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Comparing the Economic Performance and Energy Intensiveness of Alternative and Conventional Small Grain Farms in The Northwest

By: Steve Kraten and David Holland

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STEVE KRATEN is the Limited Resource Farming Extension Agent for King County, Washington. DAVID HOLLAND is on the faculty of the Department of Agricultural Economics at Washington State University.

In 1977 a study was undertaken by Eberle and Holland [1] to compare the economic returns and energy intensiveness among selected pairs of conventional and organic grain farms in the state of Washington. That study was patterned after the work of Lockeretz [2,3]. The present inquiry was an extension and expansion of the research of Eberle and Holland.

The Eberle study was limited to farms of a size greater than fifty acres that grew primarily food grains. Three organic farms that met these criteria were located. Two of the farms were matched with conventional farms in the same geographic areas. The third was left unpaired because the crops it produced were unique to the area.

Eberle's tentative conclusions, summarized in the Spring, 1978 issue of Tilth, were that the conventional farms in the study produced 33 percent more total value per acre than the organic farms while using 34 percent more energy. This was in contrast to the Lockeretz study in which net returns were equal for both groups and conventional farms were more than twice as energy intensive (measured as energy per dollar of crop output) as organic farms.

In the present study a different method of comparison was used. In place of actual comparison farms, organic and semi-organic (henceforth collectively referred to as alternative) farms were matched with regional farm and crop budgets compiled by Washington State University and the University of Idaho. For four of the six alternative farms there existed conventional budget information for the geographic areas in which they were located. Crop yields used for alternative farms were those reported by farm operators. County average yields were used in the case of conventional farms.

No budgets could be found to approximate conventional comparisons for the remaining two alternative farms. One was rematched with the same conventional farm that was its counterpart in the Eberle study. The other, because it was atypical for the region, was left unpaired. The results of the unpaired farm are not included in this report.

Upon selecting alternative farms, data were collected from each farm through a personal interview. The data gathered included: amount of cropland and yields, crop rotation practices, size and type of all equipment used in the crop and livestock enterprises, time required for each field operation for each crop, number of livestock and livestock sales, livestock feeding practices, and application rates and costs of materials such as seed, fertilizers, herbicides,

manure, and other soil amendments. Prices for crops on both alternative and synthetic farm budgets for 1976 and 1977 reflected the average of market prices for that particular year.

Total value of output per acre and total value minus variable costs per acre for the entire farm as well as for individual enterprises were calculated from the collected data. An additional return estimate was calculated by subtracting the fixed cost of machinery depreciation. Total value of output per acre was the market value of all crops divided by the total acres of cropland. Cropland included all acres producing the valued crops plus summer fallow and green manure acreage. Permanent pasture was not counted as cropland. As in the Lockeretz study, no evaluation of the livestock enterprise was made. Feed inputs raised on the farm that were put into livestock were valued at market value.

The variable costs included in this study covered only those out-of-pocket costs incurred to carry out the different enterprises. Variable costs included fuel, lubrication, machinery repairs, fertilizers, herbicides, pesticides, seed costs, and hired labor. No cost was imputed to operator or family labor. All inputs used in common, such as fuel and lubrication costs, were assigned a standardized price. The amount of fuel consumed was estimated from the tractor horsepower and number of hours as stated by the operator to perform various tasks [4,5]. All inputs not used in common, such as farm chemicals, were assigned the actual costs incurred by the farmer.

Depreciation charges and charges for property taxes, housing, insurance, and interest on machinery investment were the fixed charges reflected in the returns. Operator estimates were used for assigning machinery repair costs for the alternative farms.* For the conventional farms an average repair rate schedule was chosen.

Energy intensiveness for both the organic and synthetic farms was expressed as thousands of kilocalories per dollar value of output. Energy values were assigned only to variable inputs directly related to or dependent on fossil fuels. These inputs included fuel for all crop operations, fertilizers, herbicides, pesticides, and LP gas for crop drying. The energy value coefficients used by Pimentel and Jensen were used in this study.

