Design criteria is included in SCS Field Office technical guides.

OPERATION AND MAINTENANCE

Plan crop sequences to prevent problems such as insect buildup from one strip moving to another strip causing serious damage.

Develop a system to maintain key boundaries on fields where contour stripcropping is used.



A wide variety of close-growing grasses, legumes and forbs can be used to trap sediment before it enters a stream.

DESCRIPTION

Filter strips are strips of grass or other close-growing vegetation intended to remove sediment or other pollutants from runoff. They are normally planted in an area where water will pass over them as sheet flow. Sheet flow is a shallow and uniform flow over a broad surface. The vegetation slows the water, allowing solids to settle out and become trapped in the vegetation.

WATER QUALITY BENEFITS

Filter strips are moderately effective for trapping sediment and pollutants attached to the sediment. Sediment reductions of 30 to 50 percent can be expected for a properly designed filter strip. Filter strips are not effective for removal of very fine suspended sediment or nutrients in solution.

When used to control runoff from feedlots, filter strips can be very effective for removing solids, but only moderately effective for removing nutrients. Studies have shown 80 to 90 percent of solids in feedlot runoff can be trapped by vegetative filters when the flow over them is shallow and uniform. Nutrient removal is only moderate with vegetative filters. Total phosphorous

removal of 60 percent and total nitrogen removal of approximately 70 percent have been documented in some studies.

PLANNING CONSIDERATIONS

A filter strip must be designed to be wide enough to trap sediment as runoff passes over it. Although filter strips can be designed for sheet flow or for concentrated flow, they are much more effective for sheet flow conditions. With sheet flow filter strips, grading is usually needed to ensure that water will flow uniformly across the surface. Concentrated flow filter strips resemble grassed waterways constructed so water moves through them slowly. The outlets for filter strips must be stable and not cause soil erosion problems.

Filter strips must be maintained to prevent excessive buildup of sediment that changes flow characteristics, and buildup of nutrients. Filter strips may require periodic replacement.

Generally, a strip is 25 feet or greater in width; however, the effective width for protecting water quality will vary considerably depending on a site-specific assessment that considers slope, soil type, erodibility factors, etc.

OPERATION AND MAINTENANCE

Filter strips should never be used for roads or turn rows. Exclude livestock from the area or allow limited grazing to periods when soil moisture is optimum to prevent damage from compaction or bogging.

Maintain a good stand of vegetation at all times. Filters used primarily to trap sediment should be fertilized regularly according to soil test recommendations. Filters that receive heavy loading of nutrients may need to be mowed and the forage removed in order to reduce the nutrients in the strip.



A vigorous stand of grass effectively transports concentrated flow from a field and discharges it into a safe outlet.

DESCRIPTION

A grassed waterway is a natural or constructed channel, usually broad and shallow, planted with perennial grasses to protect soils from erosion by concentrated storm water flow. Waterways can serve as outlets for terraces or diversions as well as transporting storm water from fields without causing soil erosion.

WATER QUALITY BENEFITS

Grassed waterways provide safe water removal from either natural drainage or constructed channels. Waterways prevent gully erosion in areas of concentrated flow. The vegetation in grassed waterways also acts as a filter to remove sediment from runoff. This BMP is most effective in reducing phosphates and other nutrients or chemicals that are attached to sediment or organic matter. It is estimated that grassed waterways reduce sediment losses by 60 to 80 percent from the flow area.

Grassed waterways should not be used primarily as filter strips to remove sediment, because they can quickly load up with silt and lose their effectiveness in transporting runoff. They should not be used for roads.

PLANNING CONSIDERATIONS

Grassed waterways serving terraced fields are easier to establish before terraces are constructed; however, erosion on the contributing watershed should be minimized to prevent the waterway from being filled in with sediment. On non-terraced fields, the contributing watershed above a waterway should be treated to control erosion before waterway construction.

Soil conditions must be favorable for plant growth in the grassed waterway. Soil conditions may need to be improved with practices such as subsurface drainage for wet conditions, or addition of topsoil when unfavorable subsoil is exposed. Stable outlets are required for the ends of grassed waterways to prevent gullies from forming and progressing up the waterways. This may involve construction of grade stabilization structures.

Vegetation can be difficult to establish in a grassed waterway. Erosion control barriers and mulching is required in the waterway during vegetative establishment.

Grassed waterways must be inspected following each high intensity storm and needed repairs made promptly.

Waterways generally require periodic mowing; however, refrain from mowing during bird nesting.

OPERATION AND MAINTENANCE

Grassed waterways normally require careful maintenance or periodic reshaping to allow runoff from individual rows to enter the waterway. Vegetation must be maintained in a vigorous condition for protection during heavy rainfall events. Test soil in the waterway about every two years and apply nutrients according to recommendations.

Exercise care when operating tillage or spray equipment across the waterway to prevent damage to vegetation.

Shape rows so that each has an outlet into the waterway. Prevent erosion from occurring along the outside of the waterway.

Grassed waterways must not be used for roadways.

Crimson clover can recycle residual fertilizers in the fall and also produce nitrogen for the following crop, adding beauty to the countryside and providing food for many species of wildlife.



DESCRIPTION

A cover crop is a crop of close-growing grasses, legumes, or small grain that is grown mainly to protect or improve soil. In crop rotation, winter annuals are usually planted for cover crops. However, in orchards and other speciality crops, perennials may be utilized in conservation tillage systems. When residues of cover crops are left on the surface, they add organic matter to the soil. When legumes are used, they have the short-term benefit of providing nitrogen for subsequent crops.

