Risk Analysis of Organic Cropping Systems in Minnesota

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Abstract: When all strategies received conventional market prices, 4-year cropping sequences had greater net returns than 2-year sequences, and the organic input, 4-year strategy had the highest net return. Adding 50% of the estimated organic premium, the 4-year, organic strategy dominated all low- and high-purchased input strategies.

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In recent years there has been a growing interest in organic agriculture by both consumers and producers, but the majority of Minnesota and Midwestern farmers still use traditional, conventional practices to produce corn and soybeans in a 2-year rotation. Therefore, this study was conducted to evaluate whether organic agriculture is less profitable and/or involves greater risk than conventional production systems in southern Minnesota. More specifically, this study compared three different management strategies in both 2 and 4 year cropping sequences on land with prior management strategies similar to those used in Minnesota and the upper Midwest. The three management strategies were high purchased inputs (HI), low purchased inputs (LI), and organic inputs (OI). The cropping sequences were corn-soybeans and corn- soybeans-oats-alfalfa. Data from the Variable Input Crop Management System Study (VICM.S), established by the University of Minnesota in 1989 near Lamberton, Minnesota, was used. Average net returns were based on actual field input operations and yields using annual cost estimates and prices received by farmers in the area. Stochastic dominance techniques were used to compare the risk of the net returns from the management strategies and cropping sequences. Yield distributions were estimated using plot data from the experiment; price distributions were based on historical data from the same time period.

Previous studies have analyzed the relative profitability, sustainability, and yields of alternative or organic farming practices, and have shown that generally alternative and organic

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systems can be as, or more profitable than, conventional systems. (Chase and Duffy, 1991; Dabbert and Madden, 1986; Diebel et al., 1995; Hanson et al., 1997; Helmers et al., 1986; Lockeretz et al., 1978; Posner et al., 1995; Shearer et al., 1981; Smolik and Dobbs, 1991; Smolik et al., 1995). However, the research also found that the alternative systems were not necessarily without potential pitfalls and not necessarily for every farmer and farm site. In his recent review of the research of the economics of organic production, Welsh (1999) found that "the price premiums paid for organic products, although they increase profitability, are not always necessary for organic systems to be competitive with or outperform conventional systems" (p. 40). However, Welsh adds, "growing organic grains and soybeans in a longer rotation may not always be *the most profitable* [Welsh's italics] alternative for farmers" (p.40).

The studies mentioned above primarily focus their economic evaluation of alternative systems on profitability of respective alternative systems in comparison to a conventional system. In a literature review of 58 recent studies comparing alternative crop production strategies, Roberts and Swinton (1996) mention profitability as the primary method of evaluation in economic comparisons. They also suggest that comparisons that ignore risk and use profitability as the single measure of evaluation are insufficient, since income stability over time is also an important economic measure.

STUDY LOCATION AND DESIGN

The Variable Input Crop Management Study is situated at the University of Minnesota's Southwest Research and Outreach Center (SWROC) near Lamberton, about 150 miles southwest of Minneapolis-St. Paul. The study was started in the 1989 crop year. The research plots are on dark colored Mollisol soils developed from calcareous glacial till. This paper analyzes the results from the VICMS II site that has been cropped according to University recommendations since

1959, resulting in high soil fertility levels and low weed populations. Since the common soil condition in this part of Minnesota is high fertility and low weed pressure, results from VICMS II are important for producers interested in the transition from conventional practices to low-purchased inputs or organic practices.

A companion research site, VICMS I, is located on land which, prior to the Center acquiring the land in 1988, had a history of minimum inputs. No insecticides had been used on this land, herbicide use was very minimal, and neither commercial nor natural fertilizers had been applied. Consequently, weed pressure was high and soil test levels were very low. So, even though the same treatments were used, the data from VICMS I were not used in this paper since the soil conditions for VICMS I are not very similar to those commonly found in southwest Minnesota.

This research focuses on the VICMS II site and the three management strategies and two cropping sequences most relevant to current farmers. The three management strategies are described below.

1. **Low-Purchased Inputs (LI)**: Chemical applications were minimized by banding of fertilizers, banding of post-emergent herbicides (if needed), utilization of mechanical weed control, use of insecticides only if prescribed, and similar practices. A realistic yield goal was used to determine fertilizer rates. The yield goal is based on soil type, water availability, growing season length, and past maximum yield produced. The yield goal was “realistic” in that it was based on actual recorded yields in the past, not an optimistic view of the soils potential.
2. **High Purchased Inputs (HI)**: Chemical applications were not necessarily minimized. Broadcast (no banding) fertilizers and insecticides were used according to University recommendations. Pre-emergent herbicides were often used. Other

practices are selected on the basis of what is considered the best conventional practices for this region. An optimistic yield goal was used to determine fertilizer rates. Once again the yield goal was "realistic" in that it was based on actual recorded yields in the past, not an optimistic view of the soils potential

3. **Organic Inputs (OI)**: No synthetic chemical applications were allowed. Organic sources of nutrients, such as manure, and mechanical weed control were utilized. This strategy incorporates the best organic practices for the region so the crops grown could be certified as organically produced. Data was collected from the 1st year of the transition to organic certification standards. Potential premiums are not applied until certification was possible under the Minnesota organic certification standards (i.e. the third crop). Note, however, rotation restrictions do not allow the certification of a 2-year corn-soybean rotation as organically produced.

The organic practices followed in the agronomic part of this study are based on the Minnesota organic certification standards that were in place prior to the final rules set by the USDA's National Organic Project (NOP). Although the Minnesota standards followed in the study were in place prior to the national standards, all practices outlined above in the NOP organic crop production standards were met.

These three strategies are carried out in two cropping sequences: the popular two-year sequence[2] (corn-soybean) and a four-year sequence (corn-soybean-oat/alfalfa-alfalfa). Every

[2] In the area of Minnesota where the research station is located, crop production began in the 1870s with wheat grown almost exclusively. From the 1900s until the 1960s, corn, small grains, and pasture predominated. Since the 1960s, this region has been farmed almost exclusively with corn and soybean. Currently, corn and soybean are grown on more than 90% of the cropped land in Southwest Minnesota (Minnesota Agricultural Statistics Service, 1996).

crop was grown every year under each strategy, so all treatments were present each year. Each treatment was replicated three times.

DATA COLLECTED AND ANALYSIS METHODS

Detailed records have been maintained on field operations, labor used, rainfall, plant growth, weed counts (broadleaf and grasses separately), earthworm species and counts, mycorrhiza in the soil and plants, and crop yield (including oat straw yield). Soil P and K fertility levels were determined in the fall, and soil nitrate levels were determined in one-foot increments to 5 deep feet following alfalfa and soybeans.

For each management strategy, cropping sequence, and year, net returns were calculated as:

$$NR_{ijt} = \Sigma_k \, w_{jk}\{P_o{*}P_{kt}{*}\, Y_{ijkt} - C_{ijkt}\} \qquad (1)$$

where NR_{ijt} = net return to land, management, indirect labor, and other indirect costs per acre for the i^{th} management strategy and j^{th} cropping sequence in the t^{th} year; w_{jk} = the proportion of the k^{th} crop in the j^{th} cropping sequence; P_o = potential organic premium expressed as a ratio to the conventional price; P_{kt} = price of the k^{th} crop in the t^{th} year; Y_{ijkt} = average yield per acre of the k^{th} crop in the i^{th} management strategy, j^{th} cropping sequence, and t^{th} year; and C_{ijkt} = direct production costs per acre for the k^{th} crop in the i^{th} management strategy, j^{th} cropping sequence, and t^{th} year. The value of corn, soybean, oat, oat straw, and alfalfa is included in the net return for the 4-year sequence and corn and soybean for the 2-year sequence.

Crop prices were the typical cash prices received at harvest time in each year by the members of the Southwestern Minnesota Farm Business Management Association (Table 1) (various years, e.g., Olson et al., 1992). Crop yields in each year were the average of the three replications for each management strategy and cropping sequence within VICMS.

Production costs were estimated for each year using the actual cultural operations and equipment used, as listed in the field records. Total crop production costs are the sum of tillage, planting, fertilizer, pest control, and harvesting costs. The cost of each operation was calculated using University of Minnesota Extension Service's estimates of machinery costs which include fuel, maintenance, repairs, operator labor and overhead costs (various years, e.g., Fuller et al., 1992). Market prices were used for inputs except for herbicides. Seed prices were taken from Southwestern Minnesota Farm Business Management Association records (various years, e.g., Olson et al., 1992), and herbicide prices were taken from University of Minnesota Extension Service's weed control report (various years, e.g., Durgan et al., 1992).

Producers growing crops under the OI system can potentially receive organic premiums after becoming certified organic producers. Due to insufficient information for Minnesota, organic price premiums for corn, soybeans, and oats listed in Table 2 were estimated using Dobbs and Pourier's (1999) information on organic price quotes and the conventional U.S. cash prices for 1995-1998. Over these four years, the average organic price premium ratio (compared to the U.S. cash price) was 1.60 for corn, 2.36 for soybeans, and 1.63 for oats. Note that, although organic price ratios were given in South Dakota cash prices (which may be similar to Minnesota cash prices) in addition to U.S. cash prices, the U.S. cash price ratios were used for several reasons. First, the organic prices Dobbs and Pourier used in their calculations of the ratios are those reported for the U.S. as a whole, and therefore the U.S. cash price ratios were used. Second, the U.S. cash price ratios were smaller, and thus a more conservative estimate of organic crop price premiums. These average ratios were used for all years and crops considered to be potentially certified as organic. Due to insufficient data, no price premium was considered for either organic alfalfa or organic oat straw.

To be certified organic, the land on which organic crops are grown, must, among other rules, be free of restricted chemical inputs for at least 36 months. After certification, producers are allowed to market their commodities as certified organic. This is generally in the third year after switching to organic methods. Because it would not meet current organic certification standards concerning crop sequences, organic premiums were not applied to the products from the 2-year organic management strategy.

Potential organic premiums vary from year to year and are also dependent on each individual producer's marketing strategies or abilities. To reflect this variability, three price scenarios were used. In the first scenario, every crop in every management strategy received the conventional market price. Organic products did not receive any premiums in this scenario. This scenario reflects the possibility of a large supply of organic production relative to the demand for organic production. This first scenario can also be useful for those skeptical of being able to obtain any premium. In the second scenario, organic products in the 4-year organic management strategy received 100% of the estimated organic premiums starting in the third year after the required transition period. In the third scenario, organic products in the 4-year organic management strategy received 50% of the estimated organic premium (or, conversely, 50% of the organic products received the estimated organic premium) after the transition period. In the last two scenarios, organic premiums were not applied in the first two years of production, but were applied in the third and following years to simulate the transition a conventional farmer would have to go through to sell organically produced crops as certified organic. In all three price scenarios, the 2-year organic management strategy and non-organic products from the HI and LI strategies received conventional market prices.

The net return calculated in equation (1) was the net return to the farmer's land, management, all labor (other than operator labor included in machinery costs), and other costs. The cost of land was not subtracted because it was highly variable between farms and would be the same for every management strategy and cropping sequence. Also, the costs of the farmer's management, labor (other than operator labor included in machinery costs), and other costs such as farm insurance, interest, marketing, and general farm expenses were not subtracted for the same reasons. While it can provide a very good estimate of the relative profitability of each strategy and cropping sequence, the estimated net return does not account for the potential differences in labor and management potentially required in different management strategies. For example, the organic alternative may require more scouting, prospective market searching, selling time, etc.; collection of this information was not part of the VICMS study, and thus is not included in the calculation of ANR.

To measure risk, the cumulative distribution functions (CDFs) of ANRs were calculated based on the yields, market prices, input costs, potential organic premiums, correlations between crop yields, and correlations between crop yield and market price. The CDFs were calculated using a program called Crystal Ball © (CB) which is an add-in program that functions within Microsoft's Excel ©. Crystal Ball forecasts the entire range of results for a given situation based on data the user puts into the program. In the case of this study CB develops a probability distribution of net returns based on the averages and distributions of yields and market prices, average input costs, average potential organic premiums, correlations between crop yields, and correlations between crop yields and market prices.

Using equation (1), CDFs of ANRs were calculated for all management strategies and cropping sequences. To simulate the probability of a given outcome of crop yield and prices, probability distributions were assigned to each individual crop with in each strategy and sequence, along with the respective market price for each crop. The distribution assigned to each individual crop within each strategy and sequence was based on actual recorded yield data with the Kolmogrov-Smirnov (K-S) test used to determine the best fitting distribution (Ostle and Mensing, 1975, p.489-490). Eleven distributions (Normal, Lognormal, Weibull, Triangular, Uniform, Beta, Exponential, Gamma, Logistic, Pareto, and Extreme Value) were considered when using the best fit option of CB to determine which distribution best fits the actual recorded data. The CB best-fit option ranks all the distributions from one (being the best) to eleven (being the worst) based on the recorded yield data. Each top ranked best fitting distribution were also visually compared to the distribution of the actual yields, as were the second and third ranked best fitting distribution to compare visually the goodness-of-fit of the top three distributions. For crop yield, 30 yield observations (3 reps/crop for 10 years) from each crop were used in fitting the distributions. With the exact same methods used in the distribution fitting of yields, 10 years of crop prices (Table 1), from 1990 through 1999, were also assigned distributions.

