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Selected Best Management Practices in Southeastern Idaho

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This publication evaluates some selected Best Management Practices to determine their effectiveness and efficiency in controlling soil erosion in southeastern Idaho. Average soil losses in southern Idaho are relatively severe, averaging between 5 and 15 tons per acre each year. Oversimplifying, each acre-inch of topsoil represents 150 tons of soil loss. At the present rates of erosion, assuming a uniform rate, in 10 to 20 years an acre-inch of topsoil will erode. The value of an acre-inch of topsoil is variable depending upon how deep the soil being eroded is.

Research by Walker and Young (1982) indicates that for each inch of soil eroded, yield loss varies from 3 bushels per acre on soils 24 inches deep to 8 to 10 bushels per acre on soils 12 inches deep. Given the above levels of soil loss, obviously the potential is great for significant yield reductions in southeastern Idaho resulting from continued high levels of soil erosion.

In past years, the effects of soil erosion have been hidden by the use of new technology. Examples would be the use of fertilizers, pesticides and new crop varieties. The effect of new technology and innovations has been to increase yields at the same time farmers have been forced by government programs and increasing costs of inputs to live with thinner profit margins. Consequently, erosion control has not been a high priority item for southeastern Idaho farmers. As yields have increased, costs of production have increased, and crop prices have decreased all of which encourage farmers to mine their soils.

At the present time, evidence indicates the rate of technological increase for wheat farming may be slowing. The cropping system is no longer responding as positively to the application of new technology as evidenced by the yield plateaus observed for most crops produced in southeastern Idaho. By current estimates, attention must be given to reducing soil erosion and minimizing lost crop productivity. This publication considers three Best Management Practices (BMPs) that help to reduce soil erosion: (1) minimum tillage, (2) stripcropping and (3) terracing.

Methodology

Two techniques were used to develop the analysis — budgeting and a field tillage simulation program. The budgeting process was combined with the Field Tillage Simulation (FTS) program to evaluate the impacts of different systems of tillage using conventional and minimum tillage comparisons.

Study Area

The study area consisted of nine southeastern Idaho counties: Bannock, Bonneville, Caribou, Cassia, Franklin, Fremont, Madison, Oneida and Power. The study concentrated on the dryland wheat farming areas. The crops used in the study were winter wheat-summer fallow and spring barley.

Data

The data used in this study were obtained from several sources. The most important source was a farm survey done in 1979. Ninety-five farmers were interviewed, and a complete farm schedule was taken from each farmer. The data gathered included size of farm, rotation, machinery and power complements, age of farmer and tillage practices. These data provided the basis for the present analysis. Crop budgets were developed by updating the 1979 data to 1982 for price changes.

Other important sources of data were used. These were the Soil Conservation Service Offices in Pocatello and Idaho Falls, southeastern Idaho chemical and machinery dealers and other professional agriculturists from the University of Idaho College of Agriculture.

Minimum Tillage

This BMP involves reducing the number of tillage practices used to prepare the ground for planting, compared to what would be used under a conventional tillage regime. It also involves residue management and contour tillage. The idea is to use residue to help hold the soil in place.

Minimum tillage's purposes are (1) reduce soil erosion, (2) increase the amount of organic matter in the soil, (3) improve soil structure and (4) reduce the costs of tillage. Minimum tillage will also help improve the soil's water holding capacity. In cases where soil moisture tends to be limiting, this increased moisture holding capacity tends to contribute to increased crop yields. In cases where soil moisture is not a limiting factor, it tends to have a negative effect on crop yields. The extent of this effect is not well understood for southeastern Idaho, but probably additional moisture would be beneficial in this region of Idaho.