RESULTS

In reviewing these results it is important to keep in mind that much of the data on which this study is based were taken from the crop year of 1977. This was an atypical year characterized by a severe drought in the study area. As a result, crop yields in dryland areas were far below normal. If alternative and conventional farms were similarly affected by the drought, then their relative economic and energy performance would not be affected. However, there is reason to believe that the effects of the drought were not symmetrical.

Grain crops planted by most farmers are high response varieties developed to produce large yields when provided with ample quantities of fertilizer and water. In 1977, the lack of water prevented these yield potentials from being realized. For conventional farmers, the result was yields well below normal. The drought may therefore have served as an equalizer, negating some of the economic advantages that conventional farms would have had over alternative farms in a year of normal rainfall.

It should also be remembered that, for the sake of simplicity, this study did not take livestock enterprises into account. This will tend to underestimate the returns to the operator, as on several alternative farms livestock were an important component of the farming operation and may have contributed significantly to the operator's income.

Prices paid for inputs were assumed to be the same for alternative and conventional farms. Prices received for outputs were also assumed to be the same except in the cases where the operator was clearly linked into an alternative market in which he or she was receiving a premium for organic produce. In such cases the calculations were made both with and without the organic premium.

FARM PAIR NO. 1

The first alternative farm was in a dryland wheat area. This was a strictly organic farm using no

chemical fertilizers or pesticides. Seventy-two acres were farmed in 1976 and an additional 48 acres were added in 1977. Over half of the land was in alfalfa- grass hay with a portion being replanted each year to form a six year rotation. The remainder was on a three year rotation consisting of fallow, red wheat, and barley or oats. The 'fallow" ground was not completely fallow but was interplanted with widely spaced rows of potatoes and a green manure crop such as peas or lentils which in the latter case were plowed down early in the summer. Livestock were an integral part of the organic farm and the primary source of cash income. Conventional Farm No. 1 was a 1,278 acre farm with a white wheat, barley, summer fallow rotation. The results of the comparison, summarized in Table 1, show the economic returns and energy intensiveness for these farms in 1976 and 1977. In both years the organic farm had a greater total crop value per acre and greater returns to land and operator labor after fixed and variable costs.

TABLE I

Returns and Energy Use for Pair No. 1

Returns and Energy Use	Alternative 1976	Conventional 1976	Alternative 1977	Conventional 1977
Cropped Acres	72.00	1,278.00	120.00	1,278.00
Total Crop Value/Acre	77.18	69.41	61.01	39.77
Returns Above Variable Cost/Acre	62.56	41.11	51.44	11.47
Returns - (Fixed + Variable Costs) /Acre	26.92	22.20	33.84	-7.43
Kcal. x 10^3/Acre	282.11	630.03	291.16	630.03
Kcal. x 10^3/Dollar Output	3.66	9.08	4.77	15.84

The following coefficients were used: 1 pound of nitrogen = 8,400 Keal.
1 gallon of gasoline = 37,500 Kcal. 1 pound of phosphate = 1,520 Kcal.
1 gallon of diesel 40,830 Kcal. 1 pound active ingredients
herbicides & pesticides = 11,000 Kcal.

In 1976, the conventional farm had considerably higher yields of wheat and barley than did the organic farm. In 1977, the wheat yield was still much higher on the conventional farm but its barley yield dropped to less than half that of the organic farm. The primary reason for the greater crop value per acre on the organic farm, even in 1976, was that more than half of that farm's cropped acreage was in hay. Hay brought higher returns per acre than did the grain-fallow rotation of the conventional farm and was less energy intensive as well. If the conventional farm had grown hay also, or if only grain enterprises had been compared, the results would have been quite different and the conventional farm's economic performance would have been superior to that of the organic farm. The performance of both farms appears to have been diminished by the drought in 1977 but the conventional farm was affected more severely. The negative economic returns for the conventional farm in that year resulted primarily from high expenditures for fertilizer without the realization of correspondingly high crop yield response due to the drought.