Crop rotations involve a planned sequence of changing the crops grown on a particular field. A typical rotation might involve one or two years of peanuts, cotton or soybeans followed by a grass such as corn, grain sorghum, or wheat. Crop rotations can be used to reduce the average rate of erosion. Including a grass or legume in a rotation can be very effective for reducing erosion.

Rotations can also be used to reduce or control nematodes, insects and certain diseases by including a non-host crop in a rotation. Rotation can also aid in weed control by preventing buildup of certain weeds associated with continuous production of one crop.

WATER QUALITY BENEFITS

Cover crops can control erosion during periods of the year when the major crop would not provide adequate cover. This practice can reduce erosion by 40-60 percent when compared to bare soil conditions. By reducing erosion, the pollution from sediment, suspended solids, nutrients, and pesticides is also reduced.

Grass covers such as wheat, rye, and oats use surplus nitrogen applied to previous crops and thus prevent the leaching of nitrates into groundwater.

Crop rotation may improve surface water quality by reducing soil erosion and the need for pesticides which may also reduce the likelihood of ground water contamination.

PLANNING CONSIDERATIONS

Cover crops should be planted as soon as possible after harvest; however, they will not be effective unless the cover has enough time to become established before winter. In some situations, a cover crop can be planted after the last cultivation to provide a longer growing period.

When legumes are used in a crop rotation, the nitrogen formed by fixation should be taken into account when determining the nutrient needs for future crops. This will prevent over-application of nitrogen.



Agricultural limestone and fertilizers must be applied uniformly to the land according to recommendations determined from soil or tissue tests.

DESCRIPTION

Managing the amount, source, form, placement, and timing of nutrient applications are activities that will accomplish both crop production and water quality goals. Nutrient sources include manures, organic wastes, chemical fertilizers, and crop residues.

The water quality goal of this management measure is to minimize edge-of-field delivery of nutrients and minimize leaching of nutrients from the root zone. The nutrients of major concern are nitrogen and phosphorus. Nutrient management is pollution prevention achieved by developing a nutrient budget for the crop, applying nutrients at the proper time, using only the types and amounts of nutrients necessary to produce a crop and conducting proper evaluations of the environmental hazards of the site.

Nutrient management recommendations will be based on the current "Soil Test Handbook for Georgia" published by the Georgia Extension Service.

WATER QUALITY BENEFITS

Appropriate application rates, timing, and placement will minimize surface water and groundwater pollu-

tion, supply adequate nutrients for plant growth and development, improve nutrient efficiency, and assist in maintaining good soil conditions to reduce runoff and soil erosion.

PLANNING CONSIDERATIONS

Select realistic yield goals based on historic yield data, climatic factors, soil type, and commodity prices (or economics).

Select application rates to meet these yield goals.

Use soil and/or tissue tests to establish proper application rates.

Use appropriate soil and water conservation practices to reduce surface losses of nutrients. Local research and Extension information will assist in determining the suitability of management practices that will optimize reduction of surface losses. Conservation practices such as conservation tillage may reduce sediment bound phosphorus and organic-nitrogen losses and total runoff. Unless nitrogen uptake efficiency is improved on a given site, conservation practices that reduce surface runoff may increase leaching losses of soluble nutrients.

In certain watersheds, a nutrient management plan may be required. This plan can be obtained from the Soil Conservation Service and the Cooperative Extension Service. However, upon request, these agencies can provide these services to all citizens.

APPLICATION PRACTICES

Record and keep crop history in order to credit previous use of manure or legumes in rotation and determine nutrient application rates.

Use application techniques that reduce surface and leaching losses including incorporation when possible, split applications, and directed placement (e.g. banded and knifed placement) when possible. The benefits of split applications depends on soil and climatic conditions.

Time nutrient application to coincide with plant growth requirements. Avoid fall and winter application of nitrogen except on fall and winter crops.

Consider source of nitrogen fertilizer used. Where leaching is a problem, ammonium or urea sources should be used instead of nitrate fertilizers.

Organic nutrient sources should be applied to meet the nitrogen needs of the crop. All sources must be analyzed to determine nutrient content.

Calibrate equipment to insure proper placement and rate of delivery.

Use vegetated buffer areas to reduce nutrients from entering state waters, streams, wells, ponds and other environmentally sensitive areas. Consult the sections on **Filter Strips and Stream and Waterbody Protection** in this manual for details.

The mixing and loading of nutrients and cleansing of equipment should take place outside vegetative buffer zones.

Proper pasture management techniques on perennial pastures will reduce runoff and promote utilization of nutrients.

Adequate storage facilities should be maintained to retain organic sources of nutrients.

OPERATION AND MAINTENANCE

Test soils on an annual or semi-annual basis and keep records so that nutrient trends can be followed. All animal manures should be analyzed for nutrient content before application.



Insect nets are important tools in documenting the population of foliage insects on a crop in order to determine the need for treatment.

DESCRIPTION

Managing the type, amount, formulation, placement, and timing of pesticide applications are actions that will accomplish both crop production, pest control, and meet water quality goals. Selection of the appropriate array of pest management practices will control target organisms and minimize potential contamination of water resources and non-target organisms.