The total input cost of each crop in the risk analysis of the study was assumed a constant based on the actual historical 10-year average of input costs. Average projected costs were used since historical input prices, actual yields, and field operations were used in the calculation of the yearly input costs. By using the10-year average of input costs, it more accurately reflects the relationships and actual decisions made historically. Input costs in this part of the analysis were held constant because this is most likely the way individual farmers would represent their own costs in a similar forecasting or budgeting scenario. Potential organic premiums (i.e. ratios of organic prices to U.S. cash prices) (Table 2) were also considered constants due to the lack of adequate data to estimate a sound distribution based on the historical data.

Correlations between crop yield and price were calculated using actual crop yields and their respective crop prices (Table 3). Correlations between crops were also calculated using the actual recorded crop yields from the VICMS II data correlating the corn yield to other crops in the sequence (i.e. soybeans in the 2-year sequence and soybeans, oats, and alfalfa in the 4-year sequence; Table 4).

Using the assigned distributions of crop yields and crop market prices, CB calculated 500 different possible random draw combinations of crop yields and prices. Using these 500 possible outcomes of yield and price, in addition to input costs, potential organic premiums, and correlations, 500 possible outcomes of ANR for each input strategy and cropping sequence were also calculated. The 500 estimated ANRs for each cropping sequence and input strategy are then used to develop their respective CDFs.

Since risk preferences among individual farmers are difficult to measure, first-degree stochastic dominance (FSD) and second-degree stochastic dominance (SSD) are used in the analysis. The methods outlined below follow those described by Hardaker et al. (1997,p.138-153).

First-degree stochastic dominance assumes the decision-maker always has a positive marginal utility (i.e., more is preferred to less) for the performance measure being analyzed (i.e., ANR for this study). Using this method, the cumulative distribution function (CDF) of the outcomes (e.g., ANR) of different decisions or actions (e.g., input strategies) can be compared to measure risk between input strategies. The measurement of risk is based on the distributions of net returns for the different input strategies, and the strategy with the least risk (under FSD) is the one with the highest ANR at each probability point. In other words the strategy that lies strictly below and to the right of all others. For example, if two input strategies $F_A(x)$ and $F_B(x)$

are considered, and if the cumulative distribution of $F_A(x) \leq F_B(x)$ for all x, with the inequality holding for at least one outcome level, then $F_A(x)$ is preferred over $F_B(x)$, under FSD. Graphically, if the CDF of $F_A(x)$ is strictly below and to the right of the CDF of $F_B(x)$, A is said to be dominant over B by FSD. If the two cross at any point, neither is said to be dominant by FSD, and SSD can be used to compare the riskiness of the alternatives.

Since several of the CDFs of the outcomes from the VICMS II data do cross, SSD was also used in the risk analysis. SSD has a higher discriminatory power than FSD because of an additional restriction on the utility function, which is that the decision maker must be risk adverse for all values of x. Thus, the decision maker will have a utility function with positive but decreasing marginal utility. Graphically under SSD, the simplest way to evaluate the distributions of two different outcomes of input strategies is to compare the areas under the two individual CDFs. The distribution with the smallest total area under the CDF is said to be dominant by SSD if the CDF of the distribution with the smaller total area does not lie to the left of the alternative (larger total area) distribution(s) at low probability levels.

The methods of FSD and SSD may not be able to determine the input strategy and cropping sequence with the least risk, but these methods can determine which strategies may be preferred by reducing the efficient set, and thus, narrow down the number of decision choices between strategies. By reducing the choices to an efficient set of strategies, individual producers may be able use this information in their decision making process when considering the conversion to an organic production system.

RESULTS

Since they encompassed the production practices commonly used by farmers in southwest Minnesota, the HI and LI management strategies were used as benchmarks to evaluate the results from the OI strategy. Also, since it is so dominant in Southwestern Minnesota, the 2-year cropping sequence was used as the benchmark to compare the results from the 4-year sequence. Discussed below are: 1) crop yields and production costs by management strategy, 2) net returns under the three price scenarios, and 3) risk under the same three price scenarios.

Crop Yields. Across 10 years (1990 through 1999) of the VICMS II study, the HI strategy under the 4-year sequence had both the highest average corn yield (143 bu/acre) and the highest average soybean yield (44 bu/acre; Table 5). However, the HI yields were not higher than the yields in the other strategies in every year. For example, corn yields for the LI-2-year, LI-4-year, and HI-4-year strategies were higher than the HI-2-year corn yield in several years but were lower in others (Figure 1). The soybean yields for the 4-year sequence were typically higher than yields in the 2-year sequence. The OI strategy had a slightly higher alfalfa yield, while the oat yield for the OI and HI were equal across the 10 year period. Comparing the different input strategies for oat and alfalfa shows the yields of all input strategies for both crops were very similar in all the years. In almost every year, the 2-year sequence with either the LI or "OI" management strategy had the lowest corn and soybean yields. Under current rules, the 2-year crop sequence could not be certified as organic even though the production practices follow the organic guidelines. However, since the corn-soybean sequence is so dominant in Southwestern Minnesota, the 2-year organic strategy results are reported for comparison to the non-organic practices. For all crops, the impact of annual weather patterns was easily observed, as yield,s tended to move together regardless of cropping sequence and management strategy.

Production Costs. Across the 10 years of the study (1990 through 1999), the HI strategy had the highest average production costs for all crops and sequences compared with the other strategies (Table 6). Production costs for corn in the 2-year sequence averaged $47 higher per acre under the HI strategy than under the "OI" strategy. In the 4-year sequence, the production costs for corn averaged $36 higher under the HI strategy than under the OI strategy. With few exceptions over the 10 years of the study, the HI strategy had the highest production costs per acre for all crops under either the 2-year or 4-year cropping sequence (Figure 2, for example). Organic production had on average, but not in all years, the lowest costs of production for all crops, sequences, and strategies. Organic production costs also varied less from year to year than costs for the HI and LI strategies.

