TECHNICAL NOTES
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

TN - AGRON - 33

Davis, California
September 1976

Conservation Planning for Waste Management and Pollution Reduction on Agricultural Land

Current SCS policy makes it mandatory that waste management and pollution abatement be considered in developing farm and ranch plans. Each conservationist providing planning assistance is charged with examining resource management system alternatives being considered for assurance that the planned actions will not increase the release of pollutants to adjacent land and water resources.

Few guidelines have been presented to date to help conservationists integrate waste management and pollution abatement into farm and ranch planning procedures. The intent of this technical note is to present some discussion and principles that may prove helpful until more specific criteria is available.

Agronomic research in progress and planned for the future is making use of plant breeding, improved tillage methods, biological pest controls, advancements in irrigation, and other technology to reduce pollution credited to current agronomic systems. This paper discusses the problem in terms of existing technology.

GENERAL

It would probably be difficult to locate a watershed devoted to agricultural use in which conservation treatment would not reduce pollution down stream as compared to no treatment. The overall treatment reduces runoff, erosion and sediment production. Sediment is our number one pollutant so reducing sediment production reduces pollution.

Unfortunately, many of our requests for technical assistance involve conservation planning to intensify land use. In such instances intensification of land use usually tends toward increasing pollution of adjacent resources even though conservation treatment is applied. Examples typical to California include:

1. Converting sloping rangeland to cropland.
2. Brushland conversion to irrigated orchard or vineyard.
3. Introducing irrigation onto nonirrigated cropland.
4. Installing drainage systems on agricultural land.
5. Toxic salt reduction on agricultural land.

Much SCS technical time in California is devoted to the five activities listed above and each is considered to be a worthy area of conservation endeavor. Yet each conversion or practice tends to increase pollution in some form. Usually we are aware that the conversion will be made or practice carried out even without our assistance. This being true, we can take consolation in the fact that pollution has been reduced by our conservation planning and application assistance as compared to results without assistance.

When sheet and rill erosion is a problem on land areas being planned, the universal soil loss equation gives us a reliable tool for planning conservation systems that keep sediment production minimal. Unfortunately, our current tools for measuring and abating other forms of pollution are less direct. For example, we know that irrigation water management can be used to reduce movement of nitrates and other soluble salts to the water table. Split applications of nitrogen will reduce nitrate movement to water table. Proper use of crop residues and cover crops can also reduce nitrate pollution of surface and ground water. To date however, we have no criteria for discussing value of the practices in quantitative terms. Data has not been developed for relating how much nitrate movement will be restricted by each of the measures. Similarly, quantitative values of most other practices with pollution abatement value have not been worked out. Lack of quantitative values often makes it difficult to select a most effective practice for pollution abatement when there are alternative methods of abating the same pollutant.

Established Pollution Abatement Principles

Despite the absence of quantitative data for relating an abatement value to specific conservation practices, several broad principles exist that can serve as guidelines for planning resource management systems to provide effective pollution abatement:

1. Sediment is the most serious pollutant of surface water. It follows that the management system that provides most effective erosion control will also provide the best overall pollution abatement on land areas when erosion is a problem.

2. Effective organic waste utilization is pollution abating. Effective uses include (1) recycling crop residues through livestock or leaving them in place for erosion control and soil improvement (2) making use of all available and suitable land area for manure disposal to assure maximum recycling of its plant nutrient content.

3. Soils and crops provide a "living filter" for treating organic wastes and thus reducing air and groundwater pollution. Practices that increase infiltration and prolong periods of runoff take maximum advantage of the "living filter".

4. Efficient irrigation water use reduces pollution.
Systems that reduce the gross water required to produce crops reduce the amount of salts introduced to the field in irrigation water, avoid pollutant-laden runoff and minimize leaching of nitrate and other salts to the water table.

5. Efficient use of agricultural chemicals reduces opportunities for pollution.
This concept includes management to produce crops with balanced fertilizer programs and utilizing existing technology to reduce the amounts of fertilizer and pesticides needed.