Pesticide recommendations will be based on the "Georgia Pest Control Handbook", published by the Georgia Cooperative Extension Service, and also the pesticide label.

Use of integrated pest management (IPM) will reduce pesticide loads. Use of crop rotation to reduce buildup of insects, alternate control methods, such as cover crops, to enhance beneficial insect populations, determination of economic pest thresholds, adjusting planting and harvest periods, and field scouting are essential components of successful IPM systems.

Frequent reductions in chemical usage continues to be a significant benefit of IPM.

WATER QUALITY BENEFITS

Benefits to surface and ground water quality can be significant if these practices prevent improper application, disposal or spillage of agricultural chemicals. Studies indicate that ground water contamination by pesticides often occurs from spills at mixing and loading areas. Prevention of spills is one established method to protect water quality.

The use of IPM strategies can often reduce the amount of pesticides applied to cropland. This can help to protect water quality and maximize profits. Although it is difficult to quantify water quality benefits from IPM, it is generally assumed that the reductions in pesticide losses to waters will be proportional to the reduction in use. However, this assumption can be inaccurate due to site conditions or pesticide characteristics (solubility, half-life, etc.). In any case, the economic and environmental benefits of reduced pesticide use can be substantial.

PLANNING CONSIDERATIONS

Selection criteria for the type of pesticide should include consideration of the target species and pesticide characteristics such as solubility, toxicity, degradation, volatility, and adsorption. Site characteristics such as soil, geology, depth to groundwater, proximity to well heads, proximity to surface water, topography, and climate are also important criteria.

Selection of alternate pesticides to reduce species resistance, use of less persistent chemicals, and consideration of chemical transport modes will reduce chemical loading and potential for off-site transport.

Certain pesticides are classified as “restricted use” and can be purchased only by certified applicators. Ensure that users apply all pesticides in accordance with the label instructions on each product.

APPLICATION PRACTICES

Application methods, including aerial, ground, and chemigation, influence the partitioning and potential transport of pesticides. Band applications will reduce the amount of chemical applied to the field and limiting the potential for off-site transport. Aerial spraying is generally undesirable from all aspects of environmental losses, and alternate methods should be selected whenever possible.

Timing and amount of pesticide application, and environmental conditions, especially rainfall and temperature, determine surface and subsurface transport and degradation characteristics. Timing of application by crop stage may reduce leaching losses depending on whether multiple post-emergence applications are required compared to a single preemergence application. Restriction of application prior to anticipated storm events may be more effective in reducing surface losses of pesticides than most soil and water conservation practices.

Selection of pesticide formulation and application technique also influence pesticide losses. Wettable powders, dusts, and microgranules are generally most susceptible to surface and leaching losses.

Losses of pesticides transported almost exclusively by sediment can be reduced significantly by erosion control practices.

Pesticides lost primarily in the dissolved phase of runoff (e.g. carbamate, triazine, and anilide), will be decreased by runoff reducing practices such as terraces, contouring, and conservation tillage. However, these practices may increase losses to groundwater, especially on sandy soils or fields with tile drainage.

Equipment maintenance and proper calibration is essential for uniform applications at the rates intended.

All label instructions, storage requirements, and regulations must be followed to insure safe handling of pesticides. Proper disposal of unused chemicals and containers will insure safety of the user, water resources, and non-target organisms.

Pesticide applicators should avoid chemical exposure by safe handling practices including use of protective clothing, respirators, shoes, and/or other requirements that may be specified on the pesticide label.

OPERATION AND MAINTENANCE

Plan crop rotations to minimize problems from diseases, insects, nematodes, weeds and other pests. Provide habitat that is suitable for the reproduction of key beneficial insects when possible.



Almost one-fourth of Georgia's cropland acreage can be effectively irrigated without excessive erosion or other water quality concerns.

DESCRIPTION

Irrigation water management involves controlling the rate, timing, and amount of irrigation water so that crop moisture requirements are met while minimizing water losses and soil erosion. Studies have shown that fields are commonly irrigated at excessive rates. If water is over-applied, the excess water can cause soil erosion and excessive leaching of nutrients and pesticides. Over-application also wastes water, time, energy, and money.

Irrigation scheduling is the use of water management strategies to prevent excessive application of water while minimizing field loss due to drought stress. Scheduling will ensure that water is applied to the crop when needed and in the amount needed. Effective scheduling requires knowledge of the following factors:

- a) soil properties and soil-water relationships
- b) type of crop and stage of development
- c) status of crop stress and potential yield reduction
- d) climatic factors such as rainfall and temperature

Much of the above information can be found in SCS soil surveys and Extension Service literature.

WATER QUALITY BENEFITS

Irrigation in Georgia is commonly used on sandy soils that have high-yielding wells in sand and gravel aquifers or limestone aquifers. Many irrigated fields are located in geologically sensitive areas with a high potential for ground water contamination. Because of this, irrigated cropland may have a significant impact on ground water quality. The potential for leaching nutrients and pesticides to ground water is minimized when irrigated water is applied at the proper times and in amounts that meet but do not exceed crop needs.

By matching irrigation water application to crop needs, surface runoff during irrigation can be reduced which helps prevent erosion and loss of nutrients and pesticides in runoff. Irrigation can be timed so that the maximum benefit is realized from pesticides and the chance of leaching is reduced.