Net Returns with 100% Conventional Market Prices. When crops in all management strategies received the same conventional market prices, the 4-year crop sequences had greater average net returns than the 2-year sequences (Table 7). The OI-4-year strategy had the highest net return ($175 per acre). The similarity and dominance of the net returns for the 4-year sequences was apparent (Figure 3). The average net returns ranged from $175 for the OI strategy to $172 for the HI strategy in the 4-year cropping sequence. Within the 2-year sequence, the average net return was much more variable, with the HI strategy having the highest average net return.

Net Returns with 100% Organic Premium. When 100% of the estimated organic price premium (starting with the third year according to standard certification procedures) was applied to corn, soybeans, and oats grown under the 4-year organic input cropping system, the average net return of the strategy increased significantly in comparison to the results with all management strategies received the same conventional market prices. With the organic premium, the average net return for the 4-year, OI strategy increased to $245 per acre (from $175 using conventional prices) which was $106 more per acre than the 2-year, HI strategy and $73 more than the 4-year, HI strategy.

Net Returns with 50% Organic Premium. If 50% of the estimated organic premium was received (or only half of the production received the premium), the 4-year, OI strategy still had a higher average net return ($202 per acre) than all other management strategies and crop sequences (Table 7). The impact of this smaller organic premium was still very evident when it starts in the third year of production (Figure 4).

Risk Analysis with 100% Conventional Market Prices. With all input strategies receiving the same conventional market prices under the 4-year sequence, the CDF of the OI strategy is equal to or strictly below and to the right of the CDF of the HI strategy, thus dominating the HI strategy by FSD under the 4-year sequence (Figure 5). Under the 4-year sequence there was no FSD or SSD between the OI and LI strategies. Although it is not visible in Figure 5, the LI strategy has a lower ANR than the HI strategy at a probability level of 1% or less (i.e. the CDF of the LI strategy begins to the left of the CDF of the HI strategy), therefore there is no FSD or SSD between the LI and HI strategies. Although there is no FSD or SSD between the LI and HI strategies, the LI would be preferred to the HI at a probability level above 5% since the LI strategy has a higher ANR at all probability levels above 5%. Comparisons of the 2-year sequence resulted in both the HI strategy and the LI strategy dominating by SSD over the OI strategy, and the HI strategy also dominated the LI strategy by FSD (Figure 6). Therefore, under the 2-year sequence, with all input strategies receiving the same market prices, the HI strategy would be preferred over the OI and LI strategies.

Keeping the three preferred strategies noted above of the 2-year and 4-year sequences receiving 100% conventional market prices, these three strategies are combined to compare their CDFs. In the comparison of the 2-year HI, 4-year LI, and 4-year OI, the LI and OI 4-year strategies would be preferred to the 2-year HI strategy because they dominate the 2-year HI strategy by FSD and SSD, respectively (Figure 7). In this comparison there is no FSD or SSD between the 4-year LI and 4-year OI strategies, but as we will see this will change in the next comparison.

Risk Analysis with 100% Organic Premium. When the organic premium for the OI strategy was added to the risk analysis under the 4-year sequence, the results of the OI strategy change dramatically. In an unreported graph, the CDF of the OI strategy shifts notably to the right, and thus the OI strategy dominates the LI and HI strategies by FSD. The results between the LI and HI strategies do not change since they are still receiving conventional prices, and thus there is still no FSD or SSD between the LI strategy and the HI strategy. Adding the organic premium to 100% of the OI strategy crop clearly makes the OI strategy the preferred strategy in the 4-year sequence.

Risk Analysis with 50% Organic Premium. Applying an organic premium to 50% of the OI crop in the 4-year sequence resulted in an outcome similar to the previous analysis of applying 100% organic premiums to the OI crop. The OI strategy is again clearly below and to the right, and thus preferred to both the LI and HI strategies when applying the 50% premium to the OI strategy. Preferences between the LI strategy and the HI strategy are once again unchanged in the 4-year sequence.

Once again the three strategies that were preferred when receiving 100% conventional market prices (HI 2-year, LI 4-year, and OI 4-yr) are combined to compare their CDFs, but this second comparison is changed only by adding a 50% organic premium to the OI 4-year strategy, while the 2-year HI and the 4-year LI strategies still receive 100% conventional market prices (Figure 8). Figure 8 shows that by simply adding a 50% organic premium, the 4-year OI strategy becomes dominant by FSD and is preferred over the 2-year HI and the 4-year LI strategies. In other words, the OI 4-year sequence with a 50 % organic premium has a higher ANR at all probability levels than the 2-year HI, and 4-year LI strategies with conventional market prices. Thus, using these data, if producers are able to receive an organic premium of 50% or more for crops grown in organic systems, they can receive ANRs that are greater at all probability levels for crops grown under the 4-year OI system, compared with any other combination of input strategies or cropping sequences evaluated in this study.

CONCLUSIONS

Even though yields under the LI and OI management strategies were lower than those under the HI management strategy so were production costs, so the alternative management strategies were able to produce average net returns that were closer to net returns with conventional management than the yields would at first indicate. This is especially true under the 4-year cropping sequence. The 4-year, OI strategy had average net returns that were higher than the HI and LI strategies under either 2-year or 4-year cropping sequences even without an organic premium.

Applying the organic premiums to the OI management strategies increased the average net return dramatically. This resulted in the OI management strategies having higher average net returns in comparison to the other management strategies. The risk analysis of the combined preferred strategies and cropping sequences resulted in an outcome similar to the profitability analysis. With all crops receiving conventional market prices, the 4-year OI strategy had similar if not greater ANRs at all probability levels when comparing it to the HI and LI strategies under either 2-year or 4-year cropping sequences. By simply adding a 50% premium to the 4-year OI strategy, it clearly becomes the preferred input strategy and cropping sequence.

Thus, using the data in this study, if producers are able to receive an organic premium of 50% or more, ANRs are greater at all probability levels for crops grown under a 4-year OI system compared to other combinations of input strategies or cropping sequences. Therefore, based the conditions of this study and on the resulting profitability and risk analysis, the perception that organic agriculture is less profitable and/or involves greater risk, is not true.

Results of this study show that organic and alternative systems can compete with conventional systems, but three issues need mentioning. First, the OI strategies seem to encountering weed control problems. Unless this can be corrected, the subsequent yield loss will decrease profitability of the OI strategies.