6. Soils vary in ability to assimilate and contain pollutants.
Some criteria is available for determining the degree of limitation of various soils for safely accepting waste materials. California T.N.-EVT-7 provides guidelines for determining maximum safe loadings of animal manures to land. Tentative national criteria has been developed for determining safe loading rates of sewage plant products to agricultural land (Advisory EVT-11, April 30, 1976 with attachment). As a general rule, the best agricultural soils can safely accept the heaviest waste loadings. Ordinarily heavy waste applications are not necessary on a farming unit unless large amounts of waste are being introduced that were not produced on the unit.

Pollutants Originating From Farming Operations and Recognized Methods of Abatement

1. Sediment

Soil particles deposited by water can have many adverse effects on man's environment. In addition to reducing the capacity of streams and reservoirs, sediments from agricultural land carry chemicals that degrade surface water supplies either directly or by promoting undesirable plan growth. Sediments deposited on land during flooding can carry chemicals, weed seeds, and disease organisms in addition to leaving damaging deposits on crops and other property.

Abatement methods include use of properly selected conservation practices to minimize erosion from precipitation and runoff.

2. Animal Manures

Like sediment, animal manures contain many mineral and organic compounds that can degrade water supplies. Manures can contain pathogens capable of transmitting diseases to livestock and human beings. Unless properly stored or managed, manures can pollute the atmosphere with volatile sulfur compounds and ammonia.

Special abatement measures are usually needed only when large numbers of animals are concentrated on a small area. Typical problem areas include feed yards, dairies, poultry and swine operations, and barnyards. Criteria to maximize utilization and minimize pollution from such areas include:

a. Provision for frequent light applications of the manures to minimize nitrogen losses from volatilization and denitrification. Losses can be reduced further by irrigating or working the material into the soil immediately following application.

b. Provision for adequate and properly designed storage facilities to contain the manure and runoff from lots during periods between land applications. Runoff from lots must be diverted from water supply sources. Lots on potential floodplains should be treated as necessary to prevent flooding.

c. If limited land area makes heavy manure applications necessary, potential water and air pollution from nitrogen compounds can be reduced by:

   (1) Lengthy anaerobic storage of liquid manure, to permit biological denitrification.

   (2) Composting of manure solids to reduce volatilization.

   (3) Growing and feeding forage crops that use large amounts of nitrogen on land receiving the manure (perennial grasses, corn, forage sorghum).

3. Fertilizers and Soil Amendments

Soluble plant nutrients not taken up by crops are pollutants if carried into water supplies by runoff or percolation. In streams and reservoirs such nutrients degrade water quality by accelerating unwanted plant growth. Nutrients leached to the water table reduce ground water quality for many uses. Many factors, including variations in soil fertility and nutrient holding capacity, tend to complicate arriving at exacting procedures to reduce pollution from plant nutrients, especially on intensively farmed land where large amounts of fertilizer and soil amendments are needed for sustained production. Ordinarily crops appear to be incapable of utilizing more than about 50% of the nutrients applied in any given year when heavy applications of fertilizer are necessary. The nutrients left over after crop harvest do escape to varying degree to reduce water quality. Use of cover crops and crop residue management are two practices available to help hold residual nutrients between crops for recycling into the following crops. Both practices accomplish this by reducing erosion and by tieup of nutrients that would otherwise be leached below the root zone. Cover crops also reduce soil water movement downward by using it for transpiration.

Other known methods of increasing the efficiency of fertilizer use and thus reduce their potential to pollute water include the following:

a. Soil and plant tissue testing, and use of fertilizer test plots to determine plant nutrient needs of individual crops followed by making adjustments in the fertilizer program needed to attain plant nutrient balance.

   When any one nutrient limits crop yield, this leaves an excess of other nutrients available to escape as pollutants.

b. Even distribution of fertilizer avoids leaving parts of the field with too much and other parts without enough plant nutrients.

c. Banding fertilizer beside and slightly below the seed has been shown to increase fertilizer efficiency as compared to broadcasting.

d. Even distribution of irrigation water and applying only what the root zone will hold avoids leaching nutrients out of the crops reach.

e. Properly timed split applications of nitrogen reduce losses as compared to single large applications. Slow-release forms of fertilizer can reduce losses when single heavy applications are necessary.

f. Placing fertilizer into the soil reduces losses as compared to surface applications.

g. Keeping soil pH near neutral increases crop uptake of most nutrients as compared to either acid or alkaline soil conditions.