Properly designed and managed irrigation systems remove runoff and leachate efficiently, control deep percolation, and minimize erosion from applied water, thereby reducing adverse impacts on surface and ground water.

PLANNING CONSIDERATIONS

Irrigation volume and frequency should be determined by crop needs and soil conditions. Soil moisture should be monitored to determine when application is needed to prevent crop stress. Soil water can be measured using a range of devices such as tensiometers or gypsum blocks.

When soil is irrigated, the volume applied should not exceed the water-holding capacity of the soil in the root zone of the crop and the rate should not exceed the absorption or infiltration rate.

When fertigation or chemigation is used, wells must be equipped with check valves and anti-syphon devices to prevent well contamination.

Because there is a need for site-specific recommendations, an irrigation specialist should be consulted for information on optimum water management methods.

OPERATION AND MAINTENANCE

Inspect and maintain anti-syphon devices on a regular basis to insure they are operating properly when the system is used to apply fertilizers or pesticides.

Check the uniformity of water application periodically. With time, nozzles become worn and application rates may change.

Check soil moisture measuring devices periodically to insure they are calibrated accurately.



The correct combination of plant species, stocking rates, nutrient application and grazing management enhances the landscape and minimizes water quality problems.

DESCRIPTION

Grasslands occupy a crucial niche in the environment and economy of Georgia. Grasslands provide nutrition for cattle and other domestic livestock and provide cover and food for many species of wildlife.

Grasslands are a renewable resource. Well managed grasslands and pastures can be effective in protecting soil reserves and providing nutrition for livestock and wildlife for many years.

WATER QUALITY BENEFITS

Well managed grasslands are essential for protecting valuable soil resources and improving the quality of water in lakes and streams. Areas of properly managed grasses are protected from the erosive effects of wind and water. The fibrous root systems of healthy grassland plants hold the soil in place so that surface water supplies are not contaminated with sediment.

Well managed grasslands are efficient in utilizing fertilizer nutrients from commercial fertilizer materials and animal manures to produce forage for grazing.

PLANNING CONSIDERATIONS

Select plants that are best adapted to the soil and climatic conditions. Only permanent grasses should be grown on highly erodible sites. Annual pastures, such as millet, should be confined to more level fields.

Test soil to determine fertility levels so that proper fertilization practices can be used.

Insure that nutrients are applied in accordance with procedures recommended in the Nutrient Management section of the manual.

Grazing management determines the effectiveness of a pasture's ability to protect water quality. Continuous grazing of pastures allows livestock to concentrate along streams, around watering facilities, in shade and to create prominent eroding trails. All of these areas contribute sediment and nutrients to surface water. Excessively grazed pastures may have sheet and rill erosion as well as gullies.

Properly designed rotational grazing systems can minimize many water quality problems that are associated with pastures. Livestock and swine that have unrestricted access to streams and other water bodies generally cause water quality impairment. When pastures are separated by streams, use culverts

or hard, low-water stream crossings. Methods to reduce impairment can be found in the **Stream and Waterbody Protection** section of this manual.

Maintain shade trees along streams (especially trout streams). See the **Streamside Forest Buffers** section for additional information.

Weeds may be a problem in many pastures. Proper fertilization and good grazing management will reduce weed problems. When herbicides are necessary to control problem weeds, use only labeled products at recommended rates of application.

Pasture renovation may become necessary to improve stands. When renovating pastures, use no-till or other conservation tillage practices which will minimize erosion whenever possible.



The effluent from animal operations must be effectively managed to prevent any discharge into waterbodies of the State.

DESCRIPTION

Agricultural waste management systems are a combination of facilities and procedures used to temporarily store manure and other waste products for timely application to agricultural land. Waste may be handled as a liquid, a slurry, or a solid.

Liquid manure is normally held in earthen ponds commonly called lagoons or storage ponds. Most lagoons are anaerobic (absence of oxygen) and can be pumped as a liquid (4-10 percent solids). Recycling of the lagoon liquid for flushing alleys is common for dairy, swine and laying hens.

Slurry manure is normally handled in a waste storage structure such as a pit under a livestock confinement floor or a pit outside such as used when scrapers pull waste from a laying hen facility. The structures are usually made of reinforced concrete. The waste is commonly a slurry (10-20 percent moisture) requiring special equipment for handling the high solids content material.

Solid manure is handled as a dry material. Broiler litter is typical of a solid manure product and contains wood shavings or other moisture absorbing medium. Solid manure is often stored in stack houses (under

roof) until it can be land applied in a timely manner. Solid manure should not be stored outside (without a roof or cover) because nutrient content decreases and is a potential source of pollution from runoff. Refer to availability of manuals from the Cooperative Extension Service especially for poultry, pork, etc.

WATER QUALITY BENEFITS

Water quality considerations and benefits will depend upon the size and location of the pollution source, the topography, distance from stream and depth to groundwater. Each situation will be a little different and must be evaluated to determine what will be needed to maintain water quality. Properly designed waste storage facilities contain the wastes on the site until land application or composting is justified. Proper land application of manure to pastures and crops will cause little or no water quality impairment from animal wastes. Well-designed systems can prevent water pollution by bacteria, suspended solids, nutrients and oxygen-demanding organisms.

PLANNING CONSIDERATIONS

Planning for waste management is an essential part of facility design for any livestock or poultry production system. The waste handling and management plan should be prepared with specifics on required storage time, how handling will be accomplished and where the waste will be applied to the land. The storage should be adequate to allow for periods when waste cannot be land applied due to weather or crops.

