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Enterprise Costs and Returns for Different Cropping and Tillage Systems in Southeastern Montana and Southwestern North Dakota

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Introduction

Comparisons of costs and returns for different cropping and tillage systems are difficult to estimate. There are many different variables of production to consider with the amount and timing of rainfall at a particular farm being the most important. Soil health is also different for each of these alternative tillage and cropping systems.

Six different farmers in southeastern Montana and southwestern North Dakota were interviewed to determine their production methods and costs. Based on these interviews a generic typical farm was developed. This generic farm was used to estimate the different costs and returns for different cropping and tillage systems as well as the soil health associated with each.

The six farmers interviewed had various production practices in their agricultural crop rotations. Conventional till, minimum till and zero till farming were utilized to raise cereal grains, pulse crops and annual and perennial legumes. Clay, clay loam and sandy loam were the three main soil types in the area surveyed. Annual precipitation ranged from 11 – 14 inches.

Depending on precipitation received, all operators had cereal grain acreage where management decisions were made in early July to harvest the crop for hay or leave it for grain. Winter wheat, spring wheat, hay barley, lentils, oats, corn and alfalfa were grown for hay with lentils, hay barley, corn and alfalfa also being used for additional grazing. All but one operation included cattle grazing of standing crop or crop stubble as part of their management practices. The fields grazed one year were rested at least one year prior to grazing again. Oilseed crops grown were safflower, flax, and yellow mustard. Seed crops included winter wheat, winter rye, spring wheat, durum, soft white winter wheat, barley, hay barley, buckwheat, and spring and winter field peas.

Planting equipment included conventional hoe, single and double disc drills and air seeders with single or double disk coulters on 7 – 10 inch row spacing. Seeding rates in pounds per acre ranged from 75 – 90 for winter wheat, 63 - 120 for spring wheat, 120 for durum, 70 – 90 for barley, 30 – 60 for lentils, 22 – 30 for safflower, 80 for peas, 4 for yellow mustard, and 30 for flax. Corn, 80-90 day maturity, was planted at13,000 plants/acre. Reder and McNeal spring wheat, Erhart winter wheat, and Haybet hay barley were the most common varieties of cereal grains planted.

Roundup was used for weed control both in the spring before planting and in the fall after harvest on no-till acres. Surfactant and ammonium sulfate spray adjuvants were always used whenever Roundup was applied. Other herbicides used for weed control were

1) NRCS Economist, NRCS Agronomist, NRCS Economist

Fargo, Celebrity +, Bison and Everest. One producer noted a possible allelopathic influence from winter rye on the presence of wild buckwheat and wild oats

The two operators who used conventional till fallow had limited their cultivations to four per year. A chisel/shovel cultivator with a harrow and/or rodweeder attachment was the main piece of tillage equipment used. Use of an offset disc to do one round on strip edges in the fall for sawfly control and for spring cultivation to disc in fertilizer before planting on continuous crop rotations was also implemented.

Granular fertilizer was broadcast in the spring prior to planting or applied at seeding with the drill. Anhydrous ammonia was injected by an anhydrous implement in the fall. The most common granular formulations were 46-0-0 urea and 11-52-0 super phosphate. Annual applications of available nitrogen ranged from 18 to 40 lbs per acre with available phosphate ranging from 3 to 6 lbs per acre.

A Soil Tillage Intensity Rating (STIR) was calculated for each of the different crop rotations and tillage systems used by the six producers. The STIR is used to evaluate the effect of tillage on soil health in each of the different systems. A STIR with a low value has a minimal adverse effect on soil health. Over time a system with a low STIR value will have a minimal adverse effect on soil structure and overall soil health. The low STIR will improve organic matter, fertility, productivity and water holding capacity and soil structure. See Table 1. for the different STIR values for the different crop rotations and tillage systems.

