A Profitability and Risk Analysis of Organic and High-Input Cropping Systems in Southwestern Minnesota

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Markets for organic crops have developed substantially over the past two decades. Acreage of organic farmland in the U.S. has increased from 1.3 million acres in 1997 to over 4.8 million acres in 2008. Retail sales of certified organic foods have increased from $3.6 billion in 1997 to $21.1 billion in 2008. While early adopting organic farmers had difficulty marketing their crops, there has been an increase in reports of shortages of organic products in recent years (Dimitri and Oberholtzer 2009).

Several previous studies have analyzed the comparative profitability of organic and conventional cropping systems in the midwestern United States. In Iowa, researchers analyzed three years of data from an experimental trial and found that an organic corn-soybean-oat/alfalfa-alfalfa rotation significantly outperformed a conventional corn-soybean rotation when organic price premiums were considered (Delate et al. 2003). A recent study based on long-term trial data in Wisconsin found that when government programs and organic premiums were considered, an organic grain rotation outperformed conventional and no-till cropping systems (Chavas, Posner, and Hedtcke 2009). In Minnesota, based on ten years of trial data, lower production costs in the organic treatment resulted in competitiveness with the conventional strategy even when no organic premiums were considered (Mahoney et al. 2004). Earlier studies also show that price premiums are not always necessary for organic systems to be competitive with conventional systems (Welsh 1999).

While the results of previous studies almost universally show that organic production is competitive with conventional methods, the data upon which these results are based are often from trials that are either short in duration or small in field size, thereby potentially failing to capture the full variability in crop yields. In this study, 17 years of consecutive yield and farm management data from the University of Minnesota's Variable Input Crop Management System (VICMS) trial located in southwestern Minnesota are analyzed. The long term nature of the VICMS trial data allows an analysis that will help to provide a better understanding of the costs and returns that are likely to be faced by current organic producers in the Upper Midwest. Contrary to what Mahoney et al. (2004) found using data from a smaller, adjacent field experiment, this study finds that the organic system requires a price premium on organic crops to return profits greater than those from conventional rotations.

Background of the VICMS Trial

In response to concern among farmers and community groups regarding chemically intensive crop production and a growing interest in the practice of organic farming, the University of Minnesota initiated the Variable Input Crop Management Systems (VICMS) trials in 1989 near Lamberton, MN. The trials were designed to compare the conventional high-input farming system that is dominant in Southwestern Minnesota with what had been promoted as a more environmentally friendly, ecologically sustainable system of "organic" farming (Porter et al. 2003).

Two sites were originally employed for the implementation of the VICMS trials. The primary, larger site had not been actively managed prior to the trials, and had no history of chemical inputs. Weed pressure was very high and there was concern that organic crop yields would be of little significance for the first several years. Thus, a second site that had been actively managed prior to the start of the trial and had higher soil fertility levels and lower weed pressure was selected for the purpose of comparison.

This site, located one kilometer from the larger trial site ran identical trials until 2002, when it was terminated (Porter et al. 2003).

The primary VICMS trial, on whose results this study is based, includes four different cropping strategies and two rotation lengths. In addition to the organic-input system (OI), the VICMS trial includes a conventional high-purchased-inputs (HI) system, a low-purchased-inputs (LI) system, and a zero-inputs (ZI) system for the purpose of control. Each management strategy is applied to a two-year corn-soybean rotation and a four-year corn-soybean-oat/alfalfa-alfalfa rotation. Each crop of each rotation is present each year in the VICMS study. With two crop rotations, four crop management strategies, and four crops, there are 24 different rotation x management x crop combinations present each year. Each of these combinations is replicated three times for a total of 72 subplots that are 54.9 m long and 30.5 m wide (Porter et al. 2003).

Though the VICMS trial consists of four distinct management strategies in each of two crop rotations, this analysis focuses solely on an economic comparison of the two-year HI cropping system and the four-year OI cropping system. The four-year HI cropping system was not considered, as it is far less commonly practiced in the region than is the two-year corn-soybean rotation. Likewise, the two-year OI rotation was not considered, as rotations shorter than three years are ineligible for organic certification (USDA 2008, 2).

The HI and OI strategies are briefly explained here and descriptions of the field operations are provided in table 1. The HI strategy is characterized by yield goals that are 10% higher than the LI strategy and consequently, higher rates of fertilizer are applied to the HI plots (Porter et al., 2003). Chemical applications are broadcast rather than banded, and pre-emergence herbicides are used. The OI strategy relies on inputs and practices that are considered acceptable under organic certification guidelines. Within the OI system, beef manure is used for fertilization, no synthetic pesticides are used, and, in recent years certified organic seed has been planted.

