University of Idaho
College of Agriculture

Cooperative Extension Service
Agricultural Experiment Station

Current Information Series No. 761

Furrow Erosion Reduces Crop Yields

D. L. Carter, B. J. Sanders and R. D. Berg

Furrow irrigation erosion redistributes topsoil within fields and causes serious topsoil losses from farms. Erosion occurs on the upper portions of fields where the furrow streams are largest and the energy greatest. The furrow stream must be large enough at the head end of the furrow to supply sufficient water for infiltration over the entire furrow length.

Where the slope along the furrow exceeds about 0.7 percent, the velocity and size of the furrow stream on the upper end of the field nearly always has enough energy to erode the topsoil. As the water flows down the furrow, the stream size, and hence the stream energy, are reduced by infiltration. Eventually, the stream's energy reaches a level insufficient to erode. Then, farther downslope, the stream energy decreases to a point where it can no longer carry the accumulated sediment level. Deposition then begins.

This topsoil erosion-deposition process decreases the topsoil depth along the upper one-third of many fields and increases the depth downslope on most of these fields. Where the topsoil depth is less than the original 15 inches, crop yields are decreased.

Extent of Erosion In Southcentral Idaho

The soils of southcentral Idaho consist of Portneuf silt loam and closely related soils. The original topsoil depth was about 15 inches over a lime-silica cemented hardpan. The upper ends of many fields in this area are whitish in color because erosion has reduced the topsoil depth sufficiently that plowing has fractured and brought portions of the white lime-silica cemented hardpan to the surface (Fig. 1). Over time, these white hardpan fragments are mixed with the topsoil, resulting in whitish soil areas, commonly referred to as "white soils."

A recent survey of the Magic Valley of southcentral, Idaho indicated that about 75 percent of the fields had white soils on the upper portions. In a separate study of 14 cooperating farmers' fields, the average portion of

Fig. 1. White soil resulting from furrow erosion and tillage mixing on the upper end (foreground) and topsoil on the lower portion of a typical field.

white soil on a field was found to be 30 percent. This percentage reflects the degree of erosion over the past 80 years. Assuming that the 30 percent white soil area measured in those cooperating farmers' fields is representative of the entire area, we multiplied that value by the 75 percent of the fields eroded to the extent that white soil appears. This resulted in an estimate that 22.5 percent of the area is severely affected by erosion.

Erosion Effects on Crop Yields

The effect of topsoil depth on crop yields was determined using both farmers' fields and experimental plots. During 1982 and 1983, 14 farmers' fields were sampled along four transects across each field to determine topsoil depth and subsequent crop yields. In 1983 experimental plots were established near the Snake River Conservation Research Center at Kimberly, Idaho. Topsoil was removed from one half of the experimental area and deposited on the other half. This created a topsoil gradient 4 to 26 inches deep. Six crops were grown on the various topsoil depths in 1983 and 1984, and yields were determined. The maximum yield harvested from each crop on a farmer's field or plot area was considered 100 percent, and all other yields in that field or plot area were converted to a percent of that maximum yield. This allowed comparisons between different varieties of the same crop and minimized differences in cultural practices.

The relationships between topsoil depth and percent maximum yield for wheat, sweet corn, alfalfa, dry beans, barley and sugarbeets are shown in Fig. 2. Yields are drastically reduced on all crops at topsoil depths below 15 inches. For example, the average wheat yield decrease from topsoil depths of 15 to 5 inches is 3.5 percent per inch. Barley, dry beans and alfalfa yields are similarly affected by topsoil loss but not as severely as wheat and sweet corn yields. Sugarbeet yields are the least affected by topsoil loss. At topsoil depths greater than the original 15-inch depth, yields do not differ significantly except for dry beans.

Costs of Erosion

Furrow erosion is an additive process as topsoil is lost year after year. Topsoil lost 80 years ago, when irrigation began in this area, affects yields today. For example, where the topsoil depth has been reduced from 15 to 6 inches in a field, as is the case in many white soil areas, yields are reduced as shown in Table 1. Down-field, below the white soil area, topsoil depths are often less than the original depth but greater than the plow depth. These areas do not show as white soils because the hardpan layer has not yet been fractured; however, yield decreases still result. Percent yield reductions on a field basis are listed in Table 1. These field yield reductions were calculated by assuming 30 percent of the field is white soil with an average depth of 6 inches, and an additional 10 percent of the field has an average depth of 12.5 inches. A potential yield decrease, without an equivalent reduction in expenses, is reflected in decreased potential profits for the farmer. The erosion of yesterday is costing the farmers of today.

