SR 699 / January 1984

INFORMATION FOR LEADERS IN LAND MANAGEMENT
Research and Extension in land management technology for farm profits and conservation of soil and water.

SMALL GRAIN RESIDUE MANAGEMENT

THE PROBLEM

Many Northwest cereal producers risk the prospect of severe soil erosion losses in order to effectively dispose of bothersome small grain residues. These residues can, if heavy and not properly managed, interfere with tillage, seeding, and seedling emergence. They can be the source of poor seedbed conditions, an element in disease transmission, and the agent in toxic conditions for seedlings.

However, it is known that if properly handled, residues can make important and significant contributions to the control of soil erosion, help conserve and store moisture for crop use, and store large amounts of available plant nutrients. Additionally, the proper handling of residues will reduce fuel consumption in the farming operation.

THE RESEARCH

The objectives of the research conducted on this problem were as follows:

1. Determine the amounts of residue needed to achieve the beneficial results, but avoid or minimize the complications mentioned above.

2. Develop the technology needed to maintain satisfactory levels of surface residues.

3. Find means for computing the residue levels remaining on (or very near) the surface after various tillage operations.

This research was carried out in a series of field trials at the Columbia Plateau Conservation Research Center and on cooperating farmers' fields throughout north central Oregon over a period of 15 years. A vast array of individual observations under a wide variety of soil, weather, insect, disease, and implement management conditions are summarized in the results reported below.

RESULTS

One thousand to 2,000 pounds of crop residue slightly mixed in or on the soil surface after seeding small grains provides adequate soil erosion protection under most conditions. Large amounts of small grain residues can present problems with tillage, seeding and seedling emergence. We need to manage crop residues to control weeds and diseases, prepare a seedbed, yet leave sufficient residues to provide soil erosion protection after the crop is seeded. Crop residues provide plant nutrients, aid water conservation, and protect the soil from erosion. The value of the plant nutrients in a ton of wheat crop residue is estimated at current fertilizer prices at ten dollars. Burning this residue loses nearly all of the nitrogen and approximately one-half of the sulfur and phosphorus for a loss estimated at five dollars worth of nutrients for every ton of residue. One to nine tons per acre of small grain residues have been measured after harvest in Oregon.

Soil and water saved with residues: At Pendleton, where stubble was left standing, flailed, or burned in the fall, 76, 73, and 57 percent, respectively, of the overwinter precipitation was stored. Similar storage efficiencies at Moro were 83, 79, and 62 percent. When 1500 pounds of residue per acre remained on the soil

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surface after wheat was seeded, 10% more water was stored during the winter after seeding than where the stubble was plowed or burned. Every inch of water stored in the soil profile produces from five to seven bushels of wheat per acre.

Soil erosion of 6 to 41 tons per acre has been observed on slopes of 10 to 18%. Soil erosion was reduced two tons per acre for every 100 pounds of residue on the soil surface. The loss of 150 tons of soil per acre is equivalent to the loss of one inch of topsoil. The value of the major plant nutrients (nitrogen, phosphorus, and potassium) in a ton of average topsoil is about one dollar. The monetary loss of nutrients is small compared to the permanent loss of topsoil.

Residue amounts needed: The amount of surface residue needed after seeding for water erosion control varies with soil texture and slope and is presented in Table 1.

Slope (%)	Residue needed in lbs/A on: Medium texture soils	Coarse texture soils
0-8	750-1000	500-700
8-15	1000-1500	750-1200
15-25	1500-2250	1200-1750

Winter wheat produces about 100 pounds of crop residue for each bushel of grain harvested. Spring wheat, barley, and oats produce approximately 80 pounds per bushel of grain harvested. If you harvest 45 bushels of winter wheat per acre you can estimate that you have 4,500 pounds of residue per acre.