A nutrient management plan should be followed to prevent application of excessive nutrients which could be washed into streams or leach into groundwater.

Groundwater can be protected by providing adequate containment of waste including an impervious layer under the waste which prevents seepage. Membranes, clay layers and concrete are common methods which can be effective in preventing seepage from contaminated sites. Some type of impervious layer is essential to protect groundwater when facilities are constructed in permeable soils. **An impervious layer is required for systems located within significant groundwater recharge areas.**

Additional Components

Runoff management is a method to control pollution from rain washing wastes from animal lots into waterways and streams. Components of such a runoff management system may include the following:

A diversion may prevent surface water from above the animal lot from flowing over the animal lot preventing the transport of materials from the area.

Gutter to keep roof water away from the animal lot may prevent water from flowing over the lot.

Sediment or settling basins can separate solids from polluted runoff flowing from animal lots.

Storage ponds temporarily store runoff water until land application is possible.

Vegetative filter strips can be an effective method to help clean up runoff from animal lots if a sufficient area of vegetation is provided (**see Filter Strip section of this manual**).

OPERATION AND MAINTENANCE

The value of nitrogen in animal manure is generally increased by applying it to the land in the most expedient manner.

All animal waste facilities require maintenance that must be carried out in a timely manner. A backup system should be planned for all critical operations whose failure could result in pollution to streams.

Animal manure can be managed as a liquid, slurry or dry forms, but fly problems may be serious when a combination of methods are used.

Solids entering animal waste lagoons should be minimized to prevent them from settling out in the lagoon and causing serious maintenance problems. Effluent must be utilized in a proper manner.

All lagoons must be pumped down to control liquid and nutrient levels and to allow for storage of water from rainfall. Dilution with fresh water may be required to lower nutrient levels and control odor.

Effluent should be pumped out and applied to cropland or pasture according to a nutrient management plan. Apply at a rate that will prevent runoff.

Establishing stream crossings for livestock reduces animal access to water bodies thus minimizing the amount of suspended soil particles and waste transported in the water.



DESCRIPTION

A stream may be defined as a course of water flowing along a bed in the earth. It can carry materials such as soil sediments, organic sources, nutrients, pesticides and other chemicals through absorption, adsorption or suspension. Streams may be perennial or intermittent. A waterbody, for purposes of the practice, includes ponds, lakes, and wetlands that have standing or flowing water during part or all of the year.

Georgia's waters are classified according to use by the Georgia Department of Natural Resources. Designated water uses include: drinking water supplies, recreation, fishing, wild river, scenic river and coastal fishing. For each water use classification, water quality standards or criteria exists.

Due to the sensitivity of waters designated as drinking water, recreation and trout streams, water quality parameters must be rigidly maintained.

WATER QUALITY BENEFITS

This BMP focuses primarily on avoiding or preventing conditions that may lead to surface and groundwater pollution and managing a zone around water surfaces

that will protect and enhance the quality of water affected by agricultural activities.

Pollutants from agricultural activities may include insecticides, herbicides, fungicides, fertilizers and animal manures, bacteria, petroleum products, and sediment from farming operations.

Preventative measures should be emphasized rather than depending on treatment of problems after they occur. All agricultural chemicals must be handled with care and must be used according to label instructions. Application rates of pesticides should be at the minimum labeled amount and applied at the minimum frequency of application to provide satisfactory control. Extreme care should be exercised to prevent fuel, chemical and fertilizer spills.

PLANNING CONSIDERATIONS FOR PROTECTION OF STREAM CHANNELS AND SHORELINES

Streambank erosion is often difficult to control and requires timely repair and maintenance to achieve stability. Energy in rapidly moving water exerts

incredible force that can be extremely destructive to streambanks and streambeds.

Streambed erosion may uncover sediment and other persistent pollutants that were deposited years ago which may severely affect the quality of water.

Streambank erosion is generally reduced with vegetative cover, preferably native species. In addition to reducing or controlling streambank erosion, shading of the stream by vegetation generally enhances the quality of water for fish and other living organisms.

Additional information concerning vegetative stabilization of streambanks is available from several sources, including Guidelines for Streambank Restoration published by the Georgia Soil and Water Conservation Commission.

Structural measures such as rock riprap may be necessary where vegetation alone will not control streambank erosion. Structural modifications to stream channels or banks may require permits from the U.S. Army Corps of Engineers.

PLANNING CONSIDERATIONS FOR PROTECTION FROM CROPLAND AREAS

The primary pollutants of concern from cropland areas are sediment, nutrients and pesticides. Practices that are used to reduce effects of pollutants include grassed waterways, filter strips, streamside forest buffers and other practices. Erosion control practices such as conservation tillage, terraces and other practices will reduce the sediment loading originating within a field which reduces the transport of pollutants that are attached to soil particles. Integrated pest management may reduce the amount of pesticides required to produce a crop, therefore reducing potential problems.

Filter strips and buffers provide the final area of protection where sediment, nutrients (which may be recycled by the vegetation) and some agricultural chemicals can be collected before they reach a stream. Biological activity, especially in streamside areas, may be very high.

PLANNING CONSIDERATIONS FOR PROTECTION FROM GRAZING AREAS

As a general rule, livestock should never have free and unlimited access to streams and waterbodies. Conversely, total exclusion of these areas may not be required to maintain high quality water.

