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	<p>AN ECONOMIC ANALYSIS OF ALTERNATIVE CROP ROTATIONS IN THE INTERMEDIATE RAINFALL AREA OF EASTERN WASHINGTON: THE WILKE FARM EXPERIENCE</p>	
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THE WILKE FARM EXPERIENCE**

By

Gayle S. Willett and Adam T. Jessup*

INTRODUCTION

This publication presents an economic analysis of three crop rotations for the intermediate rainfall (15 inches annual precipitation) area of eastern Washington. The three rotations are: (1) annual cropping (spring wheat-spring wheat-spring barley), (2) three-year rotation (winter wheat-spring barley-summer fallow, and 93) two-year rotation (winter wheat-summer fallow). Conventional tillage is used with each rotation. Annual revenues, costs, and various return measures are reported for each rotation and for individual crops. The study is based on crop yields, production practices, and machinery resources associated with Washington State University's commercially operated Wilke Farm.

One of the primary research objectives for the Wilke Farm over the past decade has been to study the impacts of intensifying the cropping program relative to the typical winter wheat-summer fallow rotation. Several reasons can be cited for a growing interest in using three-year and annual spring cropping rotations: (1) improved profitability by reducing the incidence of summer fallow in the rotation, (2) environmental benefits associated with increased residue cover on fields during the summer and fall, thereby reducing soil erosion (wind and water) and improving soil quality, (3) decreased incidence of winter annual grass weeds and diseases, (4) winter kill of winter wheat, and

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(5) above normal precipitation following a cropping year may permit a continuous spring cropping program for several years. Since dryland grain production is a highly competitive and risky business, producers are interested in an economic valuation of proposed major adjustments in cropping programs. The Wilke Farm experience should be of particular interest, since the alternative rotations have been adopted on a whole-field basis for 11 years.

STUDY PROCEDURES AND ASSUMPTIONS

As noted above, many of the assumptions underlying this study are based on WSU's Wilke Farm. The Wilke Farm is a 351-acre unit willed to the university in 1982. Since that time, the property has been managed by the university and farmed by a local producer under a crop-share agreement. The farm is located in Lincoln County of northeast Washington, adjacent to the city of Davenport. Annual rainfall in this region averages about 15 inches which has traditionally supported a winter wheat-summer fallow rotation. Since 1986, the farm has been divided into four fields, each containing between 83 and 91 acres, and farmed under two rotations. Fields one, two, and three have supported a rotation of summer fallow-winter wheat and spring barley. Annual cropping has been practiced on field four (see Appendix, Table I, for the annual cropping history of each field). Detailed records on varieties, yields, cultural operations, and types and amounts of materials have been kept for each field and rotation.

Yields assumed for the study are noted below:

<u>Rotation/Crop</u>	<u>Yield Per Acre</u>
1. Annual	
Spring wheat	33.4 bushels
Spring barley	1.232 tons
2. Three-year	
Winter wheat	59.4 bushels
Spring barley	1.263 tons
3. Two-year	
Winter wheat	57.4 bushels

The yields assumed for the annual and three-year rotations are averages for the Wilke Farm, 1986-1996, as reported in Table 1. Spring wheat was produced in all or a part of field four. During that time, yields ranged from 20.0 to 53.0 bushels, and averaged 33.4 bushels per acre. Spring barley produced in the annual cropping rotation averaged 1.232 tons per acre, but varied between 2.133 and 0.750 tons over the seven years it was grown in field four. Although winter wheat was occasionally grown in field four, the average was small (except for 1996 and the crop was therefore, not included in the rotation adopted for this study).

Since three fields were used to support the three-year rotation of winter wheat-spring barley-summer fallow, both winter wheat and spring barley were planted on one of the fields each year. Winter wheat averaged 59.4 bushels per acre, but varied between 37.2 and 82.0 bushels over the 11 years. These yield data reflect two years of spring wheat production (1989 and 1991), necessitated by the total distribution of the winter wheat crop due to severe winter weather. Spring barley yields varied from 0.75 to 2.133 tons, and averaged 1.263 tons per acre.

Table 1. Yield history for the three-year and annual cropping rotations, Wilke Farm 1986-1996.

Year	Three-Year Rotation (Fields 1, 2, & 3)		Annual Cropping (Field 4)		
	Winter Wheat	Spring Barley	Spring Wheat	Spring Barley	Winter Wheat
	Bu.	Ton	Bu.	Ton	Bu.
1996	57.5	1.289	NS ²	NS	44.7 ³
1995	59.6	1.756	53.0	NS	NS
1994	72.2	1.077	NS	1.077	NS
1993	82.0	2.133	NS	2.133	NS
1992	54.9	0.916	28.2 ³	0.916	NS
1991	48.0 ¹	1.345	30.0	NS	NS
1990	72.2	0.800	20.0	NS	NS
1989	37.2 ¹	1.184	26.0	0.941 ³	34.3
1988	73.2	1.378	37.07 ³	1.544	71.1
1987	56.0	0.750	34.0	0.750 ³	56.0
1986	41.1	1.260	40.0 ³	1.260	NS
Mean	59.4	1.263	33.4	1232	49.02
Coefficient of Variation	22.8	37.9	28.3	35.7	--

¹Winter wheat crop destroyed by severe winter weather and reseeded to spring wheat. Not seeded in this year.

³Primary crop in year when two or more crops were planted in field 4.

A comparison of yields between the two rotations should recognize the potential impact of small soil quality differences between fields. Fields one, two, and three are quite similar; however, field four (annual cropping) tends to have lighter and more variable soil. Average spring barley yields for the two rotations were about the same, however.

An average winter wheat yield of 57.4 bushels per acre is assumed for the two-year rotation. Since this rotation was not utilized on the Wilke Farm during the study period, the yield assumption is necessarily based on the estimates of producers/researchers familiar with the study area.

Commodity prices assumed for the study are \$3.66 per bushel for soft white winter and spring wheat and \$91.65 per ton for barley. These are an unweighted average of monthly average prices received by Washington farmers, August-March, 1986-1997.¹ It is further assumed these prices are net of all marketing and transportation costs.

The above yield and price assumptions are adopted for a base economic analysis of the various crops and rotations. However, in recognition that yields and prices vary significantly over time, the analysis is rerun to reflect average yields and prices for the four highest revenue (yield times price) years and the four lowest revenue years.

Assumptions about field operations, types, and amounts of fertilizer and pesticides, seeding rates, and machinery complement are based on Wilke Farm records and information provided by the farm's operator. Prices for various materials and services were obtained from local vendors. Production costs represent 1996 price levels.

All machinery is owned and operated by the Wilke Farm tenant, who also uses the machinery on other farms included in his operation. Machinery costs had not been allocated to particular field operations for specific crops by farm. Thus, it was necessary to develop these detailed costs using assumptions

¹See the Appendix, Tables II and III, for August-March, 1986-1997, wheat and barley prices received by Washington farmers.

based on the operator's machinery complement.² Machinery fixed costs (depreciation, interest, property taxes, housing, and insurance) and variable costs (repairs, fuel, and lubrication) are calculated on a per acre basis for each field operation.

STUDY RESULTS

Rotation Economics

The yield, price, gross revenue, variable costs, and returns over variable costs are reported for each crop and rotation in Table 2. A valid economic comparison of the rotations can be made on the basis of returns over variable costs. Fixed costs were excluded from this phase of the analysis, since they are the same for each rotation and therefore, have no effect on the economic ranking of the rotations. Such costs include machinery ownership costs (i.e., depreciation, interest on the investment, property taxes, insurance, and housing, land rent, real estate taxes, and management. Variable costs vary with the crop and rotation and thus are relevant to an economic comparison of rotations. Variable costs include seed, fertilizer, herbicides, fuel, lubrication, repairs, labor, and insurance, miscellaneous (utilities, legal, accounting, etc.), and interest on these outlays. Returns over variable costs represent the returns available to cover fixed costs. They are a measure of relative profitability useful in ranking the profitability of crops and rotations.

Due to the time value of money (i.e., near term dollars are worth more than postponed dollars) and differences between rotations in the timing of net returns, an accurate comparison of rotations requires that returns over variable costs for each rotation be adjusted to a common point in time.

²The capital investment, annual use, and hourly costs for the machinery complement are reported in the Appendix, Table IV.

Table 2. Economic comparison of alternative crop rotations, average yields and prices, Wilke Farm, 1986-1996.

Rotation	Yield ¹	Price ²	Gross Revenues	Variable Costs ³	Returns Over Variable Costs
1. Annual (Field 4)					
a. Spring wheat	33.4. Bu.	\$ 3.66	122.24	\$115.78	\$ 6.46
b. Spring wheat	33.4 Bu.	3.66	122.24	115.78	6.46
c. Spring barley	1.232 T	91.65	112.91	115.73	-2.82
Present value of three-year returns over variable costs @ 10% interest					9.09
Annualized returns over variable costs per rotation acre @ 10% interest					3.66
2. Three Year (Fields 1-3)					
a. Winter wheat	59.4 Bu.	\$ 3.66	\$217.40	\$ 93.79	\$123.61
b. Spring barley	1.263 T	91.65	115.75	103.10	12.65
c. Summer fallow	—	—	—	19.31	-19.31
Present value of returns over variable costs @ 10% interest					108.32
Annualized returns over variable costs per rotation acre @ 10% interest					43.56
3. Two Year (Estimated)					
a. Winter wheat	57.4 Bu.	\$ 3.66	\$ 210.08	\$ 93.79	\$116.29
b. Summer fallow	—	—	—	19.31	-19.31
Present value of two-year returns over variable costs @ 10% interest					89.76
Annualized returns over variable costs per rotation acre @ 10% interest					51.72

¹Average yield, Wilke Farm, 1986-1996.

²Average monthly price received by Washington farmers, August-March, 1986-1997.

³Variable costs include seed, fertilizer, herbicides, fuel, lubrication, repairs, labor, crop insurance, and interest, Wilke Farm, 1996.

This can be accomplished by computing the present value of returns over variable costs for each crop within a rotation and summing the resulting present values. A 10% interest rate was used to compute present values. For example, the present value of returns over variable costs for the annual rotation

$$= \$6.46 \left[\frac{1}{(1.10)^1} \right] + \$6.47 \left[\frac{1}{(1.10)^2} \right] - \$2.82 \left[\frac{1}{(1.10)^3} \right], \text{ or } \$909 \text{ per rotation acre. However, a}$$

comparison of the present value of returns over variable costs between rotations is inappropriate when there are differences in the length of the rotation. Since the rotations varied in length (i.e., two to three years), it was necessary to annualize the present value of returns over variable costs for each of the three rotations. This was accomplished using a 10% interest rate and the following formula:

Annualized returns over variable costs = Present value of returns over variable costs x

$$\left(\frac{0.10 (1.10)^n}{(1.10)^n - 1} \right), \text{ where } n = \text{number of years in}$$

rotation.

Thus, for example, the annualized returns over variable costs for the annual rotation =

$$\$9.09 \left(\frac{0.10 (1.10)^3}{(1.10)^3 - 1} \right), \text{ or } \$3.66 \text{ per rotation acre. An accurate ranking of the rotations is}$$

obtained by comparing the annualized returns over variable costs per rotation acre.

As noted in Table 2, annualized returns are the highest for the two-year rotation at \$51.72, followed by the three-year rotation at \$43.56, and the annual rotation at \$3.66. The strength of the two-year rotation is based on the substantial economic advantage of winter wheat over the other crops and the higher incidence (50%) of that crop in the rotation. These benefits more than offset the disadvantages

of a slightly lower winter wheat yield relative to winter wheat in the three-year rotation and the higher incidence of summer fallow. It should be emphasized that the economic analysis does not consider differences between the rotations in susceptibility to soil erosion and the associated environmental and long-term soil quality impacts. Concerns about these issues will be greatest for the rotations containing erosion-prone summer fallow.

Thus far, the analysis has assumed average yields, prices, and revenues over the 1986-1996 study period. Of course, these key variables (plus production costs) often vary considerably from year-to-year, thereby introducing substantial risk into dryland grain production. The impact of risk on the ranking of the Wilke Farm rotations was examined by rerunning the analysis to reflect varying yields, prices, and gross revenues. Before reviewing the results of that analysis, your attention is directed to Table 1 where the coefficient of variation in yields for crops grown in the Wilke Farm rotations is reported. The coefficient of variation is derived by dividing the yield standard deviation (a measure of dispersion around the mean) by the mean yield and multiplying the result times 100. It is a measure of relative (percent) yield risk that is independent of the unit of measure (bushels, tons). A higher coefficient of variation implies more yield risk. Note the substantially lower coefficient of variation for winter wheat yields (22.8%) in the three-year rotation than for spring wheat yields (28.3%) in the annual cropping rotation. Spring barley yields were slightly more stable in the annual cropping (35.7%) than in the three-year rotation (37.9%).

To determine the impact of changing yields and prices the annualized returns over variable costs were re-calculated for each rotation to reflect years when gross revenues were above and below the averages reported earlier (Table 2). The first step in this analysis was to compute the total revenues

for each crop by year, 1986-1996, using the actual yield and average September price for the year corresponding to the reported yield. Next, the annual gross revenues were listed in descending order. Average annual yields and prices were then compiled for the four high and four low gross revenue years. Finally, the previously reported 1996 variable costs were subtracted from the average high and low gross revenues, making it possible to compute the annualized returns over variable costs per rotation acre. The results of this analysis for the average high and low revenue years appear in Tables 3-4, respectively.

The ranking of the rotations is not affected by changes in the yields and prices experienced during the 1986-1996 study period. The annualized returns over variable costs for the four high revenue years are: (1) two-year rotation, \$83.31; (2) three-year rotation, \$81.47; and (3) annual rotation, \$52.16 (Table 3). While the two-year rotation remains the most profitable, its advantage over the other rotations is reduced relative to a comparison based on 1986-1996 average gross revenues. Based on high revenue years, the advantage of the two-year rotation amounts to only 1.84 per acre over the three-year rotation and \$31.15 per acre compared to annual cropping. The improvement in the annual cropping and three-year rotations relative to the two-year rotation is largely attributable to a 46% increase in spring barley revenues.

The significant yield and price risks associated with dryland grain production are underlined by the dramatic reduction in returns over variable costs that occurs for all rotations when annual returns are based on the average of the four lowest gross revenue years (Table 4). For example, returns over variable costs for the three-year rotation dropped by 98% compared to the average of the four high revenue years. Once again, annualized returns over variable costs are highest for the two-year

Table 3. Economic comparison of alternative crop rotations, average yields and prices for four high revenue years, Wilke Farm, 1986-1996.

Rotation	Yield ¹	Price ²	Gross Revenues	Variable Costs ³	Returns Over Variable Costs
1. Annual (Field 4)					
a. Spring wheat	39.86 Bu.	\$ 4.25	\$169.41	\$115.78	\$ 53.63
b. Spring wheat	39.86 Bu.	4.25	169.41	115.78	53.63
c. Spring barley	1.662 T	98.97	164.49	115.73	48.76
Present value of three-year returns over variable costs per rotation acre @ 10% interest					129.71
Annualized returns over variable costs per rotation acre @10% interest					52.16
2. Three Year (Fields 1-3)					
a. Winter wheat	65.62 Bu.	4.25	278.89	93.79	186.10
b. Spring barley	1.639 T	98.97	162.21	103.10	59.11
c. Summer fallow	—	—	—	19.31	-19.31
Present value of returns over variable costs per rotation acre @ 10% interest					202.61
Annualized returns over variable costs per rotation acre @ 10% interest					81.47
3. Two Year (Estimated)					
a. Winter wheat	63.62	4.25	270.39	93.79	176.60
b. Summer fallow	—	—	—	19.31	-19.31
Present value of two-year returns over variable costs per rotation acre @ 10% interest					144.59
Annualized returns over variable costs per rotation acre @ 10% interest					83.31

¹Average yield for the four high revenue years, Wilke Farm, 1986-1996.

²Average September price received by Washington farmers during the four high revenue years, Wilke Farm, 1986-1997.

³Variable costs include seed, fertilizer, herbicides, fuel, lubrication, repairs, labor, crop insurance, and interest, Wilke Farm, 1996.

Table 4. Economic comparison of alternative crop rotations, average yields and prices, for four low revenue years, Wilke Farm, 1986-1996.

Rotation	Yield ¹	Price ²	Gross Revenues	Variable Costs ³	Returns Over Variable Costs
1. Annual (Field 4)					
a. Spring wheat	33.03 Bu.	\$ 3.14	\$ 103.71	\$ 115.78	\$ -12.07
b. Spring wheat	33.03 Bu.	3.14	103.71	115.78	-12.07
c. Spring barley	0.881	80.95	71.32	115.73	- 44.41
Present value of three-year returns over variable costs per rotation acre @ 10% interest					-54.32
Annualized returns over variable costs per rotation acre @ 10% interest					-21.84
2. Three Year (Fields 1-3)					
a. Winter wheat	45.58 Bu.	3.14	143.12	93.79	49.33
b. Spring barley	0.886 T	80.95	71.72	103.10	-31.38
c. Summer fallow	—	—	—	19.31	-19.31
Present value of two-year returns over variable costs per rotation acre @ 10% interest					4.41
Annualized returns over variable costs per rotation acre @ 10% interest					1.77
3. Two Year (Estimated)					
a. Winter wheat	43.58	3.14	136.84	93.79	43.05
b. Summer fallow	—	—	—	19.31	-19.31
Present value of two-year returns over variable costs per rotation acre @ 10% interest					23.18
Annualized returns over variable costs per rotation acre @ 10% interest					13.36

¹Average yield for the four low revenue years, Wilke Farm, 1986-1996.

²Average September price received by Washington farmers during the four low revenue years, Wilke Farm, 1986-1997.

³Variable costs include seed, fertilizer, herbicides, fuel, lubrication, repairs, labor, crop insurance, and interest, Wilke Farm, 1996.

rotation (\$13.36), followed by the three-year rotation (\$1.77), and annual cropping (-\$21.84). Note that, assuming 1996 variable costs, losses for the annual cropping program decrease by \$21.84 per acre if no crops are planted. By not planting a crop, losses are restricted to the fixed costs. The spread between the highest (two-year) and lowest (annual) earning rotations is \$35.20, compared to \$48.06 for the average and \$31.15 for the low revenue years.

Enterprise Economics

Detailed economic information about each enterprise, including yield, grain price, gross revenue, variable costs, fixed costs, and various measures of net returns is presented in this section of the report. The analysis is based on average yields reported for the Wilke Farm, 1986-1996 and grain prices are an average of the monthly prices received by Washington farmers, August-March, 1986-1997. Production costs reflect prices paid for materials and services in 1996. A summary of the enterprise analysis appears in Table 5. Principal conclusions are:

1. Only winter wheat generated sufficient revenues to cover total costs, providing a profit of \$15.87 and \$14.50 per acre for the three- and two- year rotations, respectively. In computing total cost, a cost is assigned to every resource used to grow the crop, including operator labor and management, and interest on equity capita. When costs are defined in this manner, profit should

Table 5. Summary of enterprise economic analysis for alternative rotations, Wilke Farm.

Rotation and Crop	Yield ¹	Price ² \$	Gross Revenues \$	Variable Costs ³ \$	Fixed Costs ⁴ \$	Total Costs \$	Profit ⁵ \$	Rate of Return on Land Investment ⁶ %
-- Per Acre --								
1. Annual								
Spring wheat	33.4 Bu.	3.66	122.24	115.78	75.30	191.08	-68.84	-5.0
Spring barley	1.232 T	91.65	112.94	115.73	71.24	186.97	-74.03	-6.0
2. Three-Year								
Winter wheat	59.4 Bu.	3.66	217.40	93.79	107.74	201.53	15.87	9.0
Spring barley	1.263. T	91.65	115.75	103.10	71.85	174.95	-59.20	-5.0
Summer fallow	—	—	—	19.31	11.35	30.66	-30.66	-3.6
3. Two-Year								
Winter wheat	57.4 Bu.	3.66	210.08	93.79	104.79	195.58	14.50	7.8
Summer fallow	—	—	—	19.31	11.35	30.66	-30.66	-3.6

¹Average yield, Wilke Farm, 1986-1996

²Average monthly price received by Washington farmers, August-March, 1986-1997.

³Includes seed, fertilizer, herbicides, fuel, lubrication, repairs, labor, crop insurance, and interest, Wilke Farm, 1996.

⁴Includes machinery ownership costs (depreciation, interest at 10%, property taxes, insurance, and housing), real estate taxes, net land rent, and management.

⁵Gross revenues - total costs.

⁶Returns to land ÷ \$850 market value.

be interpreted as the returns to risk associated with committing resources to winter wheat production.

2. A positive rate of return on the market value of the land exists only with winter wheat production. These returns, which exclude capital gain (losses) from changes in land value, are estimated to be 9% in the three-year rotation and 7.8 percent in the two-year rotation. In calculating a rate of return to the land's market value, all costs except the land cost (net rent) are subtracted from gross revenues and the remainder, defined to be the returns to land, is divided by the assessed \$850 market value of land and multiplied times 100.
3. Spring barley and spring wheat revenues failed to cover total costs. This implies that the provider of owned resources (i.e., operator labor and management, and equity capital) failed to realize the return to those resources assumed to be available from the next best, similar risk, alternative use of the resources. These alternative returns are estimated to be \$10 per hour for operator labor, 7% of gross revenues for management, 10% interest on the investment in machinery, and net rent for land based on a rental rate typical for the study area (a one-third land owner, two-thirds leases arrangement).
4. Revenues from spring barley production in the annual cropping program failed to cover variable costs. This implies that economic losses could be reduced by not growing any crop or by growing an alternative crop whose revenue is sufficient to cover variable costs.

Detailed information for each enterprise is reported in three tables as follows:

Tables 6A-11A: Schedule of Operations and Cost Per Acre

The first table (A) of the three tables used to report economic information for each enterprise is a

schedule of field operations and per acre production costs. The information reported for each field operation includes a description of the machinery, the month in which the operation occurs, machinery hours, labor hours, type and amount of materials, and associated costs. Costs are divided into two categories. The first is fixed costs which are outlays associated with the ownership of machinery, land, and management resources. Since these resources are already owned, the associated costs are incurred regardless of the enterprise in question. The second category of costs is variable costs which varies with the acreage and enterprise. Variable costs are associated with operating machinery, obtaining labor, and purchasing materials and services.

Machinery fixed costs include depreciation, interest on the investment (10%), property taxes, insurance, and housing. These costs and variable machinery costs (repairs, fuel, and lubrication) as estimated for the machinery complement owned by the Wilke Farm's lessee are reported on a per hour basis in the Appendix, Table IV. Machinery costs for a specific field operation are determined by multiplying the machine hours per acre times the per-hour costs. Thus, machinery costs are allocated to a particular enterprise and field operation on the basis of hours of use.

Land fixed costs include taxes and net rent. Net rent is based on the rental agreements typical for the study area. The typical lease is a crop-share agreement with the landowner getting one-third of the crop and the lessee the remaining two-thirds. Also, the landowner pays the property tax and one-third of the fertilizer and crop insurance costs.

Net rent is the market value of the landowner's one-third share of the crop minus the landowner's share of the fertilizer, crop insurance, and real estate taxes.

These tables also include management as a fixed cost. A management charge of 7% of gross revenues is used. This is representative of management fees charged by professional farm managers.

Variable costs vary with the type and size of enterprise. They include fuel, oil, repairs, fertilizer, chemicals, seed, miscellaneous (telephone, utilities, legal, accounting, dues, etc.), labor, and interest on operating capital. A cost of \$10 per hour is assigned to both operator and hired labor. Interest is compiled at the annual rate of 10% for the period of time between the month the operating expense is incurred and harvest time.

Tables 6B-11B: Summary of Costs Per Acre

Fixed and variable costs are reported according to the resource used to produce the crop rather than by field operation in the record (table B) of the three enterprise tables. Substantial detail regarding the type, amount, and per unit prices of most inputs is also presented in this table. See the Appendix, Table V, for a complete list of assumed input prices.

Tables 6C-11C: Summary of Revenues, Costs, and Returns Per Acre

Revenues, costs, and various measures of return are reported for each enterprise in these tables. The first return measure is returns over variable costs (line 1). This measure can be used to compare the profitability of competing crops. Selection of the enterprise with the highest returns over variable costs insures that farm profits are maximized (or losses minimized). A second return measure, returns the land and management (line 2), is calculated by subtracting machinery fixed costs and real estate

taxes from returns over variable costs. Land owners often view land as the residual claimant to enterprise earnings. Consequently, the return to land (line 3) is viewed with considerable interest. To calculate that dollar return, all costs (including a management charge), except land net rent, are subtracted from gross revenues. The rate of return on the land investment is determined by dividing the return to land by the land's estimated current market value (\$850) and multiplying the result by 100.

Table 6A. Schedule of operations and costs per acre for spring wheat following spring barley or spring wheat, annual cropping, Wilke Farm.

Operation	Tooling	Month	Mach. Hours	Labor Hours	Total Fixed Costs ¹	Variable Costs						Total Costs	Comments
						Fuel, Lubr. & Repairs	Machine Labor @ \$10/Hr.	Service	Materials	Interest @10%	Total Variable Costs		
— \$ Per Acre —													
Chisel	310 HP-WT, 30' Chisel	Fall	0.058	0.076	\$ 2.12	\$ 1.90	\$ 0.76	—	—	\$0.24	\$ 2.90	\$ 5.02	
Harrow	310 HP-WT, 80' Harrow	April	0.026	0.028	0.76	0.59	0.28	—	—	0.03	0.90	1.66	
Cultivate (2 X)	310 HP-WT, 40' Cultivator	April	0.097	0.108	2.60	3.12	1.08	—	—	0.14	4.34	6.94	
Fertilize	310 HP-WT, 50' Applicator	April	0.047	0.052	0.76	0.86	0.52	—	24.72	0.87	26.97	27.73	70 lbs. N, 12 lbs. S
Cultivate	310 HP-WT, 40' Cultivator	April	0.049	0.054	1.30	1.56	0.54	—	—	0.07	2.17	3.47	
Weed Control	310 HP-WT, 50' Applicator	April	0.047	0.052	0.76	0.86	0.52	1.75	13.51	0.55	17.19	17.95	1.25 qts. Fargo
Rodweed	310 HP-WT, 50' Rodweeder	April	0.041	0.045	1.12	0.92	0.45	—	—	0.05	1.42	2.54	
Plant	310 HP-WT, 40' Drills	April	0.059	0.065	4.01	2.09	0.65	—	19.80	0.75	23.29	27.30	70 lbs. seed, 8 lbs. N, 8 lbs. P, 5 lbs. S
Haul Seed	Grain Truck	April	0.064	0.128	0.96	0.96	1.28	—	—	0.07	2.31	3.27	
Weed Control	310 HP-WT, 55' Sprayer	June	0.036	0.039	1.20	0.74	0.39	—	4.12	0.09	5.34	6.54	½ pt. Buctril, ½ pt. MCPA
Harvest	25' Combine	August	0.118	0.141	14.24	6.43	1.41	—	—	—	7.84	22.08	
Haul Grain	Grain Truck	August	0.093	0.144	3.18	1.74	1.44	—	—	—	3.18	6.36	
Haul Grain	2 Grain Truck ²	August	0.214	0.256	1.92	1.92	2.56	—	—	—	4.48	6.40	
Taxes, Real Estate	—	Annual	—	—	3.24	—	—	—	—	—	—	3.24	
Crop Insurance	Multi-Peril	Annual	—	—	—	—	—	2.44	—	—	2.44	2.44	
Miscellaneous	Utilities, Legal, Accnt., etc.	Annual	—	—	—	—	—	—	5.51	—	5.51	5.51	
Pickup	—	Annual	0.225	0.267	2.00	1.20	2.67	—	—	—	3.87	5.87	
Service Truck	—	Annual	0.090	0.107	0.43	0.56	1.07	—	—	—	1.63	2.06	
Land ²	Net Rent	Annual	—	—	26.04	—	—	—	—	—	—	26.04	
Management ³	—	Annual	—	—	8.66	—	—	—	—	—	—	8.66	
TOTAL PER ACRE			1.263	1.562	\$75.30	\$25.45	\$15.62	4.19	67.66	\$2.86	\$115.78	\$191.08	

¹Includes depreciation, interest (10%), property taxes, housing, and insurance on machinery.

²Net rent = one-third of crop value (133.4 bu. X \$3.66) - one-third of fertilizer costs (\$33.46) - one-third of crop insurance (\$2.44) - real estate taxes (\$3.24).

³Management = 7% x crop value (33.4 bu. x \$3.66).

Table 6B. Summary of costs per acre for spring wheat following spring barley or spring wheat, annual cropping, Wilke Farm.

Item	Unit	Price or Cost Per Unit	Quantity	Cost
Variable Costs:				
Seed with Treatment	Lb.	\$0.158	70	\$ 11.06
Fertilizers:				
Nitrogen (Aqua)	Lb.	\$0.311	70	21.77
Nitrogen (Sol. 32)	Lb.	0.472	8	3.78
Phosphorus (10-34-0)	Lb.	0.466	8	3.73
Sulfur (12-0-0-26)	Lb.	0.246	17	4.18
Herbicides:				
Buctril	Pt.	8.52	0.33	2.81
MCPA	Pt.	2.55	0.5	1.28
Fargo	Qt.	10.81	1.25	13.51
w/Machine	Acre	1.75	—	1.75
Fuel & Lubrication	Acre	10.07	—	10.07
Repairs	Acre	15.41	—	15.41
Labor	Hour	10.00	1.562	15.62
Interest on Operating Capital	Dol.	10%	—	2.87
Crop Insurance	Acre	2.44	—	2.44
Miscellaneous	Dol.	—	—	5.51
TOTAL VARIABLE COSTS				\$115.78
Fixed Costs:				
Depreciation on Machinery	Acre	17.12	—	17.12
Interest on Machinery (10%)	Acre	13.79	—	13.79
Taxes, Housing, & Insurance on Machinery	Acre	6.45	—	6.45
Real Estate Taxes	Acre	3.24	—	3.24
Land (net rent) ¹	Acre	26.04	—	26.04
Management ²	Acre	8.66	—	8.66
TOTAL FIXED COSTS				75.30
Total Costs				\$191.08

¹Net rent = one-third of crop value (33.4 bu. x \$3.66) - one-third of fertilizer costs (\$33.46) - one-third of crop insurance (\$2.44) - real estate taxes (\$3.24).

²Management = 7% x crop value (33.4 bu. x \$3.66).

Table 6C. Summary of revenues, costs, and returns per acre for spring wheat following spring barley or spring wheat, annual cropping, Wilke Farm.

Item	Amount \$
Gross Revenues:	
Wheat Sales (33.4 ¹ bushel x 3.66 ²)	122.24
Total Gross Revenues	122.24
Less: Total Variable Costs	115.79
1. Returns Over Variable Costs	6.45
Less: Machinery Fixed Costs	37.36
Real Estate Taxes	3.24
2. Returns to Land and Management	-34.15
Less: Management	8.66
3. Returns to Land:	-42.81
Rate of Return to Land ($-\$42.81/\850 market value x100)	-5.0%

¹Average yield, Wilke Farm, 1986-1996.

²Average monthly price received by Washington farmers, August-March, 1986-1996.

Table 7A. Schedule of operations and costs per acre for spring barley following spring wheat, annual cropping, Wilke Farm.

Operation	Tooling	Month	Mach. Hours	Labor Hours	Total Fixed Costs ¹	Variable Costs						Total Variable Costs	Total Costs	Comments
						Fuel, Lubr. & Repairs	Machine Labor @ \$10/Hr.	Service	Materials	Interest @10%	— \$ Per Acre —			
Chisel	310 HP-WT, 30' Chisel	Fall	0.058	0.076	\$ 2.12	\$ 1.90	\$ 0.76	—	—	\$0.24	\$ 2.90	\$ 5.02		
Harrow	310 HP-WT, 80' Harrow	April	0.026	0.028	0.76	0.59	0.28	—	—	0.03	0.90	1.66		
Cultivate (2 X)	310 HP-WT, 40' Cultivator	April	0.097	0.108	2.60	3.12	1.08	—	—	0.14	4.34	6.94		
Fertilize	310 HP-WT, 50' Applicator	April	0.047	0.052	0.76	0.86	0.52	—	24.72	0.87	26.97	27.73	70 Lbs. N, 12 Lbs. S	
Cultivate	310 HP-WT, 40' Cultivator	April	0.049	0.054	1.30	1.56	0.54	—	—	0.07	2.17	3.47		
Weed Control	310 HP-WT, 50' Applicator	April	0.047	0.052	0.76	0.86	0.52	1.75	13.51	0.55	17.19	17.95	1.25 Qts. Fargo	
Rodweed	310 HP-WT, 50' Rodweeder	April	0.041	0.045	1.12	0.92	0.45	—	—	0.05	1.42	2.54		
Plant	310 HP-WT, 40' Drills	April	0.059	0.065	4.01	2.09	0.65	—	20.64	0.78	24.16	28.17	70 Lbs. seed, 8 Lbs. N, 8 Lbs. P, 5 Lbs. S	
Haul seed	Grain Truck	April	0.064	0.128	0.96	0.96	1.28	—	—	0.07	2.31	3.27		
Weed Control	310 HP-WT, 55' Sprayer	June	0.036	0.039	1.20	0.74	0.39	—	4.12	0.09	5.34	6.54	1/8 Pt. Buctril, 1/2 Pt. MCPA	
Harvest	25' Combine	August	0.118	0.141	14.24	6.43	1.41	—	—	—	7.84	22.08		
Haul Grain	Grain Truck	August	0.093	0.144	3.18	1.74	1.44	—	—	—	3.18	6.36		
Haul Grain	2 Grain Trucks	August	0.214	0.256	1.92	1.92	2.56	—	—	—	4.48	6.40		
Taxes, Real Estate	—	Annual	—	—	3.24	—	—	—	—	—	—	3.24		
Crop Insurance	Multi-Peril	Annual	—	—	—	—	—	1.52	—	—	1.52	1.52		
Miscellaneous	Utilities, Legal, Acct., etc.	Annual	—	—	—	—	—	—	5.51	—	5.51	5.51		
Pickup	—	Annual	0.225	0.267	2.00	1.20	2.67	—	—	—	3.87	5.87		
Service Truck	—	Annual	0.090	0.107	0.43	0.56	1.07	—	—	—	1.63	2.06		
Land ²	Net Rent	Annual	—	—	22.74	—	—	—	—	—	—	22.74		
Management ³	—	Annual	—	—	7.90	—	—	—	—	—	—	7.90		
TOTAL PER ACRE			1.263	1.562	\$71.24	\$25.45	\$15.62	3.27	68.50	\$2.89	\$115.74	\$186.97		

¹Includes depreciation, interest (10%), property taxes, housing, and insurance on machinery.

²Net rent = one-third of crop value (1.232 tons x \$91.65) - one-third of fertilizer costs (\$33.46) - one-third of crop insurance (\$1.52) - real estate taxes (\$3.24).

³Management = 7% x crop value (1.232 tons x \$91.65).

Table 7B. Summary of costs per acre for spring barley following spring wheat annual cropping, Wilke Farm.

Item	Unit	Price or Cost Per Unit	Quantity	Cost
Variable Costs:				
Seed with Treatment	Lb.	\$0.170	70	\$ 11.90
Fertilizers:				
Nitrogen (Aqua)	Lb.	\$0.311	70	21.77
Nitrogen (Sol. 32)	Lb.	0.472	8	3.78
Phosphorus (10-34-0)	Lb.	0.466	8	3.73
Sulfur (12-0-0-26)	Lb.	0.246	17	4.18
Herbicides:				
Buctril	Pt.	8.52	0.33	2.81
MCPA	Pt.	2.55	0.5	1.28
Fargo*	Qt.	10.81	1.25	13.51
w/Machine	Acre	1.75	—	1.75
Fuel & Lubrication	Acre	10.08	—	10.08
Repairs	Acre	15.42	—	15.42
Labor	Hour	10.00	1.562	15.62
Interest on Operating Capital	Dol.	10%	—	2.89
Crop Insurance	Acre	1.52	—	1.52
Miscellaneous	Dol.	—	—	5.51
TOTAL VARIABLE COSTS				\$115.73
Fixed Costs:				
Depreciation on Machinery	Acre	17.12	—	17.12
Interest on Machinery (10%)	Acre	13.79	—	13.79
Taxes, Housing, & Insurance on Machinery	Acre	6.45	—	6.45
Real Estate Taxes	Acre	3.24	—	3.24
Land (net rent) ¹	Acre	22.74	—	22.74
Management ²	Acre	7.90	—	7.90
TOTAL FIXED COSTS				71.24
TOTAL COSTS				186.97

¹Net rent = one-third of crop value (1.232 tons x \$91.65) - one-third of fertilizer costs (\$33.46)- one-third of crop insurance (\$1.52) - real estate taxes (\$3.24).

²Management = 7% x crop value (1.232 tons x \$91.65).

Table 7C. Summary of revenues, costs, and returns per acre for spring barley following spring wheat, annual cropping, Wilke Farm.

Item	Amount \$
Gross Revenues:	
Barley Sales (1.232 ¹ ton x \$91.65 ²)	112.91
Total Gross Revenue	112.91
Less: Total Variable Costs	115.74
1. Returns Over Variable Costs	-2.83
Less: Machinery Fixed Costs	37.36
Real Estate Taxes	3.24
2. Returns to Land and Management	-43.43
Less: Management	7.90
3. Returns to Land:	-51.33
Rate of Return to Land ($-\$51.33/\850 market value x 100)	-6.0%

¹Average yield, Wilke Farm, 1986-1996.

²Average monthly price received by Washington farmers, August-March, 1986-1996.

Table 8A. Schedule of operations and costs per acre for winter wheat following summer fallow, three-year rotation, Wilke Farm.

Operation	Tooling	Month	Mach. Hours	Labor Hours	Total Fixed Costs ¹	Variable Costs						Total Costs	Comments
						Fuel, Lubr. & Repairs	Machine Labor @ \$10/Hr.	Service	Materials	Interest @10%	Total Variable Costs		
— \$ Per Acre —													
Fertilizer	310 HP-WT, 50' Applicator	July	0.047	0.052	0.76	0.86	0.52	—	23.00	2.64	27.02	27.78	70 lbs. N, 5 Lbs. S
Rodweed	310 HP-WT, 50' Rodweeder	July	0.041	0.045	1.12	0.92	0.45	—	—	0.15	1.52	2.64	
Rodweeder	310 HP-WT, 50' Rodweeder	August	0.041	0.045	1.12	0.92	0.45	—	—	0.14	1.51	2.63	
Rodweed	310 HP-WT, 50' Rodweeder	Sept.	0.041	0.045	1.12	0.92	0.45	—	—	0.13	1.50	2.62	
Plant	310 HP-WT, 40' Drills	Sept.	0.059	0.065	4.01	2.09	0.65	—	18.96	1.99	23.69	27.70	60 Lbs. seed, 10 Lbs. N, 10 Lbs. P, 5 Lbs. S
Haul Seed	Grain Truck	Sept.	0.064	0.128	0.96	0.96	1.28	—	—	0.38	2.62	3.58	
Weed Control	310 HP-WT, 55' Sprayer	April	0.036	0.039	1.20	0.74	0.39	—	6.63	0.26	8.02	9.22	1/3 Oz. Harmony, 1/2 Pt. MCPA
Harvest	25' Combine	August	0.118	0.141	14.24	6.43	1.41	—	—	—	7.84	22.08	
Haul Grain	Grain Truck	August	0.093	0.144	3.18	1.74	1.44	—	—	—	3.18	6.36	
Haul Grain	2 Grain Trucks	August	0.214	0.265	1.92	1.92	2.56	—	—	—	4.48	6.40	
Taxes, Real Estate	—	Annual	—	—	3.24	—	—	—	—	—	—	3.24	
Crop Insurance	Multi-Peril	Annual	—	—	—	—	—	2.44	—	—	2.44	2.44	
Miscellaneous	Utilities, Legal, Acct., etc.	Annual	—	—	—	—	—	—	4.47	—	4.47	4.47	
Pickup	—	Annual	0.225	0.267	2.00	1.20	2.67	—	—	—	3.87	5.87	
Service Truck	—	Annual	0.090	0.107	0.43	0.56	1.07	—	—	—	1.63	2.06	
Land ²	Net Rent	Annual	—	—	57.22	—	—	—	—	—	—	57.22	
Management ³	—	Annual	—	—	15.22	—	—	—	—	—	—	15.22	
TOTAL PER ACRE			1.069	1.334	\$107.74	\$19.26	\$13.34	2.44	53.06	\$5.69	\$93.79	\$201.53	

¹Includes depreciation, interest (10%), property taxes, housing, and insurance on machinery.

²Net rent = one-third of crop value (59.4 bu. x \$3.66) - one-third of fertilizer costs (\$33.61) - one-third of crop insurance (\$2.44) - real estate taxes (\$3.24).

³Management = 7% x crop value (59.4 bu. x \$3.66).

Table 8B. Summary of costs per acre for winter wheat following summer fallow, three-year rotation, Wilke Farm.

Item	Unit	Price or Cost Per Unit	Quantity	Cost
Variable Costs:				
Seed with Treatment	Lb.	\$0.139	60	\$ 8.35
Fertilizers:				
Nitrogen (Aqua)	Lb.	0.311	70	21.77
Nitrogen (Sol. 32)	Lb.	0.472	10	4.72
Phosphorus (10-34-0)	Lb.	0.466	10	4.66
Sulfur (12-0-0-26)	Lb.	0.246	10	2.46
Herbicides:				
Harmony Extra	Oz.	16.05	1/3	5.35
MCPA	Pt.	2.55	1/2	1.28
Fuel & Lubrication	Acre	7.31	—	7.31
Repairs	Acre	11.95	—	11.95
Labor	Hour	10.00	1.334	13.34
Interest on Operating Capital	Dol.	10%	—	5.69
Crop Insurance	Acre	2.44	—	2.44
Miscellaneous	Dol.	—	—	4.47
TOTAL VARIABLE COSTS				\$ 93.79
Fixed Costs:				
Depreciation on Machinery	Acre	14.73	—	14.83
Interest on Machinery (10%)	Acre	11.37	—	11.37
Taxes, Housing, & Insurance on Machinery	Acre	5.86	—	5.86
Real Estate Taxes	Acre	3.24	—	3.24
Land (net rent) ¹	Acre	57.22	—	57.22
Management ²	Acre	15.22	—	15.22
TOTAL FIXED COSTS				107.74
TOTAL COSTS				\$201.53

¹Net rent = one-third of crop value (59.4 bu x \$3.66) - one-third of fertilizer costs (\$33.61 - one-third of crop insurance (\$2.44) - real estate taxes (\$3.24).

²Management = 7% x crop value (59.4 bu. x \$3.66).

Table 8C. Summary of revenues, costs, and returns per acre for winter wheat following summer fallow, three-year rotation, Wilke Farm.

Item	Amount \$
Gross Revenues:	
Wheat Sales (59.4 ¹ bushels x \$3.66 ²)	217.40
Total Gross Revenues	217.40
Less: Total Variable Costs	93.79
1. Returns Over Variable Costs	123.61
Less: Machinery Fixed Costs	32.06
Real Estate Taxes	3.24
2. Returns to Land and Management	91.55
Less: Management	15.22
3. Net Returns to Land:	76.33
Rate of Return to Land (\$76.33/\$850 market value x 100)	9.0 %

¹Average yield, Wilke Farm, 1986-1996.

²Average monthly price received by Washington farmers, August-March, 1986-1996.

Table 9A. Schedule of operations and costs per acre for spring barley following winter wheat, three-year rotation, Wilke Farm.

Operation	Tooling	Month	Mach. Hours	Labor Hours	Total Fixed Costs ¹	Variable Costs						Total Costs	Comments
						Fuel, Lubr. & Repairs	Machine Labor @ \$10/Hr.	Service	Materials	Interest @10%	Total Variable Costs		
— \$ Per Acre —													
Chisel	310 HP-WT, 30' Chisel	Fall	0.058	0.076	\$ 2.12	\$ 1.90	\$ 0.76	—	—	\$0.24	\$ 2.90	\$ 5.02	
Harrow	310 HP-WT, 80' Harrow	April	0.026	0.028	0.76	0.59	0.28	—	—	0.03	0.90	1.66	
Cultivate (2 X)	310 HP-WT, 40' Cultivator	April	0.097	0.108	2.60	3.12	1.08	—	—	0.14	4.34	6.94	
Fertilizer	310 HP-WT, 50' Applicator	April	0.047	0.052	0.76	0.86	0.52	—	24.72	0.87	26.97	27.73	70 lbs. N, 12 lbs. S
Cultivate	310 HP-WT, 40' Cultivator	April	0.049	0.054	1.30	1.56	0.54	—	—	0.07	2.17	3.47	
Weed Control	310 HP-WT, 50' Applicator	April	0.014	0.016	0.23	0.26	0.16	0.53	4.05	0.17	5.16	5.39	1.25 qts. Fargo on 0.3 ac.
Rodweed	310 HP-WT, 50' Rodweeder	April	0.041	0.045	1.12	0.92	0.45	—	—	0.05	1.42	2.54	
Plant	310 HP-WT, 40' Drills	April	0.059	0.065	4.01	2.09	0.65	—	20.64	0.78	24.16	28.17	70 lbs. seed, 8 lbs. N, 8 lbs. P, 5 lbs. S
Haul Seed	Grain Truck	April	0.064	0.128	0.96	0.96	1.28	—	—	0.07	2.31	3.27	
Weed Control	310 HP-WT, 55' Sprayer	June	0.036	0.039	1.20	0.74	0.39	—	4.12	0.09	5.34	6.54	1/3 pt. Buctril, 1/2 pt. MCPA
Harvest	25' Combine	August	0.118	0.141	14.24	6.43	1.41	—	—	—	7.84	22.08	
Haul Grain	Grain Truck	August	0.093	0.144	3.18	1.74	1.44	—	—	—	3.18	6.36	
Haul Grain	2 Grain Trucks	August	0.214	0.265	1.92	1.92	2.56	—	—	—	4.48	6.40	
Taxes, Real Estate	—	Annual	—	—	3.24	—	—	—	—	—	—	3.24	
Crop Insurance	Multi-Peril	Annual	—	—	—	—	—	1.52	—	—	1.52	1.52	
Miscellaneous	Utilities, Legal, Acct., etc.	Annual	—	—	—	—	—	—	4.91	—	4.91	4.91	
Pickup	—	Annual	0.225	0.267	2.00	1.20	2.67	—	—	—	3.87	5.87	
Service Truck	—	Annual	0.090	0.107	0.43	0.56	1.07	—	—	—	1.63	2.06	
Land ²	Net Rent	Annual	—	—	23.68	—	—	—	—	—	—	23.68	
Management ³	—	Annual	—	—	8.10	—	—	—	—	—	—	8.10	
TOTAL PER ACRE			1.230	1.526	\$71.85	\$24.85	\$15.26	2.05	58.44	\$2.51	\$103.10	\$174.95	

¹Includes depreciation, interest (10%), property taxes, housing, and insurance on machinery.

²Net rent = one-third of crop value (1.263 tons x \$91.65) - one-third of fertilizer costs (\$33.46) - one-third of crop insurance (\$1.52) - real estate taxes (\$3.24).

³Management = 7% x crop value (1.263 tons x \$91.65).

Table 9B. Summary of costs per acre for spring barley following winter wheat, three-year rotation, Wilke Farm.

Item	Unit	Price or Cost Per Unit	Quantity	Cost
Variable Costs:				
Seed with Treatment	Lb.	\$0.170	70	\$ 11.90
Fertilizers:				
Nitrogen (Aqua)	Lb.	\$0.311	70	21.77
Nitrogen (Sol. 32)	Lb.	0.472	8	3.78
Phosphorus (10-34-0)	Lb.	0.466	8	3.73
Sulfur (12-0-0-26)	Lb.	0.246	17	4.18
Herbicides:				
Buctril	Pt.	8.52	0.33	2.81
MCPA	Pt.	2.55	0.5	1.28
Fargo (0.3 acre)	Qt.	10.81	1.25	4.05
w/Machine	Acre	1.75	—	0.53
Fuel & Lubrication	Acre	9.63	—	9.63
Repairs	Acre	15.25	—	15.25
Labor	Hour	10.00	1.526	15.26
Interest on Operating Capital	Dol.	10%	—	2.51
Crop Insurance	Acre	1.52	—	1.52
Miscellaneous	Dol.	—	—	4.91
TOTAL VARIABLE COSTS				\$103.10
Fixed Costs:				
Depreciation on Machinery	Acre	16.88	—	16.88
Interest on Machinery (10%)	Acre	13.56	—	13.56
Taxes, Housing, & Insurance on Machinery	Acre	6.39	—	6.39
Real Estate Taxes	Acre	3.24	—	3.24
Land (net rent) ¹	Acre	23.68	—	23.68
Management ²	Acre	8.10	—	8.10
TOTAL FIXED COSTS				71.85
TOTAL COSTS				174.95

¹Net rent = one-third of crop value (1.263 tons x \$91.65) - one-third of fertilizer costs (\$33.46)- one-third of crop insurance (\$1.52) - real estate taxes (\$3.24).

²Management = 7% x crop value (1.263 tons x \$91.65).

Table 9C. Summary of revenues, costs, and returns per acre for spring barley following winter wheat, three-year rotation, Wilke Farm.

Item	Amount \$
Gross Revenues:	
Barley Sales (1.263 ¹ tons x \$91.65 ²)	115.75
Total Gross Revenues	115.75
Less: Total Variable Costs	103.10
1. Returns Over Variable Costs	12.65
Less: Machinery Fixed Costs	36.83
Real Estate Taxes	3.24
2. Returns to Land and Management	-27.42
Less: Management	15.22
3. Returns to Land:	-42.64
Rate of Return to Land ($-\$42.64/\850 market value x 100)	-5.0%

¹Average yield, Wilke Farm, 1986-1996.

²Average monthly price received by Washington farmers, August-March, 1986-1996.

Table 10A. Schedule of operations and costs per acre for summer fallow following spring barley (three-year rotation) or winter wheat (two-year rotation), Wilke Farm.

Operation	Tooling	Month	Mach. Hours	Labor Hours	Total Fixed Costs ¹	Variable Costs						Total Costs	Comments
						Fuel, Lubr. & Repairs	Machine Labor @ \$10/Hr.	Service	Materials	Interest @10%	Total Variable Costs		
— \$ Per Acre —													
Weed Control	310 HP-WT, 55' Sprayer	April	0.036	0.039	\$1.20	\$0.74	\$0.39	—	4.98	\$0.20	\$6.31	\$7.51	12 Oz. Roundup
Cultivate	310 HP-WT, 40' Cultivator	May	0.049	0.054	1.30	1.56	0.54	—	—	0.05	2.15	3.45	
Harrow	310 HP-WT, 80' Harrow	May	0.026	0.028	0.76	0.59	0.28	—	—	0.02	0.89	1.65	
Cultivate	310 HP-WT, 40' Cultivator	June	0.049	0.054	1.30	1.56	0.54	—	—	0.04	2.14	3.44	
Rodweed	310 HP-WT, 50' Rodweeder	June	0.041	0.045	1.12	0.92	0.45	—	—	0.02	1.39	2.51	
Taxes, Real Estate	—	Annual	—	—	3.24	—	—	—	—	—	—	3.24	
Miscellaneous	Utilities, Legal, Acct., etc.	Annual	—	—	—	—	—	0.92	—	—	—	0.92	
Pickup	—	Annual	0.225	0.267	2.00	1.20	2.67	—	—	—	3.87	5.87	
Service Truck	—	Annual	0.043	0.107	0.43	0.56	1.07	—	—	—	1.63	2.06	
TOTAL PER ACRE			0.468	0.594	\$11.35	\$7.13	\$5.94	0.00	\$5.90	\$0.34	\$19.31	\$30.66	

¹Includes depreciation, interest (10%), property taxes, housing, and insurance on machinery.

Table 10B. Summary of costs per acre for summer fallow following spring barley, three-year rotation, Wilke Farm.

Item	Unit	Price or Cost Per Unit	Quantity	Cost
Variable Costs:				
Herbicides:				
Roundup	Oz.	\$0.42	12	\$4.98
Fuel & Lubrication	Acre	3.47	—	3.47
Repairs	Acre	3.66	—	3.66
Labor	Hour	10.00	1.594	5.94
Interest on Operating Capital	Dol.	10%	—	0.34
Miscellaneous	Dol.	—	—	0.92
TOTAL VARIABLE COSTS				\$19.31
Fixed Costs:				
Depreciation on Machinery	Acre	3.40	—	3.40
Interest on Machinery (10%)	Acre	3.45	—	3.45
Taxes, Housing, & Insurance on Machinery	Acre	1.26	—	1.26
Real Estate Taxes	Acre	3.24	—	3.24
TOTAL FIXED COSTS				11.35
TOTAL COSTS				30.66

Table 11A. Schedule of operations and costs per acre for winter wheat following summer fallow, two-year rotation, Wilke Farm.

Operation	Tooling	Month	Mach. Hours	Labor Hours	Total Fixed Costs ¹	Variable Costs						Total Costs	Comments
						Fuel, Lubr. & Repairs	Machine Labor @ \$10/Hr.	Service	Materials	Interest @10%	Total Variable Costs		
— \$ Per Acre —													
Fertilize	310 HP-WT, 50' Applicator	July	0.047	0.052	0.76	0.86	0.52	—	23.00	2.64	27.02	27.78	70 lbs. N, 5 Lbs. S
Rodweed	310 HP-WT, 50' Rodweeder	July	0.041	0.045	1.12	0.92	0.45	—	—	0.15	1.52	2.64	
Rodweed	310 HP-WT, 50' Rodweeder	August	0.041	0.045	1.12	0.92	0.45	—	—	0.14	1.51	2.63	
Rodweed	310 HP-WT, 50' Rodweeder	Sept.	0.041	0.045	1.12	0.92	0.45	—	—	0.13	1.50	2.62	
Plant	310 HP-WT, 40' Drills	Sept.	0.059	0.065	4.01	2.09	0.65	—	18.96	1.99	23.69	27.70	60 Lbs. seed, 10 Lbs. N, 10 Lbs. P, 5 Lbs. S
Haul Seed	Grain Truck	Sept.	0.064	0.128	0.96	0.96	1.28	—	—	0.38	2.62	3.58	
Weed Control	310 HP-WT, 55' Sprayer	April	0.036	0.039	1.20	0.74	0.39	—	6.63	0.26	8.02	9.22	1/3 Pt. Harmony Extra, 1/2 Pt. MCPA
Harvest	25' Combine	August	0.118	0.141	14.24	6.43	1.41	—	—	—	7.84	22.08	
Haul Grain	Grain Truck	August	0.093	0.144	3.18	1.74	1.44	—	—	—	3.18	6.36	
Haul Grain	2 Grain Trucks	August	0.214	0.256	1.92	1.92	2.56	—	—	—	4.48	6.40	
Taxes, Real Estate	—	Annual	—	—	3.24	—	—	—	—	—	—	3.24	
Crop Insurance	Multi-Peril	Annual	—	—	—	—	—	2.44	—	—	2.44	2.44	
Miscellaneous	Utilities, Legal, Acct., etc.	Annual	—	—	—	—	—	—	4.47	—	4.47	4.47	
Pickup	—	Annual	0.225	0.267	2.00	1.20	2.67	—	—	—	3.87	5.87	
Service Truck	—	Annual	0.090	0.107	0.43	0.56	1.07	—	—	—	1.63	2.06	
Land ²	Net Rent	Annual	—	—	54.78	—	—	—	—	—	—	54.78	
Management ³	—	Annual	—	—	14.71	—	—	—	—	—	—	14.71	
TOTAL PER ACRE			1.069	1.334	\$104.79	\$19.26	\$13.34	2.44	53.06	\$5.69	\$93.79	\$198.58	

¹Includes depreciation, interest (10%), property taxes, housing, and insurance on machinery.

²Net rent = one-third of crop value (57.4 bu. x \$3.66) - one-third of fertilizer costs (\$33.61) - one-third of crop insurance (\$2.44) - real estate taxes (\$3.24).

³Management = 7% x crop value (57.4 bu. x \$3.66).

Table 11B. Summary of costs per acre for winter wheat following summer fallow, two-year rotation, Wilke Farm.

Item	Unit	Price or Cost Per Unit	Quantity	Cost
Variable Costs:				
Seed with Treatment	Lb.	\$0.139	60	\$ 8.35
Fertilizers:				
Nitrogen (Aqua)	Lb.	0.311	70	21.77
Nitrogen (Sol. 32)	Lb.	0.472	10	4.72
Phosphorus (10-34-0)	Lb.	0.466	10	4.66
Sulfur (12-0-0-26)	Lb.	0.246	10	2.46
Herbicides:				
Harmony Extra	Oz.	16.05	1/3	5.35
MCPA	Pt.	2.55	1/2	1.28
Fuel & Lubrication	Acre	7.31	—	7.31
Repairs	Acre	11.95	—	11.95
Labor	Hour	10.00	1.334	13.34
Interest on Operating Capital	Dol.	10%	—	5.69
Crop Insurance	Acre	2.44	—	2.44
Miscellaneous	Dol.	—	—	4.47
TOTAL VARIABLE COSTS				\$ 93.79
Fixed Costs:				
Depreciation on Machinery	Acre	14.83	—	14.83
Interest on Machinery (10%)	Acre	11.37	—	11.37
Taxes, Housing, & Insurance on Machinery	Acre	5.86	—	5.86
Real Estate Taxes	Acre	3.24	—	3.24
Land (net rent) ¹	Acre	—	—	54.78
Management ²	Acre	—	—	14.71
TOTAL FIXED COSTS				104.79
TOTAL COSTS				\$198.58

¹Net rent = one-third of crop value (57.4 bu. x \$3.66) - one-third of fertilizer costs (\$33.61- one-third of crop insurance (\$2.44) - real estate taxes (\$3.24).

²Management = 7% x crop value (57.4 bu. x \$3.66).

Table 11C. Summary of revenues, costs, and returns per acre for winter wheat following summer fallow, two-year rotation, Wilke Farm.

Item	Amount \$
Gross Revenues:	
Wheat Sales (57.4 ¹ bushels x \$3.66 ²)	210.08
Total Gross Revenues	210.08
Less: Total Variable Costs	93.78
1. Returns Over Variable Costs	116.30
Less: Machinery Fixed Costs	32.06
Real Estate Taxes	3.24
2. Returns to Land and Management	81.00
Less: Management	14.71
3. Net Returns to Land:	66.29
Rate of Return to Land (\$66.29/\$850 market value x 100)	7.8%

¹Estimated to be two bushels per acre less than realized from winter wheat following summer fallow in a three-year rotation on the Wilke Farm.

²Average monthly price received by Washington farmers, August-March, 1986-1996.

Table I. Cropping history for the three-year and annual cropping rotations Wilke Farm, 1986-1996.