Table 1. Percent maximum yield on white soil area and on a field basis for six crops.

Crop	% maximum yield on white soil area *	% maximum yield on a field basis **
Wheat	51	71
Sweet corn	52	71
Alfalfa	67	76
Dry beans	60	71
Barley	68	78
Sugarbeets	79	87

*Assuming a 6-inch average topsoil depth in white soil area.

**Assuming 30 percent of the field is white soil, and 10 percent of the field has an average topsoil depth of 12.5 inches.

Increasing Yield on White Soils

The factors causing the yield decreases on white soils have not been identified. Our studies seem to rule out both nutrient and water deficiencies by assuring adequate levels of both for growing crops. At present, we do not know how to substantially increase yields on white soil areas. Applying excess fertilizers, above the requirements of the crop, did not increase yields. Adding organic matter, in the form of manure, on white soil areas increased crop yields by an average of 5 percent in one study.

Currently, a study is underway to determine if moving topsoil from the lower portions of fields, where deposition has occurred, to the white soil area will help restore yields. Moving topsoil within a field may have limited practical application, however, because the topsoil depth on the lower portion of the field must exceed 15 inches to ensure that soil can be removed without causing yield decreases. Transporting soil within a field is expensive and may not prove economically feasible in all cases.

Erosion Control Practices

The economic impact of furrow irrigation erosion is serious. Farmers need to apply available erosion control technology to reduce the amount of erosion. The erosion damage resulting from the last 80 years of irrigation cannot be easily corrected, but we can focus our energies on ensuring that this damage does not continue.

Erosion control practices that will decrease erosion from the upper end of a field concentrate primarily on the farmer's management practices. Six factors influence the amount of erosion on furrow irrigated land: field slope, furrow stream size, soil type, crop, field length and duration of irrigation. The soil type remains constant from year to year, but farmers can better manage the other factors to reduce erosion.

Long field lengths require larger furrow stream flows to ensure adequate water to reach the lower ends. The length of a field can be reduced by splitting the field and installing another head ditch or by using gated pipe. These shorter fields require smaller stream flows that reduce the stream energy and erosion potential. The cost of installing an additional head ditch, and the land area lost to production because of equipment turn-around space, may limit the feasibility of this option. Gated pipe can be removed when cultivating and harvesting, so no additional land area is needed for equipment turn-around. The extra

