SOIL CONSERVATION AND MANAGEMENT IN THE PALOUSE 1/

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The research program of the Soil and Water Conservation Experiment Station now known as The Palouse Conservation Field Station located three miles northwest of Pullman, Washington, was established to obtain information on the problem of soil conservation in the Palouse wheat-growing region of the Pacific Northwest. Rockie (1932) was the first superintendent of this Experiment Station and was succeeded by Dr. Glenn Horner in 1935. The first ten years of research there was reported by Horner, McCall and Bell (1944). The Station, funded by the USDA, had its beginning in 1930 with 202 acres of land. It was one of the 10 original soil erosion experiment stations established with funds appropriated by the Congress and carried in the appropriation for the U.S. Department of Agriculture. This was the only such station located in the 11 western states. The general objectives of the work were: (1) determination of the factors affecting the rate and amount of soil erosion and runoff, and (2) development of practical measures for minimizing or controlling these losses, thereby protecting the fertility of soils for increased crop production. Although farming practices have changed greatly over the past 50 years, these basic objectives in erosion research have changed little, if at all.

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The erosion in this area is considered some of the most severe in the USA; hence, the location of the Experiment Station in the center of this problem area was most appropriate. It is estimated that, on average, 358 tons of soil have been eroded from every acre of cropland in Whitman County. At this rate, one could anticipate the losss of the top six inches of soil in a little more than 100 years. Some estimates would indicate a shorter time would be required for this loss. Expressed another way, since 1934, nearly three-fouths of a ton of soil has been lost for every bushel of wheat produced in the Palouse River Basin (Palouse Cooperative River Basin Study, 1978).

Some of the early research areas were aimed at determining the effect of such factors as soil characteristics, vegetal cover, land use, topography, and climate on the rate and amount of erosion and the development and testing of such control measures as cropping and tillage practices, terracing, and gully and channel protection. The research approaches included establishment of runoff plots, terraced areas, and different sized watersheds for measurement of soil and water losses. Most notable of these was the establishment of a series of runoff and erosion plots which were maintained from 1931 to the early 1960's under the supervision of Dr. Glenn Horner. Results of these early studies were summarized by Horner, Oveson, Baker, and Pawson (1960). These plots--with some modifications in the interim--were used to study the effect of crop rotations and tillage, and residue management, effects on runoff and soil loss. Other research during the early years involved testing different tillage implements for the purpose of improving erosion control and crop yields.

Studies of the economics of the various cropping systems and soil conservation practices in the Palouse were summarized by Pawson, Brough, Swanson, and Horner (1961). They confirmed what farmers believed and had practiced accordingly, namely, that heavily fertilized wheat--with government subsidized price supports--paid two to six times the net income gained from barley or peas and many times more than alfalfa hay. Of course, there is a long range price: wheat farming results in the greatest erosion losses; and under alfalfa hay production, soil erosion losses are negligible. Further, with heavy fertilization, wheat yields are little affected by cropping sequence--except where disease or weeds become a factor.

The early research reported the harmful results of moldboard plowing and the beneficial effects of tillage methods that leave the soil loose, rough, and mixed, or covered, with crop residues. This research on the effect of different tillage and cropping practices on soil surface conditions, and the resultant effects on runoff and erosion may be summarized as follows:

1. Runoff and soil losses are reduced by
    a. mixing crop residues with the upper few inches of soil instead of inverting and burying them, as with a moldboard plow,
    b. leaving a considerable portion of the crop residues on the soil surface, and
    c. using tillage methods which will leave the soil surface rough and uncompacted going into the winter precipitation season.
2. Rotations that included alfalfa or sweetclover alone or with grass were more effective for soil and water conservation than winter wheat rotations that did not include these legumes or grass.

