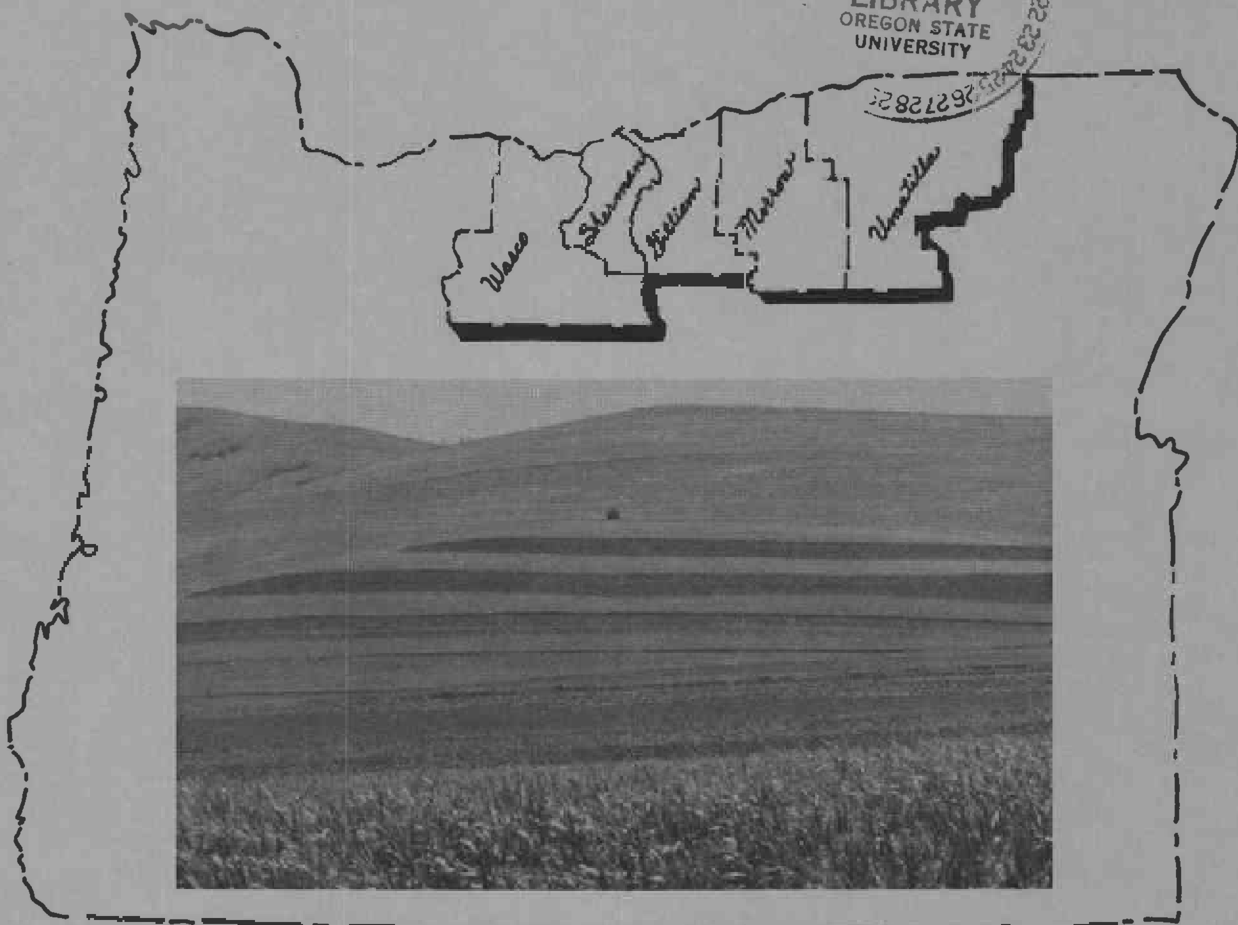
Best Management Practices and Water Quality Demonstration and Evaluation Project

Five-County North Central Oregon Area
October 1977 to April 1981

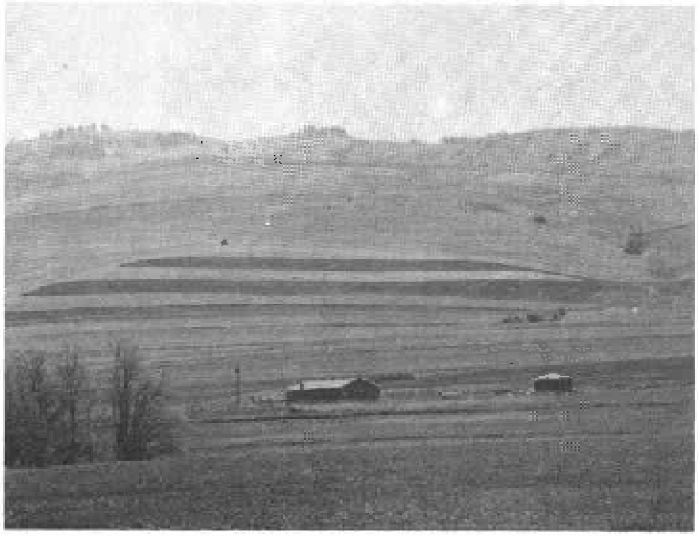


Special Report 646
January 1982

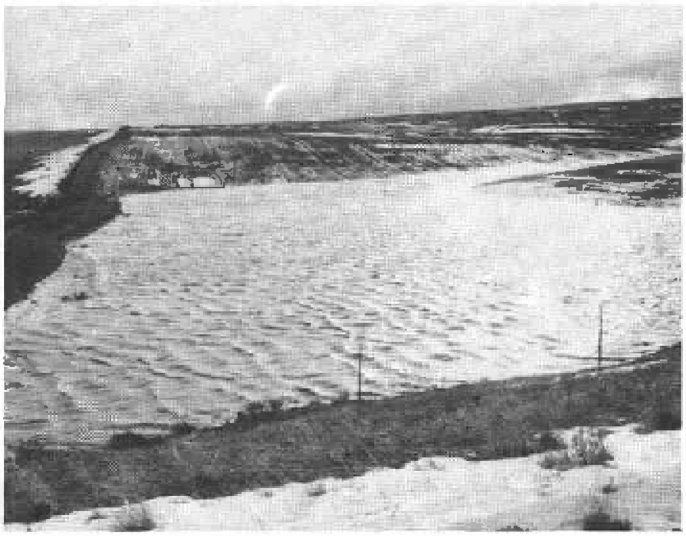
Agricultural Experiment Station
Oregon State University, Corvallis
in cooperation with
Oregon State Soil and Water Conservation Commission,
Oregon Department of Environmental Quality,
US Environmental Protection Agency, and
USDA Soil Conservation Service

Terrace

Grassed Waterway



Strip Cropping



Sediment Basin

Stubble Mulch/Conservation Tillage

AUTHOR:

Gerald O. George, Erosion Specialist, Agriculture Engineer on an Interagency Personnel Act assignment from USDA Soil Conservation Service to OSU Agriculture Experiment Station, Pendleton, Oregon.

ACKNOWLEDGMENTS:

Financial assistance was provided by the USDA Soil Conservation Service, Oregon Agriculture Experiment Station, State Soil and Water Conservation Commission, and State Department of Environmental Quality through Federal 208 funds provided by the US Environmental Protection Agency.

Thanks to the following landowners for their cooperation and assistance:

<u>Gilliam County</u>
Paul Jaeger, Condon
Clarence Potter, Condon
William Hill, Gwendolyn
Harrison Ranch, Lone Rock

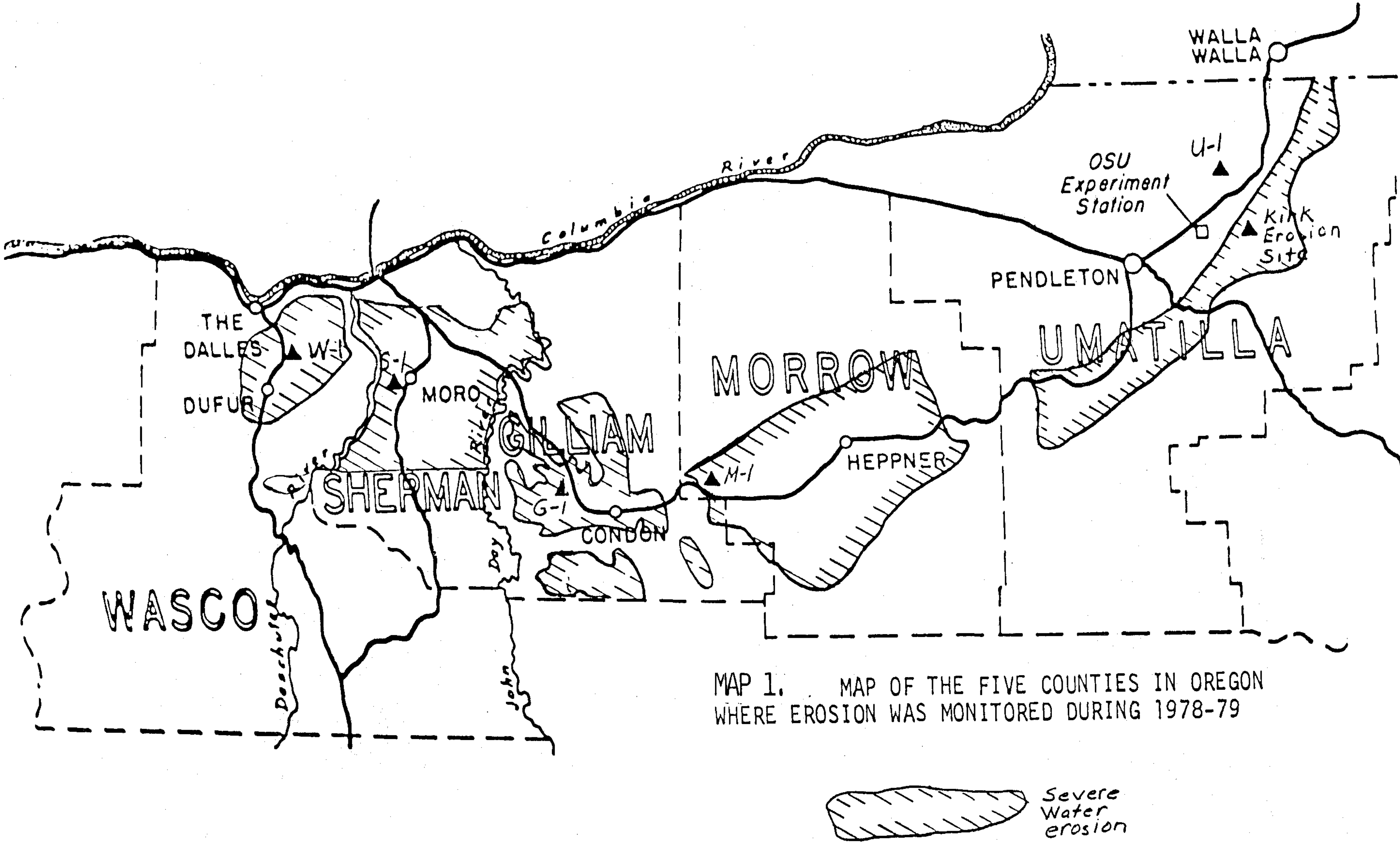
<u>Sherman County</u>
Tex Irzyk, Moro
Stanley Coelsch, Moro
Robert Olson, Moro
Robert Martin, Grass Valley
William Todd, Grass Valley

<u>Wasco County</u>
John Kerege, Dufur
John Ward, Dufur
Hillis Bolton, Dufur
Robert Brewer, Emerson
K.C. Kortge, Emerson
Wilbur Kelly, Emerson
R.K. Neal, Dufur

<u>Morrow County</u>
A.L. Bunch, Heppner
Douglas Drake, Heppner
Rex Ziegler, Heppner
Kenneth Turner, Heppner
William Rill, Eightmile
Donald Peterson, Valby

<u>Umatilla County</u>
Millard Rayborn, Weston
Bob Miller and Bud Schmidtgall, Athena
JSB Ranches, Athena
Stanley Timmermann, Helix

And to scores of other individuals, organizations, and agencies -- for materials, field assistance, valuable comments, and suggestions.



MAP 1. MAP OF THE FIVE COUNTIES IN OREGON WHERE EROSION WAS MONITORED DURING 1978-79

CONTENTS

SUMMARY	1
BACKGROUND AND HISTORY	1
WATER QUALITY AND EROSION	2
METHODOLOGY	2
CLIMATE AND SOIL CONDITION INFORMATION	3
SOILS	4
FARM MANAGEMENT	4
ESTIMATES, MEASUREMENTS AND OBSERVATIONS	4
ECONOMIC AND ENVIRONMENTAL EFFECTS OF SELECTED BMP's	6
RESULTS	9
PUBLIC INVOLVEMENT SUMMARY	12
CONCLUSION SYNOPSIS	40
RECOMMENDATIONS	41
APPENDICES	43
REFERENCES	67

AGRICULTURAL BEST MANAGEMENT PRACTICES
AND
WATER QUALITY DEMONSTRATION AND EVALUATION PROJECT.

FIVE COUNTY NORTH CENTRAL OREGON AREA
MARCH 1978 TO JUNE 1981

GERALD O. GEORGE

SUMMARY

The purpose of the project was to demonstrate, evaluate, and quantify the effectiveness of Best Management Practices (BMP's) adopted in 1978 (2) by Gilliam, Morrow, Sherman, Umatilla, and Wasco County Soil and Water Conservation Districts (SWCD's), Oregon (Map 1). These demonstrations and evaluations were designed to reduce landowner uncertainties concerning benefits to be expected from BMP's installed on their land to reduce soil erosion and improve water quality. Three years of erosion and water quality demonstration and evaluation measurements and observations indicate that terracing had the most positive effect on water quality, while dry residue in excess of 1000 pounds per acre after seeding had the most effect on the initiation of erosion. When terraces and one other BMP were present there was a measurable reduction in the amount of erosion which showed up as less sediment in the terrace and less sediment in the runoff samples.

BACKGROUND AND HISTORY

In 1972 the U.S. Congress passed the Clean Water Act, Public Law 92-500. Section 208 of the Act directed the U.S. Environmental Protection Agency (EPA) and the States to identify agriculture related non-point pollution sources (1). From 1974 to August, 1978 the five county SWCD's of North Central Oregon completed a 208 non-point source pollution control program (2) which identified soil erosion as the primary non-point source of water pollution in the area. The five county 208 non-point source pollution program also listed thirteen BMP's for water erosion control to reduce sediment. The seven BMP's demonstrated and evaluated were terraces, grassed waterways, buffer strips, strip cropping, sediment basins, cross slope farming and stubble mulch (Appendix A). While the 208 sediment reduction program was being developed, the Oregon legislature in 1977 provided funding for a two-year study to determine the effects of terraces and sediment basins on stopping soil erosion, controlling sediment, and improving water quality.

In 1979 the Oregon State Soil and Water Conservation Commission and the Oregon Department of Environmental Quality provided pass through Environmental Protection Agency section 208 funds that were used to support an Oregon Agricultural Experiment Station study whose purpose was to demonstrate and evaluate the effects on sediment reduction and water quality of all BMP's identified as adaptable to the project area.

WATER QUALITY AND EROSION

State and Federal research had developed much information on the adopted BMP's under controlled conditions. The seven adopted BMP's had been extensively observed, demonstrated, and evaluated under Great Plains farming conditions. But the effectiveness of these BMP's on large scale farm operations in the Pacific Northwest dryland agriculture areas had not been well evaluated.

Many of the BMP's require changes in farming operations and some require extensive equipment and management changes, thus landowners are reluctant to install them. This led to the present project of demonstrating and evaluating the impact that recommended BMP's have on soil erosion, water quality and farm management.

METHODOLOGY

Local Soil and Water Conservation District Directors obtained permission from selected landowners to establish demonstration and evaluation areas on their farms. Each landowner carried out his normal cultural practices using one or more of the seven BMP's. Upon completion of fall seeding of cereal crops, equipment to record various climatic and soil and water runoff data was installed (Figure 1). Recording and storage precipitation gauges were used to measure rainfall intensities and total volumes. Both heated and unheated types of precipitation gauges were used. The recording rain gauge was a seven day, tipping bucket-type with a nominal accuracy of 0.01 inches. The volume rain gauge was a triangular type that would hold six inches of precipitation. Gauge charts can be interpolated at fifteen minute intervals.

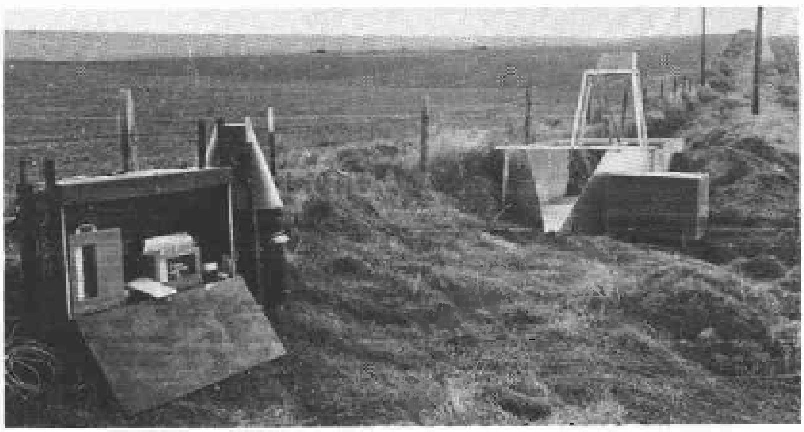


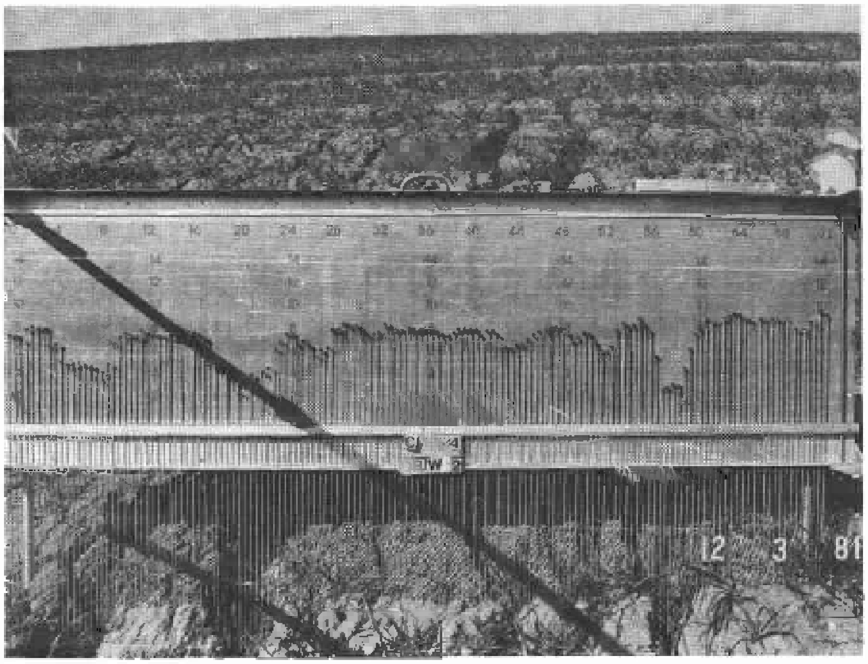
Figure 1. Runoff Sampler, "H" Flume, Stage Recorder, Thermograph, Heated Rain Gauge, Unheated Rain Gauge at one of the demonstration fields.