The second is the potential market impact of a large shift to other crops if farmers switched from the dominant corn-soybean cropping sequence by adding other crops. For example, Minnesota farmers harvested 6.6 million harvested acres of corn for grain in Minnesota and 6.9 million acres of soybeans in 1999 (Minnesota Agricultural Statistics Service, 2000). These acreages overshadow the 0.3 million harvested acres of oats and 1.6 million harvested acres of alfalfa hay. Any significant shift away from the popular corn-soybean sequence will have large price impacts on other markets as well as on the corn and soybean markets themselves. That is, if farmers shifted even a relatively small portion of their current corn and soybean acreage to oats, the increase in oat production would have a tremendous negative effect on the oat price and thus oat revenue. A similar negative impact would occur for alfalfa. Conversely, any shift away from corn and soybean production will increase the prices for those products under current demand conditions. Thus, any significant shift in the mix of crop acreages will change the potential net returns of both the 4-year and 2-year cropping sequence under any of the three management strategies. The shift to longer cropping sequences will be possible only to the extent the oat and alfalfa markets can adjust to larger volumes and the corn and soybean markets can adjust to reduced volumes.

A third concern or hurdle is the potential impact on the organic markets. Even though organic markets are growing, they are small relative to the whole market, and thus a sudden increase in the production of organic products will have a very large negative impact on the potential organic price premium and farm income. Any shift to organic production will have to be matched by an increase in the organic market demand in order for current expectations of farm income to be realized.

In summary, many farmers may be considering organic agriculture for its food and environmental safety attributes, but organic systems must also be profitable and involve comparable risk to conventional systems for full consideration to occur. Profitability and risk criteria have been proven through the current research reported in this paper, other published research, and presence of actual organic producers making their livelihood from organic production. Farmers considering converting to organic systems must also consider their individual situations and take other factors (such as soil conditions, machinery needs, labor needs, crop rotations, production and marketing knowledge and expertise, potential organic premiums and or market price fluctuations, organic certification requirements, and many other personal factors) into consideration before converting to organic production systems.

Table 1. Typical cash prices received at harvest time by members of the Southwestern Minnesota Business Management Association.

Year	Corn	Soybeans	Oats	Alfalfa	Oat Straw
	($/bush	($/bushel)	($/bushel)	($/Ton)	($/bale)
1990	2.00	5.75	1.25	60.00	1.00
1991	2.10	5.25	1.00	50.00	1.00
1992	1.80	5.25	1.00	55.00	1.00
1993	2.25	6.00	1.25	70.00	1.50
1994	1.80	5.00	1.10	70.00	1.50
1995	2.75	5.75	1.50	70.00	1.75
1996	2.40	7.00	2.00	80.00	2.00
1997	2.40	6.50	2.00	95.00	2.00
1998	1.75	5.15	1.20	65.00	1.00
1999	1.75	5.15	1.20	65.00	1.50

Note: These typical harvest-time prices were chosen each year by the fieldman in the association and published in the annual association reports from each year, e.g.,Olson et.al., 1992

Table 2. Average organic price premium ratios based on organic price quotes and U.S. cash prices.

Year	Corn	Soybeans	Oats
1995	1.35	2.14	1.35
1996	1.43	1.85	1.59
1997	1.73	2.41	1.73
1998	1.88	3.02	1.83
AVE.	1.60	2.36	1.63

Source: Dobbs, T.L and J.L. Pourier. 1999.

Note:Due to insufficient data on organic prices for alfalfa and oat straw, there were no organic premiums estimated for these two crop products.

Table 3. Price/Yield correlations for each crop in each cropping sequence and management strategy from 1990 through 1999 in the VICMS II study.

Strategy	Corn	Soybean	Corn	Soybean	Oat	Alfalfa	Oat Straw
	2-year	2-year	4-year	4-year	4-year	4-year	4-year
LI	-0.847	0.059	-0.700	0.049	-0.252	-0.020	-0.525
HI	-0.683	-0.127	-0.734	-0.024	-0.341	-0.004	-0.525
OI	-0.197	-0.226	-0.557	-0.260	-0.314	0.091	-0.537

Source: estimated from actual VICMS II experiment yield data and the prices listed in Table 2.

Table 4. Yield correlations for each crop in each cropping sequence and management strategy from 1990 through 1999 in the VICMS II study.

Strategy	Corn/SB	Corn/SB	Corn/Oat	Corn/Alfalfa	SB/Oat	SB/Alfalfa	Oat /Alfalfa	Oat/Oat Straw
	2-year	4-year	4-year	4-year	4-year	4-year	4-year	4-year
LI	0.643	0.558	0.369	-0.127	0.401	-0.479	-0.672	1.000
HI	0.713	0.456	0.353	-0.163	-0.080	-0.259	-0.570	1.000
OI	0.338	0.038	0.069	-0.180	0.328	-0.166	-0.667	1.000

Source: estimated from actual VICMS II experiment yield data.

Table 5. Average crop yields for each crop in each cropping sequence and management strategy from 1990 through 1999 in the VICMS II study*

Strategy	Corn 2-year (bu/acre)	Soybean 2-year (bu/acre)	Corn 4-year (bu/acre)	Soybean 4-year (bu/acre)	Oats 4-year (bu/acre)	Alfalfa 4-year (tons/acre)
LI	131	36	139	41	62	5
	(31.1)	(8.7)	(30.6)	(8.5)	(27.8)	(1.3)
HI	142	43	143	44	64	5.1
	(29.9)	(6.7)	(35.2)	(6.8)	(30.1)	(1.5)
OI	90	30	126	37	64	5.2
	(22.0)	(13.8)	(28.6)	(8.5)	(31.7)	(1.3)

* Standard deviations are in parentheses.

Table 6. Average crop production costs for each crop in each cropping sequence and and management from 1990 through 1999 in the VICMS II study*

Strategy	Corn 2-year ($/Acre)	Soybean 2-year ($/Ac	Corn 4-year ($/Acre)	Soybean 4-year ($/Ac)	Oats 4-year ($/Acre)	Alfalfa 4-year ($/Acre)
LI	118	77	119	77	83	100
	(11.6)	(6.6)	(11.6)	(7.3)	(13.0)	(16.9)
HI	145	82	142	88	90	104
	(15.8)	(7.4)	(19.3)	(11.3)	(14.2)	(22.4)
OI	98	73	106	75	69 (6.7)	91
	(6.7)	(9.7)	(5.6)	(5.8)		(14.3)

* Standard deviations are in parentheses.

Table 7. Average net returns for each crop in each cropping sequence and management strategy from 1990 through 1999 in the VICMS II study*

Strategy & pricing alternative	2-year sequence ($/Acre)	4-year sequence ($/Acre)
LI & Conventional prices	125 (48.9)	173 (36.9)
HI & Conventional prices	139 (43.9)	172 (32.6)
OI & Conventional prices	84 (49.2)	175 (34.2)
OI & 100% organic prices	**	245 (76.0)
OI & 50% organic prices	**	202 (52.7)

* Standard deviations are in parentheses.