Methodology

This study presents an economic analysis that can be of use to producers and other stakeholders when considering the profitability of organic farming in today's market environment. In order to make the analysis as relevant as possible to current producers, contemporary input and commodity prices were applied to VICMS yield and management data, rather than using historic production costs and crop prices. 17 years of trial data (1993 to 2009)[1] were joined with four years of commodity prices (2006 to 2009) to calculate distributions of net returns for each cropping strategy. Stochastic dominance analysis was then used to compare the resulting cumulative distribution functions (CDFs).

This methodology rests on a few key assumptions. First, it must first be established that farm-level crop yields are uncorrelated with market prices. If this assumption holds, a set of recent commodity prices can be paired with the annual production costs and yields seen in the VICMS trial to achieve a distribution of net revenue that accounts for production risk as well as risk found in input and commodity markets. Input prices, production cost estimates, and yields must also be converted into

[1] Although the VICMS trial began with planting in 1989, yield data from 1989-1992 is not analyzed. Four years, enough for one full four-year crop rotation, was allowed for soil fertility and weed pressure to reach levels typical of actively managed farms in the region and the establishment of the crop rotation background that is necessary for valid comparisons.

current terms by examining input markets from the past and present and adjusting for yield trends when appropriate. Detailed descriptions of the production cost estimates, yield calculations, and crop prices used in the net revenue analysis follow.

Production Costs

Machinery: Costs of most field operations were calculated using machinery cost estimates from University of Minnesota Extension reports (Lazarus 2009). These estimates include use-related costs such as labor to operate the equipment, fuel and lubricant, and use-related repairs and depreciation. These cost estimates do not consider overhead costs related to owning machinery such as interest payments, insurance, or machinery housing. Although including overhead costs would provide a more complete representation of the costs facing a farm, per-acre overhead costs are highly dependent on assumptions of farm size and machinery purchase prices. Thus, for the purposes of this study, only operating costs were considered. Finally, costs for the application of chemical fertilizer and pesticides were calculated using average custom application rates, since most producers in the area do not self-apply chemical inputs (Edwards, Smith and Johanns 2009).

Synthetic Fertilizer: Synthetic fertilizer applications, used in the conventional HI strategy, were priced using 2009 market prices as quoted in the Farmer's Cooperative Association (FCA) nutrient price lists (FCA 2009). Total fertilization costs were calculated for each crop in each year using current nutrient prices and applying them to the rates of nitrogen (N), phosphorus (P), and potassium (K) used on the trial plots, plus an additional cost for the custom application as explained in the previous section.

Herbicide and Insecticide: Herbicide costs were also calculated using 2009 market prices when possible. However, many of the herbicides that were used in the early years of the VICMS trial are no longer available and therefore no current market prices can be found. In these cases, an effort was made to convert past prices to current prices using a herbicide price index that was constructed for this purpose. To construct the price index, herbicide price lists from 2000 and 2004 were compared to the 2009 market prices (Boerboom and Trower 2000, 2004). For those products that were available in all three years, rates of the product's price change over time were calculated. The rates of price change were then averaged for all products that appeared on two or more price lists. Finally, the average change in price was applied to the herbicides of interest that were found only on past price lists, thereby converting the prices of these products into 2009 terms. Costs for insecticide were calculated using 2009 market prices found in FCA chemical input price lists. All insecticides that were applied during the VICMS trial are still commercially available.

Manure: In the OI strategy, plots are fertilized with beef manure rather than with chemical fertilizers. The costs of manure are much more difficult to estimate than are those of synthetic fertilizers because of availability and transportation issues. Rather than purchasing manure from a business with set nutrient prices, such as a farmer's cooperative, producers using manure as fertilizer must negotiate prices with nearby farms that raise livestock. Costs vary with local supply and demand, distance from the manure source, and nutrient content of the manure in question.

Although some similar studies assume only a cost for the application of manure and no purchase cost (e.g. Mahoney et al. (2004)), the University of Minnesota's Center for Financial Management FINBIN database shows that in recent years farmers in Minnesota often paid substantial amounts to purchase manure for fertilization. Therefore, this study calculates a purchase cost of manure based on the cost that would be incurred if the producer were to apply a chemical fertilizer of equivalent nutrient value, rather than beef manure. Nutrient prices were taken from the 2009 FCA price list just as they were for the calculation of synthetic fertilizer costs. An additional cost was assumed for the manure application, though no transportation costs were estimated as any assumptions regarding distance from manure source would be arbitrary. Transportation costs are thus considered to be included in the manure purchase price.