Energy intensiveness in both years was considerably greater for the conventional farm. On the average, the conventional farm used twice as many kilocalories per acre as did the organic farm. In terms of kilocalories per dollar value of output, the conventional farm was more than two and a half times as energy intensive as the organic farm. Most of the difference in energy use can be attributed to the energy embodied in the fertilizer and other chemical inputs used on the conventional farm.

FARM PAIR NO. 2
Alternative Farm No. 2 was the least organic of the farms studied. No insecticides were used and the only herbicide used was a small amount of 2,4-0 for spot weeding of morning glories. Chemical fertilizer, however, was used. The farmer applied 250 to 300 pounds per acre of calcium nitrate with a nitrogen content of 20 percent. The farm is presented here as a semiorganic farm approaching the conventional end of the organic-conventional continuum.

The owner of Alternative Farm No. 2 operated his own mill where he ground and packaged flour from the wheat he grew. The milling part of the enterprise was treated as breaking even and the returns from this operation were absorbed in the price assumed to be received for wheat. In this way the farmer estimated that he averaged $4.00 per bushel of white wheat and $4.50 per bushel of red wheat. Returns for this farm were calculated at both these prices and at the standard market price.

Alternative Farm No. 2 used a three year wheat and barley, lentil, fallow rotation with a small amount of rye growing in moist, lowland areas. In 1977, 15 acres were planted to white wheat and 35 acres to red wheat. The conventional comparison for Farm No. 2 was a 1,000 acre dryland farm also using a wheat, lentil, fallow rotation. The comparison results are shown in Table 2.

TABLE II
Returns and Energy Use for Pair No. 2

Returns and Energy Use	Alternative[a] 1977	Alternative[b] 1977	Conventional 1977
Cropped Acres	218.00	218.00	1,000.00
Total Crop Value/Acre	116.44	96.36	66.83
Returns Above Variable Costs/Acre	87.08	67.00	35.37
Returns - (Fixed + Variable Costs)/Acre	53.00	32.93	0.71
Kcal. x 10^3/Acre	690.28	690.28	538.03
Kcal. x 10^3 /Dollar Output	5.93	7.16	8.05

a. Actual price received by operator through own milling operation.
b. Conventional market price.

For this pair, the alternative farm's yields were higher for all crops. An improved soil pH resulting from the use of calcium nitrate may have been a factor in producing high yields.

Fixed and variable costs were similar for both farms. Under standard market prices the crop value per acre and returns after fixed and variable costs were $29.53 and $32.22 higher, respectively, on the alternative farm. When the premium received by the alternative farm for its milled wheat was taken into consideration, the differential after fixed and variable costs increased from $32.22 to $52.22.

In this comparison, the alternative farm used more kilocalories of energy per acre than the conventional farm. However, the higher value of its crop production brought the number of kilocalories used per dollar value of output below that of the conventional farm.

FARM PAIR NO. 3
Alternative Farm No. 3, with 4,299 cropped acres, was by far the largest of the farms studied. This farm was also in a dryland wheat area and used a five-year rotation consisting of wheat,

peas, wheat, peas, fallow. The only crop receiving commercial fertilizer was wheat following peas. This rotation was modified in 1977 in order to try to take advantage of anticipated high prices and because the terms on some newly leased land required a crop to be grown every year. The farm was not strictly organic. Herbicides and insecticides were used in amounts similar to that of conventional farms. Fertilizer, however, was only applied one year out of five. This is below the fertilization rates of conventional farms.

TABLE III
Returns and Energy Use for Pair No. 3

Returns and Energy Use	Alternative 1977	Conventional 1977
Cropped Acres	4,299.00	1,000.00
Total Crop Value/Acre	76.18	101.04
Returns Above Variable Costs/Acre	43.46	68.88
Returns - (Fixed + Variable Costs) /Acre	32.94	34.63
Kcal. x 10^3/Acre	395.14	553.93
Kcal. x 10^3/Dollar of Output	5.19	5.48

The conventional comparison farm was a 1,000 acre farm with wheat, peas and fallow in proportions similar to the five year rotation normally followed by the alternative farm; 250 acres in fallow, 250 acres in wheat following fallow, 250 acres in peas, and 250 acres of wheat following peas.