** Since the 2-year, OI strategy did not meet the organic certification rules, it could not receive organic premiums.

Figure 1. 1990-1999 Corn Yield, Bu/A, Vicms II, Two and Four Year Sequence, by Management Strategy

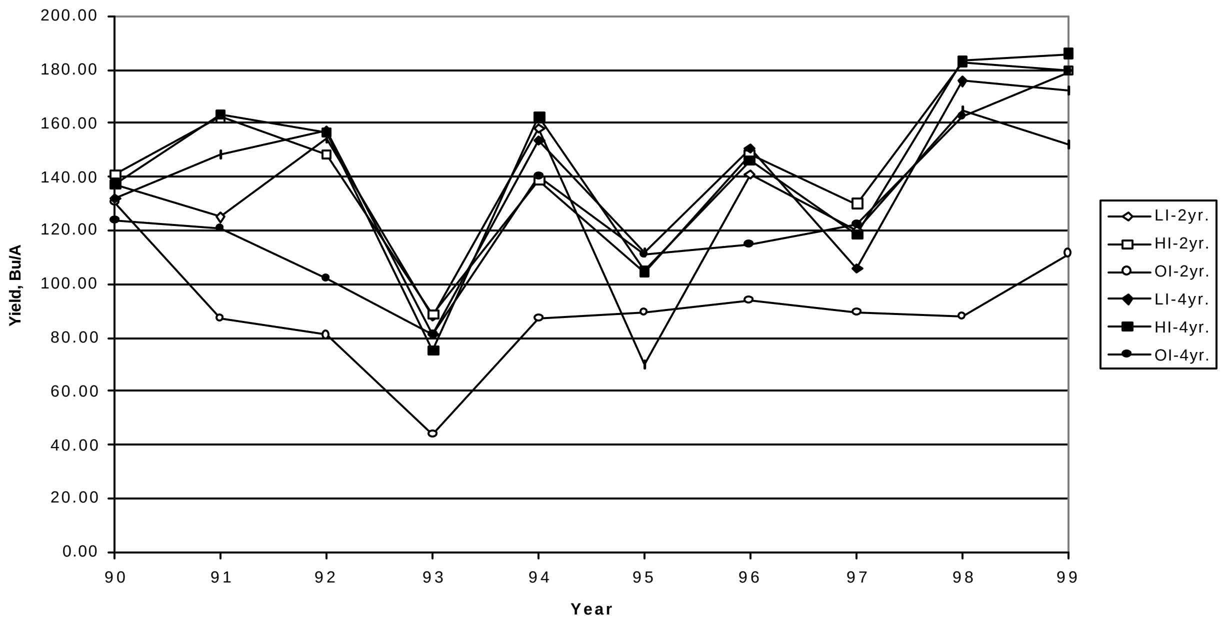


Figure 2. 1990-1999 Corn Production Cost, $/A, Vicms II, Two and Four Year Sequence, by Management Strategy

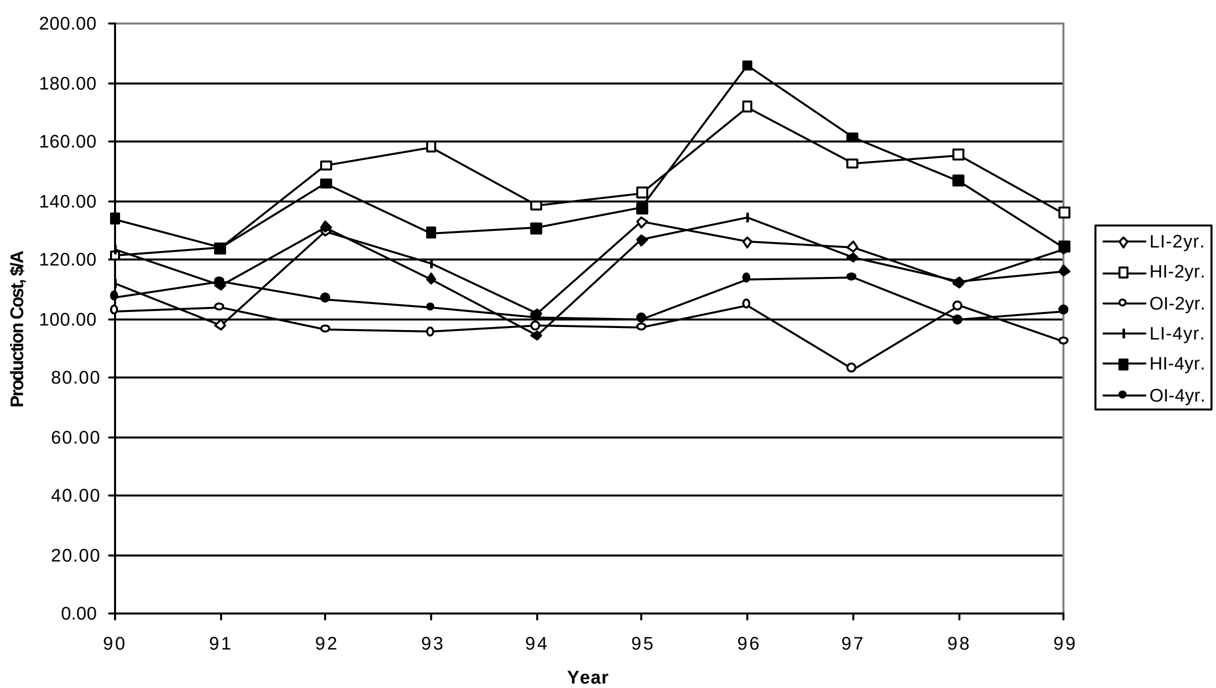


Figure 3. 1990-1999 Ave Net Returns $/A, Vicms II, 2&4-year Sequence, by Management Strategy, with Original Market Prices