Proper stocking rates of livestock to the area to be grazed may greatly affect the impact on water quality. Overstocked pastures will almost always result in serious damage to streams and streambanks.

Grazing management systems that include rotational grazing of several pastures may provide a high level of protection to watercourses. Short duration grazing, exclusion of grazing during dry or excessively wet periods, and during critical periods of vegetative growth may result in minimal effects to water quality. Locating water or salt facilities away from streams usually reduces the amount of time livestock spends near natural water sources. Establishment of stream crossings by constructing bridges, culverts, or hard surfacing the streambed with stone or other material may further reduce effects of livestock.

Livestock access to riparian areas should be limited. Rotation of livestock should be planned to allow sufficient time for vegetative regeneration.

Fencing is the least complicated way of eliminating livestock from streams and waterbodies. In some cases, it may be the only feasible way of protecting

water quality and complying with water quality standards.

OPERATION AND MAINTENANCE

Proper operation of this practice depends on proper maintenance of installed practices and naturally occurring vegetative buffers on the entire operation, especially those used for erosion and sediment control and to prevent or improve water quality problems. All structural practices such as fences, stream crossings, bridges or culverts must be maintained so they will function properly. Structures should be inspected following each heavy rainfall event and needed repairs made promptly.

75 STREAMSIDE FOREST BUFFERS

Tree and shrub buffers help protect many of the streams and waterbodies in Georgia by filtering sediment, nutrients and pesticides.



DESCRIPTION

Streamside forest buffers are areas of trees, woody shrubs and other vegetation, located adjacent to and upgradient from streams or water bodies and between open fields. Naturally occurring vegetation is generally preferred.

These areas provide a natural filter for sediment and organic material and their attached nutrients, pesticides and other pollutants prior to entry into surface waters. They also provide an area where nutrients may be utilized by vegetation, and where chemical decomposition can take place.

The filters are comprised of three vegetative zones. The first zone begins as close to the water body as possible where woody vegetation can be established and maintained and occupy a strip at least fifteen feet wide. This zone is for the purpose of stabilizing stream banks, providing shade to help moderate stream temperatures and promoting chemical and biological activity. This zone must be protected from activities that damage vegetation or soil conditions.

Zone 2 will begin at the edge of zone 1 and occupy an additional strip of land with a minimum width of 60 feet. The strip will also consist of forest or woody

vegetation, but may be managed for wood products or for limited forage production. The zone will be increased to a minimum of 100 feet when 100 or more animal units are located within 500 feet of the waterbody or when erosion in the watershed above the filter is excessive.

The purpose of zone 2 is to provide a source of carbon to enhance biological processes, provide an area for long term utilization of nutrients, and allow infiltration of surface runoff.

Zone 3 extends beyond the boundary of zone 2 and is a minimum of 20 feet wide. Vegetation on the zone may be trees and woody vegetation or grasses. The purpose of this zone is to provide sediment filtering, nutrient uptake and the conversion of concentrated flow to sheet flow and/or subsurface flow. The zone may not be required if the cover adjacent to zone 2 is already in grass or woody vegetation that is managed to prevent overuse.

WATER QUALITY BENEFITS

Streamside forest buffers provide a final opportunity to improve water quality before it enters a stream or other waterbody. They are not intended to serve as the only water quality practice or to replace erosion and

sediment control practices needed on agricultural land. Water quality problems must be prevented or treated near the site of origin when possible, and serious erosion and sediment problems will likely shorten the life or destroy the effectiveness of filters.

Buffers are effective filters to reduce the sediment load that escapes from other conservation practices before it reaches waterbodies. Sediment may carry phosphorus, organic matter, and chemicals and prevent their movement into the water.

Forest buffers provide a place where chemical and biological processes occur that converts nitrogen in organic matter to nitrates. These forms may then be used by plants or bacteria. In wet areas or when soil moisture is high, nitrogen sources may be converted to nitrogen gas which may return to the atmosphere. Chemical and biological reactions in these areas may also decompose agricultural chemicals.

PLANNING CONSIDERATIONS

Proper planting dates must be used and consideration given to the sequence of practice installation needed to protect the streamside forest buffer during establishment. Excessive erosion rates may inhibit successful establishment of the buffer.

Determine the type and quantity of potential pollutants that will be transported from the drainage area. Some adverse effects may be high maintenance costs, periodic need for reestablishment of vegetation, and the delivery of excess nutrients, sediments, and other potential pollutants through the buffer.

Use species adapted to the soils and site factors with the ability to achieve other benefits such as timber production, forage production, wildlife habitat improvement, stream shading, and aesthetics. Diverse species of native trees and shrubs are preferred and natural regeneration is an acceptable method of establishment.

Management alternatives in the buffer should be examined. These may include selective tree harvesting in the case of zone 2 and controlled grazing in zone 3.

Buffers should be considered in order to protect against future water quality impairment.

OPERATION AND MAINTENANCE

Inspect buffers following each severe storm. Perform actions needed to correct concentrated flow and restore sheet flow.

Cut and remove trees within zone 1 that jeopardize the stability of the streambank. Cut dead trees that may fall in the channel and affect stream flow.

Zone 3 vegetation should be mowed and clippings removed from the site if excessive nutrients accumulate. Remove sediment deposits that may affect sheet flow.