Both wheat and pea yields were considerably higher on the conventional farm. This difference is not fully reflected in the respective crop values per acre due to the fact that, in 1977, only 9.3 percent of the alternative farm was fallowed compared to 25 percent for the conventional farm.

Variable costs were nearly the same for both farms, but a much lower fixed cost per acre on the alternative farm brought returns to within $1.69 of the conventional return. Although the conventional farm used 40 percent more energy per acre than the alternative farm, its energy use per dollar value of output was only 5.6 percent higher.

FARM PAIR NO. 4

Farm No. 4 was strictly organic and used no chemical fertilizers or pesticides. The farm used a rotation consisting of corn, wheat, beans, wheat, beans, oats, and alfalfa. Corn and oats were only grown in small quantities, with beans, wheat, and hay being the main crops. This was the only irrigated farm of the group studied. The farm was linked into an alternative market and received a premium for its organic produce. The conventional comparison for Alternative Farm No. 4 was compiled from several different enterprise budgets for irrigated agriculture in the same area. Its crops were wheat, beans, and hay. The results are summarized in Table 4.

TABLE IV
Returns and Energy Use for Pair No. 4

Returns and Energy Use	Alternative a 1977	Alternative b1977	Conventional 1977
Cropped Acres	273.00	273.00	250.00
Total Crop Value/Acre	310.56	275.47	304.46
Returns Above Variable Costs/Acre	271.79	236.69	259.07
Returns - (Fixed ± Variable Costs)/Acre	207.56	172.56	211.81
Kcal. x 10^3/Acre	643.49	673.49	655.45
Kcal. x 10^3/Dollar of Output	2.17	2.44	2.15

a. Alternative market prices. b. Conventional market prices.

Wheat yields were 43 percent higher on the conventional farm while bean yields were 20 percent higher. Hay yields were slightly higher on the organic farm. Under standard market prices, crop value per acre was 10.5 percent higher on the conventional farm. Higher fixed costs on the organic farm further widened the gap resulting in conventional returns, after fixed and variable costs, 23 percent greater than that of the organic farm. When organic market prices were used, crop value per acre for the organic farm was slightly above that of the conventional farm. Fixed costs, however, reduced the organic returns to two percent below the conventional returns.

The organic farm used 2.7 percent more energy per acre than the conventional farm and, under conventional market prices, was 13 percent more energy intensive per dollar value of output. Under alternative market prices the energy intensiveness of both farms was nearly the same.

FARM PAIR NO. 5

Alternative Farm No. 5 was a strictly organic farm in a dryland wheat area. The farm encompassed approximately 650 acres and used a two-year rotation consisting of grain and summer fallow. Grains grown include red wheat, white wheat, barley, Oats, and rye. There was also a portion of ground in hay. Grain and fallow did not occupy separate fields but rather were alternated in strips. Sweet clover, a biennial, was interplanted with some of the grain in 1976. When the grain was harvested, the clover remained.

Alternative Farm No. 5 was matched with an actual conventional farm of a similar type in the same geographic area. Conventional Farm No. 5 was 755 acres and, like the alternative farm, used a two-year rotation of wheat, barley and rye, alternating with summer fallow. The results are shown in Table V. In 1976, crop value per acre on the conventional farm was 27 percent greater than on the organic farm. In 1977, the conventional farm had only a 3 percent higher crop value per acre than the organic farm. As had been the pattern in most of the previous cases, the conventional member of the pair had higher fixed and variable costs. Returns above variable costs were quite similar for both farms in both years. Fixed costs for the conventional farm, however, were an average of three times as great as for the organic farm. The conventional farm was more energy intensive than the organic farm in both years. On a per acre basis the difference was 42 percent in 1976 and 37 percent in 1977. The differences in kilocalories per dollar value of output for the two years was 11.7 and 32 percent, respectively.