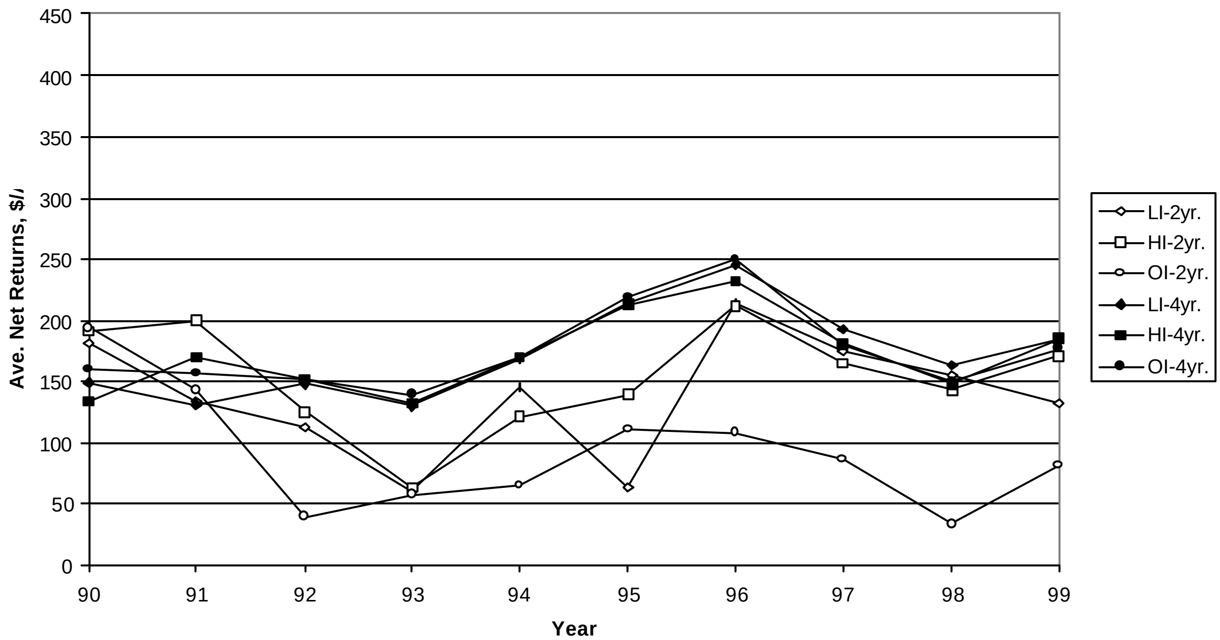


Figure 4. 1990-1999 Ave Net Returns $/A, Vicms II, 2&4-year Sequence, by Management Strategy, with 50% Original Market Prices and 50% Organic Prices

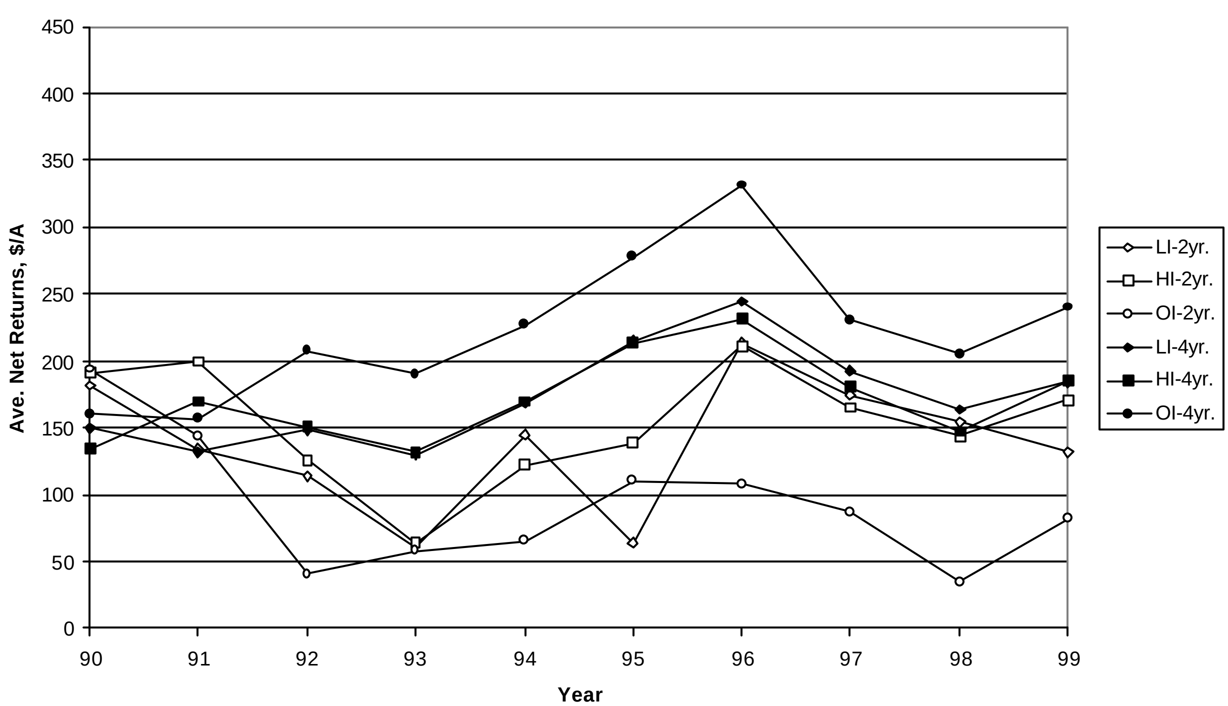


Figure 5. CDF's of LI, HI, and OI strategies, 4-year sequence, with original conventional market prices

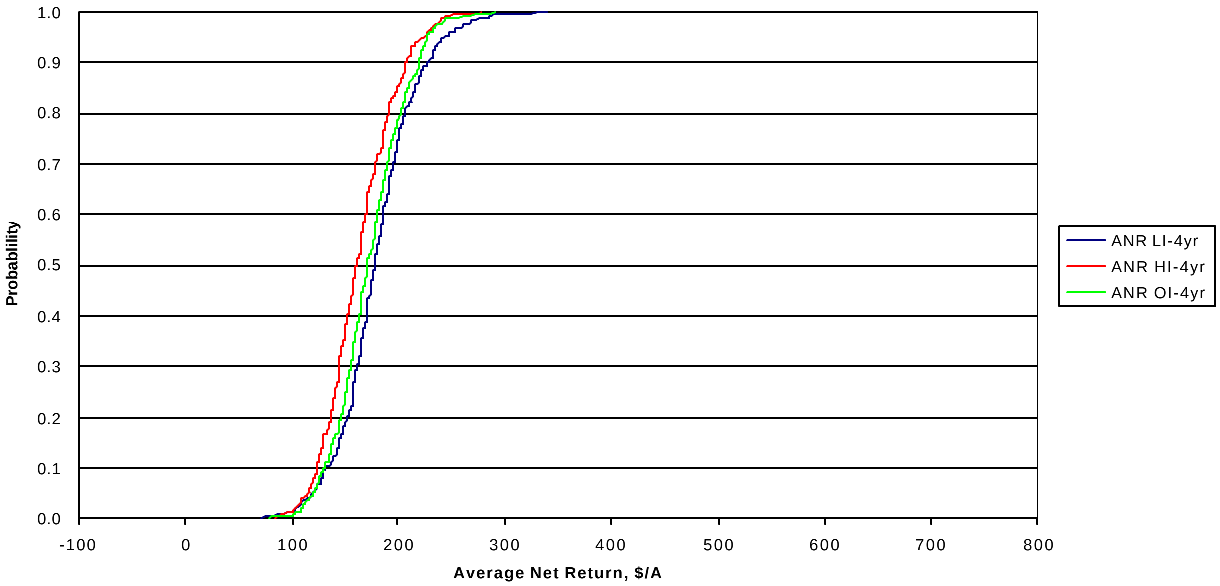


Figure 6. CDF's of LI, HI, and OI strategies, 2-year sequence, with original conventional market prices