Table 1 shows a set of residue incorporation factors for common types of tillage implements. The range in residue incorporation varies from 10 percent for light tillage implements such as rod weeders, drills and fertilizer applicators to 60 to 100 percent for moldboard plowing. The set of implements used for conventional tillage tends to achieve from 80 to 100 percent residue incorporation levels. Minimum tillage was defined in terms of residue reduction levels and was considered to be any set of tillage practices that leaves at least 50 percent of crop residue on the soil surface. The objective of holding residue in place is to maintain the soil's long-term productivity by reducing erosion. The tillage comparisons here use conventional tillage as the basis for comparison. Table 2 shows typical conventional and minimum tillage field operations for wheat and barley.

The comparisons between conventional and minimum tillage were made through use of the Idaho Enterprise Budget Generator. The costs of stripcropping and terracing were developed using the FTS program (Brooks and Michalson 1983). This program permits the analysis of specific farm fields by introducing the field coordinates into the program and simulating field operations with any package of tillage machines available. Field coordinates can be adjusted to incorporate conservation practices such as terracing and stripcropping. The costs of farming with these BMPs can be derived through FTS output and enterprise budgeting.

Crop Residue Use

Conventional tillage practices on dryland farms of southeastern Idaho are in themselves quite minimal. Because of the lower precipitation received, the need for a finely prepared seedbed must be tempered by the necessity of preserving as much soil moisture as possible. The conventional tillage operations that have emerged to balance these factors include, for a winter wheat-fallow crop, a pass with a chisel or disk in the fall, use of a disk or field cultivator in the spring and, typically, up to five rodweedings during the summerfallow period.

Minimum tillage practices are quite similar. The chisel is used in the fall rather than a disk or field cultivator, and a sweep chisel is recommended for spring plowing. Rodweedings during the fallow period are reduced to one or more depending on the weed situation.

Similarities between conventional and minimum tillage practices for spring barley are also pronounced. Typically, conventional operations include use of a chisel plow in the fall and use of a disk or field cultivator and a rodweeder with a harrow in the spring. A minimum tillage operation substitutes a sweep chisel for the disk or field cultivator in the spring and eliminates the harrow.

Table 3 indicates the effect on cost of maintaining crop residue on the soil surface using minimum tillage. The costs were estimated for a winter wheat-fallow crop and a spring barley crop and include savings in tillage costs and added fertilizer costs. The tillage savings were $5.10 per acre ($3.82 savings in fuel, etc., and $1.28 savings in labor costs) for the wheat-fallow.

Table 1. Estimated residue incorporation for various farm machines.

Type of machine	Residue incorporation
	(%)
Moldboard plow 8 inches or deeper	80-100
Moldboard plow 5 to 7 inch deep cut	60-80
Power disk	60
Tandem or offset disk	50
One-way disk	50
Chisel (2-inch chisels, 12 inches apart)	25
Field cultivator (16- to 18-inch sweeps)	20
Deep furrow (shovel or disk-opener)	20
Sweeps (24 to 36 inches)	15
Rodweeders, with semichisels or shovels	15
Semideep furrow rodweeder	15
Rodweeders, plain rod	10
Conventional drill (double and single disk opener)	10
Fertilizer applicator (anhydrous)	10

Table 2. Minimum/conventional tillage combinations considered.

Crops to which tillage is applicable	Tillage intensity	Chisel plow	Field cultivate	Rodweed	Disk	Double harrow
Winter wheat after summerfallow	conventional	1	1	5	1	—
	minimum	1	1	3	—	—
Spring barley	conventional	1	2	1	—	1
	minimum	1	1	1	—	—

Table 3. Effect on costs of maintaining crop residue in and on the soil surface using minimum tillage in southeastern Idaho.

Crop	Savings in fuel, oil, lube and repair costs/crop[1]	Savings in labor costs/crop	Added fertilizer costs/crop[2]	Net effect of crop residue use
Winter wheat-fallow[3]	+$3.82	+$1.28	-$4.20	+$0.90
Spring barley	+$0.22	+$0.00	-$4.20	-$3.98

[1]Savings are for the various implements listed in Table 2 including the tractor.

[2]Assuming an additional 20 pounds of fertilizer per cropped acre for minimum till.