Thermometers recorded soil temperatures at the surface and at depths of three and six inches below the soil surface, primarily to determine whether the soil was frozen when soil erosion and water runoff occurred.

An "H" flume (13), a water stage recorder, a sediment trap, a turbidity meter, a recording sampler, and a grab sampler were used to determine runoff and sediment volume leaving a field where a BMP was applied. The turbidity meter was capable of recording Jackson Turbidity Units (JTU's) between 100 and 2000 parts per million. The recording sampler collected soil and water runoff in one-liter bottles and the soil was allowed to settle out before the sediment volume was measured. Grab samples were taken by dipping a one-liter bottle into the flow of a stream or the outflow of a terrace or rill and the sediment was allowed to settle. Both the recording sampler and the grab sampler were recorded in milliliters of sediment per liter of water.

The McCool rillmeter (Figure 2) (3) measured field soil erosion to compare with the measured amount of sediment leaving the field, and to make comparisons with predicted erosion as determined by the Universal Soil Loss Equation (USLE) (4).

Figure 2. The McCool rillmeter measured the amount of erosion occurring at a particular point.



CLIMATE AND SOIL CONDITION INFORMATION

Normally, in the fallow-cereal systems of agriculture in North Central Oregon, approximately one-half the crop land is vulnerable to water erosion every month of the year. The soil is plowed and harrowed in the spring, leaving it without cover and vulnerable to spring showers and summer thunderstorms (cloudbursts). Spring and summer rod weeding controls weeds and reduces evaporation, but creates a powdery soil mulch highly susceptible to erosion. Generally, the cereal crop is seeded after the first heavy rainfall in the fall, usually between September 10 and November 1. Although fall precipitation causes the soil to be more solidified, the drilling of seed reloosens the soil, leaving it again susceptible to severe erosion when runoff occurs.

Freezing weather usually begins about September 15 (5), causing significant lowering of soil temperature which retards plant growth that would serve as a soil cover. By November 15, soil temperatures approach 30 degrees Fahrenheit at 3 inches and 35 degrees at 6 inches. When soil temperatures reach 32 degrees Fahrenheit, they generally remain within ± 5 degrees of that temperature until mid-March (Appendix D) even though daytime air temperatures may approach the mid 50's or low 60's. With low soil surface temperatures, and especially if surface layers are frozen, any solid or liquid precipitation, even thermal gradients within the upper soil profile, will produce runoff when the soil-air boundary temperature rises above 35 degrees Fahrenheit. This runoff may carry appreciable amounts of eroded sediment which can affect water quality.

Recorded precipitation at the various demonstration sites for the winter runoff seasons of November to April from 1977 to 1981 did not vary from the 30-year monthly normal precipitation (Appendix E). Normally, in late October or early November, one-half to one inch of rainfall occurs over a one- to five-day period that produces little or no runoff. The soil usually becomes noticeably saturated in the surface three inches. By mid-November, this three-inch layer is freezing and thawing. If the soil surface layer is frozen at the time runoff occurs in the form of melting snow, melting ice, or rain, the saturated soil thaws from the surface downward and readily erodes.

SOILS

Eleven soil series were used for the demonstration and evaluation study from the spring of 1978 to the spring of 1981. Fifty bulk density samples were taken in the fall of 1978 after seeding, and were compared to samples taken in the spring after runoff and erosion. The fall bulk densities were from 15 to 20 pounds per cubic foot (.4 to .5 g/cc) lighter than those taken in the spring. All evaluations of soil movement are based on the spring bulk density samples. Soil characteristics used to predict erosion and potential sediment are shown in Appendix F.

FARM MANAGEMENT

Farm management varied with the operator. Minimal tillage was carried out with a chisel or sweep type initial operation. The moldboard plow was used where cheatgrass (downy brome) or volunteer wheat was excessive. Different drill types were used for seeding, depending on the landowner's preference and the depth to adequate soil moisture.

ESTIMATES, MEASUREMENTS AND OBSERVATIONS

At fall seeding time (September 15th to November 1st) soil surfaces in all fields were like extremely fine flour. The soil would boil out from underfoot like ashes or flour, somewhat like stepping in shallow water. This floury soil material, when saturated with water, was quite erodible.

Estimates and measurements of residue were made on or near the soil surface. During the 1977 thru 1979 winters, less than 20 percent of the winter grain developed enough growth to provide more than 25 percent ground cover before April 1st. Twenty-five percent cover is the condition that defines the seedbed and establishment period and has a high (.5 to .8) cover factor/soil loss ratio when applied in the USLE to predict erosion (5). Canopy or ground cover is related to water storage which reduces runoff and to raindrop impact and is reflected in the USLE "C" factor. The temperature was milder than normal during the 1980-1981 winter and in most of the area 60 percent of the winter grain had developed a 25 percent crop cover by December 1, 1980. In most instances, the only appreciable crop cover for erosion control after seeding and until major erosion had occurred was the previous dry crop residue. This dry residue was less than 250 pounds per acre when measured after fall seeding if a moldboard plow had been used in the spring. If a sweep or chisel plow were used, the dry residue would exceed 800 pounds per acre. After the first major autumn rainfall (0.5 inches or more in 24 hours), the top three inches of soil became saturated (Figure 3).

Several factors could contribute to this condition. Rod weedings can develop a slightly impermeable layer at two to three inches of soil depth which restricts water movement into the soil profile. The soil mulch created by rod weeding to break soil capillary pores and reduce evaporation suddenly can become a disadvantage because available surface water will infiltrate very slowly into soil below the level of rod weeding (6). Plow pans and internal soil layers at greater soil depths, inhibit internal water movement and set up temporary shallow water tables. Changes in soil texture, structure, or induced horizontal fracture lines inhibit vertical soil water movement (6). Cool rainfall and cool soil in the fall increase water viscosity and reduce soil infiltration and permeability (7 and 8). The increased viscosity slows water movement into the soil and causes runoff to occur more quickly, causing erosion and soil movement. Also, soil infiltration and permeability might change to a slower rate because cooler weather could change the soil molecular activity and attractive forces.

Figure 3. After the first major rainfall, the soil became extremely saturated as shown by the footprints.

Snow remained on the ground from one to 12 days every year during each month from November to March (Appendix G). The soil surface froze and thawed almost daily from mid-November to mid-February. The depth of freeze varied from a skin layer to a foot or more depending on the air temperature and radiation effects. During the four years of observation, only one runoff period in each water year (beginning October 1) produced appreciable erosion and water quality degradation from sediment. This runoff was usually associated with several consecutive days of soil freezing at night and remaining frozen or slowly thawing during the day, followed by a rapid warming trend. The warming trend may be associated with ground fog which condenses and produces runoff water, or the runoff water comes from snowmelt or rainfall. The major erosion period for 1977-1978 was December 7-14, 1977; in 1978-1979, it was February 5-14, 1979; in 1979-1980, it was February 14-29, 1980; and in 1980-1981, it was December 20-27, 1980. In each instance, soil had been freezing for some time before a general thaw occurred (Figures 3 to 5). During each of the years studied, there were three or more sediment producing events, but the one major event produced 60 percent or more of the water polluting sediment. Measurements at the flow meters and computations of storage volumes in level terraces and sediment basins indicated that 95 percent of the total snowfall, rainfall, or water in the form of ice occurring during or preceeding the event (which can be as much as a month before) appears as runoff during the major erosion and sediment producing event.

Measurements with the Aquamate Turbidity Sampler of runoff water when the soil was frozen showed little sediment (<50 ppm) at the start of runoff with no increase until the soil surface started to thaw. As the soil surface thaws, the sediment concentration increases rapidly. This agrees with observations made in the northern Midwest (9). Grab samples taken when the range of the Aquamate Turbidity Sampler was exceeded contained up to 300 milliliters of sediment per liter of water and soil sediments, after sediments settled out. The sediment concentration in grab samples taken from a stream below a terraced, stubble mulched, or strip cropped field remained about the same as when the practices were not present once sediment producing runoff started. Stubble mulch and strip cropping reduced the likelihood of runoff because it required about twice the amount of precipitation to initiate runoff. The terrace type affected sediment concentration and runoff volume. The storage type level terrace did not affect concentration of sediment in the water at the field boundary, but did affect total volume of sediment produced from the field. Sediment concentration was not affected at the field boundary because the unterraced area below the last terrace still produced the same water sediment concentration as though the field were not terraced. At the outlet of graded terraces with less than 0.5 percent channel gradient, overflow water from the terrace did not exceed 20 to 40 milliliters per liter. The water having less sediment per unit of runoff reduces the sediment concentration in the receiving stream.

ECONOMIC AND ENVIRONMENTAL EFFECTS OF SELECTED BMP'S

Evaluations of recommended Best Management Practices in the north central Oregon "BMP Demonstration and Evaluation Project" indicate that environmental and economic impacts of BMP's become quite difficult to assess because of variability in BMP effects caused by management decisions and the evaluator's judgment (Appendix A). This assessment of environmental and economic impacts makes two assumptions: (1) The land will continue to be farmed as dryland cereal grain and not be returned to its natural state. (2) Any BMP's applied will not give the landowner any short-term (<5 years) economic increase in returns needed to pay capital costs and taxes.

The BMP's recognized and being demonstrated and evaluated are terraces, grassed waterways, stubble mulch, strip cropping, cross-slope farming, sediment basins, and buffer strips (Appendix A). Stubble mulch includes minimal or no-till, chemical fallow, and cloddy fallow tillages.

The costs of installing various practices vary as much as 200 percent. It depends on land topography, person doing the work, and time of year. In 1980-81 cost of ~~terrace installation~~ in Sherman and Umatilla Counties varied from $.25 per foot (an experienced terrace contractor did the installation) to $1.75 per foot (a new contractor did the work). The same variability occurs when other BMP's are installed. If stubble mulch tillage with sweeps is done in soils which have many surface rocks, the cost will be higher than the same system used on soils with few surface rocks. The shallower rocky soils usually yield poorly so any long term benefit of BMP's to the landowner is not readily apparent. Landowners, therefore, are reluctant to install any BMP's unless costs can be shown to be recoverable.

In evaluating terraces, the type of terrace determined the amount of adverse or favorable benefits. The non-farmed-over level terrace provided the most favorable economical and environmental impacts on water quality from sediment reduction. This terrace encourages the land operator to carry on most cultural operations on the contour. By operating on the contour, an operator reduces power requirements and fuel costs (10). With small fields and undulating topography, there will be an increase in the number of turns with farm machinery and some areas may require traversing two or three times unless the terrace is carefully laid out. Since the terrace is not farmed-over, it must be planted to desirable perennial vegetation to eliminate a weed source area. Perennial vegetation becomes a habitat for small animals and a potential host for diseases and insects that may damage future crops. The terrace does reduce gullys, rills, and sheet erosion by reducing the size of the runoff area and the flow length of runoff channels.

The level terrace stores water until it can percolate into the soil. This stored water may appear as a base flow. If there is a short-term shallow underground flow, there may be an increase in crop yield, but if there is a long-term shallow underground flow, it may reduce the crop yield in and below the terrace for 25 to 50 feet. If the flow is deep underground, it may create perennial stream flows and springs where none existed in the immediate past. Observations and measurements indicate the level terrace is 80 to 100 percent efficient in sediment removal and therefore reduces stream pollution from that source (Appendix B, column 5).

These terraces are 100 percent effective if they do not breach. Measurements of eroded rills entering a level terrace that breached and the sediment remaining in the level terrace indicated 95 per cent of the soil lost from the rills was still in the level terrace. When the eroded gully caused by the breach was measured and compared with the rill measurements as expanded to the field and a resurvey of the terrace was made to determine sediment volume in the terrace, the eroded gully was five percent of the expanded rill volume. Since all soil from the rill was found in the terrace, it was determined the terrace had been 90 per cent effective in total sediment removal.

The farmed-over level terrace provides many of the same water quality benefits as the non-farmed over level terrace. The farmed-over terrace will not have perennial vegetation or small animals and therefore will have fewer host plants to harbor diseases and insects. Farmed-over level terraces cause machinery breakage that will not occur with non-farmed-over level terraces. Farmed-over level terrace breakage may not be any greater than when farming with no terraces on the land, according to land operators who have both terraced and non-terraced fields. Farmed-over and non-farmed-over gradient terraces have the same impacts as similar level terraces. The gradient terrace does not reduce total volume of sediment delivered to streams to the same degree as level terraces; however, measurements of gradient terraces with slopes of less than .5 percent show them to be from 30 to 80 percent effective in sediment removal. This agrees with previous research (14). The least effective terraces are those with the largest gradient. Measurements and observations indicate that any terrace with more than one percent gradient is less than 50 percent effective in sediment removal.

According to landowners, all terraces increase farming operation time by 5 to 15 percent (10 and 12). Research has indicated that smaller fields and irregular shaped areas create more machinery turns and the terraces create these conditions (11). The farmed-over terrace tends to reduce infield speeds of equipment and generally creates an annual amount of machinery breakage from leverage and torsion caused by directional changes in towed and towing equipment. The terrace may take land out of production, but this same land area could be partially lost by gullied areas and infield sediment deposition. The terrace requires annual maintenance and periodic rebuilding.

Conservation tillage systems (stubble mulch, rough tillage, minimum tillage, chemical fallow, etc.) reduce the initiation of erosion much more effectively than a terrace system. Although the terrace stops a gully or rill that has started and keeps sediment from entering a stream, the conservation tillage system tends to keep sheet, rill, or gully erosion from starting. When enough water accumulates to create runoff in a field with a conservation tillage system, the system will not stop or break up the runoff or the associated erosion. A conservation tillage system (BMP) gives the soil better water infiltration and percolation characteristics. Better intake rates and permeability allow water to penetrate into the soil more rapidly and be less subject to runoff or freezing on or near the surface. When the soil is not frozen, there is less tendency for it to erode. Conservation tillage does not change the general flora and fauna of environmental or ecological systems that exist under present agriculture practices. Conservation tillage may cause increases in downy brome (cheatgrass), wild oats, goatgrass, and broadleaf weeds and increases in diseases and pests. If weather conditions are right, it may be possible to control these weeds with chemicals at an additional cost to the farmer and consumer and with possible adverse environmental effects off the farm.

With installation of a combination of conservation tillage and terraces, the maximum environmental and water quality benefits from reduced sediment will be realized. The installation of these BMP's may increase farmer production costs and the cost of the product to the consumer.

RESULTS

Rillmeter measurements were made at 73 sites on 29 fields (Appendix B). More than 100 turbidity and grab samples of sediment runoff were taken at the outlets of terraces, sediment basins, or at field boundaries and reduced to tons per acre to compare with soil losses. Nine sediment basins were monitored for sediment deposition. The fields used for demonstration and evaluation had level terraces, graded terraces, no terraces, sediment basins, stubble mulch, rough tillage, deep furrow drilling, disc drilling, strip cropping, up and down hill farming, and cross slope farming.

Observations, photographic data and interarea measurements indicate all terraces with gradients of less than 0.5 percent would have sediment deposited in them (Appendix B). The terrace effectiveness varied from 100 percent for a level storage terrace that did not breach to 70 percent for a gradient terrace of .5 percent. At 1.0 percent or greater, the farmed-over terraces (Appendix B, Sherman Co. Field 1-78, 2-78, 3-79) all had erosion in the terrace and non-farmed-over terraces (Appendix B, Morrow Co. Field 2-78, 3-78, 4-78) did not show erosion or deposition. Sediment deposition indicates the terrace would reduce sediment delivery to a stream. A sediment basin provided about the same results as a level storage terrace. The basin would be 100 percent effective in sediment removal until discharge occurred or a breach occurred. When runoff left a terrace with less than 0.6 percent gradient or a basin, it was found to be devoid of soil particles more than 2 millimeters in size.

Since 1977, there has been an increase in the demand for installation of terraces, stubble mulch, minimum tillage and grassed waterways. The application or installation of these practices (BMP's) has been in direct relationship to available technical and financial cost share assistance, farm income, and the emphasis being given to a particular BMP (Table 1).

In 1975, Morrow County had additional funding for cost sharing with landowners from the Soil Conservation Service through the Resource Conservation and Development program. In Umatilla and Sherman Counties, special educational emphasis was placed on terrace systems. A drought year occurred in 1976-77 reducing farmer's income so fewer conservation measures were installed. Also, Agricultural Conservation Programs and SCS technical assistance were diverted to drought programs. In 1978, the Oregon Legislature funded a program to study the impact terraces had on water quality. This publicized the terrace program and the study was able to document that properly designed terraces would remove sediment from water flowing from the terrace. This study began to answer some of the questions landowners had as to the value of terraces. Since 1978, there has been a steady increase in the number of terraces installed in all counties except Wasco.

Grassed waterway installation has been sporadic (Table 2). The waterways are used for terrace outlets and gully control. The SCS reporting system changed in 1978 from actual acres of waterways to acres benefited by the waterways. So, in some counties the SWCD's report in acres benefited, and in other counties, actual acres of grassed waterways installed. The emphasis and response given to stubble mulch and conservation tillage have been erratic. When the BMP and Water Quality Demonstration and Evaluation Project was initiated, some county SWCD's emphasized these practices and some did not.

