Direct Benefits and Costs of Conservation on a Northern Idaho Farm

Edgar L. Michalson

Introduction

In the 1990 Food Security Act (FSA) the economic benefits of the federal farm program are linked to conservation compliance. It seems realistic to approach the topic of FSA looking at the costs and benefits of participation. To do this the short-run and long-run economic impacts both on and off the farm need to be evaluated. The act attempts to reduce the economic and environmental impacts of erosion by requiring farmers to use approved conservation practices on highly erodible lands and then rewarding them. The way to do this is to tie the farm program benefits to the use of a Natural Resources Conservation Service (NRCS) plan. The carrot used to make the pill easier to swallow is continuation of farm program benefits and the stick is the loss of all farm program benefits.

Costs of Conservation Compliance

The costs of conservation compliance are the added costs of applying the NRCS approved conservation practices, as per an approved conservation plan. These are the conservation practices required by NRCS to meet FSA minimum standards for erosion control on highly erodible lands. Three conservation practices are examined in this analysis: minimum tillage used as an alternative to conventional tillage, divided slopes and minimum tillage combined, and strip cropping and minimum tillage combined. The farm analyzed is a 1,000-acre wheat, barley, pea farm located in northern Idaho. In this analysis the added costs of farming the land with the required conservation practices are evaluated.

Minimum tillage is a practice used to manage crop residues to control soil erosion. It helps farmers maintain specific levels of residue both above and below the soil surface, improving soil organic matter, soil structure, and water infiltration. Lighter equipment and fewer tillage operations are used, and farmers spend less time and money on tillage. Minimum tillage reduces fuel, oil, and repair costs on tractors and farm machinery, and therefore it should extend the lives of farm machinery and equipment. This shows up in table 1 as a lower cost for each crop. The reduction in operating costs for tillage operations varies from \$1.80 to \$2.43 per acre (1). On a 1,000-acre farm with a 3-year wheat, barley, pea rotation, minimum tillage versus conventional tillage should reduce the costs of tillage by \$2,196, table 1. This \$2,196 consists of reduced cash outlay for machinery and labor.

Dividing the field at the dead furrow (12 to 15 percent hill slope) and farming each part of the field in different crops is the *divided slopes* practice. The point is to grow alternate crops on the upper and lower slopes of the field. This allows the cover conditions on a slope to vary, decreases the slope length, and increases the protective cover that permits greater water infiltration, and reduces water runoff. Divided slopes on farm fields are beneficial in reducing soil erosion and improving downstream water quality. This practice is relatively easy to apply and maintain. Costs of divided slopes are related to the type of land and size of field on which this practice is applied, and are discussed later in this paper.

Field size and shape influence the loss of time and efficiency of using divided slopes. Studies done on divided slopes have identified three field conditions that affect the costs of farming divided slopes (1). Large gently rolling fields are the easiest to adapt to divided slopes with a low efficiency loss (efficiency

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Table 1. Comparisons of costs of conventional and minimum tillage for a 1,000-acre northern Idaho wheat, barley, pea farm.

		Cost per acre		
Crops	Acres	Conv tillage	Min. tillage	Savings
WW after SP	1	$29.98	$28.18	$1.80
SB after WW	1	$40.47	$38.04	$2.43
SP after SB	1	$39.36	$37.00	$2.36

		Total costs		
Crops	Acres	Conv. tillage	Min. tillage	Savings
WW after SP	334	$10,013	$9,413	$601
SB after WW	333	$13,447	$12,668	$809
SP after SB	333	$13,107	$12,320	$786
Totals	1,000	$36,567	$34,401	$2,196

Note: WW = winter wheat
SB = spring barley
SP = spring peas
Conv. tillage = conventional tillage
Min. tillage = minimum tillage

loss of 2.5 percent). In most cases these would be fields of more than 150 acres. Fields ranging from 50 to 150 acres were classified as medium efficiency loss fields (efficiency loss of 9.2 percent) in their ability to be adapted to divided slope farming. Those less than 50 acres in size were classified as high efficiency loss fields (efficiency loss of 19 percent).