[3]Requires 2 years to produce the crop.

crop and $0.22 per acre for spring barley. In addition, costs of applying 20 more pounds of fertilizer were added to each crop because increased nitrogen is recommended with minimum tillage. The increased nitrogen compensates for the slower decomposition of organic matter under residue management. The net effect of maintaining crop residue was a savings of $0.90 per acre for the winter wheat-fallow crop and a cost of $3.98 per acre for the spring barley crop.

The Universal Soil Loss Equation (USLE) was used to estimate soil loss under minimum tillage. Soil loss was defined in terms of soil movement and includes any and all dislocation of soil particles, whether or not they leave the field. The amount of soil loss prevented by using minimum tillage was estimated at 4 to 6 tons per acre for wheat and barley. Soil erosion for a winter wheat-fallow crop with conventional tillage was 14.8 tons per acre. With minimum tillage soil loss was reduced to 10 tons per acre. Soil loss for an annual spring barley crop with conventional tillage was 8.9 tons per acre. Minimum tillage reduced sediment loss to 2.4 tons per acre.

Field Stripcropping

Stripcropping is a BMP used to reduce erosion on long, steep slopes. The slope is divided into sections and planted so a portion is always in plant cover. Strips are laid out on the contour for maximum erosion control. In southeastern Idaho, the Soil Conservation Service recommends stripcropping on slope classes greater than 12 percent.

Table 4 gives the costs of stripcropping. These costs are divided into: (1) added fuel, oil, lube and repair costs; (2) added labor costs; (3) added herbicide, fertilizer and seed cost per acre; and (4) the net added cost of stripcropping. The net added cost was $5.34 per acre for the winter wheat-fallow crop and $5.12 per acre for spring barley. These costs were directly related to the problems of overlap and the fact that stripcropping requires more machine time related to making more turns to farm the strips.

Stripcropping is effective in reducing soil erosion. A savings of 6 to 8 tons of sediment per acre has been estimated for this practice. In the case of a winter wheat-fallow crop, soil erosion was reduced from 14.8 tons per acre to 7.0 tons per acre by using conventional tillage and stripcropping. With minimum tillage and strips, sediment loss was 4.6 tons per acre. For an annual spring barley crop using strips and conventional tillage, soil erosion was reduced from 8.9 tons per acre to 3.2 tons per acre. Using minimum tillage reduced soil loss to 0.9 tons per acre.

Terracing

Terracing is a conservation practice that reduces runoff and erosion by breaking up the slope length of a field. Terraces are of two types — graded or level. A graded terrace is sloped so that excess water is directed from the terrace to a protected outlet. Graded terraces are appropriate for areas with high precipitation or for soils with low intake rates. Level terraces allow the water to stay on the field to be absorbed into the soil. Level terraces are designed to handle up to 1 inch of precipitation runoff from the cropland above. Spacing between terraces depends on many factors including slope length and steepness, type of soil and farming practices. Terraces are designed on the contour, and maximum erosion control occurs when they are farmed on the contour as well.

In southeastern Idaho, the SCS recommends use of terraces on slope classes from 4 to 12 percent. Estimates taken in Bannock County, Idaho, indicate that 41 percent of the dryland area has slope classes between 6 and 12 percent that are treatable by terracing. Level terraces are the preferred design for southeastern Idaho so that as much moisture as possible is retained on the soil. Preliminary experiences with terracing suggest that the extra moisture has a positive effect on yields within the terraced field, but further research is needed to fully explore and quantify the effect of terracing on crop yields.

Table 4. Estimated cost of stripcropping surface using minimum tillage in southeastern Idaho.

Crop	Added fuel, oil, lube and repair cost/crop[1]	Added labor cost/crop	Added herbicide, fertilizer and seed costs/crop[2]	Net added operating cost/crop of stripcropping
Winter wheat-fallow[3]	$2.52	$1.20	$1.62	$5.34
Spring barley	$2.18	$0.84	$2.10	$5.12

[1]Added costs are for the various implements including the tractor.