27 CRITICAL AREA PLANTING

Sericea lespedeza is a low maintenance plant that is well suited for roadbank erosion control, but other plants such as bermudagrass is better suited for areas where vegetation will be mowed and managed on a regular schedule.



DESCRIPTION

Critical areas usually cannot be stabilized by ordinary conservation treatment and management, and if left untreated can cause severe erosion or sediment damage. Examples of applicable areas are dams, dikes, mine spoil, levees, cuts, fills, surface-mined areas, and denuded or gullied areas where vegetation is difficult to establish by usual planting methods.

The purpose of planting is to stabilize the soil, reduce damage from sediment transport to downstream areas, and improve wildlife habitat and visual resources.

The definition of Critical Area Planting is the planting of vegetation, such as trees, shrubs, vines, grasses, or legumes, on highly erodible or critically eroding areas.

WATER QUALITY BENEFITS

The major benefit in improving water quality by planting critical areas comes from reduction in soil erosion. Vegetation reduces the off-site movement of sediment and dissolved and sediment-attached nutrients and pesticides. The organic matter derived from plants can increase infiltration and the water-

holding capacity of the soil and thus aid in reducing run-off.

PLANNING CONSIDERATION

When possible use planting methods to place seed in the ground.

Companion crops aid in getting permanent cover established, especially when mixed plantings are done during marginal planting periods.

No-till planting is effective when planting is done following a summer or winter annual cover crop. *Sericea lespedeza* planted no-till into stands of rye is an excellent procedure on mine spoil areas.

Livestock grazing and vehicular traffic must be excluded or minimized in order to maintain good vegetative cover.

When possible, consider using irrigation to enhance rapid establishment, especially when late plantings are done.

Use low maintenance plants in most cases to ensure long-lasting erosion control.

Proper fertilization and liming are essential for establishment and maintenance of vegetation.

Avoid the use of excessive amounts of nutrients and pesticides.

OPERATION AND MAINTENANCE

Maintenance required for critical area planting depends largely on the use of the area, aesthetics, and the kind of vegetation desired. Some plants such as sericea lespedeza are generally self-sustaining once a vigorous stand is obtained. Other plants will need regular fertilization and intensive care, especially if the area is to be used for purposes other than conservation use. The SCS Field Office Technical Guide, various Cooperative Extension Service publications, and other sources provide information on maintenance requirements for a variety of plants.

29 COMPOSTING PROCESSES

Proper composting to stabilize nutrients and reduce bacteria from animal wastes requires aeration and mixing of the material to produce a quality product.



DESCRIPTION

Composting is an aerobic (oxygen-dependent) degradation process by which organic wastes decompose under controlled conditions. The composting process is carried out by bacteria and fungi which digest the organic material and reduce it to a stable humus. During the composting process, decomposing waste generally loses between 40 and 75 percent of its original volume.

There are several factors that influence the composting process. Proper moisture, aeration, carbon to nitrogen ratio, temperature and proper pH are all requirements of successful composting. Operating temperatures of 130 to 150 degrees F are desirable and should be attained in the composting process. These temperatures kill fly larvae, pathogens and weed seeds.

Composting can be carried out in windrows or bins with aeration provided by mechanical turning or forced aeration. Aerated bins with mechanical equipment for turning and/or aeration are generally more efficient yet more expensive than windrow composting.

The most commonly composted materials on farms are animal manures and dead birds from poultry

operations. Instructions for composting are available from the Soil Conservation Service and the Cooperative Extension Service. These agencies should be consulted prior to establishing composting operations. In certain targeted watersheds, cost-share funds may be available from ASCS.

Poultry mortality composting requires a permit from the Georgia Department of Agriculture.

BENEFITS OF COMPOSTING

Livestock and poultry manure and dead birds can be composted to provide an improved product for land application or for upgraded use such as horticultural planting mixtures. Composting stabilizes organic matter, improves handling characteristics, preserves nutrients and reduces product odors. The heating and chemical breakdown results in a product that has additional benefits such as:

- (a) a stabilized product that can be stored or spread with little odor or fly problem.
- (b) most disease pathogens and weed seeds are destroyed.

- (c) reduces potential for groundwater contamination because wastes are applied on or near the soil surface.
- (d) when added to the soil it improves structure, organic content and increases water holding capacity.
- (e) provides farmer with an alternative use for manure.
- (f) lowers hauling costs because of reduced volume and improves ease of handling and spreading.
- (9) location of uncovered composting operations to prevent runoff from entering streams or groundwater
- (10) possible heavy metal contamination from feed or medication and analyze material when questionable

PLANNING CONSIDERATION

Composting must be land applied at agronomically sound application rates following a scientifically developed nutrient management plan. Compost will primarily be utilized on-farm as a soil amendment and nutrient source of nitrogen. A complete laboratory nutrient analysis of compost should be performed annually. Composting can be relatively expensive in some operations. Producers must carefully consider economics and final use of the product. Considerations must also be given to the following:

- (1) storage facilities for finished product
- (2) location of composting facilities, windrows, composter bins, etc.
- (3) crop or pasture acreage available for land application
- (4) equipment available for spreading on land
- (5) vehicles for transport of compost to neighboring farms
- (6) availability of supplemental materials such as bulking agents, sludges or other composting sources
- (7) cost of equipment, labor, etc.
- (8) possible regulations in critical watersheds that may restrict use