It was assumed that 400 acres would be farmed using only minimum tillage. Of the land in divided slopes, 60 acres were high efficiency loss fields, 180 acres were medium efficiency loss fields, and 360 acres were low efficiency loss fields. Fields with divided slopes would be tilled using minimum tillage. Divided slopes costs were estimated as $36,065, or $469 more than the costs of farming them with conventional tillage (table 2). The distribution of these costs shows that the added costs related to the inefficiency losses of divided slopes were offset by the reduced costs of minimum tillage.

Strip cropping is the systematic arrangement of strips or bands of crops across a field that serve as barriers to erosion. The planting of alternating strips of three or more crops across the slope of a field creates a rough soil surface that reduces runoff velocity, allows for better water absorption, and with a winter crop in one of the strips, provides a more stable soil horizon during the critical erosion months (February and March) in the Palouse region of northern Idaho. Land used for strip cropping is usually on steeper ground, and would not typically be a large part of most farms. This is particularly true where divided slopes are also used in the farming operation.

Strip cropping would be used on 90 acres with slopes over 30 percent. The added time required to farm strips relative to conventional tillage was calculated using the Field Tillage Simulation Program developed at the University of Idaho. The output of this program includes the number of turns, field efficiency, speed, miles traveled, elapsed time, and time spent turning. In addition the program calculates the number of acres farmed,the costs of fuel, oil, lube,

Table 2. Estimated costs of divided slopes on a 1,000-acre northern Idaho wheat, barley, pea farm.

Part I
Per acre costs for divided slopes

	Conventional tillage costs per acre	Per acre costs (using minimum tillage)		
		Efficiency loss		
		High 19%	Medium 9.1%	Low 2.5%
Crops				
WW after SP	$29.98	$35.68	$32.71	$30.73
SB after WW	$40.47	$48.16	$44.15	$41.48
SP after SB	$39.36	$46.84	$42.94	$40.34

Part II. Estimated costs of using divided slopes on a 1,000-acre northern Idaho farm.

	Conventional tillage total costs (using minimum tillage)	Total Costs		
		Minimum tillage costs	Divided Slopes costs	Total costs
Crops		1,000 acres	400 acres	600 acres
WW after SP	$10,013	$3,776	$6,364	$10,140
SB after WW	$13,477	$5,059	$8,590	$12,649
SP after SB	$13,107	$4,921	$8,355	$13,276
Totals	$36,597	$13,756	$23,309	$36,065

Net difference between conventional tillage and divided slope, $36,597 - $36,065 = $532.
Note: WW = winter wheat,
SB = spring barley
SP = spring peas.

and repair costs for tractors and farm machinery and the increased costs of fertilizer, herbicide, and seed related to overlapping problems related tillage and spray machinery operation. The added tillage machinery turning and implement overlapping were estimated to result in a 10 to 20 percent increase in chemical and fertilizer use. The added costs related to using strip cropping are shown in table 3. The added costs for winter wheat were $18.01 per acre, those for spring barley were $11.52 per acre, and those for spring peas were $11.33 per acre. The magnitude of these costs changes with the amount of chemicals and fertilizer used, and the width of the strips.

Table 3. Estimated added costs of strip cropping relative to conventional tillage on a 1,000-acre northern Idaho wheat, barley, pea farm.

Crop	Acres	Added fuel oil, lube, and repairs/acre	Added labor per acre	Added herbicide, fertilizer, and seed	Total added costs/acre
Winter wheat	30	$1.18	$0.68	$16.15	$18.01
Spring barley	30	$1.74	$0.81	$8.97	$11.52
Spring peas	30	$1.74	$1.19	$8.41	$11.33

Table 4 shows an example of a complete farm operation involving minimum tillage, divided slopes, and strip cropping on a 1,000-acre northern Idaho farm. The total tillage cost of farming included the following practices. Minimum tillage alone was used on 400 acres, strips and minimum tillage on 90 acres, and divided slopes with minimum tillage on 510 acres. The total cost of tillage on this farm would be $37,576. This figure is $899 more than the cost of conventional farming. What this indicates is that the savings related to minimum tillage offset a considerable portion of the costs of applying these conservation practices.

In table 5 the conventional system is compared to: 1) a straight minimum tillage system, 2) a divided slope system combined with minimum tillage, and 3) a system that uses strips with minimum tillage. These comparisons are shown at the bottom of the table indicating both cost increases and savings related to each system. The minimum tillage system is the most cost efficient in that it saves $2,196. The next most efficient system is the divided slope minimum tillage system that costs $467 more than the conventional system. The divided slope-strip cropping system with minimum tillage increased costs by $978. When all of the other systems are compared to the minimum tillage system they tend to be less efficient. However, the loss of efficiency is very small over all. In the case of conventional tillage versus minimum tillage there is an efficiency gain of 6 percent. In the case of conventional tillage versus divided slopes with minimum tillage there is an efficiency loss of 1 percent. In the case of conventional tillage versus strip cropping and divided slopes with minimum tillage the efficiency loss was 2.6 percent. It is concluded that conservation compliance has not been expensive for most farmers. On an average per acre basis the cost increases for divided slope farming were $0.47 per acre, and those for the strip-cropping program were $0.98 per acre when compared to conventional tillage.

Table 4. Estimated costs of using minimum tillage, divided slopes, and strip cropping on a 1,000-acre northern Idaho wheat, barley, pea farm.

Part I. Acreage

Divided slopes

Crop	Minimum tillage (acres)	Medium (acres)	Low (acres)	Strips (acres)	Total acreage
Winter wheat	134	50	120	30	334
Spring barley	133	50	120	30	333
Spring peas	133	50	120	30	333
Totals	400	150	360	90	1,000

Part II. Costs of tillage

Divided slopes with minimum tillage

Crop	Minimum tillage	Medium	Low	Strips with minimum tillage	Totals
Winter wheat	$3,776	$1,636	$3,688	$1,386	$10,485
Spring barley	$5,059	$2,208	$4,978	$1,487	$13,731
Spring peas	$4,921	$2,147	$4,841	$1,450	$13,359
Totals	$13,756	$5,991	$13,507	$4,323	$37,576

Part III. Differences

Crop	Cost of conventional tillage	Cost of divided slopes and strip cropping	Net differences
Winter wheat	$10,013	$10,485	$472
Spring barley	$13,517	$13,731	$214
Spring peas	$13,146	$13,359	$213
Totals	$36,676	$37,575	$899

Cost comparisons were made between the minimum tillage, divided slopes, and strip cropping alternatives. The estimated costs were $2,663 higher for divided slopes, and $3,174 higher for the strip cropping. The relative economic efficiency loss was 7.7 percent for divided slopes, and 9.2 percent for strip cropping. The average per acre increases in tillage costs for divided slopes alternative were $2.66

Table 5. A comparison of alternative tillage systems on a 1,000-acre northern Idaho wheat, barley, pea farm.

Comparisons					
Crop	Acres	Conventional tillage	Minimum tillage	Divided slopes	Strip-cropping
Winter wheat	334	$10,013	$9,413	$10,140	$10,485
Spring barley	333	$13,477	$12,668	$13,649	$13,731
Spring peas	333	$13,107	$12,320	$13,275	$13,359
	1,000	$36,597	34,401	$37,064	$37,575

Net difference between conventional tillage and divided slopes and strip-cropping alternatives $0 ($2,196) $467 $978

Net difference between minimum tillage and divided slopes and strip cropping alternatives $0 $2,663 $3,174

per acre, and that for strip cropping was $3.17 per acre. These are still nominal costs when compared to the income received under participation in the farm programs. The average payment for the average acre of wheat produced in Latah County was $62.23 per acre and that for barley was $29.13. The cost of conservation practices yields a significant return to the farmers who participate in the farm program.

