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Soil Management To Protect Water Quality Irrigation Systems And Soil Management

Two major soil management problems are associated with irrigation of agricultural lands. One is salinization, and the other is accelerated erosion. Salinization is climatic dependent while accelerated erosion and its associated damaging effects can occur under any climate.

Irrigation And Salinization

Salinization is the buildup of salts that occurs when irrigation water is used extensively on arid and semiarid soils. Even fresh water is slightly salty, having acquired dissolved sodium, calcium, and magnesium salts. When this water is applied as irrigation to hot, dry soils, where drainage is very low and evaporation is very high, the water passes into the atmosphere and the salts are left behind on the ground, usually as a crust of sodium sulfate. This is generally not a problem in humid or sub-humid climates where natural rainfall continually flushes the soil of soluble salts.

As time passes the salts gradually build up to the point where they become toxic to plants. It has been estimated that as much as 400 tons per acre of salts have accumulated in the soils and shallow groundwater of some heavily irrigated farming regions of Southern California. Excessive fresh water is now required to flush out some of these salts to make the soils suitable for crop growth. Much of this brackish water enters nearby streams in irrigation return flows making them so salty that their downstream use for irrigation or other purposes may be jeopardized.

Desertification tends to follow widespread salinization in arid and semi-arid regions. Soil degradation reduces vegetation, leaving land exposed to greater wind and water erosion, which may permanently alter long-term productivity and habitability.

Irrigation And Accelerated Erosion

Supplemental irrigation, even in the humid Southeast, is a powerful means of increasing productivity and turning low-priced land into expensive cropland. Many other components of farming, including field ar-

range, crops, tillage, and fertilizer rates and schedules, are often changed to work with irrigation systems. Costs and returns are both increased with timely irrigation, but better management is needed to take advantage of the opportunities while avoiding potential problems. Potential problems include excessive leaching, increased surface runoff, and increased erosion. Erosion hazard is of concern because it not only degrades soil resources but can also lead to nonpoint source water pollution from sediment and sediment-associated nutrients and pesticides.

Three methods are used to apply irrigation water: (1) the sprinkler method where water is sprayed into the air and falls like rain; (2) the surface method where water is applied at ground level in furrows, by flooding, or through low-pressure trickle pipes or special emitters; and (3) the subsurface method where water is applied in open ditches or through buried pipes. Availability of water, quality and source of water, soil, climate, landscape features, crop water requirements, and expected net returns all play important roles in choosing what type of irrigation system to use.

Sprinkler and furrow irrigation are the two types that generally lead to the greatest erosion damage. However, irrigation of any kind that leaves soil saturated just prior to natural rainstorms will generally accelerate stormwater runoff and erosion. Monitoring and/or forecasting weather conditions is an important environmental aspect of irrigation scheduling, especially in the humid Southeast.

Irrigation Management Practices To Control Erosion And Sedimentation

The following irrigation management practices may be used to control erosion and sedimentation.

Method Of Irrigation. Furrow irrigation is generally much more erosive than other methods such as the various sprinkler methods or the drip or trickle irrigation methods. However, the sprinkler method can be

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very erosive if the system is improperly designed or if a properly designed system is improperly used. The sprinkler method results in very little erosion as long as the water application rate is less than the soil's intake rate and no water is applied just preceding a major rainstorm. On the other hand, low-intensity sprinkler irrigation may actually be used to wet a dry, freshly plowed soil to reduce wind or rainfall erosion from a severe storm.

Center pivots are the most erosive sprinkler systems, especially at the far end of the main boom where the soil intake rate will most likely be exceeded. Since relative ground speed increases from the center outward in a pivot system, water application rate must also be higher from the center outward in order to maintain a uniform level of application. This makes erosion potential higher with increasing distance from the pivot point; soil intake at the far end of the system is the limiting factor. The Soil Conservation Service can assist you in determining travel speed and flow-rate requirements to properly match application rate to soil conditions at the end of your system. Adjustments in nozzle size, ground speed, or pressure may be required.

Stream Size And The "Cut Back" Method. Avoiding large stream size and cutting back are both important practices that can be used in combination to reduce erosion in furrow irrigation. A general guide is to adjust the stream size so that the water reaches the tail end of the furrow in one-quarter to one-half the total irrigation period. Using the cut-back method after 12 hours reduces erosion and sediment transport in the furrows. However, a much greater reduction may be achieved by using a small stream size at the outset. Since the soil is usually most erosive at the beginning of the irrigation period, using as small a stream size as possible is very important.

Length Of Run. Erosion can be reduced significantly by reducing the length of run in furrows for furrow irrigation and adjusting stream size accordingly. Serious erosion can occur in long runs without the appearance of a great amount of sediment in the tail water. Erosion is greater near the head end of the runs.

Duration Of Irrigation. The greatest erosion takes place early in the irrigation period, especially if the land was recently cultivated. It is best to use fewer irrigations of longer duration. Two 12-hour irrigations are more erosive than one 24-hour irrigation. Of course, if the soil is sandy and/or shallow, frequent irrigations of short duration will be unavoidable.

Frequency Of Irrigation. Erosion is somewhat related to the total amount of water passing through the furrow. More important, however, is the fact that soils tend to be more erosive early in each irrigation.

Therefore, irrigating less frequently usually reduces erosion. This is especially true if the soil is cultivated between irrigations.

Cultivation. Erosion that takes place early in the irrigation period may be, for the most part, a function of cultivation. Cultivation increases not only infiltration but also erosion, especially during the first part of the succeeding irrigation. If there is no cultivation between irrigations, erosion is greatly reduced.

Slope. Erosion is a direct function of the rate of flow of water, and the flow rate obviously increases with steepness of slope. Sometimes slope can be reduced to some degree by land leveling. In some cases, slope can be reduced, in effect, by making irrigation furrows across the slope rather than straight up and down the steepest part.

Erosion can be controlled on slopes up to 2 percent with normal management practices. Fields with slopes above 2 percent will require special practices especially as they exceed 5 percent. Slopes much greater than 5 percent may have to be retired to permanent sod or changed from furrow irrigation to sprinkler or trickle irrigation. With good cover, slopes as high as 35 percent have been sprinkler irrigated for pasture and hay in the Pacific Northwest. Irregularities in slope gradient and direction make irrigation difficult.

Shape Of The Furrow. V-shaped furrows may be more erosive than U-shaped furrows especially on slopes of less than 3 percent.

Cropping. In general, fields seeded to small grains and forage crops are less erosive than those planted to row crops. Sometimes soil becomes badly eroded at the pipeline (or other distribution device) at the head end of the field in furrow irrigation. Grass or small grain strips are useful in preventing such erosion. Obviously, the strips have no effect on erosion in the main part of the field.

Minimum Tillage And Residue Management. The use of crop residues lightly incorporated into the soil surface is important for the control of erosion under furrow and sprinkler irrigation. For effective erosion control under irrigation and because of the need for keeping crop residue at or near the soil surface, the moldboard plow is a less desirable tillage implement than the chisel plow.

Filter Strips. Grass or small grain strips at the tail end of the irrigation runs are useful in filtering out sediments from the tail water.

Conclusion

Effective erosion control involves excellent water management. Water management by itself cannot be expected to eliminate erosion, but erosion and sedi-

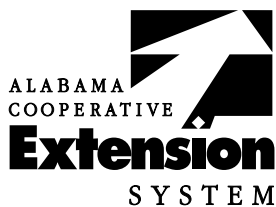
ment control begin with good water management. Good water management involves selecting a combination of management practices that best fit the cropland and that effectively control erosion.

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