TABLE V
Returns and Energy Use for Pair No. *5*

Returns and Energy Use	Alternative 1976	Conventional 1976	Alternative 1977	Conventional 1977
Cropped Acres	567.00	340.00	645.00	340.00
Total Crop Value/Acre	30.56	38.86	28.41	29.29
Returns Above Variable Costs/Acre	24.04	24.47	14.79	14.90
Returns - (Fixed + Variable Costs) /Acre	17.75	7.13	9.37	-2.44
Kcal. x 103/Acre	250.85	356.44	260.35	356.44
Kcal. x 103/Dollar Output	8.21	9.17	9.16	12.09

AVERAGE ECONOMIC RETURNS AND ENERGY INTENSIVENESS OF THE FARM PAIRS
Table 6 presents the averages for 1976 and 1977 both with and without the alternative prices received by Alternative Farms No. 2 and No. 4. Under standard market prices, crop value per acre averaged 2 percent higher on the conventional farms than on the alternative farms. The conventional farms also averaged higher fixed and variable costs. Returns after fixed and variable costs were 22.4 percent greater for the alternative farms. Under alternative prices, total crop value per acre was 6.6 percent higher on the organic farms while returns after fixed and variable costs were 43 percent higher for the alternative farms. Energy intensiveness on the conventional farms was 30.8 percent greater per acre and 52.6 percent greater per dollar value of output than for the alternative farms. Under alternative prices the latter figure rose to 58.6 percent.

SUMMARY AND CONCLUSIONS
The conventional farms produced more dollars worth of crop output per acre than the alternative farms, but not a great deal more. The average difference for both years combined was two percent under standard market prices. Under alternative prices, crop value was 6.6 percent higher for the alternative group. Fixed and variable costs were higher on the conventional farms. Returns after these costs were 22.4 percent higher on the alternative farms under conventional market prices and 43 percent higher under alternative prices. In this regard, the results were somewhat different from those of Lockeretz in which net returns after variable expenses were found to be equal.

In the area of energy use the results were also somewhat different from Lockeretz. The present study indicated that conventional farms were 52.6 percent more energy intensive per dollar value of output than alternative farms under standard market prices. This is in contrast to the Lockeretz study in which the conventional farms were nearly twice as energy intensive as the organic farms.

The difference between these results may be due to the fact that Lockeretz compared conventional farms only with strictly organic farms. They may also be due, in part, to basic differences in crops and agricultural practices between the Corn Belt and the Northwest. However, organic methods do seem to offer the potential for reduced dependence upon purchased inputs and fossil fuel based energy sources. There is also the possibility that further research and experience in organic methods will result in improved yields and energy efficiency on organic farms. The results of this study certainly suggest that more research into the economic and technical aspects of organic farming is warranted. Concerning the question of

organic methods as a feasible alternative to existing farm practices the results of this study are somewhat encouraging. Gross returns were slightly lower for the alternative farms but net returns were higher, particularly under alternative prices. This indicates that alternative farms can be financially successful in the Northwest. The question of whether it is feasible for many farms to use organic methods cannot be answered at this tine as there are a number of complicating factors.

REFERENCES

*In general, the alternative group had older equipment. Although one could argue that their repair costs would be higher than would have been the case with newer machinery, this did not seem to be true. On newer machinery a major proportion of the cost is parts. Also, if the newer machinery was technically more sophisticated, additional costs for a skilled mechanic are necessary. This high cost of parts and labor may not hold for older machinery because one can depend on salvage for parts or improvise parts. Also, older machinery repair often does not require the use of outside labor. Thus, the major costs of repairing older machinery very likely would be operator labor. A possible offsetting factor is timeliness. Old machinery may be more likely to break down when field operations must be performed, causing costly delays which result in decreased yields.

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