When minimum tillage was compared to conventional tillage it saved money. It saved enough money to offset the increased costs related to using divided slopes and strip cropping under the conditions assumed in this study. When the costs of conservation compliance were compared to the benefits of the farm program it was clear that participating in conservation compliance pays relative to loosing all farm program benefits. One does have to apply these practices to specific farm situations to determine the magnitude of the costs and resulting economic benefits. Farmers need to look carefully at their NRCS conservation plans and evaluate the changes required to be in compliance with the conservation compliance provisions of the 1990 Farm Security Act.

The costs of using conservation practices may increase the cost of farming, because as tillage is reduced weed, insect, and disease problems may increase in the short run because of the changed cropping environment. Moving to a new tillage system is more complicated than merely reducing the amount of tillage used. The tillage system that existed prior to this change was a system in equilibrium. When changes are made this often upsets this equilibrium allowing weeds, insects, and diseases to invade. The consequence of these changes is that crop yields and in some cases quality tends to decline. After a period of years, depending upon the rotation being used, a new equilibrium should be established crop yields and quality should recover, and the insect and disease problems should moderate. Farmers can expect that establishing this new equilibrium will increase their costs of doing business. They may need to spend more money on farm chemicals to control weeds, insects, and diseases.

In most cases the decline in crop yields will be minor (less than 10 percent). The tillage program suggested in this study involves a change from conventional to minimum or conservation tillage which for the most part only involves reducing the number of tillage operations. Many farmers have already moved to a form of minimum tillage as a result of the increase of fuel prices which occurred in the 1970s. So for many farms the process of adopting conservation tillage systems has been partially accomplished, and the changes required by their conservation plans will not dramatically affect their crop production system. In the longer run, the benefits of controlling soil erosion will outweigh any short run losses associated with the program. Studies done by Walker and Young have borne this out (5).

Soil Erosion Benefits

The soil erosion benefits related to the use of the above conservation practices for the case study farm used in this analysis were obtained from the NRCS Field Technical Guide (4). Practices used in this case study would reduce soil erosion by the following amounts according to the estimates used in this guide. Minimum tillage reduced soil erosion from an average of 16.2 tons to 11.7 tons per acre, or a net saving of 4.5 tons per acre. In aggregate the amount of soil saved was 4,500 tons for the farm. When both minimum tillage and divided slopes were used to control erosion, the average soil loss was reduced from the 16.5 tons per acre under conventional tillage to 6.0 tons per acre under divided slopes, or a net loss reduction of 10.5 tons per acre. When minimum tillage, divided slopes and strip cropping were used, the average soil loss was reduced from the 16.5 tons per acre under conservation tillage to 5.2 tons per acre. In the aggregate a total reduction of 11.3 tons per acre, table 6.

In terms of the estimated total tons of soil saved, the application of these practices is impressive. Total soil loss under conventional tillage that used heavy tillage equipment such as moldboard plows and heavy offset disks were estimated to be 16,533 tons per year on the 1,000 acres. Minimum tillage would reduce this by about half to 8,197 tons per acre. The use of divided slopes combined with minimum tillage would decrease soil loss to 5,707 tons, and by adding strips the soil loss would be reduced to 5,193 tons. In the case where both divided slopes and strip cropping were used the average soil loss would meet the NRCS soil loss tolerance level of 5 tons per acre, which is the level for the area that the case study farm was located in. In fact the divided slopes alone almost meet this level, and it would be a judgment call as to whether the strips would be needed.

A further point relates to the value of what is being accomplished by using conservation practices to reduce erosion. There are two points that need to be recognized with regard to the benefits generated by erosion control. First the on-site benefits that relate to maintaining and enhancing the productivity of the farm. The second source of benefits would be the reduction in off-site damages. These damages include sedimentation and water quality problems to which erosion is a contributor. In this study only the off-site benefits will be considered, and they will consist of the reduction in erosion as above in table 6.

The value per ton of soil eroded was estimated in a study done by Michalson in 1991 (3). In this study the value estimated was $1.32 per ton of soil. The basis of this value was obtained from a study done by Clark et. al. (2) in which they estimated the nature of off-site damages caused by sediment eroded into various waterways in the United States. Using this value the contribution made by the case study farm is shown in table 7.