TABLE 1. BEST MANAGEMENT PRACTICES ESPECIALLY EFFECTIVE IN REDUCING LOSSES OF NITROGEN FROM FIELD CROPS

PRACTICE	DESCRIPTION
1. Proper nutrient application rates	Match crop needs to nutrient application rates. Establish optimum economic yield goals consistent with soil "capability." Apply nutrients according to soil test program recommendations. Account for all sources of nutrients.
2. Appropriate timing of nutrient application	Nitrogen applications should correspond as closely as possible to crop needs. Use split applications of nitrogen on most soils. Avoid fall or winter applications of nitrogen or manure for spring planted crops. Avoid application of nutrients on frozen or saturated soil.
3. Appropriate method of nutrient application	Use methods that promote efficient nutrient use (for example, dribbling of nitrogen in no-till culture) and reduce erosion. Band or incorporate fertilizer and manure when consistent with tillage practices.
4. Conservation tillage practices	Select tillage practices that are consistent with soil properties, climate and farming system. Conservation tillage systems will generally reduce loss of nutrients in surface runoff. The effectiveness of these systems in controlling subsurface loss of nutrients has not been fully defined.
5. Crop rotations	Legumes used in the rotation may reduce nitrogen fertilizer requirements for the following crop. Most rotations using a sod crop reduce erosion, leaching, and improve soil structure.
6. Cover Crop	Cover crops use residual nutrients and reduce erosion and leaching. Legume cover crops may reduce nitrogen fertilizer requirements for the following crop.

TABLE 2. BEST MANAGEMENT PRACTICES ESPECIALLY EFFECTIVE IN REDUCING LOSSES OF PHOSPHORUS FROM FIELD CROPS

PRACTICE	DESCRIPTION
1. Contour farming	Field operations are performed on the contour of the land. Reduces runoff and nutrient loss in runoff.
2. Strip cropping	Alternating strips of row crops and closely grown crops on the contour or across the slope. Filters runoff and increases infiltration.
3. Grass filter strip	Permanent sod strip at the base of the slope of a field. Grass filter strips remove soil particles from runoff where sheet flow occurs and increases infiltration.
4. Natural vegetated filter	Permanent indigenous vegetation at the base of a drainage area that filters particles from runoff. Natural buffers are less expensive than designed, installed and maintained grassed filter strips.
5. Terrace	Cropped channel across the slope that reduces slope length and runoff velocity. Terraces slow water movement, reduce runoff and enhance infiltration.
6. Diversion	Grassed channel across the slope that diverts excess water to areas where it can be managed properly to reduce erosion potential.
7. Grassed waterway	Sod channel that provides a non-erosive outlet for surface runoff.
8. Sediment control basin	A basin to collect runoff and store sediment.
9. Conservation tillage	Probably the most effective practice for reducing sediment loss and adsorbed phosphorus.

33 APPENDIX

BEST MANAGEMENT PRACTICE SUMMARY GUIDE	SURFACE WATER							GROUND WATER	
	Sediment	Soluble Nutrients	Adsorbed Nutrients	Soluble Pesticides	Adsorbed Pesticides	Oxygen-Demanding Organisms	Bacteria	N Loss to Grd Wtr	Pest. Loss to Grd Wtr
Conservation Tillage	*	X	*	X	*	X	X	+	+
Contour Farming and Terracing	*	▲	*	▲	*	▲	▲	+	+
Stripcropping	▲	▲	▲	▲	▲	▲	▲	X	X
Filter Strip	▲	X	▲	X	▲	▲	▲	X	X
Cover Crop	▲	▲	▲	▲	▲	X	X	▲	X
Crop Rotation	*	▲	*	▲	*	X	X	X	▲
Nutrient Management	X	*	*	X	X	▲	X	*	X
Pest Management	X	X	X	*	*	X	X	X	*
Irrigation Water Management	▲	▲	▲	▲	▲	X	X	▲	▲
Pasture Management	▲	X	▲	X	X	▲	▲	X	X
Ag Waste Management System	*	*	*	X	X	*	*	*	X
Streambank and Waterbody Protection	*	X	*	X	X	X	X	X	X
Grassed Waterway	▲	X	▲	X	▲	X	X	X	X
Critical Area Planting	*	▲	▲	X	▲	X	X	X	X
Streamside Forest Buffers	▲	X	▲	X	▲	▲	*	X	X
Composting	X	*	*	X	X	▲	X	*	X

Note: Because of the general nature of this chart, there may be situations where practices will not perform as indicated.

- X No control to low effectiveness
- ▲ Low to medium effectiveness
- * Medium to high effectiveness
- ⊕ May increase loading in some cases

1. Georgia Pest Control Handbook. University of Georgia Cooperative Extension Service (updated annually).
2. Georgia Soil Test Handbook. University of Georgia Cooperative Extension Service (periodic updates).
3. Georgia Plant Analysis Handbook. University of Georgia Cooperative Extension Service (periodic updates).
4. USDA-Soil Conservation Service Field Office Technical Guide (regular updates).
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7. Managing Nonpoint Source Pollution: Final Report to Congress on Section 319 of the Clean Water Act (1989). Office of Water (WH-553) U.S. Environmental Protection Agency. January 1992.
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11. Recommended Best Management Practices for Forestry in Georgia. Georgia Forestry Commission.

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