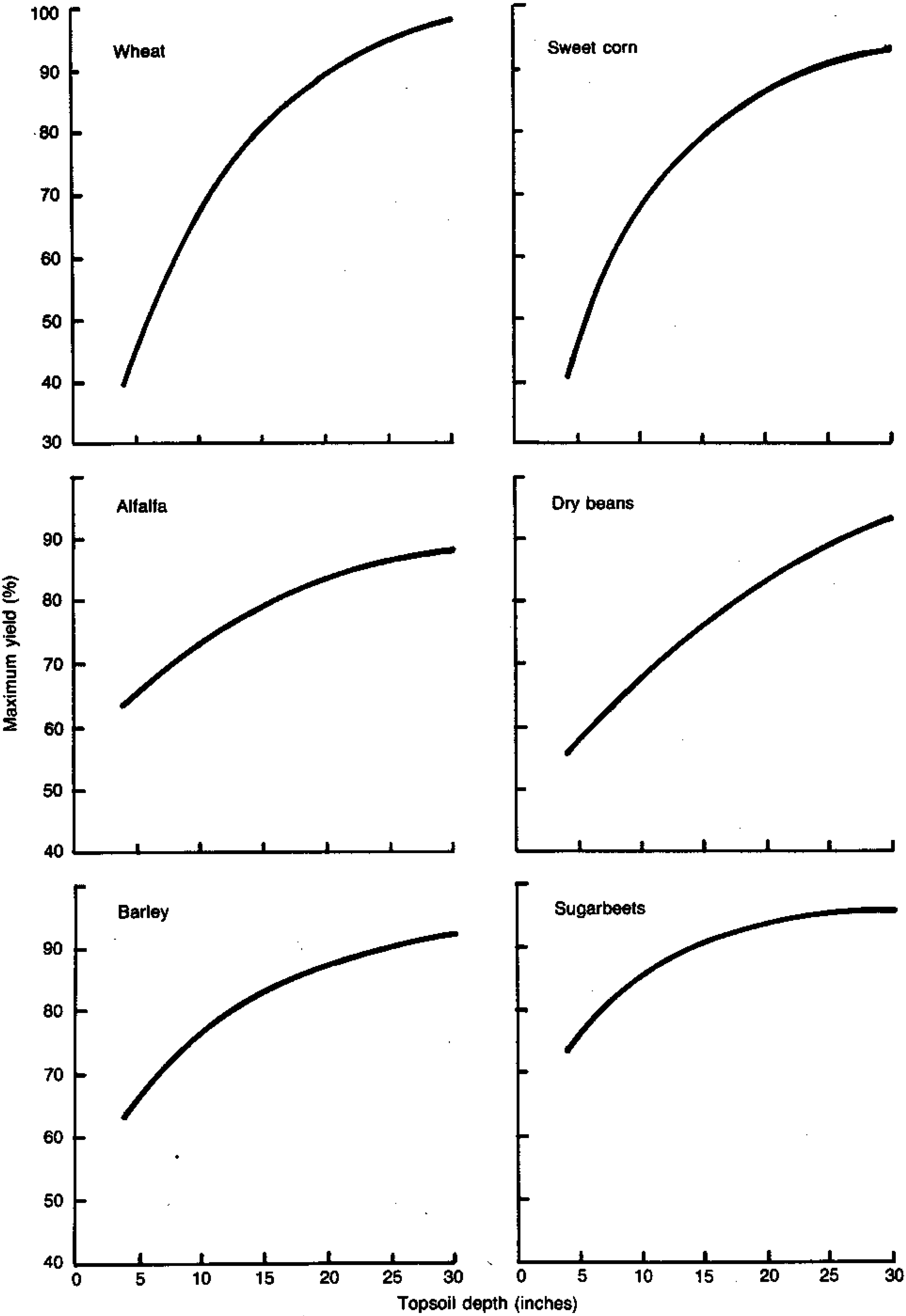

Fig. 2. Percent maximum yield at various topsoil depths for six crops grown on farmer's fields and experimental plots.

labor required, however, to move the pipe and the added cost of the pipe must be considered when determining this option's feasibility.

The number of hours a farmer allows the water to flow down the furrow and the number of irrigations per season also affect the amount of soil erosion. Farmers need to be careful to avoid over-irrigating their crops by leaving the water on longer, or irrigating more often or later into the season, than necessary. Besides increasing erosion, over-irrigation can leach nitrate nitrogen from the root zone and decrease yields.

On fields with slopes greater than 2 percent, erosion losses in row crops increase dramatically. Using crops that form a dense cover like alfalfa, barley, wheat and peas helps slow the water moving down the furrow and reduces erosion. Seeding crops such as beans and corn directly in the furrows also helps slow the velocity of the water. Tillage methods that leave some crop residue in the furrows help dissipate stream flow energy and filter some sediment from the irrigation water, thus reducing erosion.

Research is underway to evaluate the feasibility of using conservation tillage practices on furrow irrigated land to reduce furrow erosion. These practices also have the potential to reduce production costs. Research results should be available by 1986 or 1987 at the Snake River Conservation Research Center.

The Authors — David L. Carter is an affiliate professor and supervisory soil scientist and research leader stationed at Kimberly. B. J. Sanders and R. D. Berg are agricultural research technicians for the USDA, Agricultural Research Service, Snake River Conservation Research Center, Kimberly.

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, H. R. Guenthner, Director of Cooperative Extension Service, University of Idaho, Moscow, Idaho 83843. We offer our programs and facilities to all people without regard to race, creed, color, sex or national origin.

1500 5-85

35 cents per copy