Manure cost calculations for the VICMS trials were further complicated by the fact that the amounts of manure applied varied widely throughout the 17 years of study. In early years of the trial, manure was often applied in excess of the rates needed to achieve maximum yields (Rehm et al. 2008). For example, from 1993 to 2002, the average rates of N, P, and K applied through manure prior to the organic corn crop were 302, 199, and 297 lb acre^{-1}, respectively. It is unlikely that these rates contributed to higher yields and therefore, attributing market rates for these nutrients would overestimate the true cost of fertilization needed for the organic system. Therefore, it was decided that manure costs from 2003 to 2009, when application rates were more consistent with the nutrient requirements of the crops grown, should be considered representative of the manure costs throughout the trial. An average fertilization cost of $93.34 per acre prior to planting of the corn crop and $72.75 per acre prior to planting of the oats/alfalfa crop was assumed for all trial years prior to 2003. This approach is supported by FINBIN data which show that in 2008 in Minnesota the median cost of fertilizer used for organic production of corn and alfalfa were $80.00 and $47.43, respectively. Thus, the manure costs assumed by this study are slightly higher than the median fertilization costs actually faced by Minnesota organic farmers in 2008 and are therefore a conservative estimate.

Seed: Seed costs were calculated using current seed prices. For organic seed, prices were obtained from an organic seed vendor located in Southern Minnesota that is frequently patronized by organic producers in the area (Albert Lea Seed 2010). Conventional corn seed prices were based on price quotes from seed suppliers in 2009 (Coulter et al. 2010). As conventional corn seed price is dependent on the pest resistance traits contained in each hybrid variety, three price levels were applied for corn in the VICMS two-year HI strategy depending on the traits of the seed planted in each year of the trial. Separate approximations of seed cost were attributed for years in which the planted corn seed had no insect resistance, resistance to European corn borer, and resistance to both European corn borer and corn rootworm (Coulter et al. 2010). By using this hedonic pricing method, we were able to attribute an accurate seed cost for recent years in which improved seed was used, but avoid unduly assigning that cost to previous years in which the more expensive hybrid seed was not planted. A single conventional soybean seed price, based on price quotes from local seed suppliers in 2009, was assumed for all years. Prices of all seed include cash and early purchase discounts offered by seed dealers but do not include volume discounts.

Production Cost Limitations: It is important to note that this analysis does not consider costs that may result due to additional management and labor requirements of organic systems other than those explicitly mentioned. While labor costs associated with field operations were included for both organic and conventional systems as part of the machinery cost estimates, there may be additional expenses related to organic management. Organic rotations and management techniques are complex, and producers often spend more time than conventional producers per acre on the scouting of fields, mandatory record-keeping, and the marketing of final products.

Yields

Two important issues arise when considering trial yields in an analysis of profitability and risk. First, in order to apply a set of recent commodity prices to past VICMS yields in a net revenue analysis, the independence of farm-level yields and local market prices must first be established. To do this, correlation coefficients were calculated for each crop's trial yields and historic market prices (Nordquist et al. 2009). The results of these calculations are shown in table 2. The only statistically significant negative correlation was that between conventional alfalfa hay production and local hay price. This makes intuitive sense. Since alfalfa hay is usually sold to livestock producers within the region in which it is produced, one would expect higher local production to be associated with a lower local sale price. Thus, for the purposes of the net revenue analysis grain prices are treated as random but alfalfa prices remain associated with the corresponding hay yield.

Second, the improvement of U.S. corn and soybean grain yields over time has been well documented (Egli 2008). In order to account for this time-related improvement in the VICMS trial data, trial yields were de-trended with linear time trends to convert past yields into present terms. Simple linear trends of the form

$$y_t = \beta_0 + \beta_1 t + \varepsilon_t$$

were estimated using method of moments as described in Finger (2010) using local county-level (Redwood County) crop production data from 1980-2008 (USDA, 3). Then, the resulting trends, when significant, were applied to past yields. The results of the estimations are presented later in the article. It was assumed that the trends in organic crop yields are equivalent to the conventional yield trends as data on past organic yields are insufficient to estimate separate trends.

Commodity Prices

Conventional and organic prices for corn, soybean, and oat were taken from FINBIN for the years 2006 to 2009 (Table 3). Unlike the other crops, no organic price premiums were considered for alfalfa hay in this analysis. As explained above, the established correlation between alfalfa price and yield precludes the application of contemporary alfalfa prices to past trial yields. Furthermore, there is no available data on historical organic alfalfa prices in southwestern Minnesota. Therefore, conventional alfalfa prices, taken from annual reports of the Southwestern Minnesota Farm Business Management Association (SWMFBMA) from 1993 to 2009, were used for calculating the revenue from the OI alfalfa crop (e.g. Nordquist et al. 2009). Alfalfa prices were converted to real terms using the US Bureau of Labor Statistics' Consumer Price Index and are presented in table 4.

