Economics of an Irrigated No-till Crop Rotation with Alternative Stubble Management Systems Versus Continuous Irrigated Winter Wheat with Burning and Plowing of Stubble, Lind, WA, 2001-2006

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Economics of an Irrigated No-till Crop Rotation with Alternative Stubble Management Systems Versus Continuous Irrigated Winter Wheat with Burning and Plowing of Stubble, Lind, WA, 2001-2006

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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 full costs and returns of an irrigated cropping systems experiment at Lind, Adams County, Washington. To avoid drawing unwarranted conclusions from this study, closely examine the assumptions and data used and make appropriate adjustments to your situation.

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Economics of an Irrigated No-till Crop Rotation with Alternative Stubble Management Systems Versus Continuous Irrigated Winter Wheat with Burning and Plowing of Stubble, Lind, WA, 2001-2006

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SUMMARY: This bulletin compares production costs and profitability under irrigation of a 3-year winter wheat-spring barley-canola rotation using no-till with various stubble management practices versus continuous annual winter wheat with burning and plowing of stubble. The experiment was conducted during 2001-2006 at the WSU Dryland Research Station at Lind, WA. The no-till rotation was sown (i) directly into standing stubble, (ii) after mechanical removal of stubble, or (iii) after burning the stubble. The traditional practice of continuous annual winter wheat sown after burning and moldboard plowing was included as the check treatment. Six-year average net returns over total costs were similar over stubble management treatments for the alternative 3-year no-till rotation. Based on long run average prices, annual average net returns were negative ranging from -$155 to -$160 per rotational acre. The continuous winter wheat system averaged slightly higher, but still negative, at -$145/ac. Net returns of the three residue management practices in the 3-year rotation and the continuous winter wheat system were statistically equivalent. Net returns for all systems would be near or above breakeven levels at farmer cooperator yields and the high 2007 crop prices. Winter canola was frequently killed by a combination of cold and rhizoctonia root rot that necessitated replanting to spring canola in 5 of 6 years. Canola was the major economic loser in the 3-year rotation. The average annual loss for canola was -$247 per acre. Average irrigated winter wheat and canola yields from the experiment were lower than those reported by farmer advisors because of the extreme difficulty of growing no-till irrigated winter canola and the fact that winter wheat, canola, and spring barley all require different timing of irrigation (not possible in this experiment). Further research on alternative no-till irrigated cropping systems should probably exclude winter canola, and should be conducted where crop-specific irrigation scheduling is possible.

Introduction

Many deep-well irrigators in east-central Washington grow continuous annual winter wheat. After grain harvest in August, the traditional practice is to burn the stubble and invert the surface soil with a moldboard plow prior to sowing in September. Generally, growers believe they need to burn their fields because high residue levels hamper sowing and because of a need to control the grass weed downy brome (Bromus tectorum L.). A group of deep-well irrigators in the Odessa, WA area approached the authors in 1998 concerning the future of their farming operations. The farmers were concerned about potential regulations to reduce or eliminate cereal stubble burning and desired research on how to farm profitably without field burning. Alternatives to field burning are needed to reduce smoke emissions and maintain air quality. Reduction or elimination of tillage could also reduce soil erosion. The experiment reported in this bulletin was designed jointly by farmer advisors and WSU and USDA-ARS scientists.

The objective of the 6-year experiment was to assess the agronomic and economic viability of a no-till diversified crop rotation with various stubble management practices compared to the burn and plow

systems for producing continuous winter wheat.

The experiment was conducted from 2001-2006 at the Washington State University Dryland Research Station at Lind (Fig. 1). The continuous winter wheat system was patterned after farmer practices with irrigation from deep wells near Odessa, WA. The continuous annual winter wheat treatment involved stubble burning, moldboard plowing and sowing with a double-disc drill. All crops in the diversified no-till rotation were sown with a Cross-slot no-till drill.

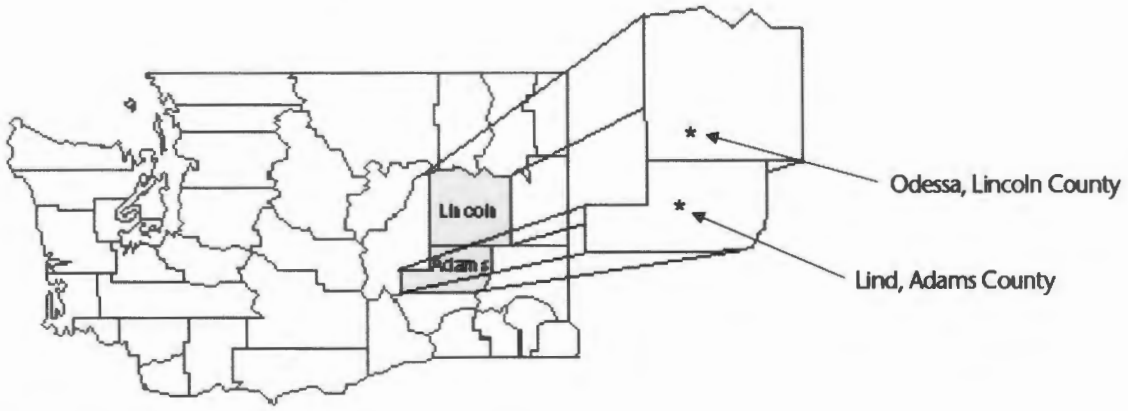

Figure 1. Map of Study Site Location

Experiment Description

The irrigated cropping study was initiated in 2000 on 10 acres of prime cropland. To obtain baseline residue levels to begin the experiment, the entire 10 acres was planted uniformly to Madsen winter wheat in September 1999. The irrigated grain yield in August 2000 was 110 bu/acre and straw production exceeded 10,000 lb/acre. Beginning in the 2001 crop year, a 3-year crop rotation of winter wheat – spring barley – canola was grown under the three stubble management methods. These are sowing: (i) directly into standing stubble, (ii) after removal of stubble, or (iii) after burning the stubble. A check treatment of continuous annual winter wheat sown after stubble burning and moldboard plowing was also included. The experiment design was a split-split plot with four replications. Each portion of the 3-year no-till crop rotation in each stubble management method was sown each year. Thus there were 40 plots (3 crops x 3 stubble management practice + the check continuous winter wheat x 4 replications).

Irrigation: Although the timing of irrigation varied from year to year, the entire experiment received 15 inches of irrigation water every year via hand lines. Six inches of water were applied in the fall, and an additional 9 inches of water was applied in the spring using the same irrigation schedule for all crops.

Fertility: All plots received 170 lb/ac N, 30 lb/ac P, and 20 lb/ac S each year.

Wheat: The burn plow continuous winter wheat received all fertilizer in the granular form with 120 lb/ac N, 30 lb/ac P, and 20 lb/ac S applied in September prior to plowing and planting with a granular spreader. The sources that made up this mix were urea, ammonium sulfate, and 11-0-52. The sulfur was all applied with the ammonium sulfate and all phosphorus was applied with the 11-0-52. The additional 50 lb/ac N was applied as granular urea N topdress to the growing wheat crop in April.

The no-till winter wheat received 120 lb/ac N, 30 lb/ac P, and 20 lb/ac S as liquid at time of sowing with the Cross Slot no-till drill. The liquid fertilizer mix was Solution 32 + 10-0-34 + thiosul. The additional 50 lb/ac N was applied as a granular urea N topdress to the growing wheat crop in April.

Winter canola received the same fertilizer regime as the no-till winter wheat. However, since winter canola was killed by either cold or disease in 5 years out of 6 years, 50 lb/ac of liquid Solution 32 N was applied at planting of spring canola in those 5 years. Spring barley received 170 lb/ac N, 30 lb/ac P, and 20 lb/ac S as Solution 32 + ammonium sulfate + 10-0-34 at time of planting with the Cross Slot no-till drill.

Sowing Rates: Winter wheat (Madsen) and spring barley (Baronesse), were sown at a rate of 100 lb/ac during all years. Winter canola and spring canola sowing rates varied from 4 to 7 lb/ac and averaged 5 lb/ac over the six years. Additional detail on field operations and inputs for production of winter wheat, spring barley, and canola in the no-till rotation and for continuous winter wheat are shown in the Appendix.

Budgeting Procedures and Assumptions

Economic budgets differ from cash budgets because they include all costs of production, both cash and non-cash. Non-cash costs include rent on land that is owned, interest on owner's machinery equity, and a charge for the owner-operator's labor. A net return over total costs of zero indicates the farmer is earning a "normal profit" by receiving prevailing market returns for all his/her resources including land, machinery, and labor.

Detailed cost of production budgets were generated for each crop and stubble management system in the Lind Experiment (Appendix). Many budgets were similar in terms of cultural practices and costs. The Appendix tables report costs for the "standing stubble" management treatment. Minor adjustments were made for the other stubble management practices. There are no costs for some stubble management practices and only minor costs for others. There is no charge for baling of wheat and barley stubble because mushroom growers or others will bale and haul away wheat and barley stubble in this region in return for the product. No charge exists for baling or burning canola stubble because the very low residue levels make these practices unnecessary. The per acre costs for burning wheat and barley stubble cover the burning permit and low burning operation costs.

The budgets presented for winter wheat and spring barley in the Appendix reflect the relatively uniform management practices and costs for these crops during the 2001-2006 experiment. Separate canola budgets are presented for 2001, 2002, and 2003-2006 because management practices varied over time. The canola budget for 2001 represents custom aerial costs, dry fertilizer, and no additional fertilizer at planting. The 2002 budget does not include replanting in the spring as in the other five years. Liquid fertilizer was applied with the Cross Slot drill in 2002-2006. The 2003-2006 canola budgets also incorporate different rates and types of fertilizers and herbicides. The canola profitability and cost results in subsequent summaries are weighted averages over the six years.

The machinery complement for all budgets listed in Appendix Table A.13 is based on that of a cooperating farmer in Odessa, WA (Painter, 2006). Typically, machinery on irrigated Lincoln County farms is purchased both new and used depending on what is available and desired. The equipment includes a 250-horsepower four-wheel drive tractor, 35-ft-wide Cross Slot no-till drill, 12-ft moldboard plow, 24-ft Smizer packer, Draper swather, and a combine with 20-ft cutting platform. Other equipment includes a truck, pickup, bankout wagon, and a four-wheel all-terrain vehicle. The equipment also includes one central pivot irrigation system per quarter section (160 acres) of land.

Custom services were employed for application of herbicides and fertilizers. Machinery age, new or used purchase price, size and type, annual hours of use, and service life listed in Appendix Table A.13 are typical of irrigated farms in the area.

Production costs are categorized as either fixed or variable. For a given land and machinery base, fixed costs do not vary with the number of acres planted. Machinery fixed costs include depreciation, interest, taxes, housing, and insurance. The "Itemized Costs Per Acre" tables in the Appendix list costs by input whereas the "Schedule of Operations and Costs Per Acre" tables list costs by operation. Farmers are encouraged to compare their costs to those reported in the Appendix tables.

Tractor and machinery interest costs are calculated on the average annual machine investment [(purchase cost + salvage value)/2]. This interest charge represents either an opportunity cost (return forgone by investing in the machine rather than in an alternative investment) or interest paid on money borrowed to finance machine purchase. Land fixed costs include both land taxes and net rent. Net rent is either an actual land rent paid by the farmer or rental income foregone for land the farmer owns. Net land rent in the study region is based on the prevailing 1/3 landlord and 2/3 tenant crop share with the landlord responsible for paying land taxes, 1/3 of the fertilizer and chemical expenses, and 1/3 of the crop insurance expense.

Including non-cash opportunity costs allows for the standardization of economic budgets among farmers regardless of whether they own or rent their land and machinery and whether they perform their own labor or hire work done. From an economic perspective, it is the cost of the resources used that count, not the source of these resources. Users who wish to compute net returns based on cash accounting can simply subtract non-cash costs.

Variable costs include costs that vary with acres planted. Machinery repairs, fuel, labor, custom services, seed, fertilizer, pesticides, and crop insurance are all examples of variable costs. The utilized 2006 and 2007 prices for fertilizer, herbicide, seed, and other inputs are reported in Appendix Table A.14. The off-road price of diesel is $2.50/gallon, labor is $14/hour, and interest rate for operating costs and machinery investment is 8%. Overhead for general items like farm utilities, sheds, and legal and accounting fees is computed at five percent of variable costs.

The utilized soft white wheat price of $3.51/bu and spring barley price of $89.16/ton are based on a five-year (2001-2005) average from the Union Elevator in Lind, Washington (http://www.unionelevator.com/charts.htm). A recent average price for winter canola of $0.12/lb was used (Painter, 2006). By December 2007, wheat prices had climbed to about $10/bu in the region and barley and canola prices were also higher. However, basing economic evaluations on short run price spikes is not recommended.

Net returns in this study include only market returns, excluding government payments and crop insurance indemnities. Although government payments have been and are an important source of farm income, the purpose of this study is to compare the market profitability of different rotations, not to measure the total farm income of individual growers. Adding the predetermined direct government payments, which do not vary by rotation, would not affect profitability rankings. Including government payments would require assumptions on historical yields and base acreages, which vary from farm to farm. Additionally, farm programs vary substantially from farm bill to farm bill and, in some years, include discretionary annual supplemental payments awarded by Congress. At time of writing, a new 2007 Farm Bill is being debated. Readers may add government payments consistent with personal cropping history and future policies if desired.

Net return per rotational acre is used to measure the profitability of different crop rotations. For

example, a rotational acre of winter wheat/spring barley/spring canola includes 1/3 acre of winter wheat, 1/3 acre of spring barley, and 1/3 acre of winter canola. This approach correctly portrays the annual income of farmers who annually allocate 1/n of their land to each crop in an n-year rotation. This diversification usually reduces annual income risk. The practice typically permits more efficient use of machinery and labor based on seasonal demands by different crops.

Results: Yields, Production Costs, and Profitability

Table 1 reports yield results of the six-year experiment. These results include six-year averages, ranges, and coefficients of variation (CV) by crop, tillage, and stubble management treatment. None of the average crop yields differed statistically at the 0.05 level by treatment using year as the variate. Based on the point estimates, the no-till stubble-burned treatment produced the highest average winter wheat yield at 93.8 bu/ac. "Burn and plow" continuous winter wheat produced the lowest yield at 84.5 bu/ac. Spring barley averaged 2.35 to 2.54 ton/ac over treatments. Canola yields, which reflect spring canola replanted following failed winter canola in all years except 2002, averaged slightly more than 1,500 lb/ac for all stubble treatments. In general, six-year average yields varied little by stubble management for canola and barley. The average canola yields varied widely over years with a range of 410 to 2,574 lb/ac. The wide variability in canola yields was likely due to the timing of air temperatures above 90^0 F. Such high temperatures often cause canola to stop flowering and abort florets. Canola yields generally suffer less if high temperatures occur later in the season. The coefficients of variation were highest for stubble burned canola (57%) and lowest for stubble burned spring barley (10%). Wheat yields were also less risky than canola with coefficients of variation of 16 to 19 percent.

The average yields in the experiment fall short of typical conventional irrigated winter wheat and canola yields in the region. A cooperating farmer at Odessa reported typical yields of 3,200 lb/ac for canola and 120 bu/ac for winter wheat (Painter, 2006; Painter et al., 2006). The winter wheat yield shortfall at Lind cannot be attributed to no-till. Indeed, no-till winter wheat yields within the 3-crop rotation averaged higher, although not significantly so, than the "burn and plow" continuous wheat yields (Table 1). The winter wheat yield shortfall at Lind was likely due in part to sub-optimal crop-specific irrigation. Hand line sprinklers were used at the Lind experiment instead of the typical center pivot systems. Because all treatments were randomized throughout the experiment, all crops had to receive irrigation water at the same time. The optimum timing for irrigation for canola, spring barley, and winter wheat differ markedly, but crop-specific tailoring of irrigation for individual crops was not possible. Winter canola was killed by a combination of cold and rhizoctonia root rot fungal disease (data not shown) in 5 of 6 years. This fungal pathogen is unique to no-till farming and can be eliminated with tillage. Winter canola appears to be quite vulnerable to winter kill when infected by rhizoctonia. Our cooperating farmer near Odessa had no problems with winter kill of winter canola during the years of this study using tillage-based cultural practices.

Table 2 displays six-year average fixed costs, variable costs, total costs, gross returns, and net returns by crop rotation and stubble management treatment. Again, production costs are based on the detailed budgets in Appendix Tables A.1–A.12.

Table 1. Grain Yields from the Irrigated Cropping Systems Experiment, Lind, WA, 2001-2006

Treatments	2001	2002	2003	2004	2005	2006	Average	Range	C.V. (%)
Winter Wheat (bu/a)									
Stubble Burned	85	106	113	102	73	84	93.8	73 – 113	16.61
Stubble Baled	67	110	96	96	81	70	86.7	67 – 110	19.41
Standing Stubble	69	107	101	92	95	75	89.8	69 – 107	16.55
Burn & Plow	75	97	74	99	68	94	84.5	68 – 99	16.14
Spring Barley (ton/a)									
Stubble Burned	2.88	2.21	2.39	2.61	2.40	2.73	2.54	2.21 - 2.88	9.78
Stubble Baled	3.03	2.33	2.24	2.55	2.26	2.38	2.47	2.24 - 3.03	12.10
Standing Stubble	2.88	2.26	2.08	2.53	2.18	2.19	2.35	2.08 - 2.88	12.73
Canola (lb/a)									
Stubble Burned	2,574	2,502	1,027	1,115	410	1,478	1,518	410 – 2,574	56.80
Stubble Baled	2,486	2,226	1,135	1,141	654	1,490	1,522	654 – 2,486	46.22
Standing Stubble	2,282	2,188	1,326	1,051	491	1,679	1,503	491 – 2,282	45.78

NOTES: C.V. = coefficient of variation = (standard deviation/average)x100. Standard deviation represents the "typical" deviation of annual yields around the average. Average yields of a crop never differed statistically over treatments at the 0.05 level using year as the variate.

Total costs in Table 2 range from $395-$400/ac for the no-till rotation to $441/ac for the continuous winter wheat. As shown in the detailed budgets in the Appendix, fertilizers contributed strongly to high variable costs, especially for winter wheat. At average 2001-2005 crop prices, all the crop rotations in the Lind experiment incurred losses averaging over $144/ac. The average net returns were statistically equal for all four treatments. The no-till rotations generated very similar point estimates of losses (-$155 to -$160 per acre) over stubble management treatments. The continuous annual winter wheat treatment earned only $10/ac more, or lost $10/ac less, than the best no-till rotation (Table 2). The relatively low crop yields in this experiment explain part of the uncompetitive net returns for all systems. As noted in subsequent sensitivity analysis, if crops had yielded similarly to those of cooperating farmers, net returns would have been closer to breakeven levels. Stagnant crop prices coupled with rising input costs during this time period also contribute to the low net returns in Table 2. As noted in subsequent sensitivity analysis, the sharply higher 2007 crop prices would boost profit markedly.

Table 2. Average Production Costs, Gross Returns, and Net Returns over Total Costs ($/rotational acre) by Rotation and Treatment. Irrigated Cropping Systems Experiment, Lind, WA, 2001-2006.

Crop and Treatment	Fixed costs	Variable costs	Total costs	Gross Return	Net returns over total costs
No-till WW, SB, Canola					
Stubble Burned	93.11	307.34	400.45	245.90	-154.55
Stubble Baled	87.56	307.34	394.90	235.69	-159.21
Stubble Standing	91.13	309.07	395.38	235.06	-160.31
Cont. WW Burn & Plow	84.62	356.81	441.43	296.60	-144.84

NOTES: Rotational acre equals 1/3 ac wheat + 1/3 ac barley + 1/3 ac canola for the 3-crop rotation. Returns are based on 2001-2005 average crop prices of $3.51/bu for wheat, $89.16/ton for barley, and $0.12/lb for canola. Average net returns did not differ statistically over treatments at the 0.05 level using year as the variate.

Table 3 displays net returns by individual crop and stubble management treatment during the six-year experiment. Annual losses for winter wheat ranged from -$22 to -$183 per acre over all treatments and years. Spring barley losses spanned -$117 to -$179 per acre over treatments and years. As expected, the high production costs and low yields for canola combined to generate exceptionally large annual losses ranging from -$135 to -$354 per acre (Table 3). As shown in Appendix Table A.12, replanting to spring canola added $59.87/acre to costs due to expensive seed at $4/lb, additional operating costs, and labor. The losses for canola listed in Table 3 are unsustainable and farmers would abandon this crop unless yields were increased, costs reduced, prices elevated, and/or canola provided an exceptional rotation benefit to the subsequent crop. Annual variability in net returns as measured by standard deviation is relatively similar within crops over stubble management practices (Table 3). Table 4 combines the crop-specific annual results in Table 3 into the four stubble management treatments. The same pattern of weather-

Table 3. Net Returns ($/ac) by Crop and Stubble Treatment. Irrigated Cropping System Experiment, Lind, WA, 2001-2006

Treatments	2001	2002	2003	2004	2005	2006	Average	S.D.
Winter Wheat								
Stubble Burned	-87.50	-38.36	-21.98	-47.72	-116.75	-89.84	-67.02	36.43
Stubble Baled	-127.22	-26.60	-59.36	-59.36	-94.46	-120.20	-81.20	39.37
Standing Stubble	-122.54	-33.62	-47.66	-68.72	-61.70	-108.50	-73.79	34.78
Burn & Plow	-167.07	-115.59	-169.41	-110.91	-183.45	-122.61	-144.84	31.90
Spring Barley								
Stubble Burned	-129.10	-168.93	-152.88	-145.14	-157.63	-138.01	-148.61	14.26
Stubble Baled	-117.37	-158.97	-166.99	-145.89	-163.13	-156.00	-151.39	18.15
Standing Stubble	-126.28	-163.13	-179.18	-147.09	-167.88	-167.29	-158.47	18.88
Canola								
Stubble Burned	-213.10	-135.20	-280.20	-269.64	-354.24	-237.77	-248.36	73.26
Stubble Baled	-220.14	-157.28	-267.24	-266.52	-324.96	-236.81	-245.49	56.09
Standing Stubble	-236.46	-160.32	-249.93	-277.32	-344.52	-221.69	-248.37	61.14

NOTE: Returns are based on 2001-2005 average crop prices of $3.51/bu for wheat, $89.16/ton for barley, and an early 2007 price of $0.12/lb for canola. Historical prices for canola are based on very thin markets due to the low production of this crop in Washington State.

Table 4. Net Return ($/ rotational acre) by Treatment and Year. Irrigated Cropping Systems Experiment, Lind, WA, 2001-2006

Treatments	2001	2002	2003	2004	2005	2006	Average	S.D.
Stubble Burned	-143.23	-114.16	-151.69	-154.17	-209.54	-155.21	-154.67	30.96
Stubble Baled	-154.91	-114.28	-164.53	-157.26	-194.18	-171.00	-159.36	26.20
Standing Stubble	-161.76	-119.02	-158.92	-164.38	-191.37	-165.83	-160.21	23.32
Burn & Plow	-167.07	-115.59	-169.41	-110.91	-183.45	-122.61	-144.84	31.90

NOTE: Rotational acre equals 1/3 ac wheat + 1/3 ac barley + 1/3 ac canola for the 3-crop rotation. Returns are based on crop prices of $3.51/bu for wheat, $89.16/ton for barley, and $0.12/lb for canola. Average net returns did not differ statistically over treatments at the 0.05 level using year as the variate. Average net returns for the first three treatments differ by small amounts from those in Table 2 due to minor differences in averaging over- crops.

related annual income variability observed in Table 3 carries forward in Table 4. Of course six-year average net return rankings by system are the same as in Table 2.

Sensitivity Analysis

Variability in net returns is caused by changes in production costs, yields, and crop prices. For example, wheat prices increased sharply during 2007 in response to world supply and demand conditions. Table 5 displays the effect of crop prices and yield variation on net returns for all treatments.

Table 5. Net Returns over Total Costs ($ per Rotational Acre)by Price and Yield Assumptions and by Treatment, Lind, WA, 2001-2006

Treatments	Yields	
	2001-2006 Experiment Av.	Farmer Cooperator Average
No-till Winter Wheat, Spring Barley, & Canola		
STUBBLE BURNED:		
2001-2005 Average Prices	-154.55	-91.09
June 2007 Prices	-106.87	-16.47
STUBBLE BALED:		
2001-2005 Average Prices	-159.21	-89.35
June 2007 Prices	-98.31	-14.73
STANDING STUBBLE:		
2001-2005 Average Prices	-160.31	-89.35
June 2007 Prices	-79.76	-14.73
Continuous Winter Wheat		
BURN AND PLOW:		
2001-2005 Average Prices	-144.84	-61.77
June 2007 Prices	-36.11	92.63

NOTES: Average 2001-2005 prices are $3.51/bu for wheat, $89.16/ton for barley, and $0.12/lb for canola (early 2007). Average prices for June 2007 are $5.44/bu for wheat, $174/ton for barley, and $0.12/lb for canola. Experiment average yields are as reported in Table 1. Farmer cooperator reported average yields are 3,200 lb/ac for canola, 120 bu/ac for winter wheat, and 2.35 ton/ac for spring barley. Total costs are as reported in Table 2 except for a small adjustment in net rent land costs to reflect yield changes. Other costs might also differ over these two scenarios.

As shown in Table 5, all systems approach or exceed breakeven levels (zero returns over total costs) using June 2007 prices and the higher yields reported by the farmer cooperator. Continuous winter wheat with burning of stubble and plowing earned a healthy profit over total costs of $92.63/ac with these conditions. All prices had increased further by late 2007. Indeed, soft white wheat was selling for about $10/bu in Lind by late October. Use of these late season prices would further increase net returns, especially for the continuous winter wheat system. Wheat price offers at Lind for summer 2008 during September 2007 were at $5.25/bu.

Summary and Conclusions

Six-year average net returns over total costs were similar over stubble management systems for all the no-till crop rotation systems. Using 2001-2005 average prices, all no-till systems lost money ranging from -$155 to -$160 per rotational acre. The continuous winter wheat system averaged slightly higher, but still negative net returns at -$145/ac. Net returns for all systems would approach or exceed breakeven levels using a farmer cooperator's higher yields and the higher crop prices of June 2007. Winter canola, which required replanting to spring canola in all but one year, was a major economic loser in the diversified no-till rotation. The annual loss from canola averaged -$247 per acre.

The comparison of the diversified no-till system with improved straw management to the conventional winter wheat system was clouded by the extremely poor agronomic and economic performance of canola. The comparison was also affected by relatively low average yields for all crops compared to typical irrigated yields. Given these factors, it is difficult to make definitive conclusions regarding the prospects for more environmentally sound alternatives to the burn and plow continuous winter wheat system. Further research on alternative no-till cropping systems should probably exclude canola and should be conducted where crop-specific irrigation scheduling is possible. Finally, other issues not considered in this comparison will likely have a greater influence on the economic and agronomic sustainability of the continuous wheat system supported by deep well irrigation. Pumping water from these wells is depleting the Odessa aquifer. Water quality is declining, well depths are increasing, and pumping costs are escalating. In the long run, water availability, quality and cost may require farmers in some areas to consider a shift to crops or systems that require less water.

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APPENDIX

DETAILED PRODUCTION COSTS BY CROP AND SYSTEM

TABLE A.1. AVERAGE ITEMIZED COST PER ACRE FOR CONTINUOUS WINTER WHEAT, LIND, WA, 2001-2006

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
BURN PERMIT	ACRE	2.00	1.00	2.00	
WW SEEDS	LB.	.13	100.00	12.50	
ROGATOR SPRAYER	ACRE	4.50	1.00	4.50	
TERRAGATOR	ACRE	6.00	2.00	12.00	
UREA	LB.	.26	211.00	54.86	
AMM. SULFATE	LB	.82	83.00	68.06	
MAP (DRY)	LB.	.25	58.00	14.50	
BRONATE	OZ.	.29	24.00	6.96	
R-11	QT.	3.68	.10	.37	
UREA	LB.	.26	109.00	28.34	
LANDMASTER II	OZ.	.18	22.00	3.96	
IRRIGATION POWER	ACRE	75.00	1.00	75.00	
CROP INSURANCE	ACRE	2.50	1.00	2.50	
MACHINERY REPAIRS	ACRE	21.19	1.00	21.19	
MACHINE FUEL/LUBE	ACRE	8.31	1.00	8.31	
LABOR(TRAC/MACH)	HOUR	14.00	.60	8.43	
INTEREST ON OP. CAP.	ACRE	16.35	1.00	16.35	
OVERHEAD	ACRE	16.99	1.00	16.99	
TOTAL VARIABLE COST				356.81	
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	17.70	1.00	17.70	
MACHINE INTEREST*	ACRE	21.00	1.00	21.00	
MACHINE INSURANCE*	ACRE	1.58	1.00	1.58	
MACHINE TAXES*	ACRE	4.73	1.00	4.73	
MACHINE HOUSING*	ACRE	.25	1.00	.58	
LAND TAX	ACRE	3.50	1.00	3.50	
LAND RENT**	ACRE	35.55	1.00	35.55	
TOTAL FIXED COST				84.62	
TOTAL COST				441.43	

*INCLUDING BUILDINGS, TOOLS, AND TANKS
**1/3 CROP - 1/3 FERTILIZER COSTS - 1/3 CROP INSURANCE - LAND TAXES
WHEAT YIELD IS 84.5 BU/AC
FIVE-YEAR AVERAGE FARM GATE PRICE OF WHEAT IS $3.51/BU

TABLE A.2. AVERAGE SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR CONTINUOUS WINTER WHEAT, LIND, WA, 2001-2006

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
						$	$	$	$	$	$	$	$
BURN STUBBLE	BURN STUBBLE, DISK FIRE BREAK	AUG	2006	.01	.01	.00	.00	.13	2.00	.00	.16	2.28	2.28
SPRAY WEEDS	CUSTOM SPRAY (ROGATOR)	AUG	2006	.00	.00	.00	.00	.00	4.50	3.96(1)	.62	9.08	9.08
FERTILIZE	CUSTOM FERTILIZER (TERREGATOR)	SEP	2006	.00	.00	.00	.00	.00	6.00	137.42(2)	9.56	152.98	152.98
PLOW & PACK	CASE 8950 W/PLOW & PACKER	OCT	2006	.08	.09	3.51	3.44	1.29	.00	.00	.28	5.01	8.53
PLANT	CASE 8950, 35' JD455 DD DRILL	OCT	2006	.07	.08	3.54	2.82	1.11	.00	12.50(3)	.99	17.41	20.95
FERTILIZE TWO	CUSTOM FERTILIZER (TERREGATOR)	APR	2007	.00	.00	.00	.00	.00	6.00	7.33(4)	.27	13.59	13.59
FERTIGATION	FERTIGATION W/ UREA	APR	2007	.00	.00	.00	.00	.00	.00	28.34(5)	.57	28.91	28.91
HARVEST WHEAT	JD 7720 COMBINE	JUL	2007	.07	.08	.66	2.19	1.12	.00	.00	.00	3.31	3.97
HAUL WHEAT	HAUL WHEAT (2 2-TON TRUCKS)	JUL	2007	.06	.07	.75	1.01	.94	.00	.00	.00	1.95	2.69
HAUL WHEAT	HAUL WHEAT (CASE 8950, WAGON)	JUL	2007	.07	.07	2.34	2.56	1.02	.00	.00	.00	3.58	5.93
IRRIGATE	IRRIGATION SYSTEM & WELL	ANN	2007	.00	.11	25.88	15.00	1.57	.00	.00	.66	17.23	43.11
IRRIGATION POWER	POWER CHARGED FOR IRRIGATION	ANN	2006	.00	.00	.00	.00	.00	75.00	.00	3.00	78.00	78.00
MISC. USE	PICKUP	ANN	2007	.05	.06	.45	.54	.84	.00	.00	.06	1.43	1.88
MICS. USE	4-WHEEL ATV	ANN	2007	.03	.03	.09	.07	.42	.00	.00	.02	.50	.59
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN	2007	.00	.00	4.60	.67	.00	.00	.00	.03	.69	5.29
MISC. USE	SHOP TOOLS	ANN	2007	.00	.00	2.04	1.00	.00	.00	.00	.04	1.04	3.08
MICS. USE	FUEL & MISCELLANEOUS TANKS	ANN	2007	.00	.00	1.70	.20	.00	.00	.00	.01	.21	1.91
LAND TAX	LAND TAX	ANN	2007	.00	.00	3.50	.00	.00	.00	.00	.00	.00	3.50
CROP INSURANCE	CROP INSURANCE	ANN	2007	.00	.00	.00	.00	.00	2.50	.00	.10	2.60	2.60
LAND RENT	LAND RENT (OPPORTUNITY COSTS)	ANN	2007	.00	.00	35.55	.00	.00	.00	.00	.00	.00	35.55
OVERHEAD	UTILITIES, LEGAL, ACCTNG., ETC	ANN	2007	.00	.00	.00	.00	.00	16.99	.00	.00	16.99	16.99
TOTAL PER ACRE				.44	.60	84.62	29.49	8.43	112.99	189.55	16.35	356.81	441.43

MATERIALS:

1. 22 OZ LANDMASTER II ($3.96/AC)
2. 211 LB UREA ($54.86/AC), 83 LB AMM. SULFATE ($68.06/AC), 58 LB MAP ($14.50/AC)
3. 100 LB SWWW SEEDS ($12.50/AC)
4. 24 OZ BRONATE ($6.96/AC), 0.1 QT R-11 ($0.37/AC)
5. 109 LB UREA ($28.34/AC)

TABLE A.3. AVERAGE ITEMIZED COST PER ACRE FOR NO-TILL WINTER WHEAT, LIND, WA, 2001-2006

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
WW SEEDS	LB.	.13	100.00	12.50	
ROGATOR SPRAYER	ACRE	4.50	1.16	5.22	
TERRAGATOR	ACRE	6.00	1.00	6.00	
SUREFIRE	OZ.	.24	5.33	1.28	
LANDMASTER II	OZ.	.18	22.00	3.96	
SOLUTION 32	GL.	1.80	29.03	52.25	
10-34-0	GL.	2.09	7.54	15.76	
THIOSUL (LIQ)	GL.	1.08	6.93	7.48	
BRONATE	OZ.	.29	24.00	6.96	
R-11	QT.	3.68	.10	.37	
UREA	LB.	.26	109.00	28.34	
CROP INSURANCE	ACRE	2.50	1.00	2.50	
IRRIGATION POWER	ACRE	75.00	1.00	75.00	
MACHINERY REPAIRS	ACRE	20.43	1.00	20.43	
MACHINE FUEL/LUBE	ACRE	6.88	1.00	6.88	
LABOR(TRAC/MACH)	HOUR	14.00	.53	7.42	
INTEREST ON OP. CAP.	ACRE	11.70	1.00	11.70	
OVERHEAD	ACRE	13.20	1.00	13.20	
TOTAL VARIABLE COST				277.26	
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	15.87	1.00	15.87	
MACHINE INTEREST*	ACRE	22.81	1.00	22.81	
MACHINE INSURANCE*	ACRE	1.71	1.00	1.71	
MACHINE TAXES*	ACRE	5.13	1.00	5.13	
MACHINE HOUSING*	ACRE	.80	1.00	.80	
LAND RENT**	ACRE	61.97	1.00	61.97	
LAND TAX	ACRE	3.50	1.00	3.50	
TOTAL FIXED COST				111.80	
TOTAL COST				389.06	

*INCLUDING BUILDINGS, TOOLS, AND TANKS
**1/3 CROP - 1/3 FERTILIZER COSTS - 1/3 CROP INSURANCE - LAND TAXES
WHEAT YIELD IS 89.8 BU/AC
FIVE-YEAR AVERAGE FARM GATE PRICE OF WHEAT IS $3.51/BU

TABLE A.4. AVERAGE SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR NO-TILL WINTER WHEAT, LIND, WA, 2001-2006

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
						$	$	$	$	$	$	$	$
SPRAY WEED ONE	CUSTOM SPRAY (ROGATOR)	AUG	2006	.00	.00	.00	.00	.00	.72	1.28(1)	.15	2.15	2.15
SPRAY WEED TWO	CUSTOM SPRAY (ROGATOR)	SEP	2006	.00	.00	.00	.00	.00	4.50	3.96(2)	.56	9.02	9.02
PLANT & FERTILIZE	CASE 8950 W/ CROSS SLOT	SEP	2006	.10	.11	7.82	4.09	1.51	.00	88.00(3)	6.24	99.83	107.65
FERTILIZE	CUSTOM FERTILIZER (TERREGATOR)	APR	2007	.00	.00	.00	.00	.00	6.00	7.33(4)	.27	13.59	13.59
FERTIGATION	FERTIGATION W/ UREA	APR	2007	.00	.00	.00	.00	.00	.00	28.34(5)	.57	28.91	28.91
HARVEST	JD 7720 COMBINE	JUL	2007	.07	.08	.66	2.19	1.12	.00	.00	.00	3.31	3.97
HAUL WHEAT	HAUL WHEAT (2-TON TRUCK)	JUL	2007	.06	.07	.75	1.01	.94	.00	.00	.00	1.95	2.69
HAUL WHEAT	HAUL WHEAT (CASE 8950, WAGON)	JUL	2007	.07	.07	2.34	2.56	1.02	.00	.00	.00	3.58	5.93
IRRIGATION POWER	POWER CHARGED FOR IRRIGATION	ANN	2007	.00	.00	.00	.00	.00	75.00	.00	3.00	78.00	78.00
IRRIGATE	IRRIGATION SYSTEM & WELL	ANN	2007	.00	.11	25.88	15.00	1.57	.00	.00	.66	17.23	43.11
MISC. USE	PICKUP	ANN	2007	.05	.06	.45	.54	.84	.00	.00	.06	1.43	1.88
MISC. USE	4-WHEEL ATV	ANN	2007	.03	.03	.09	.07	.42	.00	.00	.02	.50	.59
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN	2007	.00	.00	4.60	.67	.00	.00	.00	.03	.69	5.29
MISC. USE	SHOP TOOLS	ANN	2007	.00	.00	2.04	1.00	.00	.00	.00	.04	1.04	3.08
MISC. USE	FUEL & MISC. TANKS	ANN	2007	.00	.00	1.70	.20	.00	.00	.00	.01	.21	1.91
LAND TAX	LAND TAX	ANN	2007	.00	.00	3.50	.00	.00	.00	.00	.00	.00	3.50
CROP INSURANCE	CROP INSURANCE	ANN	2007	.00	.00	.00	.00	.00	2.50	.00	.10	2.60	2.60
LAND RENT	LAND RENT (OPPORTUNITY COSTS)	ANN	2007	.00	.00	61.97	.00	.00	.00	.00	.00	.00	61.97
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN	2007	.00	.00	.00	.00	.00	13.20	.00	.00	13.20	13.20
TOTAL PER ACRE				.37	.53	111.80	27.32	7.42	101.92	128.90	11.70	277.26	389.06

MATERIALS:

1. 5.33 OZ SUREFIRE ($1.28/AC)
2. 22 OZ LANDMASTER II ($3.96/AC)
3. 100 LB SWWW SEEDS ($12.50/AC), 29.03 GL SOLUTION 32 ($52.25/AC), 7.54 GL 10-34-0 ($15.76/AC), 6.93 GL THIOSUL ($7.48/AC)
4. 24 OZ BRONATE ($6.96/AC), 0.1 QT R-11 ($0.37/AC)
5. 109 LB UREA ($28.34/AC)

TABLE A.5. AVERAGE ITEMIZED COST PER ACRE FOR NO-TILL SPRING BARLEY FOLLOWING WINTER WHEAT, LIND, WA, 2001-2006

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
SB SEEDS	LB.	.13	100.00	13.00	
ROGATOR SPRAYER	ACRE	4.50	2.32	10.44	
TERRAGATOR	ACRE	6.00	.83	4.98	
LANDMASTER II	OZ.	.18	51.00	9.18	
R-11	QT.	3.68	.34	1.23	
SOLUTION 32	GL.	1.80	43.16	77.69	
10-34-0	GL.	2.09	7.54	15.76	
THIOSUL (LIQ)	GL.	1.08	6.93	7.48	
BRONATE	OZ.	.29	20.00	5.80	
CROP INSURANCE	ACRE	2.50	1.00	2.50	
IRRIGATION POWER	ACRE	75.00	1.00	75.00	
MACHINERY REPAIRS	ACRE	21.19	1.00	21.19	
MACHINE FUEL/LUBE	ACRE	12.37	1.00	12.37	
LABOR(TRAC/MACH)	HOUR	14.00	.73	10.28	
INTEREST ON OP. CAP.	ACRE	8.41	1.00	8.41	
OVERHEAD	ACRE	13.77	1.00	13.77	
TOTAL VARIABLE COST				289.08	
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	16.79	1.00	16.79	
MACHINE INTEREST*	ACRE	23.48	1.00	23.48	
MACHINE INSURANCE*	ACRE	1.76	1.00	1.76	
MACHINE TAXES*	ACRE	5.28	1.00	5.28	
MACHINE HOUSING*	ACRE	.89	1.00	.89	
LAND TAX	ACRE	3.50	1.00	3.50	
LAND RENT**	ACRE	26.52	1.00	26.52	
TOTAL FIXED COST				78.23	
TOTAL COST				367.31	

*INCLUDING BUILDINGS, TOOLS, AND TANKS
**1/3 CROP - 1/3 FERTILIZER COSTS - 1/3 CROP INSURANCE - LAND TAXES
BARLEY YIELD IS 2.35 TON/AC
FIVE-YEAR AVERAGE FARM GATE PRICE OF BARLEY IS $89.16/TON

TABLE A.6. AVERAGE SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR NO-TILL SPRING BARLEY FOLLOWING WINTER WHEAT, LIND, WA, 2001-2006

OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST					TOTAL VARIABLE COST	TOTAL COST
							FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.		
						$	$	$	$	$	$	$	$
SPRAY WEED ONE	CUSTOM SPRAY (ROGATOR)	SEP	2006	.00	.00	.00	.00	.00	4.50	4.33(1)	.59	9.42	9.42
SPRAY WEED TWO	CUSTOM SPRAY (ROGATOR)	OCT	2006	.00	.00	.00	.00	.00	.72	.60(2)	.08	1.40	1.40
SPRAY WEED THREE	CUSTOM SPRAY (ROGATOR)	NOV	2006	.00	.00	.00	.00	.00	.72	.42(3)	.06	1.20	1.20
SPRAY WEEDS FOUR	CUSTOM SPRAY (ROGATOR)	MAR	2007	.00	.00	.00	.00	.00	4.50	4.69(4)	.25	9.43	9.43
PLANT & FERTILIZE	CASE 8950 W/ CROSS SLOT	APR	2007	.10	.11	7.82	4.09	1.51	.00	113.93(5)	2.39	121.92	129.74
FERTILIZE	CUSTOM FERTILIZER (TERREGATOR)	APR	2007	.00	.00	.00	.00	.00	4.98	6.17(6)	.22	11.37	11.37
HARVEST	JD 7720 COMBINE	AUG	2007	.26	.28	2.53	8.45	3.98	.00	.00	.91	13.34	15.87
HAUL BARLEY	HAUL BARLEY (CASE 8950, WAGON)	AUG	2007	.07	.07	2.34	2.56	1.02	.00	.00	.00	3.58	5.93
HAUL BARLEY	HAUL BARLEY (2-TON TRUCK)	AUG	2007	.06	.07	.75	1.01	.94	.00	.00	.00	1.95	2.69
IRRIGATE	IRRIGATION SYSTEM & WELL	ANN	2007	.00	.11	25.88	15.00	1.57	.00	.00	.66	17.23	43.11
IRRIGATION POWER	POWER CHARGED FOR IRRIGATION	ANN	2007	.00	.00	.00	.00	.00	75.00	.00	3.00	78.00	78.00
MISC. USE	PICKUP	ANN	2007	.05	.06	.45	.54	.84	.00	.00	.06	1.43	1.88
MISC. USE	4-WHEEL ATV	ANN	2007	.03	.03	.09	.07	.42	.00	.00	.02	.50	.59
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN	2007	.00	.00	4.60	.67	.00	.00	.00	.03	.69	5.29
MISC. USE	SHOP TOOLS	ANN	2007	.00	.00	2.04	1.00	.00	.00	.00	.04	1.04	3.08
MISC. USE	FUEL & MISC. TANKS	ANN	2007	.00	.00	1.70	.20	.00	.00	.00	.01	.21	1.91
LAND TAX	LAND TAX	ANN	2007	.00	.00	3.50	.00	.00	.00	.00	.00	.00	3.50
CROP INSURANCE	CROP INSURANCE	ANN	2007	.00	.00	.00	.00	.00	2.50	.00	.10	2.60	2.60
LAND RENT	LAND RENT (OPPORTUNITY COSTS)	ANN	2007	.00	.00	26.52	.00	.00	.00	.00	.00	.00	26.52
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN	2007	.00	.00	.00	.00	.00	13.77	.00	.00	13.77	13.77
TOTAL PER ACRE				.56	.73	78.23	33.57	10.28	106.69	130.14	8.41	289.08	367.31

MATERIALS:

1. 22 OZ LANDMASTER II ($3.96/AC), 0.1 QT R-11 ($0.37/AC)
2. 3 OZ LANDMASTER II ($0.54/AC), 0.02 QT R-11 ($0.06/AC)
3. 2 OZ LANDMASTER II ($0.36/AC), 0.02 QT R-11 ($0.06/AC)
4. 24 OZ LANDMASTER II ($4.32/AC), 0.1 QT R-11 ($0.37/AC)
5. 100 LB SB SEEDS ($13.00/AC), 43.16 GL SOLUTION 32 ($77.69/AC), 7.54 GL 10-34-0 ($15.76/AC), 6.93 GL THIOSUL ($7.48/AC)
6. 20 OZ BRONATE ($5.80/AC), 0.1 QT R-11 ($0.37/AC)

CANOLA 2001 YEAR

TABLE A.7. ITEMIZED COST PER ACRE FOR IRRIGATED WINTER/SPRING CANOLA FOLLOWING SPRING BARLEY, LIND, WA, 2001

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
WINTER CANOLA SEEDS	LB.	4.00	8.00	32.00	
SPRING CANOLA SEEDS	LB.	4.00	10.00	40.00	
CUSTOM AERIAL	ACRE	4.50	1.00	4.50	
ROGATOR SPRAYER	ACRE	4.50	2.00	9.00	
TERRAGATOR	ACRE	6.00	1.00	6.00	
CUSTOM HAUL	ACRE	2.25	1.00	2.25	
ASSURE II	OZ.	1.00	10.00	10.00	
R-11	QT.	3.68	.10	.37	
UREA	LB.	.26	211.00	54.86	
AMM. SULFATE	LB	.82	83.00	68.06	
MAP (DRY)	LB.	.25	58.00	14.50	
LANDMASTER II	OZ.	.18	20.00	3.60	
SOLUTION 32	GL.	1.80	14.13	25.43	
CROP INSURANCE	ACRE	2.50	1.00	2.50	
IRRIGATION POWER	ACRE	75.00	1.00	75.00	
MACHINERY REPAIRS	ACRE	20.41	1.00	20.41	
MACHINE FUEL/LUBE	ACRE	11.88	1.00	11.88	
LABOR(TRAC/MACH)	HOUR	14.00	.76	10.65	
INTEREST ON OP. CAP.	ACRE	19.80	1.00	19.80	
OVERHEAD	ACRE	20.54	1.00	20.54	
TOTAL VARIABLE COST				431.36	
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	16.50	1.00	16.50	
MACHINE INTEREST*	ACRE	23.11	1.00	23.11	
MACHINE INSURANCE*	ACRE	1.73	1.00	1.73	
MACHINE TAXES*	ACRE	5.20	1.00	5.20	
MACHINE HOUSING*	ACRE	.84	1.00	.84	
LAND TAX	ACRE	3.50	1.00	3.50	
LAND RENT**	ACRE	28.06	1.00	28.06	
TOTAL FIXED COST				78.94	
TOTAL COST				510.30	

*INCLUDING BUILDINGS, TOOLS, AND TANKS
**1/3 CROP - 1/3 FERTILIZER COSTS - 1/3 CROP INSURANCE - LAND TAXES
SPRING CANOLA YIELD IS 2,282 LB/AC
FIVE-YEAR AVERAGE FARM GATE PRICE OF CANOLA IS $0.12/LB

CANOLA 2001 YEAR

TABLE A.8. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR IRRIGATED WINTER/SPRING CANOLA FOLLOWING SPRING BARLEY, LIND, WA, 2001

OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST					TOTAL VARIABLE COST	TOTAL COST
							FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.		
						$	$	$	$	$	$	$	$
PLANT CANOLA	AERIAL CUSTOM	AUG	2006	.00	.11	.00	.00	1.51	4.50	32.00(1)	2.79	40.80	40.80
FERTILIZE	CUSTOM FERTILIZER (TERREGATOR)	SEP	2006	.00	.00	.00	.00	.00	6.00	137.42(2)	9.56	152.98	152.98
SPRAY WEEDS ONE	CUSTOM SPRAY (ROGATOR)	OCT	2006	.00	.00	.00	.00	.00	4.50	10.37(3)	.59	15.46	15.46
SPRAY WEEDS TWO	CUSTOM SPRAY (ROGATOR)	MAR	2007	.00	.00	.00	.00	.00	4.50	3.60(4)	.22	8.32	8.32
PLANT & FERTILIZE	CASE 8950, CROSS SLOT	APR	2007	.10	.11	7.82	4.09	1.51	.00	65.43(5)	1.42	72.45	80.27
HARVEST	JD 7720 COMBINE	AUG	2007	.25	.27	2.45	8.19	3.78	.00	.00	.88	12.85	15.30
HAUL CANOLA	CASE 8950, BANKOUT WAGON	AUG	2007	.07	.07	2.34	2.56	1.02	.00	.00	.26	3.84	6.19
HAUL CANOLA	CUSTOM HAUL TO WAREHOUSE	AUG	2007	.00	.00	.00	.00	.00	2.25	.00	.17	2.41	2.41
IRRIGATE	IRRIGATION SYSTEM & WELL	ANN	2007	.00	.11	25.88	15.00	1.57	.00	.00	.66	17.23	43.11
IRRIGATION POWER	POWER CHARGED FOR IRRIGATION	ANN	2007	.00	.00	.00	.00	.00	75.00	.00	3.00	78.00	78.00
MISC. USE	PICKUP	ANN	2007	.05	.06	.45	.54	.84	.00	.00	.06	1.43	1.88
MISC. USE	4-WHEEL ATV	ANN	2007	.03	.03	.09	.07	.42	.00	.00	.02	.50	.59
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN	2007	.00	.00	4.60	.67	.00	.00	.00	.03	.69	5.29
MISC. USE	SHOP TOOLS	ANN	2007	.00	.00	2.04	1.00	.00	.00	.00	.04	1.04	3.08
MISC. USE	FUEL & MISC. TANKS	ANN	2007	.00	.00	1.70	.20	.00	.00	.00	.01	.21	1.91
LAND TAX	LAND TAX	ANN	2007	.00	.00	3.50	.00	.00	.00	.00	.00	.00	3.50
CROP INSURANCE	CROP INSURANCE	ANN	2007	.00	.00	.00	.00	.00	2.50	.00	.10	2.60	2.60
LAND RENT	LAND RENT (OPPORTUNITY COSTS)	ANN	2007	.00	.00	28.06	.00	.00	.00	.00	.00	.00	28.06
OVERHEAD	UTILITIES, LEGAL, ACCT., ECT.	ANN	2007	.00	.00	.00	.00	.00	20.54	.00	.00	20.54	20.54
TOTAL PER ACRE				.50	.76	78.94	32.30	10.65	119.79	248.82	19.80	431.36	510.30

MATERIALS:

1. 8 LB WINTER CANOLA SEEDS ($32.00/AC)
2. 211 LB UREA ($54.86/AC), 83 LB AMM.SULFATE ($68.06/AC), 58 LB MAP ($14.50/AC)
3. 10 OZ ASSURE II ($10.00/AC), 0.1 QT R-11 ($0.37/AC)
4. 20 OZ LANDMASTER II ($3.60/AC)
5. 10 LB SPRING CANOLA SEEDS ($40.00/AC), 14.13 GL SOLUTION 32 ($25.43/AC)

CANOLA 2002 YEAR

TABLE A.9. ITEMIZED COST PER ACRE FOR IRRIGATED WINTER CANOLA FOLLOWING SPRING BARLEY, LIND, WA, 2002

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
WINTER CANOLA SEEDS	LB.	4.00	8.00	32.00	
ROGATOR SPRAYER	ACRE	4.50	2.00	9.00	
TERRAGATOR	ACRE	6.00	1.00	6.00	
CUSTOM HAUL	ACRE	2.25	1.00	2.25	
SOLUTION 32	GL.	1.80	43.16	77.68	
10-34-0	GL.	2.09	7.54	15.76	
THIOSUL (LIQ)	GL.	1.08	6.93	7.48	
ASSURE II	OZ.	1.00	20.00	20.00	
R-11	QT.	3.68	.20	.74	
CROP INSURANCE	ACRE	2.50	1.00	2.50	
IRRIGATION POWER	ACRE	75.00	1.00	75.00	
MACHINERY REPAIRS	ACRE	22.08	1.00	22.08	
MACHINE FUEL/LUBE	ACRE	11.88	1.00	11.88	
LABOR(TRAC/MACH)	HOUR	14.00	.85	11.94	
INTEREST ON OP. CAP.	ACRE	15.46	1.00	15.46	
OVERHEAD	ACRE	15.49	1.00	15.49	
TOTAL VARIABLE COST				325.28	
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	17.99	1.00	17.99	
MACHINE INTEREST*	ACRE	24.89	1.00	24.89	
MACHINE INSURANCE*	ACRE	1.86	1.00	1.86	
MACHINE TAXES*	ACRE	5.60	1.00	5.60	
MACHINE HOUSING*	ACRE	1.06	1.00	1.06	
LAND TAX	ACRE	3.50	1.00	3.50	
LAND RENT**	ACRE	42.70	1.00	42.70	
TOTAL FIXED COST				97.60	
TOTAL COST				422.88	

*INCLUDING BUILDINGS, TOOLS, AND TANKS
**1/3 CROP - 1/3 FERTILIZER COSTS - 1/3 CROP INSURANCE - LAND TAXES
WINTER CANOLA YIELD IS 2,188 LB/AC
FIVE-YEAR AVERAGE FARM GATE PRICE OF CANOLA IS $0.12/LB

CANOLA 2002 YEAR

TABLE A.10. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR IRRIGATED WINTER CANOLA FOLLOWING SPRING BARLEY, LIND, WA, 2002

OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST					TOTAL VARIABLE COST	TOTAL COST
							FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.		
						$	$	$	$	$	$	$	$
PLANT & FERTILIZE	CASE 8950, CROSS SLOT	AUG	2006	.10	.11	7.82	4.09	1.51	.00	107.50(1)	8.29	121.39	129.21
SPRAY WEEDS ONE	CUSTOM SPRAY (ROGATOR)	SEP	2006	.00	.00	.00	.00	.00	4.50	10.37(2)	.99	15.86	15.86
SPRAY WEEDS TWO	CUSTOM SPRAY (ROGATOR)	APR	2007	.00	.00	.00	.00	.00	4.50	10.37(3)	.30	15.17	15.17
FERTILIZE	CUSTOM FERTILIZER (TERREGATOR)	APR	2007	.00	.00	.00	.00	.00	6.00	25.43(4)	.63	32.06	32.06
SWATHE	15' DPAPER SWATHER	JUN	2007	.17	.20	4.02	1.67	2.80	.00	.00	.03	4.50	8.52
HARVEST	JD 7720 COMBINE	AUG	2007	.25	.27	2.45	8.19	3.78	.00	.00	.88	12.85	15.30
HAUL CANOLA	CUSTOM HAUL TO WAREHOUSE	AUG	2007	.00	.00	.00	.00	.00	2.25	.00	.17	2.41	2.41
HAUL CANOLA	CASE 8950, BANKOUT WAGON	AUG	2007	.07	.07	2.34	2.56	1.02	.00	.00	.26	3.84	6.19
IRRIGATE	IRRIGATION SYSTEM AND WELL	ANN	2007	.00	.11	25.88	15.00	1.57	.00	.00	.66	17.23	43.11
IRRIGATION POWER	POWER CHARGED FOR IRRIGATION	ANN	2007	.00	.00	.00	.00	.00	75.00	.00	3.00	78.00	78.00
MISC. USE	PICKUP	ANN	2007	.05	.06	.45	.54	.84	.00	.00	.06	1.43	1.88
MISC. USE	4-WHEEL ATV	ANN	2007	.03	.03	.09	.07	.42	.00	.00	.02	.50	.59
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN	2007	.00	.00	4.60	.67	.00	.00	.00	.03	.69	5.29
MISC. USE	SHOP TOOLS	ANN	2007	.00	.00	2.04	1.00	.00	.00	.00	.04	1.04	3.08
MISC. USE	FUEL & MISC. TANKS	ANN	2007	.00	.00	1.70	.20	.00	.00	.00	.01	.21	1.91
LAND TAX	LAND TAX	ANN	2007	.00	.00	3.50	.00	.00	.00	.00	.00	.00	3.50
CROP INSURANCE	CROP INSURANCE	ANN	2007	.00	.00	.00	.00	.00	2.50	.00	.10	2.60	2.60
LAND RENT	LAND RENT (OPPORTUNITY COSTS)	ANN	2007	.00	.00	42.70	.00	.00	.00	.00	.00	.00	42.70
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN	2007	.00	.00	.00	.00	.00	15.49	.00	.00	15.49	15.49
TOTAL PER ACRE				.66	.85	97.60	33.97	11.94	110.24	153.67	15.46	325.28	422.88

MATERIALS:

1. 8 LB WINTER CANOLA SEEDS ($32.00/AC), 29.03 GL SOLUTION 32 ($52.25/AC), 7.54 GL 10-34-0 ($15.76/AC), 6.93 GL THIOSUL ($7.48/AC)
2. 10 OZ ASSURE II ($10.00/AC), 0.1 QT R-11 ($0.37/AC)
3. 10 OZ ASSURE II ($10.00/AC), 0.1 QT R-11 ($0.37/AC)
4. 14.13 GL SOLUTION 32 ($25.43/AC)

CANOLA 2003-2006 YEARS

TABLE A.11. ITEMIZED COST PER ACRE FOR IRRIGATED WINTER/SPRING CANOLA FOLLOWING SPRING BARLEY, LIND, WA, 2003-2006

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS		$		$	
WINTER CANOLA SEEDS	LB.	4.00	5.50	22.00	
SPRING CANOLA SEEDS	LB.	4.00	5.00	20.00	
ROGATOR SPRAYER	ACRE	4.50	2.50	11.25	
CUSTOM HAUL	ACRE	2.25	1.00	2.25	
R-11	QT.	3.68	.20	.74	
PARAQUAT	QT.	8.31	1.88	15.58	
SOLUTION 32	GL.	1.80	43.16	77.68	
10-34-0	GL.	2.09	7.54	15.76	
THIOSUL (LIQ)	GL.	1.08	6.93	7.48	
APRON XL	OZ.	6.16	.04	.25	
ASSURE II	OZ.	1.00	7.50	7.50	
LANDMASTER II	OZ.	.18	25.50	4.59	
CROP INSURANCE	ACRE	2.50	1.00	2.50	
IRRIGATION POWER	ACRE	75.00	1.00	75.00	
MACHINERY REPAIRS	ACRE	22.19	1.00	22.19	
MACHINE FUEL/LUBE	ACRE	14.36	1.00	14.36	
LABOR(TRAC/MACH)	HOUR	14.00	.96	13.45	
OVERHEAD	ACRE	16.40	1.00	16.40	
INTEREST ON OP. CAP.	ACRE	15.35	1.00	15.35	
TOTAL VARIABLE COST				344.34	
FIXED COSTS		$		$	
MACHINE DEPRECIATION*	ACRE	17.80	1.00	17.80	
MACHINE INTEREST*	ACRE	27.97	1.00	27.97	
MACHINE INSURANCE*	ACRE	2.10	1.00	2.10	
MACHINE TAXES*	ACRE	6.29	1.00	6.29	
MACHINE HOUSING*	ACRE	1.45	1.00	1.45	
LAND TAX	ACRE	3.50	1.00	3.50	
LAND RENT**	ACRE	6.34	1.00	6.34	
TOTAL FIXED COST				65.44	
TOTAL COST				409.78	

*INCLUDING BUILDINGS, TOOLS, AND TANKS
**1/3 CROP - 1/3 FERTILIZER COSTS - 1/3 CROP INSURANCE - LAND TAXES
SPRING CANOLA YIELD IS 1,137 LB/AC
FIVE-YEAR AVERAGE FARM GATE PRICE OF CANOLA IS $0.12/LB

CANOLA 2003-2006 YEARS

TABLE A.12. SCHEDULE OF OPERATIONS AND ESTIMATED COSTS PER ACRE FOR IRRIGATED WINTER/SPRING CANOLA FOLLOWING SPRING BARLEY, LIND, WA, 2003-2006

OPERATION	TOOLING	MTH	YEAR	MACH HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST					TOTAL VARIABLE COST	TOTAL COST
							FUEL, LUBE, & REPAIRS	MACH LABOR	SERVICE	MATER.	INTER.		
						$	$	$	$	$	$	$	$
SPRAY WEEDS ONE	CUSTOM SPRAY (ROGATOR)	SEP	2006	.00	.00	.00	.00	.00	3.38	15.95(1)	1.29	20.61	20.61
PLANT & FERTILIZE	CASE 8950, CROSS SLOT	SEP	2006	.10	.11	7.82	4.09	1.51	.00	97.74(2)	6.89	110.23	118.05
SPRAY WEEDS TWO	CUSTOM SPRAY (ROGATOR)	OCT	2006	.00	.00	.00	.00	.00	3.38	7.87(3)	.67	11.92	11.92
SPRAY WEEDS THRE	CUSTOM SPRAY (ROGATOR)	MAR	2007	.00	.00	.00	.00	.00	4.50	4.59(4)	.24	9.33	9.33
PLANT CANOLA	CASE 8950, CROSS SLOT	APR	2007	.10	.11	7.82	4.09	1.51	.00	45.43(5)	1.02	52.05	59.87
SWATHE CANOLA	15' DRAPER SWATHER	JUN	2007	.02	.20	.40	.17	2.80	.00	.00	.02	2.99	3.39
HARVEST	JD 7720 COMBINE	AUG	2007	.25	.27	2.45	8.19	3.78	.00	.00	.88	12.85	15.30
HAUL CANOLA	CASE 8950, BANKOUT WAGON	AUG	2007	.07	.07	2.34	2.56	1.02	.00	.00	.26	3.84	6.19
HAUL CANOLA	CUSTOM HAUL TO WAREHOUSE	AUG	2007	.00	.00	.00	.00	.00	2.25	.00	.17	2.41	2.41
IRRIGATE	IRRIGATION SYSTEM & WELL	ANN	2007	.00	.11	25.88	15.00	1.57	.00	.00	.66	17.23	43.11
IRRIGATION POWER	POWER CHARGED FOR IRRIGATION	ANN	2007	.00	.00	.00	.00	.00	75.00	.00	3.00	78.00	78.00
MISC. USE	PICKUP	ANN	2007	.05	.06	.45	.54	.84	.00	.00	.06	1.43	1.88
MISC. USE	4-WHEEL ATV	ANN	2007	.03	.03	.09	.07	.42	.00	.00	.02	.50	.59
MISC. USE	MACHINE SHED & SHOP BUILDING	ANN	2007	.00	.00	4.60	.67	.00	.00	.00	.03	.69	5.29
MISC. USE	SHOP TOOLS	ANN	2007	.00	.00	2.04	1.00	.00	.00	.00	.04	1.04	3.08
MISC. USE	FUEL & MISC. TANKS	ANN	2007	.00	.00	1.70	.20	.00	.00	.00	.01	.21	1.91
LAND TAX	LAND TAX	ANN	2007	.00	.00	3.50	.00	.00	.00	.00	.00	.00	3.50
CROP INSURANCE	CROP INSURANCE	ANN	2007	.00	.00	.00	.00	.00	2.50	.00	.10	2.60	2.60
LAND RENT	LAND RENT (OPPORTUNITY COSTS)	ANN	2007	.00	.00	6.34	.00	.00	.00	.00	.00	.00	6.34
OVERHEAD	UTILITIES, LEGAL, ACCT., ETC.	ANN	2007	.00	.00	.00	.00	.00	16.40	.00	.00	16.40	16.40
TOTAL PER ACRE				.61	.96	65.44	36.55	13.45	107.40	171.58	15.35	344.34	409.78

MATERIALS:

1. 0.1 QT R-11 ($0.37/AC), 1.88 QT PARAQUAT ($15.58/AC)
2. 5.5 LB WINTER CANOLA SEEDS ($22.00/AC), 29.03 GL SOLUTION 32 ($52.25/AC), 7.54 GL 10-34-0 ($15.76/AC), 6.93 GL THIOSUL ($7.48/AC), 0.04 OZ APRON XL ($0.25/AC)
3. 7.5 OZ ASSURE II ($7.50/AC), 0.1 QT R-11 ($0.37/AC)
4. 24.5 OZ LANDMASTER II ($4.59/AC)
5. 5 LB SPRING CANOLA SEEDS ($20.00/AC), 14.13 GL SOLUTION 32 ($25.43/AC)

TABLE A.13. PER HOUR AND PER ACRE MACHINERY COSTS

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									
TRACTOR CASE 8950	65,000.00	12	350	10.71	9.71	.73	2.19	1.21	24.56	9.29	23.00	32.29	56.84
CROSS SLOT DRILL	75,000.00	10	162	.00	37.04	2.78	8.33	4.63	52.78	6.17	.00	6.17	58.95
35' JD455 DRILL	38,000.00	20	180	8.33	10.22	.77	2.30	1.28	22.90	4.17	.00	4.17	27.07
24' SMIZER PACKER	2,400.00	15	150	.71	.85	.06	.19	.11	1.93	.80	.00	.80	2.73
SWATHER DRAPER	30,000.00	15	150	8.89	10.67	.80	2.40	1.33	24.09	10.00	.00	10.00	34.09
20' JD 7720 COMBINE	20,000.00	15	250	4.80	3.52	.26	.79	.44	9.82	4.00	28.75	32.75	42.57
12'MOLDBOARD PLOW	16,000.00	20	125	6.40	5.12	.38	1.15	.64	13.70	4.80	.00	4.80	18.50
47' CULTIVATOR	12,000.00	25	100	4.00	5.60	.42	1.26	.70	11.98	4.00	.00	4.00	15.98
2-TON TRUCK	10,000.00	25	80	4.25	5.75	.43	1.29	.72	12.44	12.50	4.31	16.81	29.26
CENT.PIV.IRRIG.	60,000.00	30	200	9.50	12.60	.95	2.84	.00	25.88	15.00	.00	15.00	40.88
BANKOUT WAGON	12,000.00	25	150	2.67	3.73	.28	.84	.47	7.99	2.67	.00	2.67	10.65
PICKUP	25,000.00	10	400	4.38	3.25	.24	.73	.41	9.01	1.25	9.49	10.74	19.74
4WD ATV	6,000.00	15	250	1.20	1.20	.09	.27	.15	2.91	.60	1.58	2.18	5.09
	ACRES COVERED			COST PER ACRE									
FARM BUILDINGS	80,000.00	30	1500	1.69	2.24	.17	.50	.00	4.60	.67	.00	.67	5.27
SHOP TOOLS	30,000.00	20	1500	.90	.88	.07	.20	.00	2.04	1.00	.00	1.00	3.04
FUEL, MISC. TANKS	25,000.00	20	1500	.83	.67	.05	.15	.00	1.70	.20	.00	.20	1.90

TABLE A.14. INPUT AND COMMODITY PRICE LIST, 2006 and 2007

MATERIAL	UNIT	PRICE ($/ UNIT)
SEED[1]		
SOFT WHITE WINTER WHEAT	BU	0.125
SPRING BARLEY	TON	0.13
WINTER CANOLA	LB	4.00
SPRING CANOLA	LB	4.00
CHEMICALS[2]		
UREA	LB	0.26
THIOSUL (DRY)	LB	1.08
MAP (DRY)	LB	0.25
LANDMASTER II	OZ	0.18
AMM. SULFATE	LB	0.82
BRONATE	OZ	0.29
SOLUTION 32	GAL	1.80
10-34-0	GAL	2.09
THIOSUL (LIQUID)	GAL	1.08
ASSURE II	OZ	1.00
R-11	QT	3.68
PARAQUAT	QT	8.31
APRON XL (FUNGICIDE)	OZ	6.16
SUREFIRE	OZ	0.24
OTHER COSTS[3]		
DIESEL[4]	GAL	2.50
INTEREST RATE	%	8.00
MACHINERY LABOR	HR	14.00
CROP INSURANCE	ACRE	2.50
LAND TAX	ACRE	3.50
TERRAGATOR	ACRE	6.00
ROGATOR	ACRE	4.50
CUSTOM AERIAL	ACRE	4.50
CUSTOM HAUL	ACRE	2.25
COMMODITY PRICES (5-YEAR AVERAGE)		
SOFT WHITE WINTER WHEAT[5]	BUSHEL	3.51
SPRING BARLEY[5]	TON	89.16
SPRING AND WINTER CANOLA	LB	0.12

[1]SEED PRICE PROVIDED BY LOCAL FARMERS.

[2]CHEMICAL PRICES FROM LOCAL SUPPLIERS PROVIDED BY T.SMITH, RITZVILLE, WA (PERSONAL COMMUNICATION), 2007.

[3]CROP INSURANCE AND LAND TAX PROVIDED BY A COOPERATING FARMER;, ODESSA, WA.

[4]DIESEL PRICE EXCLUDES ROAD TAXES.

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