Uses of the Report

The costs and returns shown in this report are averages and should only be used as a guide in decision making. Costs and returns vary from farm to farm because of geographical location, soil types, type and condition of machinery, weed and insect problems, and other factors. Actual farm records, if available, provide the best source of information for making decisions.

The ownership costs are based on a specified amount of annual use for each machine. Ownership costs tend to be inversely related to amount of use. Consequently, the ownership costs are applicable only to situations where the amount of annual use is the same as that assumed in this report.

Operating costs tend to be constant with respect to use. It costs a certain amount for repairs, fuel, etc. per hour or per acre regardless of the total amount of use. Since per unit operating costs do not vary with size of farm, they can be applied to any farm using similar equipment under similar conditions.

This cost-return report may be helpful:

1. In selecting enterprises and crop rotations which will yield the highest return to the farmer's resources.

2. In determining rental shares each party is making to a farm business. Each party's contributions may consist of a combination of production costs, capital investment, and labor.
3. In making up cash flow budgets.
4. In estimating income necessary to cover costs when one is considering future investments.

A Cautionary Note

The costs of production shown in this report do not include all costs of production. Costs for labor, management, and land are not included. The returns shown in this report are used to cover the costs of these three inputs of production.

Assumptions and Procedures for Generic Farm

1. Total farm crop acreage amounts to 1500 acres. This is the average of the producers interviewed with some having crop acres above and below the average.
2. Several different cropping and tillage systems were evaluated.
    a. Conventional Till—Winter Wheat and Fallow (750 acres of each)
    b. Conventional Till—Winter Wheat (500 acres), Recrop Spring Wheat (500 acres), Fallow (500 acres)
    c. Conventional Till—Winter Wheat (700 acres), Recrop Barley (100 acres), Fallow (700 acres)
    d. No-Till—Spring Wheat (750 acres) with alternative crops such as Safflower (150 acres), Yellow Mustard (150 acres), Lentils (150 acres), Winter Peas (150 acres), and Flax (150 acres)
3. Yields for each crop:

Spring Wheat	19 bushels
Winter Wheat after Fallow	32 bushels
Barley	38 bushels
Safflower	650 pounds
Yellow Mustard	300 pounds
Lentils	1.5 tons
Winter Peas	1000 pounds
Flax	17 bushels

4. Seeding rates for each crop:

Spring Wheat	80 pounds
Winter Wheat	90 pounds
Barley	60 pounds
Safflower	22 pounds
Yellow Mustard	4 pounds
Lentils	30 pounds
Winter Peas	80 pounds
Flax	0.50 bushels

5. Fertilizer rates for each crop:

Spring Wheat	160 pounds of 46-0-0
Winter Wheat after Fallow	60 pounds 18-46-0
Barley	60 pounds 18-46-0 100 pounds 34-0-0
Safflower	60 pounds of 11-52-0
Yellow Mustard	None
Lentils	None
Winter Peas	None
Flax	None

6. Fuel costs were $1.80 per gallon for diesel and $2.00 per gallon for gasoline.
7. Repairs were based on the following formula:
   Repairs = (Repair Factor x List Price of Machine x Hours of use per year) divided by the estimated life of the machine
8. Oil costs are estimated at 15 percent of the cost of fuel.
9. Depreciation costs are based on the following formula:
   Depreciation = (List Price of Machine x Hours of use per year) divided by the estimated life of the machine
10. Interest on machinery = Average value of the machine times the interest rate.
11. Interest on operation capital was figured at 7 percent for 12 months.