The FINBIN and SWMFBMA prices are the average crop sale prices that were received by producers participating in the Minnesota Farm Business Management programs. The FINBIN data include growers from throughout the state while SWMFBMA data include only those in southwestern Minnesota. Although these prices are not necessarily those received by any given producer in the state or region and may differ slightly from national price averages, they are a good representation of prices that producers in Minnesota are likely to face. Moreover, FINBIN provides organic and conventional prices that are collected in the same way, and are therefore directly comparable. This allows the calculation of accurate organic price premium ratios and an accurate comparison of revenues earned by conventional and organic cropping systems (Table 5). Other sources of contemporary organic price data are limited, and while the Agricultural Marketing Service (AMS) market news reports present weekly national organic prices, annual weighted averages have not been published (USDA, 1).

This study considers three separate pricing scenarios in final net revenue analysis. In the first scenario, all crops from both the OI strategy and the HI strategy receive conventional crop prices. Second, the set of organic prices is applied to the yields from the OI system and the set of conventional prices is again applied to the HI crop. Finally, the OI system receives 50% of the organic premium for each organically produced crop while the HI system receives conventional prices. In all three scenarios the alfalfa crop from the OI strategy receives the historic conventional hay price for the year in which it was produced rather than being paired with the set of recent prices, as are the other crops.

Results

Yields

The method of moments time trend estimation resulted in statistically significant linear trends in the per-acre yields of corn and soybean at the Redwood County level from 1980 to 2008 (Table 6). The estimated annual trend in corn yield growth is 2.4 bushels per acre while the estimated trend in soybean yield growth is .5 bushels per acre. Neither oat grain nor alfalfa hay production showed significant yield trends over time. Based on these results, the VICMS corn and soybean yields were detrended for the net revenue analysis. Both the HI and OI yields were detrended with the same trend estimates, as an identical yield trend was assumed in conventional and organic systems.

Annual trend-adjusted yields for the 2-year HI and 4-year OI cropping strategies are presented in table 7. It is important to note that the HI and OI yields presented in table 7 are not produced from the same crop rotations, and therefore, the effect of the management strategy is confounded with the effect of crop rotation. Comparisons of OI and HI yields are important though, as these yields are used in the net revenue analysis presented in the following section.

Across 17 years of VICMS trial data, yields of soybean were higher on average in the 2-year HI rotation than with the 4-year organic rotation, while there was no statistically significant difference in corn yield between the two rotations. Over this period, the mean organic corn yield was 96.4% of the corn yield in the high-input two-year rotation while mean organic soybean yields were 81.8% of the conventional soybean yield (Table 8). Although the alfalfa and oat yields from the high-input 4-year rotation are not shown here, the VICMS yield data indicate that the organic strategy returned equal or higher yields for both oat and alfalfa than the HI system. In fact, organic alfalfa yields averaged 118% of the alfalfa crop grown in the HI 4-year rotation, a difference that was statistically significant at the 95% confidence level. Yields of oat grain in the OI 4-year and the HI 4-years strategies were not significantly different.

Production Costs

The HI strategy had higher production costs on average than the OI system (Figure 1). Corn produced in the 2-year HI rotation had an average production cost that was $35 per-acre greater than the corn in the 4-year OI system, primarily as a result of higher seed and weed management expenses (Table 8, Figure 2). However, the cost of organic corn production was not less in every year. Herbicide costs in the HI strategy were variable and in some years low herbicide costs helped make the HI system less expensive than the OI system. Soybean production was also more costly on average under HI management than organic management. The HI soybeans had an average cost that was $41 per-acre higher than the organic soybeans, due primarily to higher weed control costs (Table 8, Figure 3).

Although in general average costs were higher in the HI strategy, the OI strategy had higher machinery costs for the production of corn and soybean, as weeds were controlled mechanically rather than chemically. In fact, the average number of tillage passes per year in the production of OI corn was almost double that of HI corn (7.1 and

3.7 respectively). Similarly, 6.6 tillage passes, on average, were needed for the OI soybeans, compared with only 4 in the conventional rotation.

Finally, OI oats and alfalfa had average production costs that were higher than organic soybeans but lower than organic corn. While oat and alfalfa production costs related to weed control and tillage were lower than the organically produced corn and soybean, harvest costs were higher. Again, because no HI four-year rotation was considered, oat and alfalfa costs are not directly comparable across the two management strategies.

Net Revenue

In order to calculate net revenue and compare the levels of risk found in the two production strategies, 68 states of nature were constructed by matching the four sets of recent commodity prices available in the FINBIN database (2006 to 2009) to the crop yields and production costs calculated from the VICMS trial data from 1993 to 2009. This procedure, which is predicated on statistical independence between yields and prices at the farm level, captures not only the fluctuation in commodity prices but also the variation in production costs and yields that result from weather, pest problems, and weed pressure. Using this distribution of net revenue from each of the rotations, cumulative distribution functions (CDFs) were constructed and analyzed by stochastic dominance.