While monitoring terraces in 1978-79, it was observed that fields with minimal tillage and high residue (1,000 pounds or more) in or on the surface had less apparent erosion than terraced fields with clean tillage. Therefore, measurements were made in Umatilla County Field 3-79 and compared to Umatilla County Field 2-79 (Appendix B). Measurements were made in Wasco county Field 4-79 where Site 4 can be compared to Sites 1, 2, and 3 (Appendix B). In both counties the stubble mulched field had appreciably less erosion than the terraced field where little residue was present. During the 1979-80 season, seven identified BMP's were to be monitored. The only site available with residue more than 1,000 pounds per acre was Morrow County Field 6-80. The field was between two terraces and had more than 1,000 pounds of dry residue after seeding. When it was compared to fields in other counties, much less erosion was evident. The only measureable erosion was where drill rows ran up and down hill.

In 1981, Wasco County Field 8-81 and 9-81 were measured for erosion because they were adjacent, with 8-81 being clean tilled and 9-81 with approximately 1,000 pounds per acre of residue. The fields were separated by a fence, the rillmeter sites were 50 feet apart. Each site was 25 feet from the fence into the field. Both fields were drilled up and down hill. Erosion became visible in field 8-81 the first week of December but it was not visible in field 9-81 until February 1981 when a major runoff occurred. The December runoff was caused by 1 inch of rain in 24 hours. The February runoff was caused by a thawing soil and 1.15 inches of rainfall in 24 hours. The only strip crop field to be monitored was Morrow County Field 7-81, and there was no visible runoff or erosion because of lower than normal rainfall at Heppner and no appreciable erosion occurred on any fields near the strip cropped field.

During 1980, three counties reported stubble mulch or conservation tillage practices being installed (Table 3). In 1981, all counties reported these practices or some type of reduced tillage, i.e., stubble mulch, trashy fallow, chemical fallow, minimum tillage, etc. As more education and publicity on these practices are provided and cost sharing and technical assistance become available, it is anticipated more will be installed.

Evaluations at Fifteen Mile Creek, Wasco County, and Slaughterhouse Gulch, Sherman County, indicate that the increased special cost share assistance created an increase in demand by landowners to install BMP's. Consequently, more BMP's in both project areas were installed. The total amount of sediment reduction in each special project is difficult to predict with any certainty. But based on Sherman County Fields 1-80 and 4-80 in Slaughterhouse Gulch and Wasco Fields 5-80 and 3-80 in Fifteen Mile Creek, where measurements were made on installed BMP's and no BMP's, there is a 90 to 100 percent reduction in sediment delivered to streams relative to the soil moved (Appendix B) when well designed resource conservation systems (BMP's) are in place.

Table 1. Feet of terraces installed by SWCD in North Central Oregon from 1975 through 1980

	Wasco Co.	Sherman Co.	Gilliam Co.	Morrow Co.	Umatilla Co.
			Feet		
1975	31,281	574,390	9,990	1,233,385*	424,781
1976	5,390	533,095	306,228	93,858	330,720
1977	41,177	208,030	119,840	40,823	165,595
1978	55,054	187,113	98,600	78,095	64,603
1979	223,866	363,680	110,057	236,700	430,800
1980	120,260	268,332	158,400	361,325	312,700

*Special RC&D Funding for Project.

Table 2. Acres of grassed waterways installed by SWCD in North Central Oregon from 1975 through 1980

	Wasco Co.	Sherman Co.	Gilliam Co.	Morrow Co.	Umatilla Co.
			Acres		
1975					
1976	3			14	
1977		5			10
1978		10			43
1979		7		5	3,510
1980		13.5	5	10	2,319

Table 3. Acres of stubble mulch installed by SWCD in North Central Oregon from 1975 through 1980

	Wasco Co.	Sherman Co.	Gilliam Co.	Morrow Co.	Umatilla Co.
			Acres		
1975					
1976	7,513				
1977		8,643	150		
1978		11,940			1,800
1979					
1980		7,735		2,089	1,520

PUBLIC INVOLVEMENT SUMMARY

The BMP Demonstration and Evaluation Project Five-County North Central Oregon Area was instigated because of two basic questions posed after enactment of Public Law 92-500 Section 208. Those questions were: (1) Will conservation practices identified and adopted as Best Management Practices (BMP's) actually have an effect on water quality? (2) If so, how much effect do the practices have on water quality?

With these questions in mind, the five Soil and Water Conservation District boards were contacted to discuss the formation of water quality and public advisory committees. Each board decided, since it met monthly and experience indicated that mos persons on advisory committees attended the SWCD's regular monthly meeting, that the SWCD board would act as each county's advisory committee. The decision was also made that any progress on the project was of such a nature that each Soil Conservation Service District conservationist could report monthly on BMP project activities in the SWCD. The project leader was to make oral reports to the SCS District conservationist and, if asked by the SWCD Board or unusual events occurred, was to report to the SWCD Board. An annual summary report on progress and findings was made to each SWCD by the project leader after the annual data had been analyzed and evaluated. During the project, each district was presented with two or more formal slide photo progress reports to demonstrate the effects of BMP's. The following private citizen, public interest, public officials, and economic interest groups were represented at SWCD Board meetings where the Demonstration and Evaluation Project leader made presentations.

GROUPS REPRESENTED AT FIVE COUNTY SWCD MEETINGS

<u>Umatilla County</u>

Soil and Water Conservation District
Oregon Department of Fish and Wildlife
Oregon Department of Forestry
Cooperative Extension Service
Hermiston Vector Control District
U. S. Forest Service
Oregon Wheat League
U.S.D.A. Farmers Home Administration
U.S.D.A. Soil Conservation Service
U.S.D.A. Agricultural Conservation Service
Umatilla County Commissioners
State Soil and Water Conservation Commission
Oregon Agricultural Experiment Station

<u>Morrow County</u>

Soil and Water Conservation District
Soil Conservation Service
State Soil and Water Conservation Commission
Oregon Department of Fish and Wildlife
Morrow County Planning Commission
Morrow County Health Office
Morrow County Commission
Farm Bureau
Grange
National Farm Organization
Morrow County Assessor's Office
Oregon Agricultural Experiment Station

Gilliam County

Soil and Water Conservation District
Cooperative Extension Service
USDA Agriculture Stabilization and Conservation Service
Gilliam County Grain Growers
Farm Bureau
Gilliam County Planning Commission
Oregon Agricultural Experiment Station

Wasco County

Soil and Water Conservation District
Wasco County Commission
USDA Agriculture Stabilization and Conservation Service
Wasco County Cooperative Extension Service
National Farm Organization
Grange
Farm Bureau
Oregon Agricultural Experiment Station

Sherman County

Soil and Water Conservation District
Mid-Columbia Grain Growers
Sherman County Planning Commission
Sherman County Wheat League
Sherman County Cattleman's Association
North Pacific Grain Growers
Sherman County High School
USDA Soil Conservation Service
USDA Agricultural Stabilization and Conservation Service
Sherman County Commission
Agricultural Experiment Station
Cooperative Extension Service
Sherman County Oregon Women for Agriculture
Oregon Agricultural Experiment Station

Project findings and progress were reported by the project leader to 10 organizations or groups. The statewide 208 State Soil and Water Conservation Commission Project coordinator made project progress reports at each quarterly State Policy Advisory Committee meeting. The State PAC and the SS&WCC were presented with project implementation program reports on seven occasions.

Date	Group	Where
1/26/80	SSWCC	Hermiston
1/23/81	SSWCC	Salem
2/9/81	PAC	Portland
4/28/81	SSWCC	Pendleton
5/22/81	SSWCC	Pendleton
6/12/81	PAC	LaGrande
6/26/81	SSWCC	Pendleton

PUBLIC PARTICIPATION COMMENTS -- SUMMARY AND ACTION TAKEN:

The major public input was at various meetings where questions were answered after slides were shown to dramatize the effects of demonstrated BMP's. Typical questions were:

1) The slides you have shown indicate the level terrace retains all the runoff water and sediment if it doesn't breach. Do you think these terraces will satisfy the 208 non-point sediment pollution reduction regulations of EPA and DEQ?

This question was addressed by stating there were no EPA or DEQ 208 non-point source pollution regulations at this time. The level terrace that does not breach solves the sediment problem of runoff water but it doesn't solve the erosion problem and it may not solve the total water quality problem from non-point sources. We don't know the extent to which soil chemicals will go into solution and be carried into ground water as water stored in the terrace percolates into the soil nor do we know what salts will appear on the soil surface as the water evaporates. The slides do show us sediment will be deposited in the terraces.

2) What do you consider the best 208 non-point source pollution control measure?

The answer to this was no one BMP is best. The BMP'S should be installed on each piece of land as a resource management system to control erosion, sediment, runoff water, land quality and water quality. Generally it takes two or more practices to provide adequate protection. My rating would be (1) high residue (stubble mulch) and level terrace, (2) strip cropping and contour ridges, and (3) no-till and contour drilling.

AGENCY COMMENTS

1) Department of Environmental Quality.

On page 1 Summary, the stated purpose of the project in the first sentence should state "the effectiveness of BMP's in reducing erosion."

The goal and purpose set forth in the grant application were "to demonstrate the effectiveness of BMP's...to solve water pollution problems." The project was not specifically erosion oriented; it was an attempt to determine the effectiveness of BMP's in handling sediment after erosion had occurred.

Is it necessary to do two or three rod weedings?

The initial rod weeding is usually done to establish a soil mulch to control evaporation and weeds. Subsequent rod weedings are for weed control. These rod weedings can be reduced if chemical weed control is carried out.

Is this (rod-weeder formed) impermeable layer formation a common problem?

Yes, this is common in all soils except it is not as pronounced in the more sandy soils. It is more pronounced when the soil is rodweeded and the soil is at field water holding capacity.

2) Soil Conservation Service.

Viscosity is left hanging as a statement that it is affected by rainfall and temperature. How much viscosity above or below freezing temperatures -- infiltration and/or permeability change? I'd suggest that if viscosity is mentioned it should be explained and identified and a literature reference included.

This suggestion was acted upon and recent reference included.

Would like to see the terminology changed from "Resource and Water Quality Management Practices " to "Resource Management Systems" and "Water Quality Practices."

This suggested change was made.

3) SEA-AR, Washington State University, Pullman, Washington.

I liked the idea of a summary and wondered if you could expand it to include two or three major conclusions. Perhaps your conclusions could include (a) the need for conservation systems rather than practices, (b) the benefits of demonstrating BMP's and (c) the need for an information and education program.

Suggestion was complied with.

I do not understand the phrase "even near surface thermal gradients within the profile."

An attempt was made to clarify the statement.

Table 2 could be in the Appendix.

Table 2 was moved to the Appendix.

Some conclusions are not supported by the study, or rather they have been pulled in from results of other studies. Supporting information is needed, even if you did not do the work as part of this study.

Additional literature references were obtained to support field observations.

4) SEA-AR, Columbia Plateau Conservation Research Center, Pendleton, Oregon.

Where discussing terraces there needs to be a clarification of non-farmed over vs. farmed over and level vs. gradient.

This statement was addressed.

Footnote on Appendix B needs explanation.

This statement was addressed.

5) Oregon State University, Corvallis, Oregon.

Improvement should be made in organization, wording, sentence structure, etc.

An attempt was made to meet this requirement.

The report was poorly written with many confusing, contradictory or inaccurate statements.

These cannot be addressed until they are specifically pointed out as to what, where, how, and what the confusion is.

This report presents some interesting observations and conclusions. The reader however is left guessing as to the data on which the conclusions are based.

Need more specific guidance as to what the reader expects so data can be cleaned up. Specific comments in the returned report were addressed and incorporated.

6) Environmental Protection Agency, Seattle, Washington.

The public participation summary does not (1) identify the significant comments and suggestions received, (2) identify the specific responses made to the input received, or (3) evaluate the effectiveness of the public participation program in developing the report.

The public participation summary has been enlarged to include concerns raised by EPA. A file of all comments, news releases and meetings has been established at the project grantee's office. Major comments are included above and were incorporated in the final report.

Are the proposed implementing agencies SWCD's, SSWCC, SCS, ARS, and others in agreement with the recommendations and committed to carrying them out?

The District Management Agency Implementation Statements for the five SWCD's are attached as Exhibits 1 through 5. The SSWCC has developed an agricultural plan and has cooperative agreements with the other agencies involved in plan implementation.

Informational Program.

News letters and local newspapers were the primary sources used to inform the public as the North Central Oregon Demonstration and Evaluation program progressed. (Exhibits 6 through 14).

EXHIBIT #1

IMPLEMENTATION STATEMENT

by

Umatilla County Soil and Water Conservation District

Soil and Water Conservation District programs are administered by a locally elected board of directors acting under the authority of ORS 568.210 - 568.800. Responsibilities of the district boards include control and prevention of soil erosion, prevention of flood water and sediment damage; conserve and develop water resources and water quality and protect and promote the health, safety, and general welfare of the people of this state.

Through contractual agreements, memorandums of understanding and mutual agreements various federal, state and local agencies provide technical and/or financial assistance to the owners/operators of land within the district. District directors will carry out their administrative and coordinating fundtions as required for 208 implementation.

The Umatilla County Soil and Water Conservation District agrees to serve as the local management agency for 208 implementation. This is in accordance with the Sediment Reduction Project 208 Non-Point Source Pollution Control Program for Wasco, Sherman, Gilliam, Morrow and Umatilla Counties. In its management role consistant with available resources, the district will be responsible for implementing an active non-point source water quality plan for Umatilla County.

Responsibilities for the Local Management Agency

A. Adopt and keep current a district Natural Resource Conservation Program which will identify the major resource conservation needs of the district including a commitment to improve water quality.

B. Prepare and adopt an annual work plan which includes,

1. An identification of priority problem areas which need application of BMP's.

2. A commitment to prioritize available technical or financial assistance to priority problem areas within limits of SWCD responsibility.

3. A time schedule for achieving installation of BMP's in problem areas.

4. A commitment to seek additional resources for BMP implementation where available.

C. Prepare an annual report for submission to the Soil and Water Conservation Commission which indicates progress made in installation of BMP's.

D. Annually review adopted BMP's and revise as needed.

E. Coordinate and organize an active information and education program to reach both the general public and landowner/operators.

1. Cooperate with Oregon State University Extension Service personnel in I & E efforts.

2. Cooperate with Pendleton and Hermiston Branches of Oregon Agricultural Experiment Station in establishment of demonstration areas for Water Quality Control.

3. Organize and coordinate tours, slide programs, and other information activities.

4. Make direct contact with operators in priority areas to enlist their cooperation in installation of BMP's within limits of available technical and financial assistance.

ACCEPTANCE STATEMENT

This is to certify that the Umatilla County Soil and Water Conservation District will accept the responsibility for implementing the Umatilla County Non-Point Source Water Quality Management Plan within the limits of technical and financial resources which shall be made available for the purpose.

______________________, Chairman

______________________, Secretary

by resolution of the Board of Directors November 25, 1980.
Date

Umatilla County Soil and Water Conservation District Implementation Statement approved by the Oregon Soil and Water Conservation Commission.

______________________________, Chairman

____

Date

Charles V. Liles, Director

12/31/80

Date

EXHIBIT #2

IMPLEMENTATION STATEMENT

by

Morrow Soil and Water Conservation District

Soil and Water Conservation District programs are administered by a locally elected board of directors acting under the authority of ORS 268.210 - 568.800. Responsibilities of the district boards include control and prevention of soil erosion, prevention of flood water and sediment damage; conserve and develop water resources and water quality and protect and promote the health, safety and general welfare of the people of this state.

Through contractual agreements, memorandums of understanding and mutual agreements various federal, state and local agencies provide technical and/or financial assistance to the owners/operators of land within the district. District directors will carry out their administrative and coordinating functions as required for 208 implementation.

The Morrow Soil and Water Conservation District agrees to serve as the local management agency for 208 implementation. This is in accordance with the Sediment Reduction Project 208 Nonpoint Source Pollution Control Program for Wasco, Sherman Gilliam, Morrow and Umatilla Counties. In its management role consistant with available resources, the district will be responsible for implementing an active nonpoint source water quality plan for Morrow County.

Responsibilities for the Local Management Agency

A. Adopt and keep current a district Natural Resource Conservation Program which will identify the major resource conservation needs of the district including a commitment to improve water quality.

B. Prepare and adopt an annual work plan which includes,

1. An identification of priority problem areas which need application of BMPs.
2. A commitment to prioritize available technical or financial assistance to priority problem areas within limits of SWCD responsibility.
3. A time schedule for achieving installation of BMPs.
4. A commitment to seek additional resources for BMP implementation where available.

C. Prepare an annual report for submission to the Soil and Water Conservation Commission which indicates progress made in installation of BMPs.

D. Annually review adopted BMPs and revise as needed.

E. Coordinate and organize an active information and education program to reach both the general public and landowner/operators.

1. Cooperate with Oregon State University Extension Service personnel in I & E efforts.
2. Organize and coordinate tours, slide programs, and other information activities.
3. Make direct contact with operators in priority areas to enlist their cooperation in installation of BMPs within limits of available technical and financial assistance.

ACCEPTANCE STATEMENT

This is to certify that the Morrow Soil and Water Conservation District will accept the responsibility for implementing the Morrow County Nonpoint Source Water Quality Management Plan within the limits of technical and financial resources which shall be made available for the purpose.

______________________, Chairman, Morrow SWCD

______________________, Secretary, Morrow SWCD

by resolution of the Board of Directors

12-5-80
Date

Approved by the State Soil and Water Conservation Commission.

______________________, Chairman 12/19/80
Date

______________________, Director 12-23-80
Date

EXHIBIT #3

IMPLEMENTATION STATEMENT

by

Gilliam County Soil and Water Conservation District

Soil and Water Conservation District programs are administered by a locally elected board of directors acting under the authority of ORS 268.210 - 568.800. Responsibilities of the district boards include control and prevention of soil erosion, prevention of flood water and sediment damage, conserve and develop water resources and water quality and protect and promote the health, safety and general welfare of the people of this state.

Through contractual agreements, memorandums of understanding and mutual agreements various federal, state and local agencies provide technical and/or financial assistance to the owners/operators of land within the district. District directors will carry out their administrative and coordinating functions as required for 208 implementation.