12. Crop insurance rates for each crop:

Spring Wheat	$5.85
Winter Wheat after Fallow	$6.50
Barley	$2.00
Safflower	$4.00
Yellow Mustard	None
Lentils	None
Winter Peas	None
Flax	None

13. Weed control for each crop:

Spring Wheat	16 ounces Roundup
Winter Wheat after Fallow	10 ounces 2,4-D LV-6 1 ounce Banvel
Barley	6 ounces Puma
Safflower	16 ounces Roundup 16 ounces Poast
Yellow Mustard	16 ounces Roundup 16 ounces Poast
Lentils	16 ounces Roundup 16 ounces Poast
Winter Peas	16 ounces Roundup 16 ounces Poast
Flax	16 ounces Roundup Bison

Results

Table 2 summarizes the difference in total farm income between the two tillage methods and four cropping systems. The no-till continuous cropping system had total farm income of $75,275. The three conventional cropping systems had total farm incomes of $31,899 (Winter Wheat-Barley-Fallow rotation), $32,205 (Winter Wheat-Spring Wheat-Fallow rotation), and $32,565 (Winter Wheat-Fallow rotation). The no-till continuous cropping system had more than twice as much total farm income as compared to a conventional cropping system. This difference in total farm income occurred regardless of the cropping system used for conventional cropping.

Two of the farmers interviewed were following a conventional tillage system. Fallow was tilled conventionally rather that using a minimum till or no-till system. Four of the farmers interviewed were following a continuous cropping system using a no-till cropping system. Other crops grown that were not listed in Table 2 are: oats, recrop winter wheat, durum, soft white wheat, winter rye, corn and hay barley.

There was a large difference in yields for conventional tilled winter wheat between the two farmers interviewed. This was probably due to the different average yearly moisture levels between the two farms. Table 3 shows the total farm income when an average yield of 25 bushels is used for winter wheat. When an average yield of 32 bushels is used for winter wheat, the difference in total farm income between the three conventional tillage systems is similar (See Table 2). This is not the case when the average yield is 25 bushels per acre. The winter wheat-spring wheat-fallow rotation had $4,500 to $4,900 higher income than the other two cropping systems.

Table 4 shows the total farm income when the average yield for winter wheat was increased to 38 bushels. The conventional till cropping system with the larger total farm income changes. The winter wheat-fallow rotation had a $1,600 to $4,900 higher income than the other two cropping systems. Regardless of the yield used for winter wheat, the total farm income was always less than the income from the continuous cropping system.

The STIR for the no-till continuous cropping system was 3. The STIR for the conventional tillage Winter Wheat-Spring Wheat-Fallow rotation was 95. The STIR for the conventional tillage Winter Wheat-Barley-Fallow rotation and the Winter Wheat-Fallow rotation were similar since only 100 acres of barley was recropped and the rest of the rotation was crop-fallow. The STIR for the conventional tillage Winter Wheat-Fallow rotation was 114.

Table 1. Soil Tillage Intensity Rating (STIR) for Different Cropping Systems and Different Tillage Systems		
Cropping Rotation	**Soil**	**STIR**
1. No Till Spring Wheat - Winter Wheat or Flax or Peas or Safflower - Lentils	Sandy Loam	3
7 inch single disc drill, broadcast fertilizer preplant, graze winter wheat stubble and lentil crop		
2. No Till Spring Wheat - Winter Wheat - Flax or Peas or Safflower - Corn	Sandy Loam	3
7 inch single disc drill, broadcast fertilizer preplant, graze winter wheat stubble and bale corn crop		
3. No Till Winter Wheat/Rye - Safflower or Peas or Buckwheat or Yellow Mustard - Spring Wheat - Spring Wheat	Sandy Loam	6
7 inch single disc drill, fertilize with drill, graze wheat stubble 1 out of 4 years		
4. No Till Winter Wheat - Hay Barley - Winter Wheat - Hay Barley	Clay Loam	6
7 inch disc drill, apply anhydrous fertilizer, graze stubble each year		
5. No Till Winter Wheat/Rye - Safflower or Peas or Buckwheat or Yellow Mustard - Spring Wheat - Spring Wheat	Sandy Loam	7
7 inch single disc drill, apply fertilizer with drill, graze wheat stubble 2 out of 3 years		
6. No Till Winter Wheat/Rye - Safflower or Peas or Buckwheat or Yellow Mustard - Spring Wheat - Spring Wheat	Sandy Loam	10
7 inch single disc drill, apply fertilizer with drill, no grazing, heavy harrow after second spring wheat crop		
7. No Till Winter Wheat - Hay Barley - Winter Wheat - Hay Barley	Sandy Loam	10
7 inch double disc drill, apply anhydrous fertilizer each year, graze stubble each year		
8. Minimum Till Spring Wheat/Winter Wheat - Lentils - Hay Barley/Corn	Sandy Loam	19
9. Minimum Till Spring Wheat/Winter Wheat - Lentils - Hay Barley/Corn	Sandy Loam	23
7.5 inch double disc drill, broadcast fertilize preplant, harrow 2 times per year, graze stubble, corn and lentil crops		
10. Minimum Till Spring Wheat - Fallow - Winter Wheat - Barley	Clay Loam	71
10 inch hoe drill, broadcast fertilizer preplant, 6-12 inch sweep cultivator/ rodweeder, graze stubble one year, bale straw one year		
11. Minimum Till Winter Wheat - Barley/Oats - Fallow	Silty Clay	80
10 inch hoe drill, no fertilizer, sweep shovel chisel/rodweeder/harrow, graze stubble		
12. Minimum Till Winter Wheat - Barley - Fallow	Clay Loam	95
10 inch hoe drill, broadcast fertilizer preplant, 16 inch swee cultivator/ rodweeder, graze stubble one year, bale straw one year, disc once		

13. Minimum Till Spring Wheat - Fallow - Winter Wheat - Fallow								Silty Clay		96
10 inch hoe drill, no fertilizer, sweep shovel chisel, graze stubble, disc										
following two years no/zero till										
14. Minimum Till Spring Wheat - Fallow - Winter Wheat - Barley								Silty Clay		99
10 inch hoe drill, broadcast fertilizer preplant, three tillages with 13 inch sweep										
cultivator/rodweeder, graze stubble two years, bale straw one year,										
disc twice										
15. Conventional Till Winter Wheat - Fallow - Barley -Fallow								Clay Loam		100
10 inch hoe drill, broadcast fertilizer preplant, three tillages with 13 inch sweep										
cultivator/rodweeder, graze stubble one year, bale straw one year,										
disc twice										
16. Conventional Till Spring Wheat - Fallow - Winter Wheat - Fallow								Silty Clay		114
10 inch hoe drill, no fertilizer, four tillages with fallow with 13 inch plus										
sweep shovel chisel, graze stubble										
17. Conventional Till Winter Wheat - Fallow - Winter Wheat - Fallow								Silty Clay		123
10 inch hoe drill, no fertilizer, four tillages with fallow with 13 inch plus										
sweep shovel chisel/rodweeder, graze stubble										

Table 2. Income from Alternative Cropping Systems in Southeastern Montana and Southwestern North Dakota

	Spring Wht	Alternative Crops				
		Safflower	Yellow Mustard	Lentils	Winter Peas	Flax
Yield	19	650	300	1.5	1000	17
Price	$ 3.75	$ 0.15	$ 0.15	$ 75.00	$ 0.20	$ 8.00
Total Income	$ 71.25	$ 97.50	$ 45.00	$ 112.50	$ 200.00	$ 136.00
Operating Costs	$ 45.46	$ 39.50	$ 20.78	$ 51.04	$ 34.04	$ 15.92
Ownership Costs	$ 5.77	$ 6.63	$ 6.63	$ 4.91	$ 4.91	$ 4.91
Returns over Operating Costs	$ 25.79	$ 58.00	$ 24.22	$ 61.46	$ 165.96	$ 120.08
Returns over Total Costs	$ 20.02	$ 51.37	$ 17.59	$ 56.55	$ 161.05	$ 115.17
Acres each Crop	750	150	150	150	150	150
Total Income from Crop	$ 15,015	$ 7,706	$ 2,639	$ 8,483	$ 24,158	$ 17,276
Total Income from Farm						$ 75,275

	Winter Wht	Barley	Fallow
Yield	32	38	0
Price	$ 3.00	$ 1.80	0
Total Income	$ 96.00	$ 68.40	$ -
Operating Costs	$ 33.17	$ 47.96	$ 8.27
Ownership Costs	$ 7.60	$ 5.39	$ 3.54
Returns over Operating Costs	$ 62.83	$ 20.44	$ (8.27)
Returns over Total Costs	$ 55.23	$ 15.05	$ (11.81)
Acres each Crop	700	100	700
Total Income from Crop	$ 38,661	$ 1,505	$ (8,267)
Total Income from Farm			$ 31,899

	Winter Wht	Spring Wht	Fallow
Yield	32	19	0
Price	$ 3.00	$ 3.75	0
Total Income	$ 96.00	$ 71.25	$ -
Operating Costs	$ 32.55	$ 44.94	$ 8.52
Ownership Costs	$ 6.78	$ 5.87	$ 4.18
Returns over Operating Costs	$ 63.45	$ 26.31	$ (8.52)
Returns over Total Costs	$ 56.67	$ 20.44	$ (12.70)
Acres each Crop	500	500	500
Total Income from Crop	$ 28,335	$ 10,220	$ (6,350)
Total Income from Farm			$ 32,205

	Winter Wht	Fallow
Yield	32	0
Price	$ 3.00	0
Total Income	$ 96.00	$ -
Operating Costs	$ 33.16	$ 8.30
Ownership Costs	$ 7.66	$ 3.46
Returns over Operating Costs	$ 62.84	$ (8.30)
Returns over Total Costs	$ 55.18	$ (11.76)
Acres each Crop	750	750
Total Income from Crop	$ 41,385	$ (8,820)
Total Income from Farm		$ 32,565

Table 3. Income from Alternative Cropping Systems in Southeastern Montana and Southwestern North Dakota

	Spring Wht	Alternative Crops				
		Safflower	Yellow Mustard	Lentils	Winter Peas	Flax
Yield	19	650	300	1.5	1000	17
Price	$ 3.75	$ 0.15	$ 0.15	$ 75.00	$ 0.20	$ 8.00
Total Income	$ 71.25	$ 97.50	$ 45.00	$ 112.50	$ 200.00	$ 136.00
Operating Costs	$ 45.46	$ 39.50	$ 20.78	$ 51.04	$ 34.04	$ 15.92
Ownership Costs	$ 5.77	$ 6.63	$ 6.63	$ 4.91	$ 4.91	$ 4.91
Returns over Operating Costs	$ 25.79	$ 58.00	$ 24.22	$ 61.46	$ 165.96	$ 120.08
Returns over Total Costs	$ 20.02	$ 51.37	$ 17.59	$ 56.55	$ 161.05	$ 115.17
Acres each Crop	750	150	150	150	150	150
Total Income from Crop	$ 15,015	$ 7,706	$ 2,639	$ 8,483	$ 24,158	$ 17,276
Total Income from Farm						$ 75,275

	Winter Wht	Barley	Fallow
Yield	25	38	0
Price	$ 3.00	$ 1.80	0
Total Income	$ 75.00	$ 68.40	$ -
Operating Costs	$ 33.17	$ 47.96	$ 8.27
Ownership Costs	$ 7.60	$ 5.39	$ 3.54
Returns over Operating Costs	$ 41.83	$ 20.44	$ (8.27)
Returns over Total Costs	$ 34.23	$ 15.05	$ (11.81)
Acres each Crop	700	100	700
Total Income from Crop	$ 23,961	$ 1,505	$ (8,267)
Total Income from Farm			$ 17,199

	Winter Wht	Spring Wht	Fallow
Yield	25	19	0
Price	$ 3.00	$ 3.75	0
Total Income	$ 75.00	$ 71.25	$ -
Operating Costs	$ 32.55	$ 44.94	$ 8.52
Ownership Costs	$ 6.78	$ 5.87	$ 4.18
Returns over Operating Costs	$ 42.45	$ 26.31	$ (8.52)
Returns over Total Costs	$ 35.67	$ 20.44	$ (12.70)
Acres each Crop	500	500	500
Total Income from Crop	$ 17,835	$ 10,220	$ (6,350)
Total Income from Farm			$ 21,705

	Winter Wht	Fallow
Yield	25	0
Price	$ 3.00	0
Total Income	$ 75.00	$ -
Operating Costs	$ 33.16	$ 8.30
Ownership Costs	$ 7.66	$ 3.46
Returns over Operating Costs	$ 41.84	$ (8.30)
Returns over Total Costs	$ 34.18	$ (11.76)
Acres each Crop	750	750
Total Income from Crop	$ 25,635	$ (8,820)
Total Income from Farm		$ 16,815

Table 4. Income from Alternative Cropping Systems in Southeastern Montana and Southwestern North Dakota

	Spring Wht	Alternative Crops				
		Safflower	Yellow Mustard	Lentils	Winter Peas	Flax
Yield	19	650	300	1.5	1000	17
Price	$ 3.75	$ 0.15	$ 0.15	$ 75.00	$ 0.20	$ 8.00
Total Income	$ 71.25	$ 97.50	$ 45.00	$ 112.50	$ 200.00	$ 136.00
Operating Costs	$ 45.46	$ 39.50	$ 20.78	$ 51.04	$ 34.04	$ 15.92
Ownership Costs	$ 5.77	$ 6.63	$ 6.63	$ 4.91	$ 4.91	$ 4.91
Returns over Operating Costs	$ 25.79	$ 58.00	$ 24.22	$ 61.46	$ 165.96	$ 120.08
Returns over Total Costs	$ 20.02	$ 51.37	$ 17.59	$ 56.55	$ 161.05	$ 115.17
Acres each Crop	750	150	150	150	150	150
Total Income from Crop	$ 15,015	$ 7,706	$ 2,639	$ 8,483	$ 24,158	$ 17,276
Total Income from Farm						$ 75,275

	Winter Wht	Barley	Fallow
Yield	38	38	0
Price	$ 3.00	$ 1.80	0
Total Income	$ 114.00	$ 68.40	$ -
Operating Costs	$ 33.17	$ 47.96	$ 8.27
Ownership Costs	$ 7.60	$ 5.39	$ 3.54
Returns over Operating Costs	$ 80.83	$ 20.44	$ (8.27)
Returns over Total Costs	$ 73.23	$ 15.05	$ (11.81)
Acres each Crop	700	100	700
Total Income from Crop	$ 51,261	$ 1,505	$ (8,267)
Total Income from Farm			$ 44,499

	Winter Wht	Spring Wht	Fallow
Yield	38	19	0
Price	$ 3.00	$ 3.75	0
Total Income	$ 114.00	$ 71.25	$ -
Operating Costs	$ 32.55	$ 44.94	$ 8.52
Ownership Costs	$ 6.78	$ 5.87	$ 4.18
Returns over Operating Costs	$ 81.45	$ 26.31	$ (8.52)
Returns over Total Costs	$ 74.67	$ 20.44	$ (12.70)
Acres each Crop	500	500	500
Total Income from Crop	$ 37,335	$ 10,220	$ (6,350)
Total Income from Farm			$ 41,205

	Winter Wht	Fallow
Yield	38	0
Price	$ 3.00	0
Total Income	$ 114.00	$ -
Operating Costs	$ 33.16	$ 8.30
Ownership Costs	$ 7.66	$ 3.46
Returns over Operating Costs	$ 80.84	$ (8.30)
Returns over Total Costs	$ 73.18	$ (11.76)
Acres each Crop	750	750
Total Income from Crop	$ 54,885	$ (8,820)
Total Income from Farm		$ 46,065