As described above, three pricing scenarios are considered in this analysis: i) both organic and conventional crops receive conventional prices; ii) conventional crops receive conventional prices while organic crops receive the full organic price premium; and iii) conventional crops receive conventional prices and organic crops receive 50% of the organic premium. When conventional prices were applied to both the OI and HI crops, the two-year HI strategy had a significantly higher mean net revenue as well as higher variance (Table 9). With no organic price premium, the HI CDF nearly dominates the OI CDF by first degree stochastic dominance, but the two CDFs do in fact cross at low levels of net revenue (Figure 4).

When organic price premiums were applied to the organically produced crops, the four-year OI rotation outperformed the two-year HI rotation by a large margin. The HI mean net revenue stayed at $295 per acre while the OI mean net revenue jumps to $527 per acre. The variability was larger when organic premiums are introduced, as a result of variations in the organic prices themselves, but the OI CDF was still clearly to the right of the HI CDF, indicating first degree stochastic dominance (FSD) for the OI strategy (Figure 4). When the organic price premiums were reduced to 50% of the actual price premiums received by organic farmers from 2006 to 2009, the OI CDF moved to the left, but still dominated the HI CDF. The mean net revenue for the OI strategy with 50% premiums was $377.81, significantly higher than the mean net revenue for the HI strategy.

Conclusions

Though the average yields of corn and soybean in the VICMS trials were higher for the HI management strategy than the OI strategy, lower average production costs and the availability of substantial price premiums for organically grown crops caused the OI strategy to produce higher net per-acre returns than the HI strategy at all probability levels. When organic price premiums were not taken into account, the OI strategy had lower net returns, at the mean, than the HI strategy. When only half of the organic price premiums were applied to the OI yields, the OI strategy still exhibited first-degree stochastic dominance over the HI strategy. This indicates that organic premiums could decline in the future without necessarily causing organic production to lose its profitability advantage over the conventional corn-soybean rotation.

These results show that with current price premiums, an organic crop farm in the upper Midwest can earn greater per-acre profits than a conventional farm using the two-year corn-soybean rotation that is predominant in the region. This would seem to suggest that any grower considering transition to an organic system should convert as soon as possible, but there are several issues that need to be considered. First, this analysis is based on an experimental trial in which many agronomists and established organic farmers contributed knowledge and expertise with regards to crop rotations and crop management techniques. Organic crop production often involves more complicated crop rotations than conventional production and requires more time spent scouting fields, marketing products, and on record keeping. These increased managerial requirements constitute a cost that was not included in this study.

Second, this study assumes that crops produced in the OI strategy are certified organic and therefore eligible for organic price premiums in all years of the VICMS trial. However, organic certification of cropland requires a transition period of three years, during which organic regulations must be followed but whose products may not carry the organic label. A study modeling the decision to convert to organic production in The Netherlands found that, despite higher returns to labor in the organic system, the costs associated with transition and the certification process are an impediment to conversion (Acs, Berentsen, and Huirne 2007).

Third, organic price premiums may not always be as high as they have been in recent years. Further increases in the amount of cropland under organic acreage or the deterioration in consumer demand for organic foods could lead to the weakening of organic price ratios in the long term. Though this analysis shows that a decrease in price premiums would not necessarily cause per-acre returns to organic production to drop below those to conventional rotations, a decrease in revenues, combined with the other cost issues mentioned above, would make organic production less attractive than it is now.

Finally, machinery costs, which represent a major expense in modern conventional and organic farming strategies, are sensitive to the size of machinery and amount of land to which a farmer has access. The machinery cost estimates used in this analysis take into consideration only the use-related costs precisely in order to avoid making difficult assumptions regarding farm size, though this is certainly a consideration for real-world producers. In fact, FINBIN data show that Minnesota farms smaller than 500 acres have per-acre machinery costs associated with corn production that are 15.7% higher than those seen on farms larger between 1,000 and 2,000 acres. As organic farms tend to be smaller for a variety of reasons, fixed costs related to machinery use may be higher on a per-acre basis than on conventional farms, thereby altering the relative economic outlook. Further study on the whole-farm returns to organic production is necessary to make more general conclusions about the comparative profitability of organic and conventional agriculture in the upper Midwest.