CONCLUSIONS

You should use the sequence of tillage and seeding operations that will handle the residue without difficulty and yet retain an adequate amount on the soil surface after seeding for all the numerous benefits of conservation farming (photos 1 and 20. Before deciding what tillage to use, review the quantity of residue left on the surface after each type of tillage operation (Table 2). Proper combinations of tillage operations will enable you to manage any quantity of crop residue successfully.

The winter after seeding small grain on fallow is the most critical time for soil erosion. You can help control this erosion loss by determining the quantities of residue needed from Table 1. The crop residue (pounds per acre) left after harvest can be estimated by multiplying the yield of winter wheat in bushels per acre by 100. For winter and spring barley and spring wheat multiply the yield, in bushels per acre, by 80. Selection and use of the proper sequence of tillage operations from Table 2 will leave an adequate amount of residue to control soil erosion after you have seeded your fallow. You may use the attached worksheet to assist you in your tillage sequence selection. Example: A medium textured soil on a slope of 8 to 15% needs 1,000 to 1,500 pounds of residue per acre to control soil erosion (from Table 1). Your winter wheat yielded 45 bushels per acre. 45 x 100 pounds of residue per bushel = 4,500 pounds of residue per acre after harvest.

One possible choice of tillage and seeding operations would be to chisel in the fall (.70), chisel in the spring (.70), inject fertilizer (.80), rodweed (.90), rodweed (.90), and furrow drill (.80). The residue remaining on the surface after seeding can be estimated by consecutively multiplying the individual values from Table 2 expressed as decimals (.70 x .70 x .80 x .90 x .90 x .80) = 0.25. Multiplying the amount of residue after harvest (4500 lbs) by the residue retention factor (0.25) provides an estimate (1143 lbs) of the surface residue remaining. This should be enough to control the soil erosion. If your yield was 90 bushels, instead of 45, you would be dealing with 9,000 pounds of residue per acre. A choice of tillage and seeding sequence might be offset disk (.40), cultivate (.70), fertilize (.80), rodweed (.90), rodweed (.90), and drill (.90). It can be calculated that 0.16 (0.40 x 0.70 x 0.80 x 0.90 x 0.90 x 0.90) of the 9,000 pounds of residue, that is, 1,440 pounds will remain on the surface after seeding.

Table 2. Estimates of crop residues left on the soil surface after various tillage or seeding operations.*

Tillage or seeding implement	Crop residue left per implement trip, %
Primary tillage:	
Moldboard plow	20
Disk, offset	40
Chisel (2" chisels, spaced 12")	70
Sweep plow	90
Secondary tillage:	
Field sweep (16" to 24" sweeps, or wider)	90
Field cultivate with chisels	70
Spring tooth harrow	50
Tandem disk	50
Fertilizer injector, 16" spacing	80
Rodweeder with chisels or shovels	80
Rodweeder, plain rod	90
Deep furrow drill	80
Double or single disk drill	90

* Values given are for average conditions. Actual values depend on implement setting, speed, type and amount of residue, soil moisture, etc.

SUGGESTIONS

Your goals for an alternate wheat-fallow sequence could be:

1. Conserve and store water by leaving the stubble stand the first winter after harvest except where crop residue amounts are excessive (more than 6,000 lbs/acre).

2. Select and use a sequence of tillage operations that will allow residues to pass through the implement yet retain an adequate quantity on the surface after seeding to store water and control soil erosion.

3. When you have excessive amounts of crop residues after harvest, use fall tillage, usually disking or chiseling, to start the residue reduction in the fall rather than the following spring.

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Publication was made possible by a grant from Extension Service, USDA, and contract funds from the Soil Conservation Service, USDA, for a special program to extend research results developed by a project entitled "Solutions to Environmental and Economic Problems (STEEP)." STEEP is a special research program conducted by USDA-ARS and the Agricultural Experiment Stations of Idaho, Oregon, and Washington.

Extension Service, Oregon State University, Corvallis, O. E. Smith, Director. This publication was produced and distributed in futrherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties.