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WASHINGTON STATE UNIVERSITY
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Note

Enterprise costs and returns vary per farm and over time for any particular farm due to differences in

- Capital, labor, land, and management resources
- Type and size of machinery complement
- Cultural practices
- Size of farm and enterprise
- Crop yields
- Input prices
- Commodity prices

Costs can also be calculated differently depending on the intended use of the cost estimate. The information in this publication represents costs and returns of a case study in Adams County, Washington, of a farmer using both low-disturbance V-sweep undercutter conservation tillage* and traditional tillage systems for summer fallow prior to producing winter wheat. To avoid drawing unwarranted conclusions from this case study, closely examine the assumptions and data used and make appropriate adjustments to your situation.

*The Haybuster™ undercutter implement used in this study has 32-inch wide V-shaped blades with 28-inch spacing between blades (on two tiers) to slice below the soil surface with minimum soil lifting. As a primary spring tillage implement, the undercutter completely severs capillary pores to halt liquid water movement towards the soil surface to retain seed-zone moisture in summer fallow. The pitch of each blade can be individually adjusted to ensure uniform horizontal movement (i.e., minimum soil lifting) underneath the soil and easily fitted to deliver aqua nitrogen fertilizer for primary spring tillage. Depending on soil texture, farmers may or may not want to attach a finishing implement behind the undercutter to break large soil clods and fill air voids. The undercutter also works well for killing Russian thistles after wheat harvest.

ECONOMIC COMPARISON OF UNDERCUTTER AND TRADITIONAL TILLAGE SYSTEMS FOR WINTER WHEAT-SUMMER FALLOW

Andrey A. Zaikin, Douglas L. Young, William F. Schillinger

ABSTRACT

Wind erosion and blowing dust are major problems for traditional winter wheat-summer fallow tillage in eastern Washington due to reduced soil productivity and air quality. Although conservation tillage summer fallow can reduce wind erosion markedly, relatively few farmers in the low-precipitation (less than 12 inch/year) region of the Inland Pacific Northwest use it because of investment requirements for conservation tillage machinery and reluctance to change "tried and proven" traditional tillage methods. This bulletin addresses these barriers by comparing economic results from using a conservation V-sweep undercutter and traditional fallow tillage systems on a case-study farm near Ritzville, Washington. The undercutter produced a similar wheat yield to the 46 bu/ac eight-year average with traditional fallow. Furthermore, the conservation method was more profitable than the traditional system on the case-study farm due to slightly lower production costs. Eligibility for conservation payments further strengthened the profitability advantage of the undercutter system.

INTRODUCTION

Winter wheat-summer fallow (WW-SF) is the dominant dryland cropping system in regions of the U.S. Pacific Northwest that receive 14 inches or less annual precipitation. The WW-SF system often offers economic advantages compared to more intensive cropping, including reduced financial and production risks and more evenly balanced seasonal demands for labor and machinery.

About 30% of the precipitation that occurs during the 13-month-long fallow period is stored in the soil. This additional soil water allows farmers to plant WW in late August or early September to optimize grain yield and reduce the risk of crop failure from drought. Tillage during the spring of the fallow year breaks soil capillary continuity from the subsoil to the surface and creates a 4- to 6-inch deep dry soil mulch that conserves moisture in the seed zone. Wheat farmers generally do not practice no-till (i.e., chemical) summer fallow because of increased evaporative loss of seed-zone soil moisture during the dry summer months compared

to tillage. Elimination or reduction of tilled summer fallow by converting to annual cropping, especially using no-till planting methods, has been shown to greatly reduce airborne dust that is a health concern when inhaled into lung tissue. However, to date, long-term efforts by farmers and researchers have not identified alternative cropping systems that can compete economically with WW-SF fallow in the Inland Pacific Northwest (Nail et al., 2005).

Traditional and conservation tillage fallow differ in operations, timing, and production costs. Traditional tillage practices are intensive, requiring eight or more separate tillage passes over the field during the fallow period that often bury surface crop residue, pulverize soil clods, and reduce surface roughness. Blowing dust from excessively tilled fields leads to recurrent soil losses and reduced air quality (Papendick, 1998). Development and adoption of agronomically feasible, profitable, and more environmentally friendly fallow management methods are needed.

The undercutter method of SF farming employs a wide-blade V-sweep for primary spring tillage plus fertilizer injection, followed by as few as two non-inversion rodweeding operations. Tillage is reduced from the traditional eight to as few as three operations using the undercutter method, which increases surface residue and roughness that generate more protective cover against wind erosion compared to traditional tillage.

Questions remain about the profitability and risk of the undercutter method of SF farming in the Inland Pacific Northwest. In response, this bulletin compares the economic performance of traditional tillage with conservation tillage using the undercutter on a farm near Ritzville in Adams County, Washington (Fig. 1).

The case-study area is characterized by cool-wet winters, hot-dry summers, and frequent sustained winds of 25 miles/hour or more, with gusts that can exceed 50 miles/hour. Annual precipitation averages 10.5 inches. Economic production budgets[1] were prepared for both the traditional and undercutter WW-SF systems on the case-study farm, which had used both methods in the past. As stated in the Note at the beginning of this bulletin, conditions and practices that vary by farm may cause costs and profitability to differ from that reported here.

[1]Economic budgets produce higher costs than cash budgets because they include opportunity costs or foregone returns on owned resources. These opportunity costs include a “land rent” on land that is owned, interest on owner’s machinery equity, and a wage for the owner-operator’s labor. This full cost budgeting is necessary to compare costs on a consistent basis for farms that have different mixes of owned versus rented resources. Economic budgeting takes into account the complete set of resources required to produce a crop.

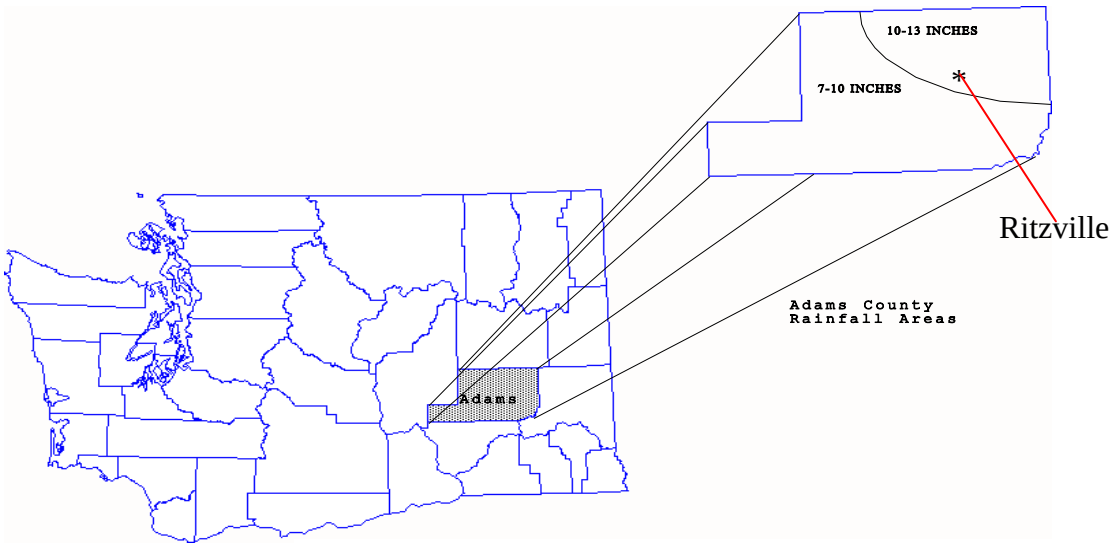

Figure 1. Study site location in Washington State.

BACKGROUND

Tillage-intensive WW-SF became the standard cropping practice in the low-precipitation region of east-central Washington and north-central Oregon soon after land was broken out of native bunchgrass and sagebrush in the 1880s. Walker and Young (1986) computed significant economic costs associated with lost soil productivity from long-term soil erosion. Wind erosion also imposes off-site costs by harming human health, reducing recreational values, impairing traffic safety, and increasing cleaning costs in downwind areas (Papendick, 2004).

Washington State University (WSU) scientists have sought solutions for reducing wind erosion from irrigated and dryland croplands. Schillinger et al. (2001), in a Lind, Washington (9.6 inches annual precipitation) study, showed that undercutter minimum tillage and undercutter delayed minimum tillage performed equally to traditional fallow tillage in terms of grain yield and weed and disease control. Averaged over the six years of the experiment, soil water content in the seed zone as well as total soil water storage was not affected by tillage treatment. This conservation wheat-fallow system also reduces wind erosion. Nail et al. (2006) computed that the undercutter system was more profitable than traditional tillage fallow at a high level of statistical significance. Its relative profitability advantage was strengthened by the recent increase in diesel prices and decline in glyphosate prices.

Despite its identified advantages, conservation-tillage fallow is not widely used in eastern Washington (Janosky et al., 2002). Based on the last reliable estimate, 88% of fallow small grain acreage in Adams County was traditionally tilled (Conservation Technology Information Center,

1998). Farmers and researchers have cited several reasons why adoption of conservation-tillage fallow has lagged, including difficulties in controlling grass weeds, plugging of grain drills due to excessive straw, and concern about the financial risk of converting to conservation farming systems (Janosky et al., 2002; Juergens et al., 2002; Ogg, 1993).

This bulletin is intended to help alleviate some of the economic concerns about conservation tillage fallow and increase understanding of the undercutter system. Adoption of this system could promote the environmental and economic sustainability of farming in the low precipitation WW-SF region of the Pacific Northwest.

SOURCES OF INFORMATION

The information for this publication was obtained through contacts with an Adams County wheat farmer who had recently used both traditional tillage and the undercutter method for preparing SF over a large acreage. This was the only grower in the region the authors were aware of who had accumulated extensive experience with the new undercutter system. The wheat farmer provided detailed information on machinery, field operations, inputs used, overhead costs, and grain yields. The 2005–2006 price information used in this bulletin was obtained from local agricultural supply businesses and a recent study in the same area (Nail et al., 2005, 2006).

BUDGET ASSUMPTIONS

The following cost accounting assumptions were followed:

1. The case study farm for undercutter and traditional tillage exceeds 5,000 acres, with 50% of the farm in WW and 50% in SF each year. SF and WW budgets were developed for both undercutter and traditional tillage practices. Table 1 describes the timing of field operations and inputs for the case-study farm.
2. WW yields of 46 bu/ac were used for both the undercutter and traditional tillage systems based on an eight-year average grain yield (1998–2005) of primarily traditional tillage yields on the case-study farm and statistically equivalent yields from these two systems in a six-year experiment at Lind, Washington (Schillinger, 2001).
3. The utilized soft white wheat price of $3.32/bu in Table 2 is based on a five-year average from 2001 to 2005 at the Union Elevator in Lind, Washington (http://www.unionelevator.com/charts.htm). In contrast, wheat was $4.50/bu in the region by October 2006. Government “direct payments” for wheat averaged $6.75/ac/yr on the case-study farm.

4. Averaged over total farm acres, the undercutter tillage system qualified for conservation incentive payments of $20.40/2 ac/yr because it maintained 30% residue cover on fallow. Machinery types, costs, input types, and rates are from the case-study farm (Tables A1–A9).
5. The off-road price of diesel for December 2005–January 2006 was $1.94/gallon (http://tonto.eia.doe.gov/oog/info/gdu/dieselpump.html), with labor at $15/hour and an 8% interest rate. Other input prices are listed in Table A10.

Since the calculated budgets represent the costs associated with the case-study farm, application to other farms may require adjustments. Furthermore, these budgets contain only production costs and do not consider marketing costs.

DISCUSSION OF BUDGET INFORMATION

Detailed production cost budgets were developed for both undercutter and traditional tillage systems using WSU's Farm Enterprise Budget Simulator. Field operations and timing for the undercutter and traditional tillage systems are presented in Table 1.

Table 1. General field operations and inputs for SF and WW after SF by tillage system, Ritzville, WA

Date	Undercutter	Traditional
Summer Fallow		
Aug	Undercut at 2 inches (every five cycles) for post-harvest control of Russian thistle	Undercut at 2 inches (every five cycles) for post-harvest control of Russian thistle
Nov	Rip (once every three cycles) to a depth of 15 inches on 30-inch-wide shank spacing	Rip (once every three cycles) to a depth of 15 inches on 30-inch-wide shank spacing
Mar	Apply herbicide to stubble: 14 oz glyphosate/acre, 0.65 lb ammonia sulfate/acre, and 0.05 gal surfactant/ac (every year)	Apply herbicide to stubble: 14 oz glyphosate/acre, 0.65 lb ammonia sulfate/acre, and 0.05 gal surfactant/acre (every year)
Mar		First cultivation with field cultivator (every year)
Apr	Apply herbicide to stubble: 10 oz glyphosate/acre (every five cycles)	Second cultivation with field cultivator (every year)
Apr	Undercut at 5-inch depth plus fertilize: 50 lb N and 5 lb S/acre (every year)	
May	First rod weed (every year)	
Jun	Second rod weed (every year)	Fertilize: 50 lb N and 5 lb S/acre (every year)
Jun		First rod weed (every year)
Jul	Third rod weed (every two cycles)	Second rod weed (every two cycles)
Winter Wheat		
Late Aug	Plant 40 lb/ac certified seed and fertilize at 10 lb of P_2O_5/ac	Plant 40 lb/ac certified seed and fertilize at 10 lb of P_2O_5/ac
Mar	Apply in-crop herbicide: 10 oz 2,4-D/acre (every year) and 0.9 oz Olympus/ac (every two cycles)	Apply in-crop herbicide: 10 oz 2,4-D/acre (every year) and 0.9 oz Olympus/ac (every two cycles)
Jul	Harvest and transport grain	Harvest and transport grain

Appendices

Detailed budget information for the SF and WW budgets by tillage system are presented in the Appendices. Tables A2, A4, A6, and A8 outline the schedule of field operations by calendar month, the type of machinery used, the machine and labor hours per acre, and total production costs for SF and WW. The production costs are divided into two categories, with the first applying to fixed costs related to machinery ownership and land and the second, known as variable costs, associated with operating machinery, hiring labor, and purchasing services and materials. Fixed and variable costs sum to total costs.

Machinery fixed costs include depreciation, interest on investment, property taxes, insurance, and housing costs, as detailed in Tables A1, A3, A5, and A7. For a given machinery complement, annual fixed costs for the farm do not vary with the acres of crop produced. The per-hour fixed costs are determined by dividing the total annual fixed costs by the annual hours of machinery used for the farm. Machinery fixed costs for a specific field operation are determined by multiplying the machinery hours per acre times the per-hour fixed costs (Table A9). Tables A3 and A4 include the previous year's SF costs, plus interest, as part of the fixed cost of raising WW. These are costs that must be covered by the sale of wheat if the enterprise is to remain profitable over the long run.

Variable costs vary directly with the crop grown and number of acres produced. Examples are fuel, fertilizer, pesticides, machinery repair, custom hire services, crop insurance, interest on operating capital, and machine operating labor, including that provided by the owner-operator. Management costs are not included in the budgets.

Land fixed costs include property taxes and net land rent. Net rent is based on rental agreements typical for the area minus landlord expenditures. A typical lease agreement for wheat is a one-third landlord crop share, with the landlord paying land taxes, one-third of the fertilizer cost, one-third of the crop insurance, and one-third of the herbicide cost for in-crop control of downy brome. The tenant covers all other production expenses. As an example, the net land rent per two acres under SF-WW with undercutter tillage is calculated as follows:

$50.91	(one-third gross receipts from production)
- $10.66	(two years' land tax; summer fallow and winter wheat)
- $0.67	(one-third herbicide costs for in-crop control of downy brome)
- $8.14	(one-third fertilizer)
- $2.00	(one-third crop insurance costs)
$29.44	Net rent per two acres

While the owner-operator does not actually experience a land rental cost, the net rent cost represents the minimum return the owner-operator needs to justify growing the crop on his/her land. This return represents the income the owner-operator foregoes by producing the crop rather than renting to a tenant who produces the crop. Land cost is an opportunity cost for an owner-operator rather then an out-of-pocket expense. Appreciation in land value is not considered as part of the returns to the owner-operator in this wheat enterprise budget.

Tables A1 and A3 itemize the undercutter method costs for SF and WW, respectively. Most of the items are self-explanatory or have been previously explained. Fixed machine interest costs were calculated on the average annual investment in the machine:

$$\text{Interest Cost} = (8\%)\ \frac{(\text{Purchase Cost} + \text{Salvage Value})}{2}$$

Interest cost represents either an opportunity cost (return foregone by investing in the machinery rather than an alternative investment) or interest paid on money borrowed to finance the machine purchase. Machinery interest costs for one acre of SF or WW are determined by multiplying the respective machinery hours per acre times the per-hour interest costs (Table A9).

Machinery Complement and Hourly Machinery Costs

Table A9 identifies the equipment and building complements from the case-study farm used to derive machinery and buildings costs. Typically, machinery on Adams County farms is purchased both new and used depending on what is available and desired. This table includes the type of machinery used on the case-study farm, their current average replacement value, years of use before trade-in, salvage value at trade-in, and annual repair costs. Table A9 data are used to estimate the per-hour fixed and variable machinery costs.

PROFITABILITY AND SENSITIVITY RESULTS

Table 2 compares the costs and returns associated with traditional and undercutter tillage fallow systems. Production costs are based on the detailed budgets in Tables A1–A8. Total costs represent both cash and opportunity costs for land and machinery, owner's labor, and other inputs. Three measures of net return without conservation payments are reported in Table 2: net return over total costs, net return to operator labor (with labor opportunity costs excluded), and net return to operator labor and equity in machinery (with the opportunity cost of interest on machinery equity also excluded). Because management costs are not charged, net returns to total

costs could be interpreted as returns to management and risk bearing. Only the undercutter method qualifies for conservation payments. For both systems, government commodity direct payments for wheat growers are added to market returns to compute gross returns. No countercyclical or loan deficiency payments under the 2002 Farm Bill had been received by soft white wheat growers at the study site.

Table 2. Comparing gross and net returns with total costs for traditional versus undercutter tillage on a Ritzville, WA wheat farm using WW-SF with and without conservation payments

	Unit[a]	Undercutter Method	Traditional Method[b]
Gross Returns:			
Wheat yield	bu/ac	46	46
Wheat price	$/bu	3.32	3.32
Market return (yield x price)	$/2 ac	152.72	152.72
Direct government payments	$/2 ac	13.50	13.50
Gross return	$/2 ac	166.22	166.22
Total Costs	$/2 ac	155.30	158.61
Net Return (without conservation payments):			
Net return over total costs (TC)	$/2 ac	10.92	7.61
Net return to operator labor	$/2 ac	18.68	15.62
Net return to operator labor & machinery equity	$/2 ac	29.52	27.77
Conservation Payments			
EQIP	$/2 ac	20.40	NA[b]
Net Return over TC (with conservation payments)	$/2 ac	31.32	NA[b]

[a]Values/2 ac include both the SF and WW years. If desired, values per rotational acre (0.5 acre of WW and 0.5 acre of SF) could be obtained by dividing by two.

[b]The traditional tillage method does not qualify for conservation payments.

Before conservation payments, Table 2 shows the undercutter tillage method has a net return over total costs of $10.92/2 ac versus $7.61 for the traditional method based on the long-term $3.32/bu wheat price. The undercutter has a modest advantage of $3.31/2 ac over traditional tillage. The profit advantage comes from total cost savings of $3.31/2 ac for the undercutter. Recall that both systems have the same yield, wheat price, and commodity payment. On the case-study farm, both systems were able to generate sufficient market returns at the low $3.32/bu wheat price to cover total costs without conservation payments. But autumn 2006 wheat prices rose to $4.50/bu, which generated substantially higher net returns as shown in Tables 4 and 5.

Some farmers may consider net returns to operator labor and machinery equity ($29.52/2 ac and $27.77/2 ac for the undercutter and traditional systems, respectively; Table 2) a more appropriate measure of profit if they consider the return to their own unpaid labor and machinery equity is part of their "take home" earnings. Ultimately, however, returns to machinery equity are needed to finance replacement machinery, and returns to labor for family living expenses. The undercutter system's net returns over total costs is markedly strengthened by conservation payments that raise the profitability comparison for undercutter versus traditional to $31.32 versus $7.61/2 ac (Table 2), which raises the undercutter's advantage to $23.71/2 ac. These case-study results with and without conservation payments show that the undercutter tillage system can be economically competitive relative to traditional fallow tillage.

Table 3 presents required breakeven prices and yields for both systems' gross wheat returns (and direct payments) to cover total costs. With an equal wheat yield of 46 bu/ac, direct payments of $13.50/2 ac, no conservation payments, and total costs as listed in Table 2, breakeven wheat prices are $3.08/bu for undercutter tillage and $3.15/bu for traditional tillage to cover total costs. With a wheat price of $3.32/bu, $13.50 direct payments, total costs from Table 2, and no conservations payments, breakeven yields are 42.7 bu/ac for the undercutter and 43.7 bu/ac for traditional tillage to cover total costs (Table 3). These results show that the case-study farm can produce soft white wheat at the very competitive cost of only $3.08/bu using the undercutter method. Other farms may experience different production costs.

Table 3. Prices and yields required for gross returns to cover total costs (breakeven values) for undercutter versus traditional WW-SF production with and without conservation payments on a Ritzville, WA wheat farm

	Unit[a]	Undercutter Method	Traditional Method[b]
Without Conservation Payments			
Price	$/bu	3.08	3.15
Yield	bu/ac	42.7	43.7
With Conservation Payments			
Price	$/bu	2.64	NA[b]
Yield	bu/ac	36.6	NA[b]

[a]Values/2 ac include both the SF and WW years.

[b]The traditional method does not qualify for conservation payments.

The breakeven analysis shows that conservation payments provide a substantial benefit to the undercutter system. A breakeven wheat price of only $2.64/bu is required to cover total costs

for this system, while breakeven yield drops to 36.6 bu/ac with the payment (Table 3). These are $0.51/bu and 7.1 bu/ac lower, respectively, than for traditional tillage that does not qualify for the conservation payment. As expected, conservation payments substantially reduce the financial and production risks of using the undercutter system.

Variability in net returns is caused by changes in production costs, wheat yields, government payments, and wheat prices. Wheat and diesel prices, for example, have both fluctuated widely in response to market forces over the last decade. Tables 4 and 5 display the effects of wheat and diesel price variations on net returns (with eligible payments) for undercutter and traditional tillage systems, respectively.

Table 4. Net returns over total costs ($/2 ac) for undercutter WW-SF tillage (assuming conservation and direct payments) at varying wheat prices and off-road diesel prices

Wheat Price ($/bu)	Change in Diesel Price					
	%	-50%	-25%	0%	+25%	+50%
	$/gal	0.97	1.46	1.94	2.43	2.92
2.00		-3.23	-6.18	-9.16	-12.11	-15.09
2.50		12.10	9.15	6.17	3.22	0.24
3.00		27.43	24.48	21.50	18.55	15.57
3.50		42.77	39.82	36.84	33.89	30.91
4.00		58.10	55.15	52.17	49.22	46.24
4.50		73.43	70.48	67.50	64.55	61.57
5.00		88.77	85.82	82.84	79.89	76.91

As shown by the shaded area of Table 4, undercutter tillage with conservation payments earns profits except when wheat sells for less than $2.50/bu.

Table 5. Net returns over total costs ($/2 ac) with direct payments for a traditional tillage system at varying wheat prices and off-road diesel prices

Wheat Price ($/bu)	Change in Diesel Price					
	%	-50%	-25%	0%	+25%	+50%
	$/gal	0.97	1.46	1.94	2.43	2.92
2.00		-26.45	-29.66	-32.87	-36.07	-39.28
2.50		-11.12	-14.33	-17.54	-20.74	-23.95
3.00		4.22	1.01	-2.20	-5.40	-8.61
3.50		19.55	16.34	13.13	9.93	6.72
4.00		34.88	31.67	28.46	25.26	22.05
4.50		50.22	47.01	43.80	40.60	37.39
5.00		65.55	62.34	59.13	55.93	52.72

Table 5 presents a similar price sensitivity analysis for a traditional tillage WW-SF system, which is not eligible for conservation payments. The traditional system fails to cover total costs whenever wheat prices are $2.50/bu or lower for all diesel prices considered. This also occurs when wheat prices are $3.00/bu or lower and diesel prices are $1.94 to $2.92/gal. Again, all these sensitivity results are based on the production costs for the case-study farm presented in Table 2.

SUMMARY AND CONCLUSIONS

To combat the dust storms and soil erosion on tilled SF in the Inland Pacific Northwest and to address financial concerns of farmers about operational changes, this study compared the profitability of the undercutter method of SF farming (conservation tillage) with traditional intensive tillage SF. Based on a large farm in Adams County, Washington that had used both systems, the undercutter system outearned the traditional tillage system by $3.31/2 ac (SF and WW years) even with identical yields and wheat prices. The profit advantage was due to modest production cost savings. Adding conservation payments made net returns over total costs $23.71/2 ac higher for the undercutter versus the traditional system.

This study indicates that adopting a soil-conserving undercutter tillage fallow system can increase profit. Diminished wind erosion with this system additionally protects public health and the environment in downwind areas. If conservation payments are available, profitability is further increased relative to traditional fallow. It should be noted that the annual conservation payment of $20.40/2 ac assumed in this study is still less then one-fourth the typical annual Conservation Reserve Program rent of $40–$50/ac in Adams County. Current USDA funding is insufficient for conservation payments of this magnitude for all farmers in the study area. However, in summer 2006 the Washington Association of Wheat Growers (WAWG) secured a $905,000 federal grant to provide a 50% cost-share to purchase V-sweep undercutters for 50 wheat growers in precipitation zones with less than 12 inches. The program will extend to summer 2009 and include 14 counties in Washington and Oregon. The results of the case study in this bulletin indicate that the WAWG program should have a reasonable chance of economic success for participating growers.

Future research should measure the precise reduction in dust emissions with undercutter and other conservation fallow systems to compare their cost effectiveness (e.g., taxpayer cost per unit of dust abated). Such information could facilitate acquisition of additional funding to

encourage adoption of conservation tillage practices by farmers in the WW-SF region of the Inland Pacific Northwest.

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Appendix

Budget Tables

TABLE A1. ITEMIZED COST PER ACRE FOR SUMMER FALLOW, UNDERCUTTER METHOD, RITZVILLE, WA, 2005

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
GLYPHOSATE	OZ	.13	14.00	1.76	_____
SURFACTANT	GAL	13.00	.05	.65	_____
AMM.SULFATE	LB	1.10	.65	.72	_____
GLYPHOSATE	OZ	.13	2.00	.25	_____
AQUA-NITROGEN	LB	.34	50.00	17.00	_____
SULFER	LB	.36	5.00	1.80	_____
MACHINERY FUEL/LUBE†	ACRE	5.03	1.00	5.03	_____
MACHINERY REPAIRS*†	ACRE	2.39	1.00	2.39	_____
LABOR(TRAC/MACH)	HOUR	15.00	.21	3.22	_____
OVERHEAD	ACRE	5.00	1.00	5.00	_____
INTEREST ON OP. CAP.	ACRE	1.25	1.00	1.25	_____
TOTAL VARIABLE COST				39.08	_____
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	1.75	1.00	1.75	_____
MACHINE INTEREST*	ACRE	5.05	1.00	5.05	_____
MACHINE INSURANCE*	ACRE	.38	1.00	.38	_____
MACHINE TAXES*	ACRE	1.14	1.00	1.14	_____
MACHINE HOUSING*	ACRE	.63	1.00	.63	_____
LAND TAX	ACRE	5.33	1.00	5.33	_____
TOTAL FIXED COST				14.28	_____
TOTAL COST				53.36	_____

†INCLUDING TRACTORS
*INCLUDING BUILDINGS, TOOLS, AND TANKS

TABLE A2. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR SUMMER FALLOW, UNDERCUTTER METHOD, RITZVILLE, WA, 2005

OPERATION	TOOLING	MTH YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL, LUBE, & REPAIRS	VARIABLE COST: MACH LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATER.	VARIABLE COST: INTER.	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$	$
UNDERCUT AT 2"	85E CHLNGR, 32' UNDERCUTTER	AUG 2003	.01	.01	.20	.40	.17	.00	.00	.01	.58	.78
RIP	85E CHLNGR, 22' RIPPER	NOV 2003	.03	.03	.81	1.08	.48	.00	.00	.09	1.65	2.46
SPRAY ONE	45 CHLNGR, 90' SPRAYER	MAR 2004	.01	.01	.38	.28	.20	.00	3.13(1)	.14	3.75	4.13
SPRAY TWO	45 CHLNGR, 90' SPRAYER	APR 2004	.00	.00	.08	.06	.04	.00	.25(2)	.01	.36	.43
UNDERCUT &FERTIL	85E CHLNGR, 32' UNDERCUTTER	APR 2004	.07	.08	1.60	2.72	1.25	.00	18.80(3)	.74	23.51	25.11
ROD WEED ONE	45 CHLNGR, 70' RODWEEDER	MAY 2004	.03	.03	.58	.65	.43	.00	.00	.03	1.11	1.69
ROOD WEED TWO	45 CHLNGR, 70' RODWEEDER	JUN 2004	.03	.03	.58	.65	.43	.00	.00	.02	1.10	1.69
ROD WEED THREE	45 CHLNGR, 70' RODWEEDER	JUL 2004	.01	.01	.29	.32	.22	.00	.00	.01	.55	.84
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN 2004	.00	.00	3.53	1.03	.00	.00	.00	.03	1.06	4.59
MISC. USE	SHOP TOOLS	ANN 2004	.00	.00	.58	.16	.00	.00	.00	.01	.16	.74
MISC. USE	FUEL & MISCELLANEOUS TANKS	ANN 2004	.00	.00	.32	.09	.00	.00	.00	.00	.09	.41
LAND TAX	LAND TAX	ANN 2004	.00	.00	5.33	.00	.00	.00	.00	.00	.00	5.33
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN 2004	.00	.00	.00	.00	.00	5.00	.00	.16	5.16	5.16
TOTAL PER ACRE			.18	.21	14.28	7.42	3.22	5.00	22.18	1.25	39.08	53.36

MATERIALS:

1. 14 OZ GLYPHOSATE ($1.76/AC), 0.05 GAL SURFACTANT ($0.65/AC), 8 OZ AMM SULFATE ($0.72/AC)
2. 2 OZ GLYPHOSATE ($0.25/AC)
3. 50 LBS AGUA-NITROGEN ($17/AC), 5 LBS SULFUR ($1.80/AC)

TABLE A3. ITEMIZED COST PER ACRE FOR SOFT WHITE WINTER WHEAT AFTER SUMMER FALLOW, UNDERCUTTER METHOD, RITZVILLE, WA, 2005

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
S.W. WHEAT SEED	LB	.13	40.00	5.32	_____
PHOSPHORUS	LB	.49	10.00	4.90	_____
2,4-D	OZ	.14	10.00	1.38	_____
OLYMPUS	OZ	10.50	.45	4.73	_____
SURFACTANT	GAL	13.00	.05	.65	_____
RENT HRVST COMB	ACRE	11.98	1.00	11.98	_____
INSURANCE WWSF	ACRE	6.00	1.00	6.00	_____
MACHINERY FUEL/LUBE†	ACRE	6.16	1.00	6.16	_____
MACHINERY REPAIRS*†	ACRE	1.83	1.00	1.83	_____
LABOR(TRAC/MACH)	HOUR	15.00	.29	4.33	_____
OVERHEAD	ACRE	5.00	1.00	5.00	_____
INTEREST ON OP. CAP.	ACRE	1.05	1.00	1.05	_____

TOTAL VARIABLE COST				53.33	_____
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	1.80	1.00	1.80	_____
MACHINE INTEREST*	ACRE	5.45	1.00	5.45	_____
MACHINE INSURANCE*	ACRE	.41	1.00	.41	_____
MACHINE TAXES*	ACRE	1.23	1.00	1.23	_____
MACHINE HOUSING*	ACRE	.68	1.00	.68	_____
SF+INTEREST	ACRE	57.63	1.00	57.63	_____
LAND TAX	ACRE	5.33	1.00	5.33	_____
LAND RENT**	ACRE	29.43	1.00	29.43	_____

TOTAL FIXED COST				101.97	_____
TOTAL COST				155.30	_____

†INCLUDING TRACTORS
*INCLUDING BUILDINGS, TOOLS, AND TANKS
**1/3 CROP – 1/3 FERTILIZER COSTS – 1/3 CROP INSURANCE – 2 YR LAND TAXES
WHEAT YIELD IS 46 BU/AC
FIVE-YEAR AVERAGE FARM GATE PRICE OF WHEAT IS $3.32/BU

TABLE A4. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE SOFT WHITE WINTER WHEAT AFTER SUMMER FALLOW, UNDERCUTTER METHOD, RITZVILLE, WA, 2005

						VARIABLE COST							
OPERATION	TOOLING	MTH YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$	$
SEED & FERTILIZE	85E CHLNGR, 48' IH DRILL 7100	SEP 2004	.07	.09	1.81	2.63	1.34	.00	10.22(1)	.08	14.27	16.08
SPRAY ONE	45 CHLNGR, 90' SPRAYER	MAR 2005	.01	.01	.38	.28	.20	.00	6.76(2)	.27	7.51	7.90
HARVST RENT COMB	JD 9760STS COMBINE (RENTED)	JUL 2005	.00	.07	.00	1.49	.99	11.98	.00	.24	14.70	14.70
HAUL WHEAT	85E CHLNGR, GRAINCART	JUL 2005	.05	.06	1.02	1.71	.90	.00	.00	.04	2.65	3.67
HAUL WHEAT	HARVEST TRUCK	JUL 2005	.05	.06	1.93	.61	.90	.00	.00	.02	1.53	3.46
SUMMER FALLOW	SUMMER FALLOW COST + INTEREST	ANN 2005	.00	.00	57.63	.00	.00	.00	.00	.00	.00	57.63
CROP INSURANCE	CROP INSURANCE	ANN 2005	.00	.00	.00	.00	.00	6.00	.00	.20	6.20	6.20
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN 2005	1.00	.00	3.53	1.03	.00	.00	.00	.03	1.06	4.59
MISC. USE	SHOP TOOLS	ANN 2005	1.00	.00	.58	.16	.00	.00	.00	.01	.16	.74
MISC. USE	FUEL & MISCELLANEOUS TANKS	ANN 2005	1.00	.00	.32	.09	.00	.00	.00	.00	.09	.41
LAND TAX	LAND TAX	ANN 2005	.00	.00	5.33	.00	.00	.00	.00	.00	.00	5.33
LAND RENT	LAND RENT (OPPORTUNITY COST)	ANN 2005	.00	.00	29.43	.00	.00	.00	.00	.00	.00	29.43
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN 2005	.00	.00	.00	.00	.00	5.00	.00	.16	5.16	5.16
TOTAL PER ACRE			3.18	.29	101.97	7.98	4.33	22.98	16.98	1.05	53.33	155.30

MATERIALS:

1. 40 LBS SWWW SEED ($5.32/AC), 10 LBS PHOSPHORUS ($4.90/AC)
2. 10 OZ LV-6 (2,4-D ESTER) ($1.38/AC), 0.45 OZ OLYMPUS ($4.73/AC), 0.05 GAL SURFACTANT ($0.65/AC)

TABLE A5. ITEMIZED COST PER ACRE FOR SUMMER FALLOW, TRADITIONAL METHOD, RITZVILLE, WA, 2005

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
GLYPHOSATE	OZ	.13	14.00	1.76	_____
SURFACTANT	GAL	13.00	.05	.65	_____
AMM.SULFATE	LB	1.10	.65	.72	_____
AQUA-NITROGEN	LB	.34	50.00	17.00	_____
SULFUR	LB	.36	5.00	1.80	_____
MACHINERY FUEL/LUBE†	ACRE	5.92	1.00	5.92	_____
MACHINERY REPAIRS*†	ACRE	2.41	1.00	2.41	_____
LABOR(TRAC/MACH)	HOUR	15.00	.23	3.45	_____
OVERHEAD	ACRE	5.00	1.00	5.00	_____
INTEREST ON OP. CAP.	ACRE	1.07	1.00	1.07	_____
TOTAL VARIABLE COST				39.78	_____
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	2.30	1.00	2.30	_____
MACHINE INTEREST*	ACRE	6.28	1.00	6.28	_____
MACHINE INSURANCE*	ACRE	.47	1.00	.47	_____
MACHINE TAXES*	ACRE	1.41	1.00	1.41	_____
MACHINE HOUSING*	ACRE	.79	1.00	.79	_____
LAND TAX	ACRE	5.33	1.00	5.33	_____
TOTAL FIXED COST				16.57	_____
TOTAL COST				56.35	_____

†INCLUDING TRACTORS
*INCLUDES BUILDINGS, TOOLS, AND TANKS

TABLE A6. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR SUMMER FALLOW, TRADITIONAL METHOD, RITZVILLE, WA, 2005

						VARIABLE COST						
OPERATION	TOOLING	MTH YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$	$
UNDERCUT AT 2"	85E CHLNGR, 32' UNDERCUTTER	AUG 2003	.01	.01	.20	.40	.17	.00	.00	.01	.58	.78
RIP	85E CHLNGR, 22' RIPPER	NOV 2003	.03	.03	.81	1.08	.48	.00	.00	.09	1.65	2.46
SPRAY ONE	45 CHLNGR, 90' SPRAYER	MAR 2004	.01	.01	.38	.28	.20	.00	3.13(1)	.14	3.75	4.13
CULTIVATE ONE	85E CHLNGR, 52' JD CULTIVATOR	MAR 2004	.04	.04	1.75	1.53	.66	.00	.00	.08	2.27	4.03
CULTIVATE TWO	85E CHLNGR, 52' JD CULTIVATOR	APR 2004	.04	.04	1.75	1.53	.66	.00	.00	.07	2.26	4.01
FERTILIZE	85E CHLNGR, 60' CULTER WEEDER	JUN 2004	.03	.04	1.04	1.26	.63	.00	18.80(2)	.45	21.14	22.18
ROD WEED ONE	45 CHLNGR, 70' RODWEEDER	JUN 2004	.03	.03	.58	.65	.43	.00	.00	.02	1.10	1.69
ROD WEED TWO	45 CHLNGR, 70' RODWEEDER	JUL 2004	.01	.01	.29	.32	.22	.00	.00	.01	.55	.84
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN 2004	1.00	.00	3.53	1.03	.00	.00	.00	.03	1.06	4.59
MISC. USE	SHOP TOOLS	ANN 2004	1.00	.00	.58	.16	.00	.00	.00	.01	.16	.74
MISC. USE	FUEL & MISCELANEOUS TANKS	ANN 2004	1.00	.00	.32	.09	.00	.00	.00	.00	.09	.41
LAND TAX	LAND TAX	ANN 2004	.00	.00	5.33	.00	.00	.00	.00	.00	.00	5.33
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN 2004	.00	.00	.00	.00	.00	5.00	.00	.16	5.16	5.16
TOTAL PER ACRE			3.20	.23	16.57	8.33	3.45	5.00	21.93	1.07	39.78	56.35

MATERIALS:

1. 14 OZ GLYPHOSATE ($1.76/AC), 0.05 GAL SURFACTANT ($0.65/AC), 8 OZ AMM SULFATE ($0.72/AC)
2. 50 LBS AQUA-NITROGEN ($17/AC), 5 LBS SULFUR ($1.80/AC)

TABLE A7. ITEMIZED COST PER ACRE FOR SOFT WHITE WINTER WHEAT AFTER SUMMER FALLOW, TRADITIONAL METHOD, RITZVILLE, WA, 2005

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
S.W. WHEAT SEED	LB	.13	40.00	5.32	_____
PHOSPHORUS	LB	.49	10.00	4.90	_____
LV-6	OZ	.14	10.00	1.38	_____
OLYMPUS	OZ	10.50	.45	4.73	_____
SURFACTANT	GAL	13.00	.05	.65	_____
RENT HRVST COMB	ACRE	11.98	1.00	11.98	_____
INSURANCE WWSF	ACRE	6.00	1.00	6.00	_____
MACHINERY FUEL/LUBE†	ACRE	8.00	1.00	8.00	_____
MACHINERY REPAIRS*†	ACRE	1.83	1.00	1.83	_____
LABOR(TRAC/MACH)	HOUR	15.00	.29	4.33	_____
OVERHEAD	ACRE	5.00	1.00	5.00	_____
INTEREST ON OP. CAP.	ACRE	1.05	1.00	1.05	_____

TOTAL VARIABLE COST				53.32	_____
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	1.80	1.00	1.80	_____
MACHINE INTEREST*	ACRE	5.45	1.00	5.45	_____
MACHINE INSURANCE*	ACRE	.41	1.00	.41	_____
MACHINE TAXES*	ACRE	1.23	1.00	1.23	_____
MACHINE HOUSING*	ACRE	.68	1.00	.68	_____
SF+INTEREST	ACRE	60.86	1.00	60.86	_____
LAND TAX	ACRE	5.33	1.00	5.33	_____
LAND RENT**	ACRE	29.52	1.00	29.52	_____

TOTAL FIXED COST				105.29	_____
TOTAL COST				158.61	_____

†INCLUDING TRACTORS
*INCLUDING BUILDINGS, TOOLS, AND TANKS
** 1/3 CROP – 1/3 FERTILIZER COSTS – 1/3 CROP INSURANCE – 2 YR LAND TAXES
WHEAT YIELD IS ASSUMED TO BE 46.0 BUSHELS
FIVE-YEAR AVERAGE FARM GATE PRICE OF WHEAT IS $3.32/BUSHEL

TABLE A8. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE OF SOFT WHITE WINTER WHEAT AFTER SUMMER FALLOW, TRADITIONAL METHOD, RITZVILLE, WA, 2005