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Table 1. Description of the high purchased input (HI) two-year rotation and the organic input (OI) four-year rotation.[1]

Agronomic Practice	HI	OI
Corn		
Prior Fall Tillage	chisel	MB
Spring Tillage	field cul. (2x) [2]	field cul. (2x)
Rotary Hoeing	none	1-3x
Row Cultivation	1-3x	2-3x
Tillage After Harvest	MB	MB
Herbicides	PRE and POST	none
Fertilizer Application	broadcast	beef manure
Soybean		
Prior Fall Tillage	MB	MB
Spring Tillage	field cul. or disk	field cul. or disk
Rotary Hoeing	none	1-2x (as needed)
Row Cultivation	1-2x	2-3x
Tillage After Harvest	chisel	chisel
Herbicides	PRE and POST	none
Fertilizer Application	broadcast	beef manure
Oat/Alfalfa		
Prior Fall Tillage		chisel
Spring Tillage		field cul. (1x)
Rotary Hoeing		none
Row Cultivation		none
Tillage After Harvest		none
Herbicides		none
Fertilizer Application		beef manure
Alfalfa		
Prior Fall Tillage		none
Spring Tillage		none
Rotary Hoeing		none
Row Cultivation		none
Tillage After Harvest		MB
Herbicides		none
Fertilizer Application		beef manure

1 Specific operations used each year may have been different.
2 Field cul., field cultivation; MB, moldboard plowing; PRE, preemergence; and POST, postemergence

Table 2. Price/Yield Correlations for Each Crop in the OI and HI Rotations. 1993-2008.

Crop	OI 4-Year	HI 2-Year	
Corn	-0.338	-0.224	
Soybean	-0.333	0.114	
Oats	0.655	0.612	
Alfalfa	0.283	-0.512	*

*Significant negative correlation at the 5% level

Source: Estimated from actual VICMS experimental yield data and conventional prices received by the SWMFBA.

Table 3. Per Bushel Prices of Conventional and Organic Corn, Soybean, and Oats: 2006-2009.

Crop	2006	2007	2008	2009
Corn-Organic	$5.39	$8.43	$9.25	$7.78
Corn-Conventional	$2.88	$3.66	$3.87	$3.81
Soybean-Organic	$14.82	$20.91	$21.96	$21.08
Soybean-Conventional	$6.03	$9.28	$9.54	$9.84
Oats-Organic	$3.08	$4.74	$4.81	$4.58
Oats-Conventional	$1.92	$2.48	$2.63	$2.10

Source: FINBIN

Table 4. Inflation Adjusted Prices for Alfalfa Hay: 1993-2009.

Year	$/Ton
1993	$92.60
1994	$74.10
1995	$86.59
1996	$108.15
1997	$114.37
1998	$85.13
1999	$83.12
2000	$60.54
2001	$95.91
2002	$111.48
2003	$56.66
2004	$98.97
2005	$88.94
2006	$102.81
2007	$99.42
2008	$101.35
2009	$110.00
*Source: SWMNFBMA Annual Reports	
** Adjusted for inflation using Consumer Price Index (http://www.bls.gov/cpi)	

Table 5. Organic Price Premium Ratios Based on Organic and Conventional Prices Reported in FINBIN Database.

Year	Corn	Soybeans	Oats
2006	1.87	2.46	1.60
2007	2.30	2.25	1.91
2008	2.39	2.30	1.83
2009	2.04	2.14	2.18
Average	2.19	2.34	1.78

Source: FINBIN

Note: Due to insufficient price data and local nature of the market, no organic premiums were considered for alfalfa hay.

Table 6. Annual Yield Trend Estimates for Redwood County, MN From 1980-2009 in Bushels/Acre.

Crop	Estimate	S.E.	
Corn	2.36	(0.267)	***
Soybeans	0.448	(0.079)	***
Oats	0.374	(0.333)	
Alfalfa	0.009	(0.016)	

***Significant at the 1% level
Data Source: USDA NASS

Table 7. Detrended VICMS Trial Yields for the Organic-Input (OI) 4-year Rotation and the High-Input (HI) 2-Year Rotation. 1993-2009.

	HI 2-Year Rotation		OI 4-Year Rotation			
	Corn	Soybean	Corn	Soybean	Oats	Alfalfa
Year	Bu/A	Bu/A	Bu/A	Bu/A	Bu/A	Tons/A
1993	119.0	44.8	118.3	39.0	33.5	5.41
1994	222.2	48.4	190.5	52.4	88.2	4.93
1995	140.1	48.2	139.7	51.5	37.9	4.49
1996	195.8	55.3	169.0	52.5	62.2	4.95
1997	150.8	47.2	131.9	23.1	47.1	4.58
1998	216.8	49.2	204.8	29.1	48.7	4.97
1999	197.6	51.6	190.4	44.3	81.0	5.01
2000	185.7	46.8	181.7	26.8	74.1	5.47
2001	171.5	46.2	176.6	44.9	75.5	6.68
2002	146.7	43.6	178.5	46.4	42.7	4.53
2003	159.6	25.4	143.8	22.1	63.7	4.18
2004	177.7	55.4	172.9	22.2	50.4	4.64
2005	183.1	44.5	189.0	31.5	44.6	5.37
2006	196.6	52.0	187.2	28.0	113.6	5.48
2007	151.4	48.9	158.0	37.0	129.4	6.39
2008	131.5	42.2	121.9	23.8	136.7	5.26
2009	173.0	44.2	162.6	19.8	124.0	4.71
Mean	171.7	46.7	165.7	35.0	73.7	5.1
St. Dev.	29.39	6.69	26.09	11.74	33.80	0.66

Figure 1: Average Per-Acre Production Costs by Category for High-Input and Organic-Input Management Strategies.