The reduction in off-site damages is impressive. These savings are also a measure of environmental benefits related to the conservation compliance program. Looking at the total column in table 7, it appears that the case study farm is generating from about $6,000 to more than $15,000 of environmental benefits by using the practices listed in table 7. The environmental benefits of minimum tillage alone were $5,895. The use of minimum tillage and divided slopes generated added, environmental benefits of $8,696, and these increased further to $9,497 when strips were added to the farm plan. The margin between the use of minimum tillage plus divided slopes and minimum tillage, divided slopes, and strips was only $1,101. This indicates that the effectiveness

Table 6. Estimated soil losses in ton per acre for alternative tillage practices for a 1,000-acre northern Idaho wheat, barley, pea farm.

Acres of cropland by slope category	Flat 400	Slight 360	Medium 150	High 90	Avg. 1,000
Tillage practice					
Conventional tillage (t/ac.)	8.1	17.4	22.0	30.7	16.5
Min. tillage (t/ac.)	4.6	13.1	17.2	23.0	8.2
Min. tillage plus divided slopes (t/ac.)	4.6	4.9	6.5	8.8	6.0
Min. tillage, divided slopes, strips (t/ac.)	4.6	3.7	5.5	7.4	5.2
Tillage practice					
Conventional tillage (tons)	3,240	2,610	7,920	2,763	16,533
Min. tillage (tons)	1,840	1,965	6,192	2,070	8,197
Min. tillage plus divided slopes (tons)	1,840	735	2,340	792	5,707
Min. tillage, divided slopes & strips (tons)	1,840	555	1,980	498	5,193

(Min. = Minimum)

Table 7. The estimated value of off-site benefits related to controlling soil erosion on a 1,000-acre northern Idaho wheat, barley, pea farm.

Acres of land by slope category	Flat 400	Slight 150	Medium 360	High 90	Total 1,000
Conventional tillage	$0	$0	$0	$0	$0
Min. tillage	$1,848	$851	$2,281	$915	$5,895
Min. tillage plus divided slopes	$1,848	$2,475	$7,366	$2,602	$14,291
Min. tillage, divided slopes and strips	$1,848	$2,713	$7,841	$2,990	$15,392

(Min. = Minimum)

of these practices declines as more of them are used. It is clear that farmers who participate in the conservation compliance program are generating significant off-site environmental benefits. Further it is also clear that these environmental benefits need to be recognized by environmental policy makers.

In conclusion, the cost of applying the conservation practices required for participation in the conservation compliance part of the farm program was determined to be moderate. In the case where a farmer may be moving from conventional tillage to minimum tillage there are savings in fuel and time because tillage operations are reduced. Even in the case where the number and types of conservation practices do require more time and money the increased costs were minor varying from about $1 per acre up to a maximum of $3 per acre. However when the benefits generated by these programs are considered, farmers are not being credited for the environmental benefits that these conservation plans generate. The magnitude of these benefits is considerable, ranging from approximately $6,000 to more than $15,000 for the whole farm. These numbers translate into $6 and $15 per acre, and should be compared to the costs of the conservation practices which farmers are being asked to use. It appears that farmers can survive under "Food Security Act," (FSA) because the increased costs are not great enough to offset the average benefits that the FSA provides, which were $62.23 per acre for wheat, and $29.13 for barley. The significant point is that the environmental benefits that this program is generating are being ignored. It would be a better world for farmers' if the FSA included their contribution toward environmental enhancement. The net environmental benefits generated by FSA vary from $2 to $5 per acre for the low end environmental improvement. At the high end the net benefits ranged from $12 to $14 per acre.

Farmers who adopt conservation plans create environmental benefits that accrue to society. Conservation plans must be in place if farmers are to participate in the Farm Security Act. It is probably true that in most situations the conservation benefits that accrue to society are greater than the FSA payments made to farmers. This should be recognized by policy makers and those people who influence them.

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About the author

Ed Michalson is a professor of agricultural economics at the University of Idaho.

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