The best overall tools available for minimizing pollution from plant nutrients on land requiring fertilizer for sustained high production are erosion control practices and efficient fertilizer use. Possibilities for reducing fertilizer costs should provide farm operator incentive to use fertilizers efficiently. For most California operators, local University Extension Service recommendations probably provide the best guidelines for attaining efficient use.

4. Pesticides

Chemicals used for control of agricultural weeds, insects, and diseases are of great concern to individuals and agencies concerned with maintaining high water quality, especially in surface water supplies. Research has shown definite correlation between sheet and rill erosion on cropland and pesticide contamination of surface water bodies. Pesticides absorb on the surface of clay and humus particles and move into water bodies along with the particles. Pesticide content of runoff is greatly reduced by erosion control, other factors being equal.

Two other principles important in reducing pollution from pesticides follow:

a. Use the minimum amounts recommended for control of the target pest. Follow label and other reliable instructions carefully to obtain thorough coverage, even distribution and maximum effectiveness. Avoid weather conditions that reduce effectiveness and might increase volatalization and drift into adjacent non-target areas.

b. Use cultural methods and other technology to reduce need for pesticides. Use crop rotations that provide some pest control when possible. Use pest resistant varieties. Manage crop residues to favor large populations of pest predators. Make use of biological controls when they are available.

5. Soil and Water Salts

Soluble salts in soils and irrigation water present serious pollution abatement problems in extensive arid areas that have only water of high salt content to support irrigated agriculture. As water is transpired by crops salt left in the root zone must be leached to drains or towards water table to sustain production. The problem becomes most acute when the groundwater must provide all or part of an areas water supply and must be reused as its salt content increases. Permanent relief can take two forms:

1. Introducing an exterior source of irrigation water that is low in soluble salts.

2. Use of group drainage systems to carry excess salts to permanent sinks that are closed off from the irrigation water supply.

Efficient irrigation water management is the most effective on farm conservation practice for reducing water pollution from salts. Use of salt tolerant crops can also help. Research in progress should make crop varieties with improved salt tolerance available with time.

6. Field Dust

Microscopic sized soil particles become air borne and suspended in the atmosphere, quite often in sufficient amounts to be injurious to human health. The primary cause of this dust is known to be wind erosion, but recent research shows that significant amounts are also air borne by the movement of agricultural equipment and vehicles, primarily during crop harvest and preparation for planting.

Conservation measures that control wind erosion are also effective in abating pollution from dust that is airborne by wind. Fugitive dust from field equipment and vehicles are reduced by minimum tillage and slower operation of tillage, planting, harvesting, and transportation equipment. Dust is also reduced by providing dust-free inroads and timing operations to have a little soil surface moisture when practical.

7. Crop Residues

The dominant environmental problems created by the left over materials from crop production and processing may be classified as follows:

a. Residue burning which adds objectionable odors and compounds to the atmosphere and wastes food materials needed by various living organisms to maintain ecological balances.

b. Surface water pollution from processing plant wastes.

c. Flies and other vectors attracted by accumulations of processing waste.

d. Unpleasant odors given off by decomposing wastes.

Methods available for reducing the problem include:

a. Returning residues to the soil for erosion control and maintenance of organic matter, fertility and tilth.

b. Utilization for livestock feed.

c. Utilization for soil mulches.

d. Proper storage to permit biological volume reduction without unpleasant odor and vector problems. (holding ponds, composting facilities, etc.).

Conclusion

The preceeding pages discuss waste management and pollution abatement problems commonly encountered in developing and implementing conservation plans on agricultural lands. No attempt was made to suggest solutions for specific example cases because specific examples are too numerous and variable for example solutions to be of much value.

An attempt was made to list known conservation methods of treating each problem. The numerous instances cited in which conventional erosion control, soil improving and water conservation practices can be used to abate pollution should help define the Environmental Protection Agency term "best management practices". On most farms and ranches high quality soil and water conservation plans provide for adequate waste management and pollution abatement without special measures. Certain intensively managed and/or specialized operations require additional practices to resolve waste and pollution problems. It is hoped that this technical note will prove helpful in identifying and treating situations requiring specialized waste management and pollution abatement systems.

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