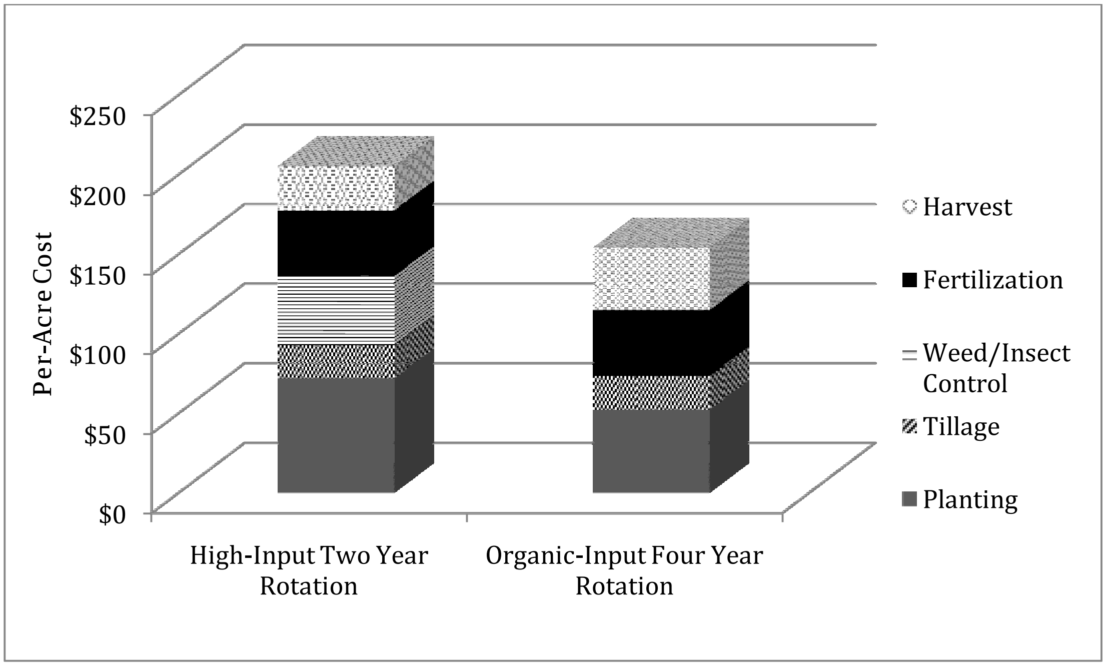

Table 8. Average Crop Production Costs for Crops by Management Strategy 1993-2009.

	4-Year HI Average Cost		2-Year OI Average Cost	
Corn	$265.49	(34.83)	$230.60	(18.85)
Soybean	$144.68	(24.05)	$103.07	(3.85)
Oat	N/A	N/A	$148.80	(33.33)
Alfalfa	N/A	N/A	$132.36	(9.03)

*Standard deviations are in parentheses

Figure 2: Corn: Average Per-Acre Production Costs in High-Input and Organic-Input Rotations

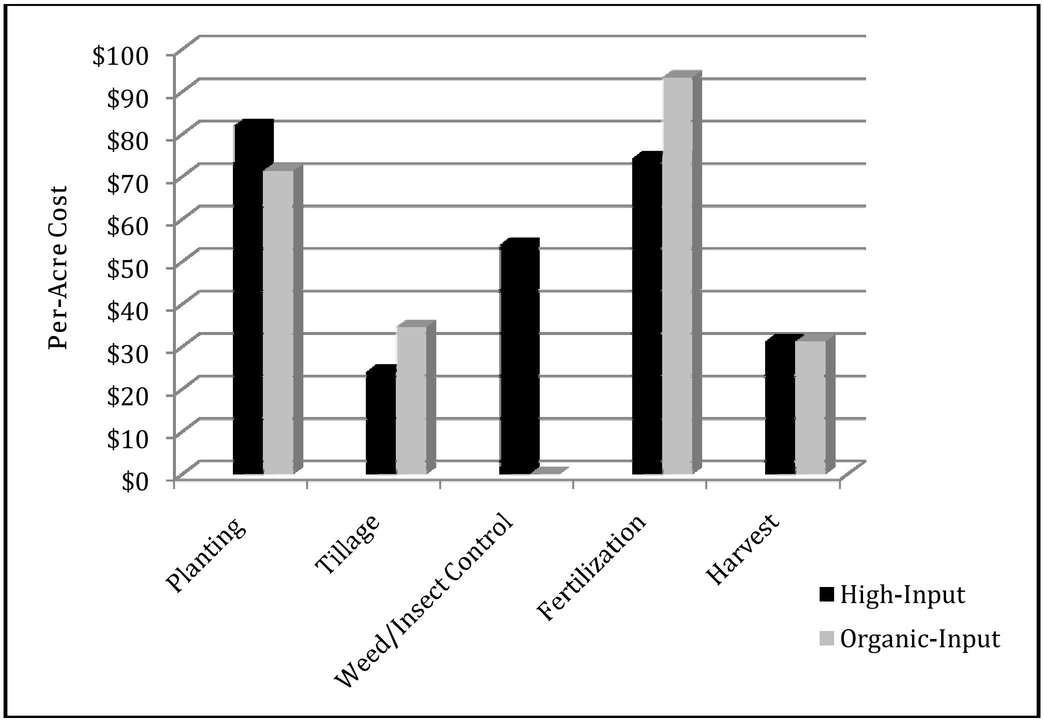

Figure 3: Soybean: Average Per-Acre Production Costs in High-Input and Organic-Input Rotations

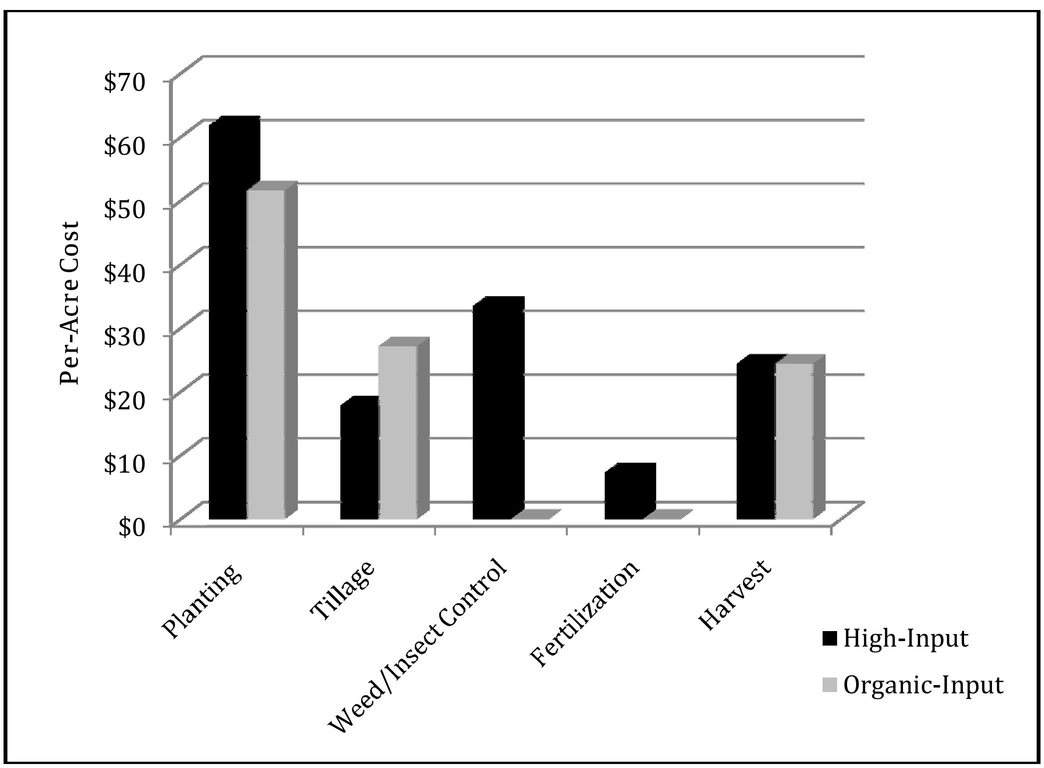

Table 9. Average Net Revenue for HI and OI Crop Rotations 1993-2009

Rotation	Price Structure	Net Revenue	
HI 2-year	Conventional Prices	$295.09	(97.23)
OI 4-year	Conventional Prices	$227.57	(61.68)
OI 4-year	50% of organic premium	$377.81	(96.65)
OI 4-year	Full organic premium	$527.48	(133.79)

*Standard deviations are in parentheses

Figure 4: Cumulative Distribution Function for 2-Year HI and 4-Year OI Rotations, Considering 0%, 50%, and 100% of Organic Price Premiums.