[2]Added herbicide, fertilizer and seed costs are estimates from operators who have installed strips.

[3]Requires 2 years to produce a crop.

Table 5. Estimated operating costs of farming with terraces in southeastern Idaho.

Crop	Added fuel, oil, lube and repair cost/crop[1]	Added labor costs/crop	Added herbicide, fertilizer and seed costs/crop[2]	Net added operating cost/crop of terracing
Winter wheat-fallow[3]	$3.64	$1.20	$1.62	$6.46
Spring barley	$3.00	$0.84	$2.10	$5.94

[1]Added costs are for the various implements including the tractor.
[2]Added herbicide, fertilizer and seed costs are estimates from operators who have installed strips.
[3]Requires 2 years to produce a crop.

Table 5 estimates the added costs of performing field operations with terracing. These costs were divided into the same categories used for stripcropping. The total additional cost was $6.46 per acre for a wheat-fallow crop and $5.94 per acre for barley. Note that these costs do not include the costs of constructing the terraces. The same reasons existed for these added costs as for those related to stripcropping. These costs were a function of the added miles travelled and more turns required to farm between the terraces.

Terrace construction costs in southeastern Idaho vary from $0.48 to $1.30 per lineal foot of terrace. The length and number of terraces in a field depends on many factors. A representative average of 75 feet per acre was taken from sample fields in Bannock County. Installation costs per acre of terrace were estimated between $36.00 and $97.50. When a 10-year declining balance payment schedule was applied to the initial investment of terrace installation, assuming an interest rate of 14 percent, the annual cost for constructing the terrace was between $7.00 and $20.00 per acre.

Terraces are an effective soil conserving practice. Terracing was estimated to retain from 3 to 4 tons of additional topsoil per acre on the field. In the case of a winter wheat-fallow crop with conventional tillage, soil loss was reduced from 14.8 tons per acre to 8.2 tons per acre with terracing. Use of minimum tillage reduced sediment loss to 5.6 tons per acre. For an annual spring barley crop, soil loss was reduced from 8.9 tons per acre to 4.9 tons per acre with conventional tillage and terracing and to 1.3 tons with minimum tillage.

Conclusions

This publication has evaluated the costs of applying crop residue use, stripcropping and terracing in southeastern Idaho. Table 6 shows the added costs of operating with these BMPs. Minimum tillage is the least expensive practice, followed by stripcropping and terracing. In fact, using minimum tillage with a wheat-fallow crop shows a $0.90 per acre savings in operating costs.

The efficiency of conservation practices depends not only on their costs but also on their effectiveness in controlling soil erosion. Table 7 shows soil loss values for the BMPs. Stripcropping provides the greatest reduction in soil loss, followed by terracing and minimum tillage. Using minimum tillage with stripcropping and terracing provides the greatest amount of protection for the soil.

Table 6. Estimated operating costs of selected Best Management Practices in southeastern Idaho by crop.

Practices	Winter wheat-fallow	Spring barley
	(per crop)	(per crop)
Crop residue use	+$0.90	$3.98
Stripcropping	+$5.34	$5.12
Terracing[1]	+$6.46	$5.94

[1]Installation costs are not included in these figures.

Table 7. Estimated soil loss values for Best Management Practices in southeastern Idaho by crop.

Practices	Winter wheat-fallow	Spring Barley
	(tons per crop)	(tons per crop)
Crop residue use		
Conventional tillage	14.8	8.9
Minimum tillage	10.0	2.4
Terracing[1]		
Conventional tillage	8.2	4.9
Minimum tillage	5.6	1.3
Stripcropping[1]		
Conventional tillage	7.0	3.2
Minimum tillage	4.6	0.9

[1]Assumes terrace or strip is farmed on the contour.

In the longrun, the benefits of implementing crop residue use, stripcropping and terracing will tend to result in improved productivity over time when compared to conventional tillage. The evidence to support this is the fact that the maintenance of productivity has historically required the use of more technology.

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