THREE-YEAR ROTATION							ANNUAL CROPPING					
Field #1 (83.4 Ac.)			Field #2 (83.3 Ac.)		Field #3 (83.3 Ac.)		Field #4 (91 Ac.)					
Year	Crop & Variety	Yield per Acre	Crop & Variety	Yield per Acre	Crop & Variety	Yield per Acre	Primary Crop		Secondary Crop		Secondary Crop	
							Crop & Variety	Yield per Acre	Crop & Variety	Yield per Acre	Crop & Variety	Yield per Acre
1995-96	Summer Fallow	—	S. Barley <i>Baronesse</i>	1.289 Tons	W. Wheat <i>Rely</i>	57.5 Bushels	W. Wheat <i>Lewjain</i>	44.69 Bushels	CRP			
1994-95	S. Barley <i>Baronesse</i>	1.756 Tons	W. Wheat <i>Rhode</i>	59.6 Bushels	Summer Fallow	—	S. Wheat <i>Penawawa</i>	53 Bushels	CRP			
1993-94	W. Wheat <i>Madsen</i>	72.2 Bushels	Summer Fallow	—	S. Barley <i>Camelot</i>	1.077 Tons	S. Barley <i>Camelot</i>	1.077 Tons	CRP			
1992-93	Summer Fallow	—	S. Barley <i>Camelot</i>	2.133 Tons	W. Wheat <i>Madsen</i>	82 Bushels	S. Barley <i>Camelot</i>	2.133 Tons				
1991-92	S. Barley <i>Camelot</i>	0.916 Tons	W. Wheat <i>Lewjain</i>	54.9 Bushels	Summer Fallow	—	S. Wheat <i>Penawawa</i>	28.2 Bushels	S. Barley <i>Camelot</i>	0.916 Tons		
1990-91	S. Wheat <i>Penawawa</i>	48 Bushels	Summer Fallow	—	S. Barley <i>Camelot</i>	1.345 Tons	S. Wheat <i>Penawawa</i>	30 Bushels	S. Canola	0		
1989-90	Summer Fallow	—	S. Barley <i>Camelot</i>	0.8 Tons	W. Wheat <i>Lewjain</i>	72.2 Bushels	S. Wheat <i>Penawawa</i>	20 Bushels	S. Canola	743 Lva.	Summer Fallow	—
1988-89	S. Barley <i>Steptoe</i>	1.184 Tons	S. Wheat <i>Owens</i>	37.19 Bushels	Summer Fallow	—	S. Barley <i>Harrington</i>	0.941 Tons	S. Wheat <i>Owens</i>	26 Bushels	W. Wheat <i>Owens</i>	34.26 Bushels
1987-88	W. Wheat <i>Lewjain</i>	73.17 Bushels	Summer Fallow	—	S. Barley <i>Steptoe</i>	1.378 Tons	S. Wheat <i>Edwall</i>	37.07 Bushels	S. Barley <i>Steptoe</i>	1.544 Tons	W. Wheat <i>Lewjain</i>	61.11 Bushels
1986-87	Summer Fallow	—	S. Barley <i>Cougbar</i>	0.75 Tons	W. Wheat <i>Lewjain</i>	56 Bushels	S. Barley <i>Cougbar</i>	0.75 Tons	S. Wheat <i>Edwall</i>	34 Bushels	W. Wheat <i>Lewjain</i>	56 Bushels
1985-86	S. Barley <i>Steptoe</i>	1.26 Tons	W. Wheat <i>Lewjain</i>	41.1 Bushels	Summer Fallow	--	S. Wheat <i>Edwall</i>	40 Bushels	S. Barley <i>Steptoe</i>	1.26 Tons	Summer Fallow	—

Table II. Average Prices Received by Farmers, All Wheat, 1986-1997, Washington

Marketing Year	August	September	October	November	December	January	February	March	Mean
	Dollars per Bushel								
1986-87	2.38	2.40	2.44	2.53	2.58	2.62	2.74	2.83	2.57
1987-88	2.56	2.63	2.76	2.72	2.74	2.93	2.91	2.88	2.77
1988-89	3.86	4.06	4.15	4.30	4.43	4.56	4.57	4.39	4.29
1989-90	4.26	4.21	4.19	3.94	4.28	4.27	3.73	3.58	4.06
1990-91	2.90	2.76	2.66	2.60	2.64	2.62	2.64	2.87	2.67
1991-92	3.16	3.30	3.58	3.91	4.11	4.13	4.24	4.16	3.82
1992-93	3.67	3.94	3.90	3.87	3.87	3.99	3.76	3.68	3.84
1993-94	3.29	3.16	3.15	3.18	3.24	3.32	3.27	3.19	3.23
1994-95	3.54	3.86	4.23	4.20	4.15	4.04	3.94	3.79	3.97
1995-96	4.29	4.54	4.79	4.94	5.03	5.05	5.18	5.09	4.87
1996-97	4.92	4.51	4.07	3.92	3.82	3.82	--	--	4.18
Mean	3.53	3.58	3.62	3.64	3.71	3.76	3.70	3.65	3.66

Source; USDA, *Washington Agricultural Statistics*.

Table III. Average Prices Received by Farmers, Barley, 1986-1997, Washington

Marketing Year	August	September	October	November	December	January	February	March	Mean
	Dollars per Ton								
1986-87	62.09	69.17	69.17	70.01	67.09	72.09	74.59	77.09	70.16
1987-88	75.84	77.09	76.67	78.76	80.01	79.59	76.67	73.76	77.30
1988-89	104.59	100.01	98.34	101.67	98.76	100.42	100.42	104.18	88.50
1989-90	98.34	89.59	85.42	97.51	102.92	103.76	97.51	100.42	96.93
1990-91	80.84	82.51	88.76	95.42	97.51	98.76	94.69	86.67	90.63
1991-92	85.84	89.59	95.01	99.17	99.59	99.59	94.59	96.26	94.96
1992-93	86.67	86.26	82.51	83.76	82.09	87.92	90.84	92.51	86.57
1993-94	81.26	74.59	76.84	82.92	88.76	90.42	89.59	87.92	83.91
1994-95	75.84	77.92	82.92	82.92	80.84	86.26	88.34	88.34	82.92
1995-96	100.84	108.34	132.93	136.68	140.84	139.59	135.01	140.43	129.33
1996-97	124.59	112.93	100.01	101.26	100.84	104.17	--	--	107.30
Mean	88.79	88.00	89.78	93.64	94.48	96.60	94.21	94.76	91.65

Source; USDA, *Washington Agricultural Statistics*.

Table IV. Machinery complement, capital investment, annual use, and hourly costs, Wilke Farm.

Machine Item	Purchase Price	Years to Trade	Annual Hours	Fixed Costs			Variable Costs			Total Costs	
				Deprecation	Interest @ 10%	Taxes, Housing Insurance	Total	Repair	Fuel & Lubrication		Total
--\$ Per Hour--											
310 HP WT, Used (2)	\$50,000	15	400	7.26	7.05	1.83	16.15	5.00	13.27	18.27	34.42
30' Chisel, New	20,000	20	150	6.32	7.01	1.40	14.74	9.31	--	9.31	24.05
40' Cultivator, New	24,000	20	250	4.55	5.05	1.01	10.61	13.71	--	13.71	24.32
80' Harrow, New	12,000	20	100	5.69	6.31	1.26	13.26	4.75	--	4.75	18.01
50' Rodweeder, Used (2)	10,00	20	100	4.74	5.26	1.05	11.05	3.96	--	2.63	20.27
55' Sprayer, Home-made	7,000	15	50	8.44	7.67	1.53	17.64	2.63	--	2.63	20.27
40' Drill, new	28,000	15	75	22.50	20.46	9.00	61.96	17.21	--	17.21	69.17
25' Combine, Used	130,000	8	200	67.69	37.93	15.17	120.78	47.73	6.84	54.57	175.35
Grain Truck, Used	30,000	20	180	7.83	8.83	9.80	26.47	10.65	3.91	14.47	40.94
Grain Truck, Used (2)	9,000	20	160	2.64	2.98	3.31	8.93	3.75	5.24	8.99	17.93
Pickup	16,000	10	330	3.29	3.15	2.46	8.91	3.36	1.95	5.32	14.22
Service Truck	4,500	20	130	1.65	1.73	1.35	4.72	2.36	3.93	6.30	11.02

Source: The costs appearing in this table were generated by a microcomputer program, MACHCOST, developed by L. Stodick and R. Smathers, Department of Agricultural Economics and Rural Sociology, University of Idaho, Moscow, ID.

Table V. Prices of selected inputs, Wilke Farm, 1996

Item	Unit	Price
FUEL:		
Diesel	Gal.	\$ 0.85
Gasoline	Gal.	1.14
FERTILIZER:		
Solution 32	Gal.	\$ 1.67
10-34-0	Gal.	2.46
12-0-0-26	Gal.	1.33
Aqua	Gal.	0.47
CHEMICALS:		
Roundup	Gal.	\$53.12
Buctril	Gal.	68.16
MCPA	Gal.	20.42
Harmony Extra	Oz.	16.05
Fargo	Gal.	43.22
WHEAT SEED:		
Winter Wheat	Bu.	7.75
Spring Wheat	bu.	8.90
Spring Barley	Ton	320.00
Seed Treatment	Bu.	0.60
LABOR:	Hr.	10.00
INTEREST:	%	10.00

Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is violation of law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

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