3. The ability of legume or legume-grass combinations in a rotation to influence infiltration, through their effects on aggregate stability or other soil properties, can be overridden by the physical effects of tillage or soil freezing.
4. Summer fallowing resulted in the highest runoff and erosion. The high content of soil moisture, pulverization of the soil, and depletion of organic matter are factors that cause this situation.
5. Runoff and erosion losses were reduced by the use of organic material. The effect was greater when the material was left on the surface as a mulch than when plowed under.
6. Approximately 90% of the total erosion for all cover conditions under various rotations studied occurred on land cropped to winter wheat. Cropping practices had a marked effect on runoff and erosion on wheat land.
7. Terraces are not very practical or satisfactory for runoff control on slopes steeper than 15%.
8. The rate and amount of runoff from cropland are affected by watershed characteristics, climatic factors, and farming practices.

In the years subsequent to the mid 60's, the emphasis and approaches on erosion and water conservation research changed somewhat from previous years. For one, there was a shift towards developing an erosion prediction equation for use in designing farm management plans and assessing the affect of land management on water quality in the Pacific Northwest. Secondly, about the same time research emphasis was given to non-conventional farming practices such as minimum tillage and no-till for cereal crops. Also, in 1972, the Washington State Wheat Commission submitted a proposal, now entitled STEEP (Solutions to Economic and Environmental Problems), to Congress for increased funding for erosion control research on nonirrigated lands. The effort was unsuccessful until 1974, when the Commission joined with the wheat grower organizations of Idaho and Oregon in submitting the proposal to Congress. This was funded for the USDA-Agricultural Research Service in 1975 and additionally through the USDA-State Cooperative Research in 1976. The project has been funded each year since and involves the USDA/ARS, and the state experiment stations of Idaho, Washington, and Oregon.

First attempts to predict erosion under Nothwest conditions were made with the Universal Soil Loss Equation which was developed largely for conditions east of the Rocky Mountains (Johnson, and Papendick, 1968). The early results using the Midwest-derived factors greatly underestimated soil loss over a range of conditions which was learned later to be true because of major differences in rainfall, slope length and steepness, and management factor relationships between the Pacific Northwest and the Midwest. Research was conducted to modify these relationships for the Pacific Northwest and revised first and second generation adaptations of the USLE were developed which greatly improved erosion prediction capability for Northwest conditions (McCool, Wischmeier, and Johnson, 1974; and McCool, Malnau, Papendick and Brooks, 1977). Subsequent work on erosion prediction methods has involved use of more sophisticated, physically based models referred to as CREAMS II and EPIC. Such models appear to be ones that will eventually succeed the USLE and serve the need for erosion prediction in the Pacific Northwest as well as in the rest of the nation.

STEEP (Solution to Environmental and Economic Problems) is a multidisciplinary research effort to develop new techniques and strategies to control soil erosion on Pacific Northwest croplands (Oldenstadt et al., 1982).

Interest in reduced tillage for erosion control in the Northwest region was first evident in the mid to late 1960's, about the same time as for other parts of the nation experiencing erosion problems.

Some of the earliest research on minimum tillage and no-till for wheat was started in the late 1960's at both the Oregon State University research station at Pendleton, Oregon, and the Palouse Conservation Field Station at Pullman, Washington. Much of the early work was fragmented and there were many failures due to lack of weed control, poor planting equipment, and problems with germination and emergence in heavy surface residues. One of the first crop rotation experiments with no-till was established in 1972 at the Palouse Conservation Field Station and though there were numerous failures with crop yields, the tillage plots are still in place.

The STEEP program initiated in 1975 by the state experiment stations of Idaho, Oregon, and Washington, and the USDA's Agricultural Research Service gave new impetus to erosion control research. The program is still active.

The research emphasis is to develop and utilize new and improved systems of management in which new tillage methods, plant types, and methods of pest control will be integrated into complete economic management systems to hold the soil in place better than is now possible. Principal areas of research include studies of crop residue management, cropping systems, fertilizer requirements and application methods, and planting equipment design. The overall objective of the research is to develop new methods, or to modify existing soil and crop management practices to enhance adoption of conservation tillage systems. Some very significant advances in knowledge and technology have been produced as a result of the STEEP program. Some of these are as follows:

1. Research over 5 years shows rather conclusively that crop residues left on the soil surface substantially benefit overwinter storage of precipitation when precipitation is not sufficient to thoroughly wet the soil profile. For example, in the intermediate precipitation zone, overwinter water storage was increased by 20% where the crop stubble was left undisturbed compared with clean fall tillage. Similarly, in a higher precipitation zone, surface residues increased water storage by about one-third on slopes and ridgetop positions of the field where runoff generally occurs (Oldenstadt et al., 1982).
2. Short-chain fatty acids found in decomposing surface residues may account for the frequently observed temporary stunting of no-till winter wheat. However, other unidentified toxins of biological origin are likely responsible for the more severe and permanent type injury that often occurs in heavy residues. There is now also preliminary evidence that roots of wheat growing under trashy tillage systems, or where heavy residues are shallowly incorporated, are often more heavily colonized by certain growth-inhibiting bacteria than wheat roots growing in clean tillage systems which may also account for poor growth (Elliott, et al., 1984).
3. A novel approach for crop residue management developed from STEEP research is the slot-mulch concept. This unique development has both the potential for reducing runoff and erosion from frozen soils and enhancing the feasibility of no-till planting in cereal stubble fields. Conceptually, the approach is to compact crop residues into a narrow, continuous slot approximately 3 to 6 inches wide by 10 to 12 inches deep formed preferably on the field slope contour. The compacted residue insulates the soil and prevents freezing at the base of the slot and, hence, allows water infiltration when the surface

soil is frozen. Utilizing the excess loose straw following harvest of a cereal crop for slot mulching also reduces the mechanical seeding, phytotoxic and microbiological problems associated with no-till planting (Saxton et al., 1982).

4. Highest yields of winter wheat in the Palouse with no-till are obtained where the crop follows a low residue crop such as peas or lentils. No-till planting of winter wheat following these grain legumes is now well along to becoming a common practice with growers in eastern Washington and adjacent Idaho, and wheat yields equal or sometimes exceed those obtained with conventional tillage planting (Oldenstadt et al., 1982).

5. No-till management offers distinct possibilities for more intensive cropping in the low to intermediate precipitation areas (12- to 15-inch average annual precipitation) where alternate wheat-fallow previously has been the more traditional practice. This method would increase water storage most years compared with fall cultivation which would reduce surface cover. Instead of the usual fallow cultivation, a spring crop such as barley or spring wheat is no-till planted as early as conditions permit in the spring. In addition to a greater overall production, the substitution of cropping for fallow provides more continuous soil cover and, hence, more erosion control as well as greater water-use efficiency (Oldenstadt et al., 1982).

6. A new planting geometry concept called, "paired row planting" has emerged with no-till small grain planting and appears to offer new opportunities with fertilizer placement for increasing seedling vigor, early crop growth, and crop competition against weeds as compared with traditional even row spacing and banding the fertilizer below the seed or in the center of evenly spaced seed rows. The paired row concept

involves seeding two rows of wheat--or other small grain-5 inches apart, etc. Other geometries can be used. Fertilizer can be placed with the seed or banded between the 5-inch spacing during the seeding operation. In either case, the fertilizer is placed in close proximity to the seed row so as to favor the crop in the early growth stages for more immediate nutrient uptake and greater accessibility to fertilizer over that of weeds (Papendick, 1984).

SUMMARY

Soil and crop management research for erosion control and water conservation has received considerable emphasis since establishment of the Soil and Water Conservation Experiment Station at Pullman in 1930. Research was carried out on effects of tillage systems and cropping sequences on crop yields, runoff, and soil erosion. Early research showed the harmful effects of moldboard plowing in accelerating soil erosion and the beneficial effects of rough tillage, surface crop residues, and use of sod crops in the rotation for erosion control. Much research in later years was carried out on soil erosion prediction which led to adaptation of the Universal Soil Loss Equation for Pacific Northwest conditions. Recent emphasis on soil and crop management research is being directed to development of reduced tillage and no-till practices for small grains and grain legumes. The STEEP (Solutions to Environmental and Economic Problems) program being carried out by the state experiment stations of Idaho, Oregon, and Washington and the USDA-Agricultural Research Service, beginning in the mid 1970's, has given considerable new impetus to erosion control research in the Palouse region.

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