The Gilliam County Soil and Water Conservation District agrees to serve as the local management agency for 208 implementation. This is in accordance with the Sediment Reduction Project 208 Nonpoint Source Pollution Control Program for Wasco, Sherman, Gilliam, Morrow and Umatilla Counties. In its management role consistant with available resources, the district will be responsible for implementing an active nonpoint source water quality plan for Gilliam County.

Responsibilities for the Local Management Agency

A. Adopt and keep current a district Natural Resource Conservation Program which will identify the major resource conservation needs of the district including a commitment to improve water quality.

B. Prepare and adopt an annual work plan which includes:

1. An identification of priority problem areas which need application of BMPs.
2. A commitment to prioritize available technical or financial assistance to priority problem areas within limits of SWCD responsibility.
3. A time schedule for achieving installation of BMPs.
4. A commitment to seek additional resources for BMP implementation where available.

C. Prepare an annual report for submission to the Soil and Water Conservation Commission which indicates progress made in installation of BMPs.

D. Annually review adopted BMPs and revise as needed.

E. Coordinate and organize an active information and education program to reach both the general public and landowner/operators.

1. Cooperate with Oregon State University Extension Service personnel in I & E efforts.
2. Organize and coordinate tours, slide programs, and other information activities.
3. Make direct contact with operators in priority areas to enlist their cooperation in installation of BMPs within limits of available technical and financial assistance.

ACCEPTANCE STATEMENT

This is to certify that the Gilliam County Soil and Water Conservation District will accept the responsibility for implementing the Gilliam County Nonpoint Source Water Quality Management Plan within the limits of technical and financial resources which shall be made available for the purpose.

Melvin C. Pattee, Chairman, Gilliam County SWCD

Jack E. Osterlund, Secretary, Gilliam County SWCD
by resolution of the Board of Directors

____
Date

Approved by the State Soil and Water Conservation Commission.

_______________, Chairman _______________
Date

Charles V. Liles, Director 12/31/80
Date

EXHIBIT #4

IMPLEMENTATION STATEMENT
by
Sherman County Soil and Water Conservation District

Soil and Water Conservation District programs are administered by a locally elected board of directors acting under the authority of ORS 268.210 - 568.800. Responsibilities of the district boards include control and prevention of soil erosion, prevention of flood water and sediment damage; conserve and develop water resources and water quality and protect and promote the health, safety and general welfare of the people of this state.

Through contractual agreements, memorandums of understanding and mutual agreements various federal, state and local agencies provide technical and/or financial assistance to the owners/operators of land within the district. District directors will carry out their administrative and coordinating functions as required for 208 implementation.

The Sherman County Soil and Water Conservation District agrees to serve as the local management agency for 208 implementation. This is in accordance with the Sediment Reduction Project 208 Nonpoint Source Pollution Control Program for Wasco, Sherman, Gilliam, Morrow and Umatilla Counties. In its management role consistant with available resources, the district will be responsible for implementing an active nonpoint source water quality plan for Sherman County.

Responsibilities for the Local Management Agency

A. Adopt and keep current a district Natural Resource Conservation Program which will identify the major resource conservation needs of the district including a commitment to improve water quality.

B. Prepare and adopt an annual work plan which includes,

1. An identification of priority problem areas which need application of BMPs.
2. A commitment to prioritize available technical or financial assistance to priority problem areas within limits of SWCD responsibility.
3. A time schedule for achieving installation of BMPs
4. A commitment to seek additional resources for implementation where available.

C. Prepare an annual report for submission to the Soil and Water Conservation Commission which indicates progress made in installation of BMPs.

D. Annually review adopted BMPs and revise as needed.

E. Coordinate and organize an active information and education program to reach both the general public and landowner/operators.

1. Cooperate with Oregon State University Extension Service personnel in I & E efforts.
2. Organize and coordinate tours, slide programs, and other information activities.
3. Make direct contact with operators in priority areas to enlist their cooperation in installation of BMPs within limits of available technical and financial assistance.

ACCEPTANCE STATEMENT

This is to certify that the Sherman County Soil and Water Conservation District will accept the responsibility for implementing the Sherman County Nonpoint Source Water Quality Management Plan within the limits of technical and financial resources which shall be made available for the purpose.

Bill E. Todd, Chairman, Sherman County SWCD

Delmer A. Smith, Secretary, Sherman County SWCD

by resolution of the Board of Directors

12-18-80
Date

Approved by the State Soil and Water Conservation Commission.

Truscott Irby, Chairman 12/19/80
Date

Charles V. Liles, Director 12/23/80
Date

EXHIBIT #5

IMPLEMENTATION STATEMENT

by

Wasco County Soil and Water Conservation District

Soil and Water Conservation District programs are administered by a locally elected board of directors acting under the authority of ORS 268.210 - 568.800. Responsibilities of the district boards include control and prevention of soil erosion, prevention of flood water and sediment damage; conserve and develop water resources and water quality and protect and promote the health, safety and general welfare of the people of this state.

Through contractual agreements, memorandums of understanding and mutual agreements various federal, state and local agencies provide technical and/or financial assistance to the owners/operators of land within the district. District directors will carry out their administrative and coordinating functions as required for 208 implementation.

The Wasco County Soil and Water Conservation District agrees to serve as the local management agency for 208 implementation. This is in accordance with the Sediment Reduction Project 208 Nonpoint Source Pollution Control Program for Wasco, Sherman, Gilliam, Morrow and Umatilla Counties. In its management role consistant with available resources, the district will be responsible for implementing an active nonpoint source water quality plan for Wasco County.

Responsibilities for the Local Management Agency

A. Adopt and keep current a district Natural Resource Conservation Program which will identify the major resource conservation needs of the district including a commitment to improve water quality.

B. Prepare and adopt an annual work plan which includes:

1. An identification of priority problem areas which need application of BMPs.
2. A commitment to prioritize available technical or financial assistance to priority problem areas within limits of SWCD responsibility.
3. A time schedule for achieving installation of BMPs.
4. A commitment to seek additional resources for BMP implementation where available.

C. Prepare an annual report for submission to the Soil and Water Conservation Commission which indicates progress made in installation of BMPs.

D. Annually review adopted BMPs and revise as needed.

E. Coordinate and organize an active information and education program to reach both the general public and landowner/operators.

1. Cooperate with Oregon State University Extension Service personnel in I & E efforts.
2. Organize and coordinate tours, slide programs, and other information activities.
3. Make direct contact with operators in priority areas to enlist their cooperation in installation of BMPs within limits of available technical and financial assistance.

ACCEPTANCE STATEMENT

This is to certify that the Wasco County Soil and Water Conservation District will accept the responsibility for implementing the Wasco County Nonpoint Source Water Quality Management Plan within the limits of technical and financial resources which shall be made available for the purpose.

Grant E. Wilson, Chairman, Wasco County SWCD

Robert Brewer, Secretary, Wasco County SWCD

by resolution of the Board of Directors

Dec 8, 1980

Date

Approved by the State Soil and Water Conservation Commission

Truscott Irby, Chairman 12/19/80

Date

Charles V. Liles, Director 12-23-80

Date

EXHIBIT #6

Agricultural
Experiment Station
Communications

Oregon State University

Corvallis, Oregon 97331 (503) 754-3615

Gerald George
Columbia Basin Agricultural Research Center
Box 370
Pendleton, OR 97801

Gerry,

The August 13, 1980, news release on EROSION went to:

23	eastern Oregon weeklies
18	special agriculture writers (off campus)
20	agriculture publications (mostly in western U.S.)
40	Extension (on and off campus)

Special distribution included 10 copies to Pendleton (daily and radio), LaGrande, Baker, Ontario, The Dalles, Bend, Klamath Falls

Pictures were sent (there were 2 shots) to:

Pendleton (both pictures)
LaGrande, Baker, Ontario and weeklies in Hermiston, Milton-Freewater, Pendleton, Pilot Rock, Heppner, Elgin were sent one photograph

Hope this helps.

Sincerely,

Dick

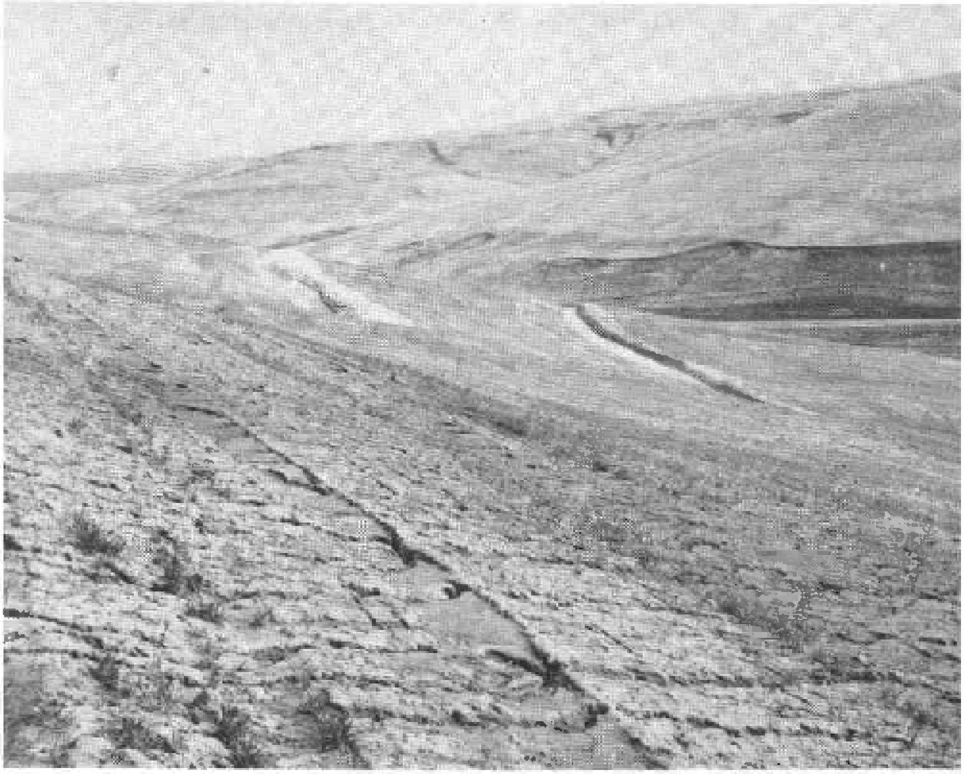
RICHARD FLOYD, Editor
Agricultural Experiment Station

G. O. "Jerry" George, Pendleton Experiment Station Erosion and Sediment Specialist, said after two years of monitoring terraces he has found they would reduce sediment delivery to streams and water bodies by 60 percent or more. He stated the type of terrace, terrace spacing, land slope, and terrace management all affected sediment delivery. George said a level terrace that did not breach was 100 percent effective in removing sediment from water courses. Level terraces with planned outlets or that breached were 75 to 90 percent effective in sediment removal, while graded terraces were 50 to 70 percent effective. The steeper the terrace grade, the less effective the terrace was in sediment removal. George also stated that any farmed over terrace that outleted to a stream is less effective in the amount of sediment removed than a non-farmed over terrace. The reason being the terrace will have more readily moveable soil near the outlet and this will enter the stream as sediment.

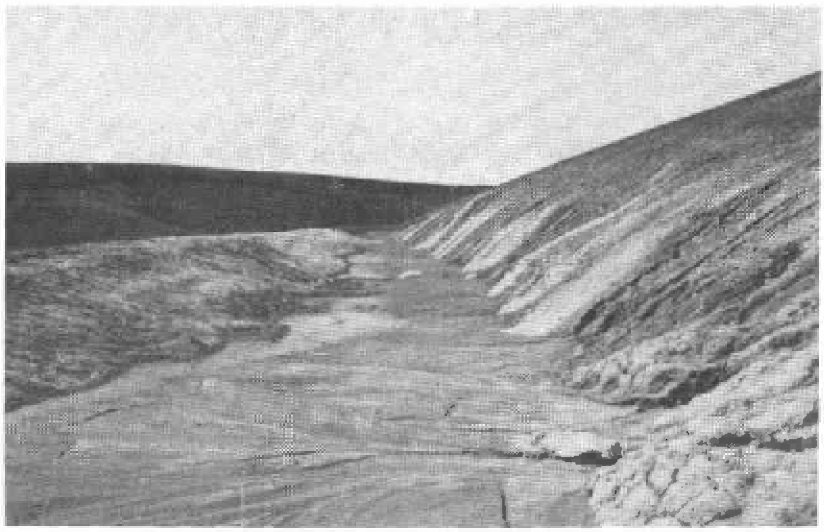
As an erosion reduction tool, the terrace appears to be much less effective than stubble mulching, reduced tillage, rough cloddy tillage, contour or cross slope farming, and strip cropping. Terraces do reduce erosion since they reduce the area from which water can accumulate and the distance it can flow. However, under the climatic conditions of North Central Oregon dryland wheat, the terrace does not stop erosion from starting. Stubble mulch, reduced tillage, rough or cloddy tillage, contour farming and strip cropping all reduce the tendency for erosion to start. With less erosion there is less sediment to be removed by the terrace, and consequently less need to rebuild the terrace every few years.

George said he would like to see more stubble mulch, reduced tillage, rough or cloddy tillage, contour or cross slope farming, and strip cropping carried out in conjunction with terraces. He said more combinations of these cultural, management and structural practices were needed in the North Central Oregon region.

He said most of the fields he has been able to monitor and evaluate have been in a single practice and not in an erosion and water quality conservation system that has two or more practices in effect.



Non farmed over terrace on 30 percent slope in Wasco County. Where terraces were in place there was 50 percent less erosion than occurred where there were no terraces.



This terrace on a 31 percent slope retained all the sediment that was eroded from the slope above it.

The Gazette-Times, Heppner, Oregon, Thursday, February 26, 1981—SEVEN

The Peterson ranch was used again in 1979-80. During this particular season the field had between 600 and 1000 pounds of dry residue on or within one inch of the soil surface. The field was drilled on a cross slope with deep furrows. Measured erosion was 6 tons per acre with approximately 1.5 tons per acre leaving the field.

Water Quality Influenced by Runoff from Cropland

The Columbia Basin Agricultural Research Center is studying water quality runoff from cropland. According to their Best Management Practices (BMP) system, which was started in 1978, the first BMP to be evaluated was terraces and their impacts on eroision and water quality. THe findings in 1978 indicated for a given slope that direction of seeding (up and down hill or cross slope) and methods of seeding (shallow furrow or deep furrow) would effect erosion approximately as much as the terraces.

In the fall of 1978 sites were located on Don Peterson's farm, Valby. Measurements at these sites indicated an average in field soil movement of 13 tons per acre with 2.9 tons per acre reaching the terrace outlet. The field this year was in seeded crop.

The Peterson farm was used again in 1979. During this year the field had between 600-1000 pounds of dry residue on or within one inch of the soil surface. The field was drilled on a cross slope with deep furrows. Measured erosion was 6 tons per acre with approximately 1.5 tons per acre leaving the field.

This current crop year the site was moved to the Al Bunch ranch to reduce servicing time and to evaluate strip cropping and stubble mulching. The strips are between 150-200 feet wide with over 1200 pounds of residue in the top inch of soil and he has drilled deep furrows.

From observations of stubble mulched fields it appears that stubble mulch will greatly reduce erosion and, with terraces, will substantially improve water quality.

EXHIBIT #8

Thurs., Feb. 19, 1981 Sherman County Journal, Moro, Oregon,

Sherman S&WCD 31st ANNUAL MEETING Feb. 26

Program For 31st Annual Meeting

Sherman Soil & Water Conservation District

Thursday, February 26, 1981

IOOF Hall -- Grass Valley, Oregon

District Hosted Luncheon—12:30 P.M.

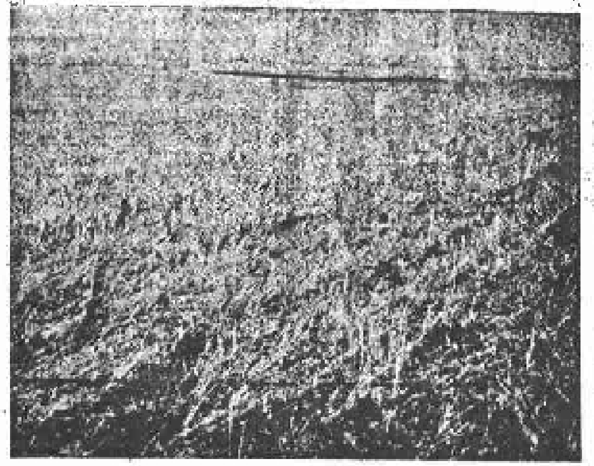
Presentation of Conservation Awards

Soil-Water Measuremeue Studies and
Annual Cropping Results—Dr. R. H. Ramig

Terrace Efficiency Studies—Jerry George

Slides of Sherman County—Hans Salomon

Stubble Utilization Can Stop Erosion

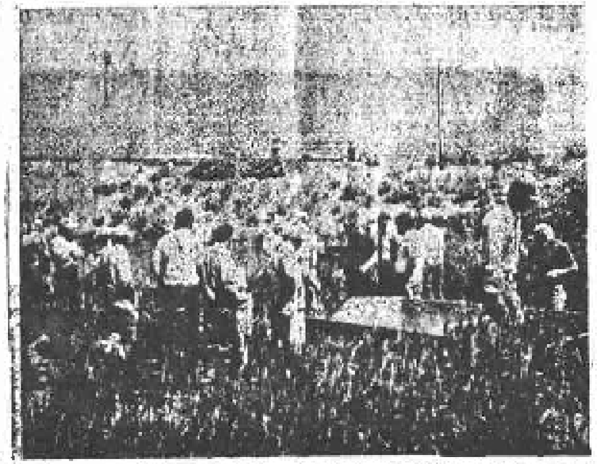


Stubble Mulch can reduce erosion. Crop residues left on or near the surface of the soil during summer fallow operations can reduce the amount of erosion occuring the following winter when planted to winter wheat. If the summer fallow operations are done in such a manner that a minimum of 1000 pounds of residues are left at or near the surface after seeding the amount of soil loss by water and/or wind erosion is reduced.

The photo with this article shows a field that has had the first operation completed on it. An implement that works the ground without inversion gives the farmer a better chance to maintain his residues on the surface the summer fallow year.

Early fall seeding of winter wheat is another practice that can help reduce erosion. This past year the two practices, stubble mulching and early fall seeding, have been successful in the reduction of erosion by waters. Where stubble has been turned under and the planting was done late has been where there has been the most erosion the past winter.

Monitoring Site Observed On Field Trip



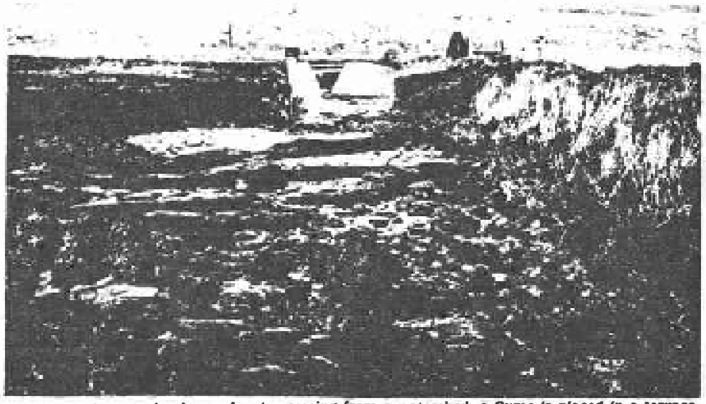
THE ANNUAL CROPS AND CONSERVATION TOUR observe a monitoring iste at the Tex Irzyk farm. Jerry George, Science and Education Administration, is monitoring the effects of terraces on erosion control and water quality. Annually the District sponsors a field trip to look at conservation first hand.

EXHIBIT #9

Supplement to The Heppner Gazette-Times

ANNUAL REPORT 1979

MORROW SOIL AND WATER CONSERVATION DISTRICT



To provide the actual volume of water coming from a watershed, a flume is placed in a terrace channel. A stage recorder is used in conjunction with the flume to provide a self-recording document of the flow.

A sediment trap located immediately below the flume provides information on the amount of soil loss which is occurring in the same watershed. In addition samples are taken with a special meter to measure how much sediment is carried out with the water.

Sediment pollution site evaluated

In October 1979 Gerald O. George, agricultural engineer, erosion specialist, Columbia Basin Agricultural Research Center, Pendleton, established a terrace evaluation and demonstration monitoring site on Don Peterson's ranch at Valby. The site consisted of a recording thermometer, a measuring flume and depth recorder. The rain and snow gauge was to determine hourly rainfall and snowfall intensity. The volume rain gauge was to determine total weekly precipitation and backup for the recording gauge. The thermometer was to determine the zero, three- and six-inch soil temperatures. The flume and depth recorder were to determine the amount of runoff out of the terrace.

The site provided evaluation of the conditions that influence soil movement. Major erosion occurred last February after the snow had essentially melted. Erosion was caused by thawing of the ice in the frozen soil. As the ice melted downward in the soil, the soil became a quagmire, then fluid, and would start to flow. As the flow progressed downhill, it accumulated more fluid soil and water until it amassed to create visible erosion. The soil and water mixture would continue to move until there was a change in field slope, a terrace, waterway, stubble mulched field or other physical barrier.

The average soil movement between terraces was measured to 12.5 tons per acre last year on this site. Approximately 20 percent of the soil movement was transported out through the flume and terrace outlet.

From observations of stubble mulched fields in 1978-79, it appears that stubble mulch will greatly reduce erosion, and with terraces, will substantially improve water quality.

Farmers save water

What a sight it would be: 42.7 million gallons of water stored behind a dam only 18 inches high and 200,000 feet long.

The equivalent of such a dam is the accomplishment of Morrow County farmers in 1979, by constructing level, basin-type terraces. What this means is storing an amount of water equal to a rainfall of about one-half inch spread over 3,300 acres of cropland.

What is the value of saved moisture? It can be converted into increased production, equal to two bushels per acre.

The primary and perhaps most important function of a terrace system is the gully and rill erosion control. The terraces are designed and layed out according to each individual field needs. These needs are based on the type of soils present, slopes of the land and the owners' method of tillage. Minimum tillage and proper use of the crop residues are directly related to terrace spacing. As residue increases the erosion hazard decreases. Another consideration and a major one is contour farming, parallel to the terraces within the system.

The maximum benefit to the terrace system would include all of the above practices. In addition, use of chemicals to control vegetation and reduce tillage operations would be highly beneficial. The highest compliment to the terrace structure is to provide the best management system, available to a farming operation.

EXHIBIT #10

OREGON NATURAL RESOURCES CONSERVATION NEWS

Oregon Association of Conservation Districts

Oregon Soil & Water Conservation Commission

Vol. 20, No. 3 — Salem, Oregon — August, 1980

STUDY SHOWS STRAW-MULCH/TERRACES EFFECTIVE IN REDUCING SOIL EROSION

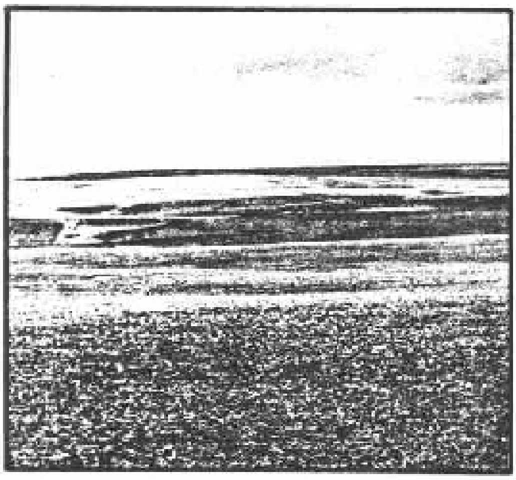
North Central Oregon is characterized by miles of rolling hills and steep slopes, low annual precipitation and wheat. People farming these undulating hills are concerned about erosion, making the best use of their farm land and installing cost-efficient conservation practices.

Under the federally-funded 208 nonpoint source pollution program being managed by the SWCC, a demonstration and evaluation project was set up in the five-county area to determine the best management practices for this dry wheatland region.

Gerald O. George, Ag Engineer for OSUs Agricultural Experiment Station in Pendleton, is conducting the 208 study and working with local landowners to determine the best way to keep the soil on the ground and out of the water. To date, he has collected soil erosion data from 25 fields in the area which included both terraced and non-terraced fields. The terraced fields had level, graded, farmed-over and nonfarmed-over terraces. George reported there was no apparent difference between graded and level terraces in erosion reduction, but level terraces and graded terraces with grade slopes less than 0.006 feet per foot of terrace length had excellent sediment deposition within the terrace.

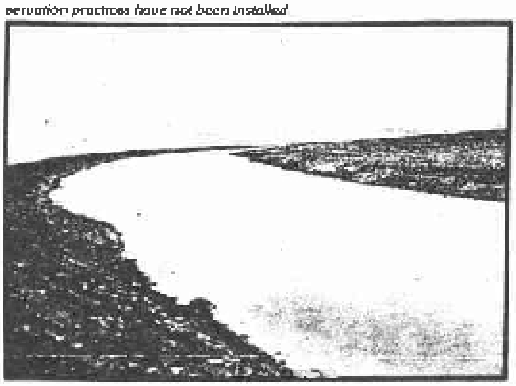
According to George, level terraces that did not breach were 100 percent effective in sediment deposition; those that did breach were 80 to 90 percent effective. Graded terraces with slopes less than 0.006 feet per foot were 70 to 90 percent effective when within-terrace sediment fans were measured and compared to measured erosion. Terraces with grades of 0.01 to 0.015 feet per foot did not have any measurable sediment fans and where they are farmed over these terraces actually eroded.

In all instances the terrace reduced runoff-caused erosion and sediment, which improved water quality. The erosion reduction was caused by reduced slope lengths which reduced accumulated sediment-carrying runoff volumes.



Dryland wheat growing area. The field in the foreground had straw residue exceeding 1000 pounds per acre to reduce runoff.

Rill erosion marks this field in Sherman County, Oregon where soil conservation practices have not been installed.



This level terrace was found to be 100% effective in retaining water and sediment, thus preventing erosion.

Two fields that were monitored and evaluated had straw residue that exceeded 1000 pounds per acre. One of these fields had terraces; the other did not. In both instances there was less measured erosion than on terraced fields with clean tillage, George said. All sediment from erosion on the unterraced field entered a stream, while that from the terraced field remained in the terrace.

Monitoring and evaluations indicate that straw residue exceeding 1000 pounds per acre is more effective than terraces in reducing erosion for a given slope length, but when erosion-producing runoff occurs on a straw residue field, the sediment carried in the runoff will enter the water unless a terrace deposition area is provided. When a straw residue and terrace are used together, (1) initial erosion is reduced by the straw residue; (2) the slope length for accumulated erosive runoff is reduced by the terrace; (3) the terrace collects sediment from any runoff that occurs; and (4) both the straw residue and terrace increase the opportunity for moisture to enter the soil.

George said that when a farm operator's goal is sediment control and water quality improvement, he should plan a conservation system that utilizes straw residue and terraces to minimize erosion and sediment and to maximize water management and quality.

George is presently monitoring and evaluating the impacts of grassed waterways, buffer strips, strip cropping and minimum tillage on erosion, sediment and water quality.

November 6, 1980 . Price 60 Cents

OREGON Farmer-Stockman
Inland Edition

Terraces Are Effective Management Tools

TERRACES monitored on a wheat farm near Athena OR since the fall of 1978 have been from 60 to 100% effective in removing sediment from water, reports Gerald O. George, erosion specialist stationed at the Columbia Basin Agricultural Research Center near Pendleton.

He emphasizes that the terraces are "a water management tool" rather than just for erosion control. A combination of conservation tillage practices and terraces is needed for best results.

"Conservation tillage will keep erosion from starting, but it won't do anything to remove sediment or protect water quality once erosion starts," George pointed out. On the other hand, "the terrace will not keep erosion from starting, but will remove sediment and protect water quality."

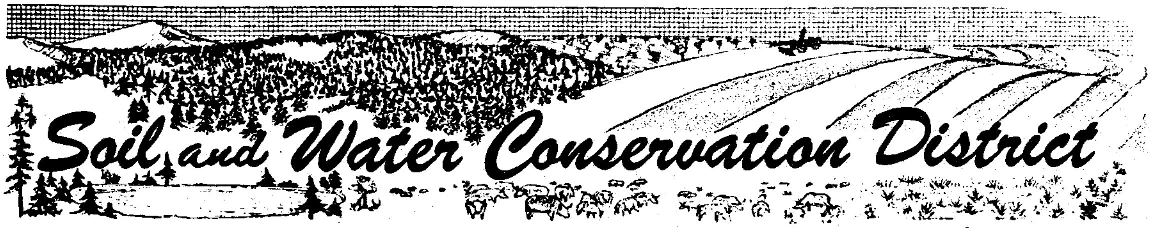
The terraces George has been monitoring are on S & M Farms, operated by Bud Schmidtgall and Bob Miller, who, all told, have 1,000 acres protected with terraces on slopes ranging from 4 to 15%. Some terraces are level, some graded; all are farmed over.

"The graded terraces retain about 60% of the eroded material within the terrace; the level terraces retain 85 to 100% of the material," he reports.

EXHIBIT #12

UMATILLA COUNTY

1229 S.E. 3rd
Pendleton, Oregon 97801



News

SOIL EROSION STUDY FOCUSES ON TERRACES

Jerry George is reviewing an old wrinkle to the war against land erosion. George is a U.S. Soil Conservation Service engineer based at Oregon State University's Columbia Basin Agricultural Research Center at Pendleton. His weapon in the endless fight to save soil is a terrace, known somewhat inelegantly in the past as a diversion ditch. The terrace breaks up the pattern of runoff water, gets it to dump much of its load of heavier sediment and cleans water before it reaches a stream. George's program is aimed at water quality. His goal: Keep soil out of water.

The terraces he studies, usually made with a bulldozer or a grader, are in farmer's fields. The farmer likes to work crop equipment over the terrace but if the field slope is too steep, the land must be contoured around it. "Terraces can be level, which means level from one end to the other," said George. "Or they can be graded, sloping from one end to the other, usually about six inches per 100 feet. Terraces can be from a couple of hundred feet to a mile long." "My three basic concerns are land quality, water quality and water management," said George.

While terraces are not new to Oregon's wheat-growing counties, terracing has become more popular in the last five years. Farmers became deeply concerned about non-point pollution because of the Public Law 92-500, Section 208 erosion control program which sets "fishable and swimmable" water quality requirements to be met by 1983. More farmers have started applying for terrace installation assistance from the Agricultural Stabilization and Conservation Service and the Soil Conservation Service, George said.

In Umatilla County alone this year, 44 have applied to the Soil Conservation Service for permits. A cost-sharing plan is available through the Agricultural Stabilization and Conservation Service for building terraces. Maintenance is up to the land owner. "And Maintenance is important because terraces not only need attention after major storms, but are often plagued with hole damage from digger squirrels, gophers, badgers, field mice and an occasional coyote," said George.

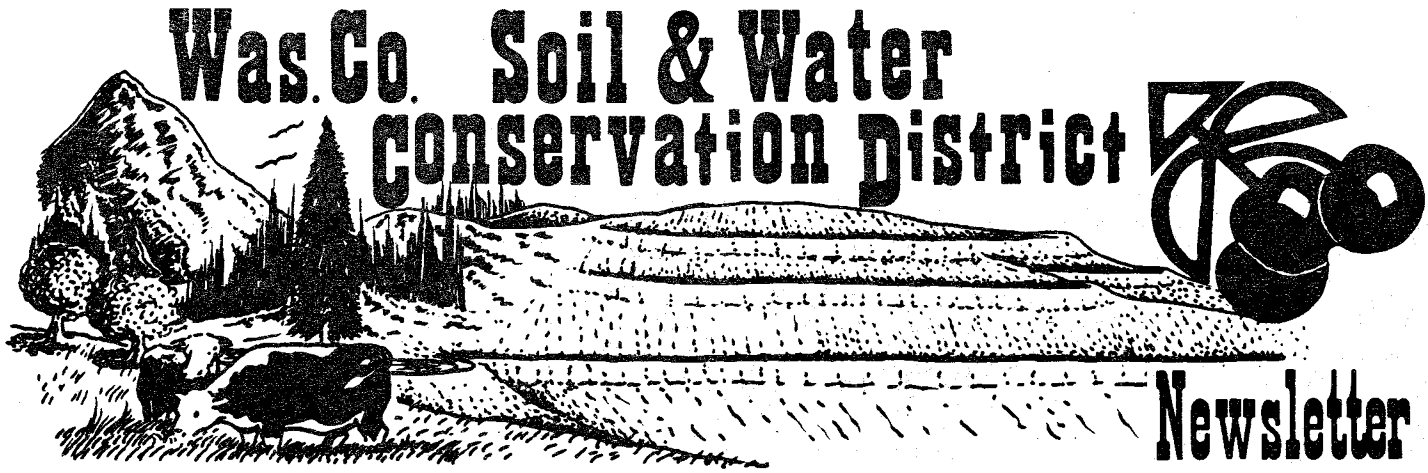
To find out what happens to water on land, he has monitored terraces in Umatilla, Morrow, Gillia , Sherman and Wasco Counties since March, 1978, all on private farms. Rain guages record how much rain falls and when; thermometers record temperatures at the soil surface, 3 inches deep and 6 inches deep and tell when the ground is forzen during runoff and out-flow of terraces is measured with flumes. Traps are used to show the amount of sediments leaving a field.

"This year, I will monitor different fields and more of them and hope to get better monitoring on rate of sediment discharge when erosion occurs," said George. "During the last two runoff seasons I have found that the first intense runoff of the season accounts for the major erosion and sediment damage." He also found that a terrace with six inches off all per 100 feet of length will trap approximately 50 percent of the discharged sediment, that the terrace will begin eroding when its slope reaches 1 percent and that the kind of soil is improtant in building and maintaining a terrace.

"And I found one thing more," said George, who is looking forward to collecting data for at least five years. "A level terrace is 100 percent effective in reducing water pollution by sediment if the water stays in the terrace."

Oregon State University - Department of Information

EXHIBIT #13



Volume 4 No. 1 | APRIL, 1981 | Office Phone: 296-6178

SOIL EROSION IN WASCO COUNTY

Gerald George

One of our major agriculture concerns in Wasco County is the Control of Soil Erosion. Researchers tell us if we can see a rill in the field there is too much erosion. If visiable it exceeds 4 or 5 tons per acre. They also state that most of our man accelerated erosion occurs between November 15 and March 15 while the land is in winter grain.

Since we have identified erosion or a problem we must define what we are talking about. The Basic definition of erosion is the movement of a soil particle from one position to a second position. This movements may be for many miles when the particle is carried by wind or water. It may be for a few hundred feet when caused by earthquakes or gravitational movement of soil masses. It may be a few hundred feet where plowing or livestock are present. Or it may be a fraction of an inch when freezing, thawing, heat and radiation are the cause.

The causes we are most interested in are those we can control by our land management activities. We can control livestock, tillage, wind and water. This control can be done in many ways. We attain our control by providing some type of soil protection and less opportunities for concentrated flows. We disperse livestock to reduce trails. We do rough or minimum tillage to keep move material on the surface to reduce wind and waters erosion. We roll our plow layer up hill to reduce the downhill movement of soil.

There are many practices that will reduce erosion. To keep the erosion from initiating we can use stubble mulch, minimum tillage, perennial cover crops & spring crops. To break up the rills and water flow patterns we can use terraces, diversions, divided slope farming strip croppings, and slot trenches. And to remove sediment before it gets to a receiving stream we can use grassed waterways, buffer strips, sediment basins, and special flat areas for sedimentation.

The erosion we are interested in controlling is initiated through our activities and generally we are not fully aware of costs to us. When we lose soil we reduce the root depth for plants, we lose the fertility of that residue with the lost soil and we lose water holding capacity. These losses are equal to 5 to 10 bushels of yield per acre. Then we have off field costs we have the cost of sediment removal from the roads, we have sediment covered fish spawningbed, we have navigational channel dredging, we have city water purification and filtration, we have stream meandering through prime farm land.

Nearly all of these costs are either directly or indirectly paid by the land owners or uses. They will be a direct out of pocket cost through reduced yield and machinery breakage of field gullies or indirect costs through taxes and, cost of retail products the landowners buys.