							VARIABLE COST							
OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.	TOTAL VARIABLE COST	TOTAL COST
						$	$	$	$	$	$	$	$
SEED & FERTILIZE	85E CHLNGR, 48' IH DRILL 7100	SEP	2004	.07	.09	1.81	2.63	1.34	.00	10.22(1)	.08	14.26	16.07
SRAY ONE	45 CHLNGR, 90' SPRAYER	MAR	2005	.01	.01	.38	.28	.20	.00	6.76(2)	.27	7.51	7.90
HARVST RENT COMB	JD 9760STS, COMBINE (RENTED)	JUL	2005	.00	.07	.00	1.49	.99	11.98	.00	.24	14.70	14.70
HAUL WHEAT	85E CHLNGR, GRAINCART	JUL	2005	.05	.06	1.02	1.71	.90	.00	.00	.04	2.65	3.67
HAUL WHEAT	HARVEST TRUCK	JUL	2005	.05	.06	1.93	.61	.90	.00	.00	.02	1.53	3.46
SUMMER FALLOW	SUMMER FALLOW COST + INTEREST	ANN	2005	.00	.00	60.86	.00	.00	.00	.00	.00	.00	60.86
CROP INSURANCE	CROP INSURANCE	ANN	2005	.00	.00	.00	.00	.00	6.00	.00	.20	6.20	6.20
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN	2005	1.00	.00	3.53	1.03	.00	.00	.00	.03	1.06	4.59
MISC. USE	SHOP TOOLS	ANN	2005	1.00	.00	.58	.16	.00	.00	.00	.01	.16	.74
MISC. USE	FUEL & MISCELLANEOUS TANKS	ANN	2005	1.00	.00	.32	.09	.00	.00	.00	.00	.09	.41
LAND TAX	LAND TAX	ANN	2005	.00	.00	5.33	.00	.00	.00	.00	.00	.00	5.33
LAND RENT	LAND RENT (OOPORTUNITY COST)	ANN	2005	.00	.00	29.52	.00	.00	.00	.00	.00	.00	29.52
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN	2005	.00	.00	.00	.00	.00	5.00	.00	.16	5.16	5.16
TOTAL PER ACRE				3.18	.29	105.29	8.00	4.33	22.98	16.98	1.05	53.32	158.61

MATERIALS:

1. 40 LBS SWWW SEED ($5.32/AC), 10 LBS PHOSPHORUS ($4.90/AC)
2. 10 OZ LV-6 (2,4-D ESTER) ($1.38/AC), 0.45 OZ OLYMPUS ($4.73/AC), 0.05 GAL SURFACTANT ($0.65/AC)

TABLE A9. PER HOUR AND PER ACRE MACHINERY COSTS, UNDERCUTTER AND TRADITIONAL TILLAGE, RITZVILLE, WA, 2005

MACHINERY	PURCHASE PRICE	YEARS TO TRADE	ANNUAL HOURS	DEPREC-IATION	INTER-EST	INSUR-ANCE	TAXES	HOUSING	TOTAL FIXED COST	REPAIR	FUEL AND LUBE	TOTAL VARIABLE COST	TOTAL COST
	$			COST PER HOUR									
85E CHALL. 375HP	140,000.00	10	1200	4.58	7.50	.56	1.69	.94	15.27	1.40	32.06	33.46	48.73
45 CHALLEN 200HP	75,000.00	10	700	4.29	6.86	.51	1.54	.86	14.06	.75	21.37	22.12	36.18
30'JD2200 CULTIV	32,000.00	15	132	6.06	15.76	1.18	3.55	1.97	28.52	4.81	.00	4.81	33.33
IH 7100,48'DRILL	22,000.00	30	225	1.48	6.04	.45	1.36	.76	10.09	3.31	.00	3.31	13.40
HARVEST TRUCK	25,000.00	20	72	6.94	22.22	1.67	5.00	2.78	38.61	1.50	10.69	12.19	50.80
GRAIN CART	13,000.00	12	300	.83	3.07	.23	.69	.38	5.20	.65	.00	.65	5.85
CALKINS TANKCART	5,500.00	20	158	.63	2.28	.17	.51	.28	3.88	.82	.00	.82	4.70
60'CULTER WEEDER	18,000.00	25	119	2.69	9.41	.71	2.12	1.18	16.10	4.49	.00	4.49	20.59
CALKINS RODWEEDR	15,600.00	25	216	.67	5.11	.38	1.15	.64	7.95	2.34	.00	2.34	10.29
22' RIPPER	24,000.00	15	201	2.99	7.76	.58	1.75	.97	14.04	5.99	.00	5.99	20.03
90' SPRAYER 2005	23,000.00	10	144	5.56	10.56	.79	2.38	1.32	20.60	3.44	.00	3.44	24.04
32' UNDERCUTTER	13,000.00	20	298	.67	2.95	.22	.66	.37	4.88	6.50	.00	6.50	11.38
			ACRES COVERED	COST PER ACRE									
FARM BUILDING	300,000.00	50	>5000	.46	2.15	.16	.48	.27	3.53	1.03	.00	1.03	4.56
SHOP TOOLS	45,000.00	30	>5000	.12	.32	.02	.07	.04	.58	.16	.00	.16	.73
FUEL & MISC TANKS	25,000.00	30	>5000	.06	.18	.01	.04	.02	.32	.09	.00	.09	.41

Table A10. INPUT AND COMMODITY PRICE LIST, 2005 and 2006

MATERIAL	UNIT	PRICE ($/UNIT)
SEED[1]		
SOFT WHITE WINTER WHEAT, CERTIFIED	LB	0.133
CHEMICALS[2]		
AMMONIA SULFATE	LB	1.10
AQUA – NITROGEN	LB	0.34
PHOSPHORUS (P_2O_5)	LB	0.49
SULFUR (S)	LB	0.36
GLYPHOSATE	OZ	0.126
2,4-D, LV-6	OZ	0.138
OLYMPUS	OZ	10.50
SURFACTANTS	GAL	13.00
OTHER COSTS[3]		
DIESEL[4]	GAL	1.94
INTEREST RATE	%	8.00
MACHINERY LABOR	HR	15.00
CROP INSURANCE	ACRE	6.00
LAND TAX	ACRE	5.33
COMBINE RENTAL	ACRE	11.98
COMMODITY PRICES (5-YEAR AVERAGE)		
SOFT WHITE WINTER WHEAT[5]	BUSHEL	3.32
CONSERVATION PAYMENT	$/2 AC/YR	20.40

[1]SEED PRICE PROVIDED BY THE CASE-STUDY FARMER

[2]CHEMICAL INPUT PRICES SUPPLIED BY THE CASE-STUDY FARMER

[3]COST OF CROP INSURANCE AND LAND TAX PROVIDED BY THE CASE-STUDY FARMER

[4]EXCLUDING ROAD TAXES

[5]FIVE-YEAR (2001-2005) AVERAGE FARM GATE PRICE OF WHEAT FROM LIND, WA UNION ELEVATOR

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