EXHIBIT #14

Oregon Soil and Water Conservation Commission

MINUTES

Agricultural Service Center
Pendleton, Oregon
May 22, 1981

ATTENDANCE

Calvin Krahmer, President, OACD
Elizabeth Harvery, Secretary, OACD
C. J. Gilbert, Umatilla County SWCD
Jeanne Marie Gilbert, Umatilla County SWCD
Gerald George, Project Leader, 5 County Wheat Area Project
Gary Yeoumans, Area Conservationist-SCS, Baker
Gene Sturtevant, District Conservationist-SCS, Pendleton
Gordon R. Staker, BLM, Baker
Ernest Timmermann, Wheat League, Pendleton
Virgil Rupp, EAST OREGONIAN, Pendleton
Jim Phelps, State Fish & Wildlife Dept., Pendleton

THE FIVE-COUNTY DRYLAND AGRICULTURAL BMP EVALUATION REPORT

Jerry George reported on some of the findings of his project including his recognition that stubble mulch has proven to be one of the most effective erosion control devices that he has evaluated. He also found great value from a water quality benefit to level and low gradient terraces. Level terraces also provide the benefit of having a water holding capacity and an apparant increase in production. George's report was completed except for review and editing. The Commission approved the report as it was presented on a motion by Moore, seconded by Josi and carried unanimously. It is now to be transmitted to DEQ and EPA for their consideration.

George then reported on the new 208 Project for Umatilla County which will be getting under way as soon as the report for the previous project is completed. The new project will be an implementation planning project with local landowners, getting them to install the BMPs which have been proven to be effective through the evaluation study.

CONCLUSION SYNOPSIS

1. Level and graded terraces with gradients less than 0.5 percent, will reduce sediment volumes carried to streams and water impoundments.

2. To keep stream flow sediment concentrations low where storage type level terraces are used will require a pipe outlet to increase volume of available stream flow while removing sediment from areas above the terrace.

3. All sediment basins reduce the heavier silt and sands that enter streams or major water impoundments.

4. All conservation tillage that has 1000 pounds or more dry residue on or in the top inch of the soil surface reduces erosion and the amount of available sediment for water pollution.

5. Not enough information could be obtained on strip cropping to provide adequate information to determine if reduced erosion will occur by breaking up rill patterns and this would reduce sediment amounts in the water. The first year's data indicates it would.

6. All Best Management Practices evaluated will reduce total volumes of runoff and sediment delivered to a stream or impoundment.

7. Only graded terraces, level terraces with outlets, sediment basins with outlets, and grassed waterways will appreciably affect sediment concentrations in water delivered to a stream or pond.

8. Better evaluation methods should be developed to predict sediment delivery volumes at farm or watershed boundary so BMP planning recommendations can be more effectively provided to landowners.

9. Additional planning and installation assistance to aid landowners in the appraisal and evaluation of various cultural, tillage, and management practices when used in a conservation system will accelerate implementation of BMP's and resource management systems.

10. Carring out special evaluation and demonstration projects in areas where the Best Management Practices are not being established or are being established very slowly will make landowners more aware of the value of BMP'sin their farming areas.

RECOMMENDATIONS

1. Each of the five county Soil and Water Conservation Districts (SWCD's) should develop an annual agreement with the Extension Service to carry out an information and education program to keep landowners and the public aware of Resource and Water Quality Management practices and systems that are effective in the SWCD's.

2. The State Soil and Water Commission (SSWCC) should develop an annual agreement with the Extension Service to carry out a statewide information and education program to keep the SWCD's, landowners, and the public aware of the BMP Demonstration and Evaluation project research and new opportunities in applying Resource and Water Quality Management practices and systems.

3. Each of the five County SWCD's, with the assistance of the SSWCC, the Agriculture Stabilization and Conservation Service, the Soil Conservation Service, and the Extension Service initiate one demonstration and evaluation project, special project, or model watershed project every two years in areas where little or no Resource or Water Quality Management activity has occurred.

4. Each of the five County SWCD's, at their annual planning meeting, should identify and establish priority areas for Resource and Water Quality Management emphasis where critical water quality problems for sediment occur. Then the SWCD's should develop an agreement with the ASCS County Committee so they can provide special or accelerated funding for the priority area.

5. The Soil Conservation Service should strive to maintain stability and continuity in technician staffing in each of the five counties (Wasco, Sherman, Gilliam, Morrow and Umatilla) to provide guidance to SWCD's so Resource and Water Quality system planning and implementation can be carried out to the extent cost sharing is available.

6. The SSWCC and the SWCD's should attempt to get State of Oregon funding to provide technical and cost sharing assistance to landowners in the North Central Oregon five county area who are installing Resource and Water Quality management systems.

7. That, prior to their annual meeting, each of the five County SWCD's, in consultation with the ASCS, the Extension Service, and the SCS, review the RMP's and BMP's they are recommending and recertify these practices at the SWCD annual meeting for use in Resource and Water Quality management plans.

8. The SCS and the Agriculture Experiment Station (AES), through cooperative agreements with the SWCD's and the SSWCC, should develop a program for demonstration and evauluation of Resource and Best Management Practices for water quality control potential which have not been previously emphasized, but are recognized in the SCS National Handbook of Resource Management Practices, such as hillside ditches, slot trenching, slot mulching, and level terrace pipe outlets (Appendix C).

9. The AES should conduct research in the five county North Central Oregon area during the next five years to determine the effects of reduced soil depth, soil fertility and water holding capacity on crop yields.

10. The U. S. Department of Agriculture Research Service (ARS) should develop a program, with the cooperation of the Extension Service, to monitor and evaluate erosion and water quality research findings under applied conditions once plot size information indicates the erosion or water quality practice will work.

11. That the Oregon Department of Environmental Quality and the U. S. Environmental Protection Agency should immediately provide funding to assist the SSWCC and the SWCD's in developing a program whereby public benefits can be evaluated for water quality improvements, so that the SWCD's and County ASCS Committees can better determine the BMP's to be emphasized for technical and financial assistance.

DRY CROPLAND BEST MANAGEMENT PRACTICES

Title	Definition	Purpose	Condition Where Practice Applies
Filter Strip	A strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff.	To remove sediment and other pollutants from runoff by filtration, infiltration, absorption, adsorption, decomposition, and volatilization , thereby reducing pollution and potecting the environment.	This practice applies: (1) on cropland at the lower edge of fields or on fields adjacent to streams, ponds, and lakes; (2) in areas requiring filter strips as part of a waste management system to treat polluted runoff or waste water; (3) in wooded areas where filter strips are needed as part of a harvesting system to reduce delivery of sediment into waterways.
Grassed Waterway or Outlet	A natural or constructed waterway or outlet, shaped or graded, and established in suitable vegetation for the safe disposal of runoff.	To provide for the disposal of excess surface water from terraces, diversions, or natural concentrations without causing erosion or flooding.	All sites where added capacity, vegetative protection, or both are required to control erosion resulting from concentrated runoff and where such control can be achieved by the use of these pratices alone or in combination with others.
Sediment Basin	A basin constructed to collect and store debris or sediment.	To preserve the capacity of reservoirs, ditches, canals, diversions, waterways, and streams; to prevent undesirable disposition on bottom lands and developed areas; to trap sediment originating from construction sites; and to reduce or abate pollution by providing basins for deposition and storage	This practice applies where physical conditions or land ownership preclude treatment of a sediment source by installation of erosion-control measures to keep soil and other material in place or where a sediment basin offers the most practical solution to the problem.

AND RESOURCE MANAGEMENT

DEMONSTRATED AND EVALUATED

Environmental Impacts		Economic Impacts		Range of Installation Costs
Benefits	Adverse Effects	Benefits	Adverse Effects	
Provides filter area to remove sediment. provides habitat for birds and animals.	Provides habitat for pests, diseases and weeds. Will require additional applications of chemicals.	No obvious economic benefits.	Loss of productive land to perennial cover. Time and fuel to maintain and control weeds, pests, and diseases.	$.25 to $2.00 cost because of loss of production from land in strip and maintenance to control pests, diseases, and weeds.
Provides filter area to remove sediment. Provides habitat for birds and animals.	Provides habitat for pests, diseases and weeds. Will require additional applications of chemicals.	No obvious economic benefits.	Loss of productive land to prennial cover. Time and fuel to maintain and control weeds, pests, and diseases.	$.25 to $2.00 cost because of loss of production from land in strip and maintenance to control pests, diseases, and weeds.
Provides source of water for some time after sediment producing runoff occurs. Provides settling area for sediment that is produced. Will provide water quality improvement until it fills.	Does not stop erosion; gives false impression of erosion benefits. Generally cannot be constructed to contain all the runoff for any appreciable amount of runoff.	Provides water storage and water management benefits. Available water can be used for any number of purposes until transpired, evaporated or purcolated.	Costly to construct. Will need maintenance of spillways.	$2.00 to $5.00 per cubic yard of soil moved.

APPENDIX A continued

Title	Definition	Purpose	Condition Where Practice Applies
Sediment Basin cont'd		of silt, sand, gravel, stone, agricultural wastes, and other detritus.	
Stripcropping	Growing crops in a systematic arrangement of strips or bands to reduce water erosion. The crops are arranged so that a strip of grass or close-growing crop is alternated with a strip of clean-tilled crop or fallow or a strip of grass is alternated with a close growing crop.	To reduce erosion and and control water.	On sloping cropland and on certain recreation and wildlife land where the topography is uniform enough to permit tilling and harvesting, and where it is an essential part of a cropping system to effectively reduce soil and water losses.
Stubble Mulching	Managing plant residues on a year-round basis. Harvesting, tilling, planting, and cultivating operations are performed in such a way that protective amounts of vegetation remain on the soil surface.	To reduce soil loss from wind and water; improve water infiltration; and improve the physical condition of the soil.	On nonirrigated cropland in semiarid and sub-humid areas that are susceptible to wind or water erosion.

Environmental Impacts		Economic Impacts		Range of Installation Costs
Benefits	Adverse Effects	Benefits	Adverse Effects	
Retards start of erosion and therby reduces sediment available for stream pollution.	Provides host habitat for perpetuation of diseases, pests and non-desirable plant species. Requires increased use of chemicals.	Reduces rilling and because of reduced rilling, reduces machinery breakage. provides wildlife habitat.	Makes small fields. Increases time and fuel to carry out cultural operations.	$1.00 to $5.00 per acre additional costs.
Retards the start of erosion and thereby reduces sediment available for stream pollution.	Provides host habitat for perpetuation of diseases, pests, and non-desirable plant species. Requires increased use of chemicals.	Reduces power requirements. Reduces time of cultural operations.	Requires additional fertilizer. Requires purchase of different equipment. May reduce yields because of control required for pests, diseases, and weeds.	$.50 to $2.50 per acre additional cost because of loss of yield. If yield remains same, a gain of $.50 to $1.50 may be realized.

Title	Definition	Purpose	Condition Where Practice Applies
Terrace	An earth embankment, a channel, or a combination ridge and channel contructed across the slope.	To: (1) reduce slope length, (2) reduce erosion, (3) reduce sediment content in runoff water, (4) intercept and conduct surface runoff at a nonerosive velocity to a stable outlet, (5) retain runoff for moisture conservation, (6) prevent gully development (7) reform the land surface, (8) improve farmability, and (9) reduce flooding.	This practice applies where: 1. Water erosion is a problem, 2. There is a need to conserve water, 3. The soils and topography are of such that terraces can be constructed and farmed with reasonable effort, 4. A suitable outlet can be provided, or 5. Runoff and sediment can damage land or improvements downstream or impair water quality.

Environmental Impacts		Economic Impacts		Range of Installation Costs
Benefits	Adverse Effects	Benefits	Adverse Effects	
Reduces size of rills and gullies by reducing length in which runoff can accumulate. Provides settling area for sedimentation. Non-farmed over terraces provide a prennial cover for wildlife. Level terraces provide on-farm storage of runoff in more locations than sediment basins can. All terraces will reduce total volumes of sediment delivered to a water course or stream.	Non-farmed over terraces create small fields. These terraces provide host areas for weeds, diseases, and rodents. Level Basin type terraces will reduce total peak volumes of runoff and possibly total runoff volumes.	Can aid in maintaining a contour for farmer to follow, which can reduce power and fuel requirements. Level basin type terraces will retain water on upland areas so it can infiltrate and become available for crop use.	Non-farmed over terraces create small fields. These terraces require more maintenance for weed, insect and rodent control. Farmed over terraces create situations where there is more awareness of breakage that occurs.	$.35 to $1.50 per foot plus a possible $.50 to $2.50 lost because of poor machinery efficiency from turns.

APPENDIX B. Erosion measured with rillmeter, soil leaving terrace or field by grab sample, and comments on field conditions 1977-1981.

Field	Site	Average slope %	Length of slope ft.	Soil moved Tons/acre 1/	Amount of soil 2/ leaving terrace outlet or field boundary Tons/ acre	Period when major erosion occurred	Remarks
					UMATILLA COUNTY		
1-78	1	11	225	18	unknown	12/4 - 10/77	Non-farmed-over gradient terraces at top and bottom of site. Terraces were grassed in and outletted into grassed waterway. Visible sediment deposited in terrace and waterway from areas not terraced. Field was fall plowed in partial cross slope and harrowed. Large clods 3-4 inches were present, and 100 pounds dry vegetation at surface.
2-79	1	5	601	13	none	2/5 - 14/79	Field was controlled by farmed over storage type level terrace. No runoff left field. Less than 100 pounds of dry material was present when seeding was completed. No clods. Disc drilled around and around the field. Visible silting within the terrace. Sites 3 & 4 are over the terrace 100 feet from and parallel to site 5 which is at full slope length at end of terrace.
	2	10	234	30	none	2/5 - 14/79	
	3	6	370	27	none	2/5 - 14/79	
	4	16	152	29	none	2/5 - 14/79	
	5	8	578	34	34	2/5 - 14/79	
3-79	1	12	166	12	12	2/5 - 14/79	Field was unterraced and had 1000 or more pounds of dry residue in the surface layer. Field outletted into 200 feet wide buffer strip then into grassed waterway. Visible sediment deposits in both buffer strip and waterway.
4-80	1	5	433	20	1.8	2/14 - 29/80	Farmed over gradient terrace (0.6%) controlled area. Terrace outletted through pipe drop to natural channel. Field had 250 pounds of dry straw after seeding. Field was disc drilled on partial cross slope. Sites 1 & 3 were about 45 degrees to up & downhill while site 2 was near the contour. The field had 2.5 inches or larger clod size over 70% of the surface. Grain was about 3 inches high at time of erosion.
	2	4	429	0	0	2/14 - 29/80	
	3	3	202	10	.9	2/14 - 29/80	
5-80	1	6	661	28	28	2/14 - 29/80	No terrace in measured area. Field had 250 pounds of dry material after seeding. Field was disc drilled up and down hill. There were no clods over 1 inch in diameter. Grain was about 3 inches high at time of erosion.
	2	3	505	26	26	2/14 - 29/80	
2-81	1	4	611	0	none	2/13 - 16/81	Field was controlled by farmed over storage type level terrace. No runoff left field. There was less than 500 pounds of dry material per acre at time of seeding. There was a fair amount of clods. Disc drilled around the field. Site 1 faces south, site 3 faces east, and site 2 faces west. Sites 1 & 3 started thawing as soon as sun hit. Site 2 didn't start until about 4 hours later, and was still thawing when rain started.
	2	7	408	7	none	2/13 - 16/81	
	3	7	373	0	none	2/13 - 16/81	

1/ Average annual soil moved from a site within a field as measured by the McCool Rillmeter.

2/ Estimated amounts of sediment leaving a field based on grab samples and compared to the soil moved.

APPENDIX B. cont. Erosion measured with rillmeter, soil leaving terrace or field by grab sample, and comments on field conditions 1977-1981.

Field	Site	Average slope %	Length of slope ft.	1/ Soil moved Tons/acre	Amount of soil 2/ leaving terrace outlet or field boundary Tons/ acre	Period when major erosion occurred	Remarks
					GILLIAM COUNTY		
1-78	1	12	282	21	21	12/4 - 10/77	No terraces were present. 250 pounds dry residue per acre. Field disc drilled round and round. Few clods present. Winter grain about 1.5 inches tall at time of erosion.
2-79	1	12	675	10	2.5	2/5 - 14/79	Non-farmed-over graded terraces with <1.0 percent gradient. 250 pounds dry residue per acre, some clods. Disc drilled on terrace grade. Site 2 pickedd up erosion accumulation in a depression from one terrace to the next. Soil leaving field was obtained b sediment basin and grab samples.
	2	4	585	25	6.3	2/5 - 14/79	
3-80	1	11	460	26	26	2/14 - 29/80	Gradient terrace controls runoff at top of these sites, field boundary is lower end of sites. Field had 250 pounds of dry straw per acre. Field was seeded in August, one month ahead of normal seeding for the area. 70 percent of soil surface had cover from green canopy at time erosion occurred. Site 1 was deep furrow drilled at 30 degrees to up and downhill and the rill followed the furrow of the drill. It was on partial cross slope. Field had few clods.
	2	18	680	22	22	2/14 - 29/80	
2-81	1	4	602	0	0	2/13 - 16/81	Non-farmed-over gradient terrace control runoff. Field had 250 pounds of dry straw per acre. Field was disc drilled on cross slope between terraces. Winter grain was 3 inches high when erosion occurred. Site 2 was in a depression where runoff accumulated. No erosion occurred in first 300 feet of slope. Soil leaving field was obtained by sediment basin, grab sample, and recording sampler.
	2	4	648.5	12	2.5	2/13 - 16/81	
	3	3	614	0	0	2/13 - 16/81	

APPENDIX B. cont. Erosion measured with rillmeter, soil leaving terrace or field by grab sample, and comments on field conditions 1977-1981.

Field	Site	Average slope %	Length of slope ft.	1/ Soil moved Tons/acre	Amount of soil 2/ leaving terrace outlet or field boundary Tons/ acre	Period when major erosion occurred	Remarks
					MORROW COUNTY		
1-78	1	20	102	26	unknown	12/4 - 14/77	Farmed over outletted level terrace had some outflow. Disc drilled on cross slope. 200 pounds per acre dry straw. No clods, some rocks. Winter grain about 1.5 inches tall at time of erosion.
	2	18	189	18	unknown	12/4 - 14/77	
2-78	1	22	232	25	unknown	12/4 - 14/77	Non-farmed-over graded terraces had less than 1.0 percent grade. No visible erosion in terrace. Deep furrow drilled on cross slope. Winter grain was about 1.5 inches high when erosion occurred.
3-78	1	30	193	29	unknown	12/4 - 14/77	Non-farmed-over gradient terrace (< 1%) with no visible erosion or sediment in terrace. Disc drilled on cross slope. Field seeded to perennial grasses.
4-78	1	10	370	19	unknown	12/4 - 14/77	Non-farmed-over gradient terrace (< 1%) with no visible erosion or sediment in terrace. Deep drilled on cross slope. Winter grain about 1.5 inches high when erosion occurred.
5-79	1	4	478	10	2.0	2/5 - 14/79	Farmed over gradient terrace (< .6%) with no visible erosion, in terrace was visible deposition. Deep furrows up and down slope. Sites 2 & 3 were reseeded in the spring, and had second runoff and erosion period that was measured. Site 1 was not reseeded.
	2	4	468	16	3.2	2/5 - 14/79	
	3	6	474	17	3.4	2/5 - 14/79	
6-80	1	12	205	0	0	2/14 - 29/80	Non-farmed-over gradient terraces (< .3%) control the area. Field had 1000 pounds per acre dry straw at surface when seeding was complete. Field had numerous small rock and clods 2 to 3 inches in diameter. Field was deep furrow drilled. Sites 1 & 2 were on approximate contour. Site 3 was on 20 degrees to straight up and downhill. Winter grain was about 3 inches high at time of erosion.
	2	14	218	0	0	2/14 - 29/80	
	3	12	230	18	0	2/14 - 29/80	
7-81	1	7	762	0	0	3/13 - 16/81	Field was strip cropped. 200 foot strips, deep furrow drilled between strips. 1250 pounds of dry material on surface at seeding time. No visible erosion occurred. Site 3 was parallel to the stubble strip and up a steep slope. Sites 2 & 3 were perpendicular to the stubble strips.
	2	11	721	0	0	3/13 - 16/81	
	3	12	738	0	0	3/13 - 16/81	

APPENDIX B. cont. Erosion measured with rillmeter, soil leaving terrace or field by grab sample, and comments on field conditions 1977-1981.

Field	Site	Average slope %	Length of slope ft.	1/ Soil moved Tons/acre	Amount of soil 2/ leaving terrace outlet or field boundary Tons/ acre	Period when major erosion occurred	Remarks
					SHERMAN COUNTY		
1-78	1	6	588	5	5	12/7 - 12/77	Graded terraces with 1.5 percent gradients. Erosion occurred within the terrace. 250 pounds per acre dry straw, no appreciable clods. Disc drilled up and downhill. Winter grain was about 2 inches tall at time of erosion.
	2	14	218	7	7	12/7 - 12/77	
2-78	1	14	516	10	10	12/7 - 12/77	
3-79	1	6	370	9	1.8	2/5 - 14/79	Graded terraces with 1.0 percent gradient, some erosion in terrace. Grassed waterway outlet showed siltation in heavy grassed areas. 300 pounds per acre dry straw, some rocks and clods. Winter grain 3.5 inches tall at time of erosion. Amount of soil leaving field obtained by grab samples. Deep furrow drilled up and downhill.
	2	5	455	10	2.0	2/5 - 14/79	
1-80	1	23	133	27	None	2/14 - 29/80	Graded terrace controls top of slope. Sites 1 & 2 controlled by level terrace at bottom of slope, terrace has outlet to stream. No discharge from terrace. 500 pounds per acre dry straw at time of seeding. Deep furrow drilled up and downhill. No clods present. Soil creep was visible in this field.
	2	10	257	30	None	2/14 - 29/80	
	3	13	337	22	22	2/14 - 29/80	
4-80	1	6	391	10	1.0	2/14 - 29/80	Length of slope in Sites 1 and 3 are total lengths over level terraces. Sites 1 & 3 are parallel to and on each side of Site 2. Site 2 was unterraced. All sites had 1000 to 1250 pounds dry straw at surface after seeding. Field had numerous clods 2.5 to 3 inches. Excess erosion in fields 1 and 3 occurred within 50 feet of terrace where all vegetation had been removed to build terrace. Sediment that left field was from below the terrace to field edge.
	2	6	394	7	7	2/14 - 29/80	
	3	6	468	10	1.0	2/14 - 29/80	
5-81	-	—	—	—	—	—	Site was not laid out as no measureasble erosion occurred in this field on Rosebush Creek during the 1980-81 runoff periods. Runoff did occur.
					WASCO COUNTY		
1-78	1	16	446	46	46	12/7 - 12/77	Non terraced field, disc drilled around and around, less than 200 pounds of dry residue or cover.
2-78	1	30	199	108	108	12/7 - 12/77	Non terraced, disc drilled cross slope, less than 200 pounds per acre of dry residue or cover.
3-78	1	31	612	69	69	12/7 - 12/77	Non terraced, disc drilled cross slope, less than 200 pounds per acre dry residue or cover.

APPENDIX B. cont. Erosion measured with rillmeter, soil leaving terrace or field by grab sample, and comments on field conditions 1977-1981.

Field	Site	Average slope %	Length of slope ft.	1/ Soil moved Tons/acre	Amount of soil 2/ leaving terrace outlet or field boundary Tons/ acre	Period when major erosion occurred	Remarks
					WASCO COUNTY (cont.)		
4-79	1	15	199	10	None	2/5 - 14/79	Level storage type terrace, disc drilled partial cross slope, less than 300 pounds per acre dry residue and cover. Site 3 drill rows ran up and downhill.
	2	12	307	12	None	2/5 - 14/79	
	3	10	279	17	None	2/5 - 14/79	
5-80	1	9	448	19	1	2/14 - 29/80	Level storage type terrace, terrace breached. Soil surface was rough and cloddy. Drill rows ran up and downhill. 500 to 700 pounds per acre dry straw on surface after seeding. Winter grain was 3 inches tall at time of erosion.
	2	10	407	15	1	2/14 - 29/80	
	3	11	372	11	1	2/14 - 29/80	
3-80	1	31	585	50	50	2/14 - 29/80	Site 1 was at the end of the terrace in the same field as Site 2. Site 2 was split with a terrace, 100 feet from and parallel to Site 1. Both sites had 200 to 300 pounds per acre dry straw on surface after seeding. Winter grain was 1.5 inches tall at time erosion occurred. The sites were disc drilled on cross slope approximately on the contour.
	2	32	475	27	6	2/14 - 29/80	
4-81	1	13	271.5	1	None	12/20 - 27/80	Same field as 4-79. All cultural actions were carried out in the same way. There was 500 pounds of dry residue per acre. Disc drilling was done near the contour at Site 1. At Sites 2 and 3 there was concentration into low areas near these sites and effects were noticeable at the sites.
	2	12	306.5	6	None	12/20 - 27/80	
	3	14	233.0	15	None	12/20 - 27/80	
6-81	1	20	145	36	36	12/20 - 27/80	No terrace in field, soil surface was quite smooth, no clods but some rocks. Disc drilled around the field. Less than 250 pounds straw on surface after seeding. Winter grain was 2 inches tall when erosion occurred. Site 1 had water concentrated into the area by cross slope and up and downhill rows. Sites 2 and 3 were drilled near the contour. Site 4 was up and downhill with turn rows present.
	2	8	106	17	17	12/20 - 27/80	
	3	11	306	9	9	12/20 - 27/80	
	4	8	109	20	20	12/20 - 27/80	
7-81	1	32	180	33	33	12/20 - 27/80	No terraces in field, soil surface was very smooth, disc drilled rows were across slope. Less than 250 pounds per acre dry straw on surface after seeding. Winter grain was 2 inches tall when erosion occurred.
	2	37	210	59	59	12/20 - 27/80	

APPENDIX B. cont. Erosion measured with rillmeter, soil leaving terrace or field by grab sample, and comments on field conditions 1977-1981.

Field	Site	Average slope %	Length of slope ft.	1/ Soil moved Tons/acre	Amount of soil 2/ leaving terrace outlet or field boundary Tons/ acre	Period when major erosion occurred	Remarks
					WASCO COUNTY (cont.)		
8-81	1	16	723	41	41	12/20 - 27/80	Non terraced, deep furrow drilled around field, measured area was up and downhill in deep furrows. Less than 250 pounds of dry straw at surface after seeding. Winter grain was 1.5 inches tall when erosion occurred. Field is terraced fence to west of field 9-81.
9-81	1	18	689	17	17	12/20 - 27/80	Non terraced, deep furrow drilled around the field, measured area was up and downhill rows with turn rows to fill in corners. Site had 800 to 1100 pounds per acre dry straw on surface after seeding. Winter grain was about 1.5 inches tall at time of erosion. The site was deep furrow drilled. Field is east across fence from field 8-81.

Appendix C. Recognized Resource Management Practices recommended for the Five-County North Central Oregon Area.

Title	Definition	Purpose	Condition Where Practice Applies
Channel Vegetation	Establishing and maintaining adequate plants on channel banks, berms, spoil, and associated areas.	To stabilize channel banks and adjacent areas and reduce erosion and sedimentation. To maintain or enhance the quality of the environment, including visual aspects and fish and wildlife habitat.	On channel banks, berms, spoil, and associated areas; except grassed waterways, deversions and areas with protective linings, those covered with water for an extended period, or in areas where conditions will not support adequate vegetation.
Conservative Cropping System	Growing crops by using a combination of needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes, as well as rotations in which the desired benefits are achieved without the use of such crops.	To improve or maintain good physical condition of the soil; protect the soil during periods when erosion occurs, help control weeds, insects, and diseases; and meet the need and desire of farmers for an economic return.	On all cropland and on certain recreation and wildlife areas.
Conservation Tillage System	A form of noninversion tillage that retains protective amounts of residue mulch on the surface throughout the year. These include no-tillage, strip tillage, stubble mulching, and other types of noninversion tillage.	To protect the soil from erosion and help maintain and develop good soil tilth and desirable water infiltration rate.	On cropland and on certain other lands where annual vegetation is grown.
Critical Area Planting	Planting vegetation, such as trees, shrubs, vines, grasses, or legumes, on highly erodible or critically eroding areas (does not include tree	To stabilize the soil, reduce damage from sediment and runoff to downstream areas, and improve wildlife habitat and visual resource.	On highly erodible or critically eroding areas. These areas usually cannot be stabilized by ordinary conservation treatment and management and if left un-

Title	Definition	Purpose	Condition Where Practice Applies
Critical Area Planting cont'd	planting mainly for wood products).		treated 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.
Crop Residue Use	Using plant residues to protect cultivated fields during critical erosion period.	To conserve soil moisture, increase soil infiltration, reduce soil loss, and improve soil tilth.	On land where adequate crop residues are produced.
Diversion	A channel with a supporting ridge on the lower side constructed across the slope.	To divert excess water from areas to sites where it can be used or disposed of safely.	This practice applies to sites where: 1. Runoff from higher lying areas is damaging cropland, pastureland, farmsteads, feedlots, or conservation practices such as terraces or stripcropping. 2. Surface and shallow subsurface flow caused by seepage is damaging sloping upland. 3. Runoff is in excess and available for diversion and use on nearby sites. 4. A diversion is required as part of a pollution abatement system. 5. A diversion is required to control erosion and runoff on urban or dev-

APPENDIX C continued

Title	Definition	Purpose	Condition Where Practice Applies
Diversion cont'd			eloping areas and construction sites. Diversion shall not be substituted for terraces onland requiring terracing for erosion contról. Diversions shall not be used below high sediment-producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with or before the diversions.
Emergency Tillage	Roughening the soil surface by such methods as listing, ridging, duck-footing, or chiseling. (This emergency conservation measures does not provide long-term benefits).	To temporarily protect cultivated land against soil loss during high winds, especially during critical erosion periods.	On cropland that is in immediate danger of being eroded by wind because of insufficient residues, cloddiness, or roughness or where other practices fail to control erosion.
Contour Ridge	A channel having a supporting ridge on the lower side constructed across the slope at definite vertical intervals and gradient, with or without a vegetative barrier.	To control the flow of water from sloping areas and to provide a detention area so runoff water will have time to percolate into the soil, thus minimizing erosion and runoff	areas that are suitable for cultivation and that have sufficient soil depth for construction of a hillside ditch system.
Mulching	Applying plant residues or other suitable materials not produced on the site to the soil surface.	To conserve moisture; prevent surface compaction or crusting; reduce runoff and erosion; control weeds; and help establish plant cover.	On soils subject to erosion on which low-residue-producing crops, such as grapes and small fruits, are grown; on critical areas; and on soils that have a low infiltration rate.

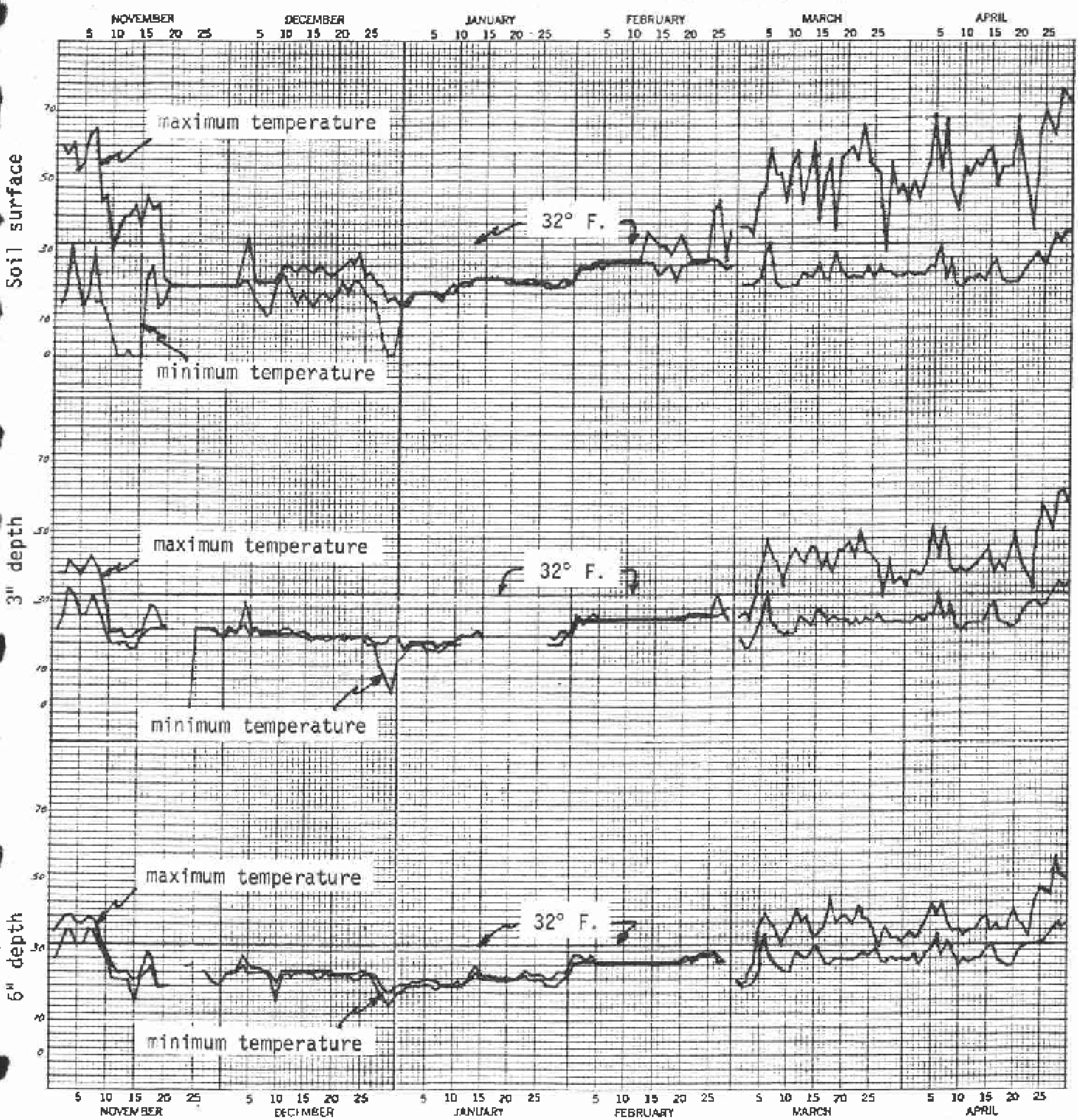
APPENDIX C continued

Title	Definition	Purpose	Condition Where Practice Applies
Runoff Management	A system for controlling excess runoff caused by construction operations at development sites, changes in land use, or other land disturbances.	Mainly to regulate the rate and amount of runofff and sediment from development sites during and after construction operations to minimize such undesirable effects as flooding, erosion and sedimentation.	This practice applies if there is a need to control runoff, erosion, and sedimentation to compensate for increased peak discharges and erosion resulting from construction operations at development sites or from other changes in land use. The discharges may be caused by such factors as increased runoff, reduced time of concentration, or reduced natural storage.
Water- and Sediment-Control Basin	A short earth embankment or a combination ridge and channel renerally constructed across the slope and minor watercourses to form a silt or sediment basin.	To: trap and collect sediment, reduce onsite erosion, reduce the content of sediment in water, reduce peak rate of flow at downslope locations, reduce flooding, reduce gully erosion, reform the land surface, and improve the potential of areas for farming.	This practice applies: to sites where: 1. The topography precludes installing and farming terraces with reasonable effort, 2. Runoff and sediment from high areas can damage downstream land or improvements, 3. Water erosion is a problem. 4. Site conditions are suitable for installation; and 5. Adequate outlets can be provided.
Waterspreading	Diverting runoff from natural channels or gullies by means of a system of dams, dikes, or ditches and spreading it over relatively flat areas.	To provide moisture for plants in areas that can nake effective use of additional moisture to supplemental natural precipitation.	Waterspreading systems apply where runoff can be diverted from drains to relatively flat areas where it will soak into the ground and remain until it is used by growing plants. Soils shall be relatively free of problems associated with

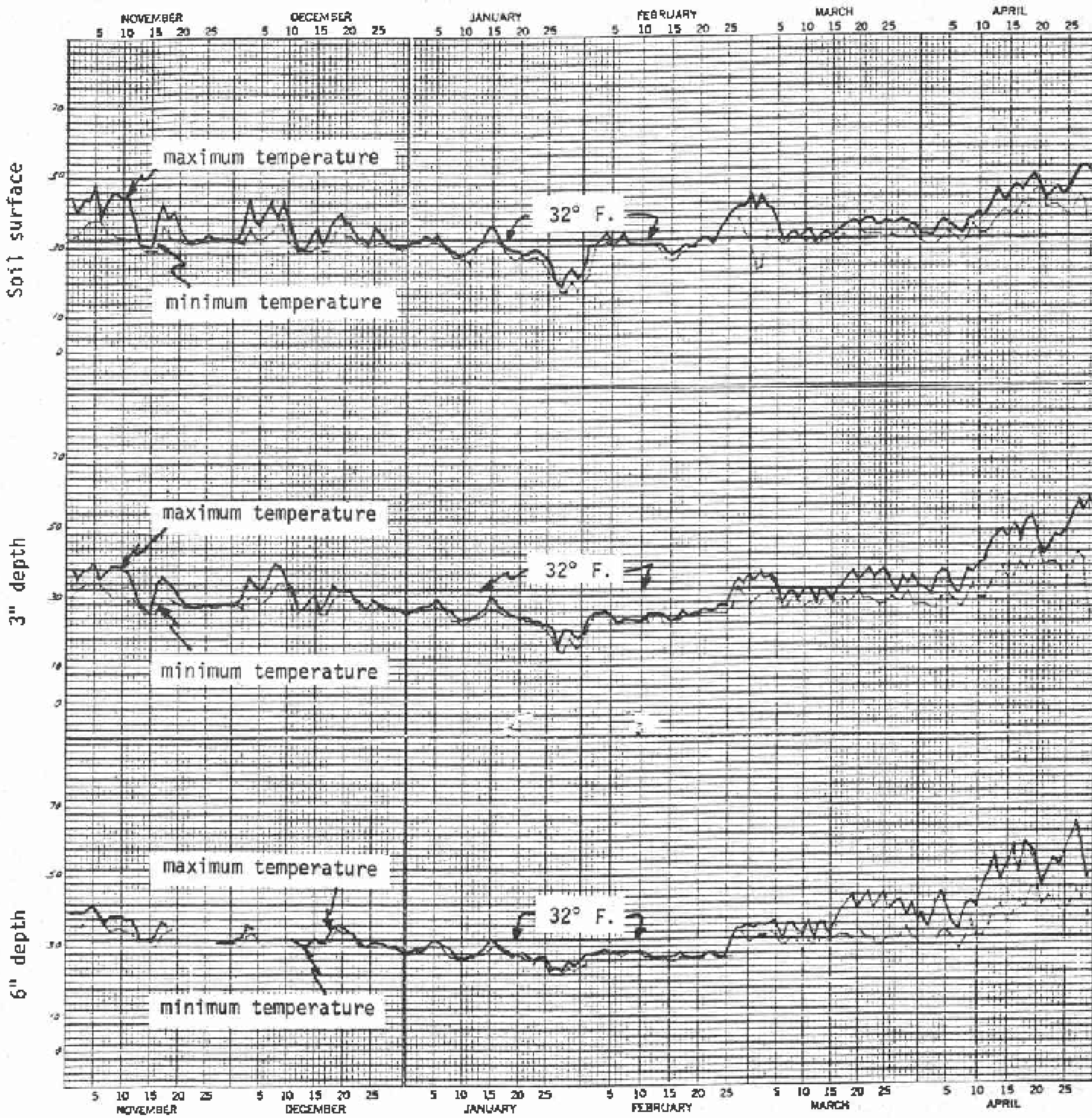
Title	Definition	Purpose	Condition Where Practice Applies
Waterspreading cont'd			alkalinity and salinity. They shall have a moderate to high available moisture capacity. The soil profile shall be deep enough so that the available moisture capacity will be at least 4 in. for the normal extraction depth of the plants to be grown. Intake rates shall be slow enough to permit the spread of flood waters by surface methods. The topography of the spreading area shall be relatively flat, smooth, and free of rills or channels. The normal seasonal distribution and volunmes of runoff water from both rainfall and snowmelt shall be of such that the water applied by the spreading system will effectively increase plant growth. The diverted storm flows shall not be great enough to cause undue maintenance problems and shall not contain salts or sediments in kinds and amounts that will be damaging to the spreading area. The plants to be grown shall be able to withstand inundation for the length of time and at the season contemplated in the design. The combination of soils, slopes, and plants

Title	Definition	Purpose	Condition Where Practice Applies
Waterspreading cont'd			shall be such that the area can withstand the application of flood waters without scour or erosion losses beyond allowable limits. Care shall be exercised to creat no deterimental effects for fish and wildlife.

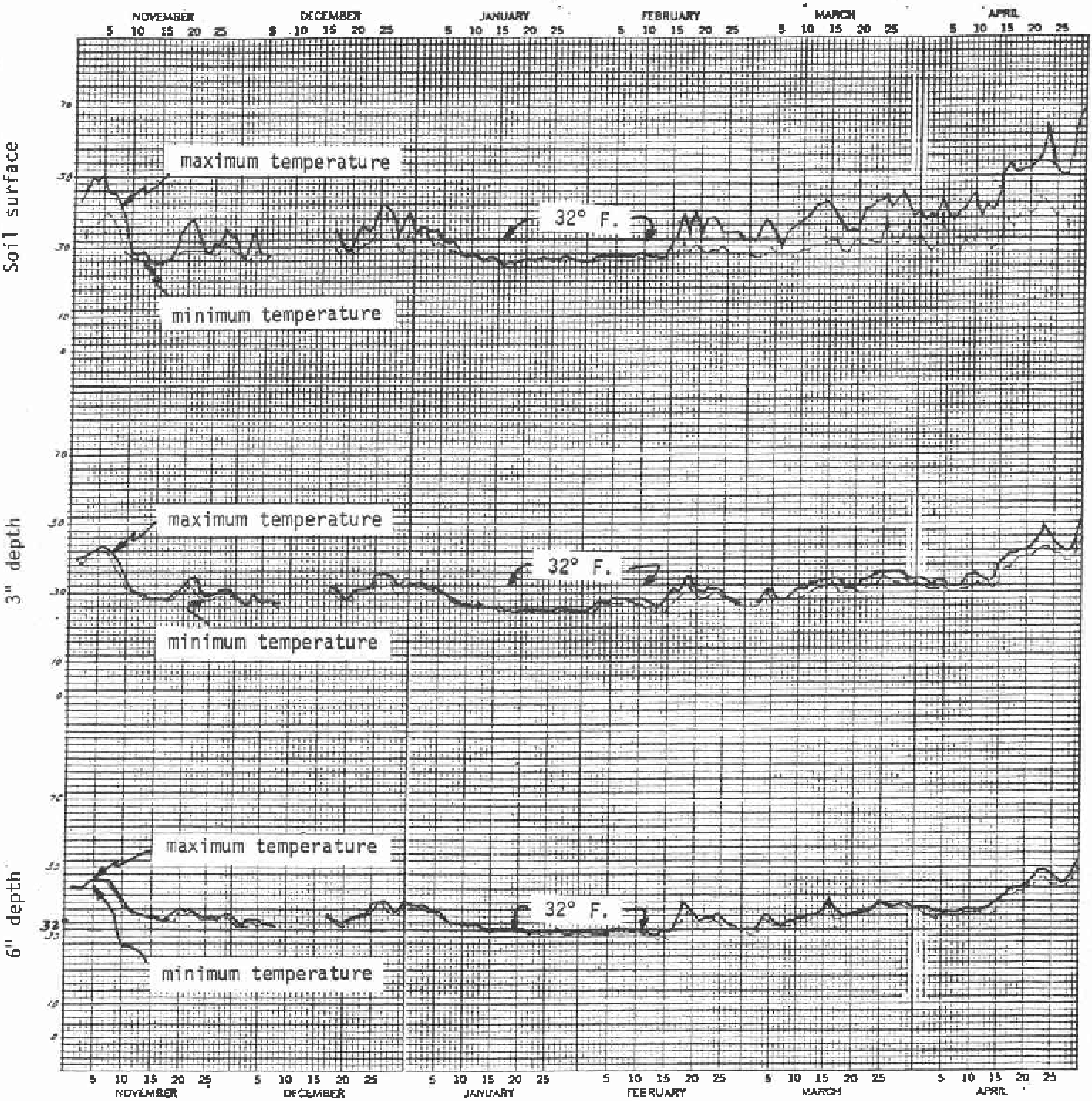
Appendix D. Typical Five-County North Central Oregon Area minimum and maximum soil temperatures at three depths for the 1978-79 runoff season.



Appendix D. (cont.) Typical Five-County North Central Oregon Area minimum and maximum soil temperatures at three depths for the 1979-80 runoff season.



Appendix D. (cont.) Typical Five-County North Central Oregon Area minimum and maximum soil temperatures at three depths for the 1980-81 runoff season.



Appendix E - Precipitation at weather stations and field sites during the erosion season from 1977-81 as compared to the normal precipitation.

	November					December					January				
	77	78	79	80	normal*	77	78	79	80	normal*	78	79	80	81	normal*
						Umatilla County									
Pendleton WS	1.79	1.68	2.31	1.81	1.50	3.19	2.28	1.05	1.20	1.53	2.27	1.31	2.85	.89	1.60
AES	2.00	2.37	1.83	.84		2.42	.33	.62	1.99		2.82	1.43	2.48	1.26	1.60
Study Field 1		.88	1.60	.90			.83	.86	.78			.82	1.81	.86	
						Morrow County									
Heppner WS	2.40	1.90	2.16	1.62	1.62	2.33	1.45	.74	1.48	1.54	2.21	1.37	1.10	2.68	1.30
Ione	2.27	1.83	2.20	1.25	1.54	2.49	.78	.62		1.51	2.12	1.43		1.27	1.30
Study Field 1				.32					2.20					1.31	
Study Field 2		1.24	1.38				.74	.47				1.03	.76		
						Gilliam County									
Condon WS	2.37	1.60	2.56	2.00	1.71	3.69	.99	1.24	2.36	1.68	2.51	1.41	1.20	1.50	1.34
Mikkalo	2.12	1.19	1.88	1.51	1.43	2.67	.58	.55	2.02	1.49	2.66	1.19	2.57	1.98	1.54
Study Field 1		3.08	1.59	3.90			1.20	.69	3.16			1.13	.85	.88	
Study Field 2			1.59	.12				.19	.76				.27	.33	
Study Field 3															
						Sherman County									
Moro WS	2.00	.79	2.23	1.73	1.80	3.22	.69	.65	2.95	1.73	2.80	1.59	3.41	1.52	1.78
Study Field 1		.54	1.45				.48	.74	1.70			.70	1.30	.63	
Study Field 2															
						Wasco County									
Dufur WS	2.44	.82	1.46	1.58	1.83	3.86	.86	.70	3.79	1.85	3.34	1.99	4.39	1.24	2.19
Study Field 1		.04		1.54			.23	.23	4.20			.86	.18	1.52	
Study Field 2			.08	2.42				.57	1.76				.03	1.52	

	February					March					April					Annual
	78	79	80	81	normal*	78	79	80	81	normal*	78	79	80	81	normal*	normal*
						Umatilla County										
Pendleton WS	1.71	1.54	1.55	1.35	1.07	1.40	1.74	2.12		1.00	3.50	1.82	1.20		1.01	12.31
AES	1.60	1.72	1.39	2.31		1.03	1.18	1.60			2.78	1.17	.59			
Study Field 1		1.63	.87	2.05			1.43	.77	1.78			1.46	.58	.96		
						Morrow County										
Heppner WS	1.22	1.15	.84	1.26	1.11	1.24	1.21	.65		1.19	1.26	2.61	.45		1.03	13.01
Ione	1.03	.75	2.50	.74	1.13	.51	1.43	1.04		1.23	1.82	2.39	.63		1.03	13.27
Study Field 1				1.63					1.46					.12		
Study Field 2		.35	1.00				.84	.91				2.33	.47			
						Gilliam County										
Condon WS	1.42	1.69	2.50	1.99	1.11	.69	1.50	.95		1.10	2.04	2.70	.94		.90	13.23
Mikkalo	1.08	1.08	1.48	1.20	1.03	.42	.69	.76		.86	1.57	1.90	.53		.74	10.88
Study Field 1		.87	.79	.55			.88	.59	2.06			1.69	1.06	2.44		
Study Field 2			.75	.50					.52				.50	.22		
Study Field 3																
						Sherman County										
Moro WS	1.31	1.54	1.83	1.22	1.17	.74	.99	.94		.95	1.42	1.06	.89		.72	11.77
Study Field 1		1.34	1.80	2.52			.95	.69	.24			1.00	.70			
Study Field 2																
						Wasco County										
Dufur WS	2.00	1.73	2.22	1.71	1.34	.96	1.06	1.10		1.16	1.47	1.13	1.12		.66	12.53
Study Field 1		1.23	.92	1.76			.56	.49	.08			.63	.36			
Study Field 2			1.41	1.60				.36	.94				.13	.14		

*Normal precipitation taken from Climatological Data, Annual Summary, Oregon, National Oceanic and Atmospheric Administration.

Appendix F: Characteristics of soils monitored during the course of this study with their soil erodibility and soil loss tolerance. used in the USLE to predict potential sediment production.*

County	Watershed	Field Number & Year	Soil Series	USLE Soil Erodibility Surface	USLE Soil Erodibility Sub-Soil	USLE Soil Tolerance Tons/Acre
Wasco	Fifteen Mile	1-78	Anderly	.49	.64	2
	Eight Mile	2-78	Dufur	.43	.37	5
	Eight Mile	3-78	Duart	.43	.43	2
	Fifteen Mile	4-79-81	Duart	.43	.43	2
	Fifteen Mile	5-80	Duart	.43	.43	2
	Fifteen Mile	6-81	Condon-Bakeoven	.32	.43	2
	Eight Mile	7-81	Duart	.43	.43	2
	Eight Mile	8-81	Walla Walla	.49	.54	5
	Eight Mile	9-81	Walla Walla	.49	.64	5
Sherman	Slaughterhouse Gulch	1-78-80	Walla Walla	.49	.64	5
	Slaughterhouse Gulch	2-78	Walla Walla	.49	.64	5
	Slaughterhouse Gulch	3-79	Walla Walla	.49	.64	5
	Slaughterhouse Gulch	4-80	Walla Walla	.49	.64	5
	Rosebuch Creek	5-81	Condon	.32	.43	2
Gilliam	Thirty Mile Creek	1-78	Rhea	.43	.49	5
	Ferry Canyon	2-79-81	Condon	.32	.43	2
	Rock Creek	3-80	Ritzville	.49	.55	5
Morrow		1-78	Valby	.43	.49	2
		2-78	Valby	.43	.49	2
		3-78	Morrow	.37	.43	2
		4-78	Morrow	.37	.43	2
		5-79	Valby	.43	.49	2
		6-79	Valby	.43	.49	2
		7-81	Valby	.43	.49	2
Umatilla	Dry Creek	1-78	Walla Walla	.49	.64	5
	Wildhorse Creek	2-79-81	Walla Walla	.49	.64	5
	Wildhorse Creek	3-79	Walla Walla	.49	.64	5
	Wildhorse Creek	4/5-80	Walla Walla	.49	.64	5

*For additional soils data see Oregon Soils Interpretation records or the County Soil Survey Reports.

Appendix G. Number of days with snow on ground reported by National Weather Service stations

	November					December					January				February				March*				April*			
	77	78	79	80	81	77	78	79	80	81	78	79	80	81	78	79	80	81	78	79	80	81	78	79	80	81
UMATILLA COUNTY																										
Pendleton WS	6	4	8	1		10	6	4	7		10	5	10	2	7	5	4	2	4	6	8		9	7	3	
AES	6	8	7			9	4	4			12	5	7		4	6	4		4	7	6		7	4	1	
MORROW COUNTY																										
Heppner WS	8	6	7	2		9	2	2	5		7	4	8	2	6	3	8	11	3	5	6		6	7	3	
Ione																										
GILLIAM COUNTY																										
Condon WS	7	5	8	3		11	2	2			12	4	6	6	5	6	10	12	2	5	6		4	7	4	
Mikkalo	7	3	5			6	3	3			10	3	7		4	6	5		1	3	3		3	4	1	
SHERMAN COUNTY																										
Moro WS	7	3	8	3		8	3	3	10		11	6	9	11	6	5	6	9	2	4	2		5	2	2	
WASCO COUNTY																										
Dufur WS	7	2	6			7	2	5			12	4	8		9	6	12		3	2	4		3	3	3	

*March and April reports haven't been received from National Weather Service.

REFERENCES

(1) ---- 1972. PL 92-500, Federal Water Pollution Act Amendment, 92nd Congress.

(2) ---- 1978. Sediment Reduction Project, 208 Non-point Source Pollution Control Program, State Soil and Water Commission, Salem, OR.

(3) McCool, D. K. Agriculture Engineer, WSU, Pullman, Washington. A portable rill meter for measuring field soil loss, Scientific Paper No. 5872, or IAH's Publ. No. 133.

(4) U. S. D. A. SEA, AR 1978. Predicting Rainfall Erosion Losses, Agricultural Handbook Number 537.

(5) Sternes, G.L. 1966. Climatological Data for Oregon's Columbia Basin Counties, Special Report 225, OSU Cooperative Extension Service.

(6) Gardner, Walter H. Soil Scientist, WSU, Pullman, Washington. 1968. How Water Moves in the Soil (Reprint for sale by Crop and Soils Magazine, 677 South Seque Road, Madison, Wisconsin 53711).

(7) Klock, Glen O. 1972. Snowmelt Temperature Influence on Infiltration and Soil Water Retension, Journal of Soil and Water Conservation, pp. 12-14.

(8) Chow, V. T. - Handbook of Applied Hydrology. Vol. II. Control of Water Pollution from Runoff.

(9) Lyon, Buckman, Brady. 1950. The Nature and Property of Soils, McMillian Co.

(10) McGill, Steve. 1981. Neighborhood Conservation. The Furrow, Deere Company, 86(4):4-5.

(11) Berglund, Steve; Michalson, E. L. 1980. U. I. Economics of the Five Point Program in Total County. Research Bulliten No. 113.

(12) B.L. Davis Ranch, Umatilla County, Oregon. 1980. Report to Senator Foley, US Senator, on Terracing Costs.

(13) USDA Science and Education Administration. 1979. Field Manual for Research in Agriculture Hydrology, USDA Handbook 224 (For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Stock No. 001-000-03798-6).

(14) Foster, G.R.; Ferreira, V.A. 1981. Deposition in Uniform Grade Terrace Channels, Paper presented at ASAE Conference on Crop Production with Conservation in 1980's, and Purdue Journal No. 8294.