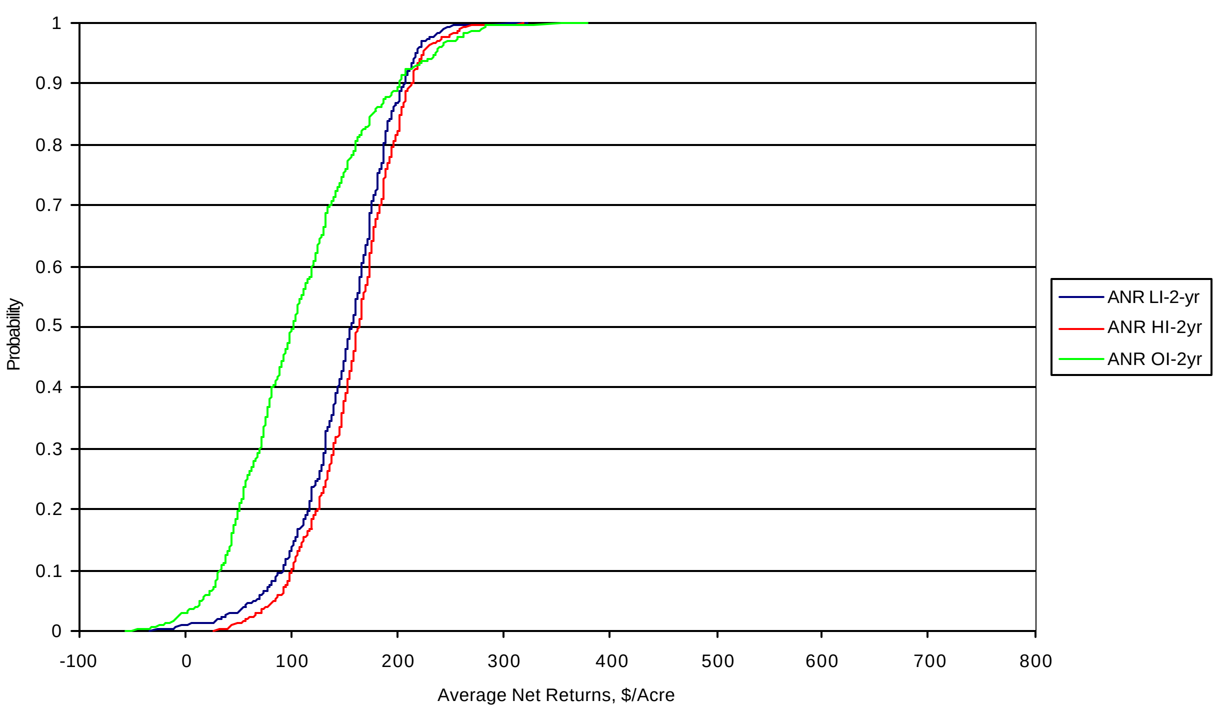


Figure 7. CDF's of HI-2yr, LI-4yr, and OI-4-yr strategies, all with original conventional market prices

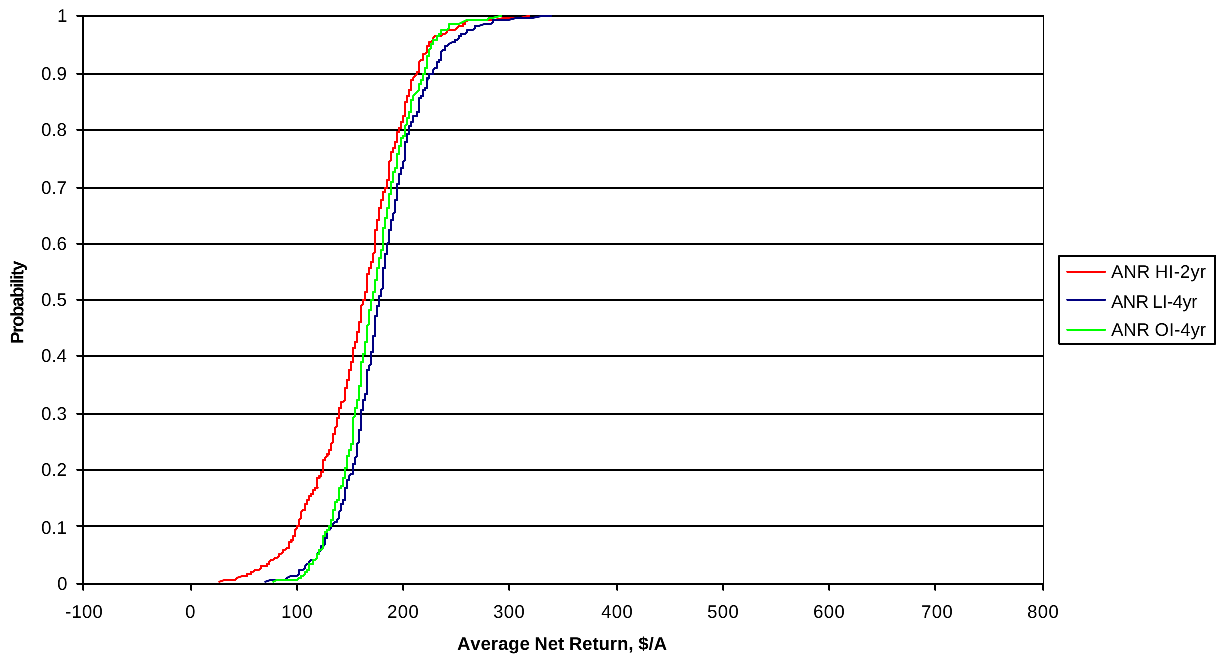
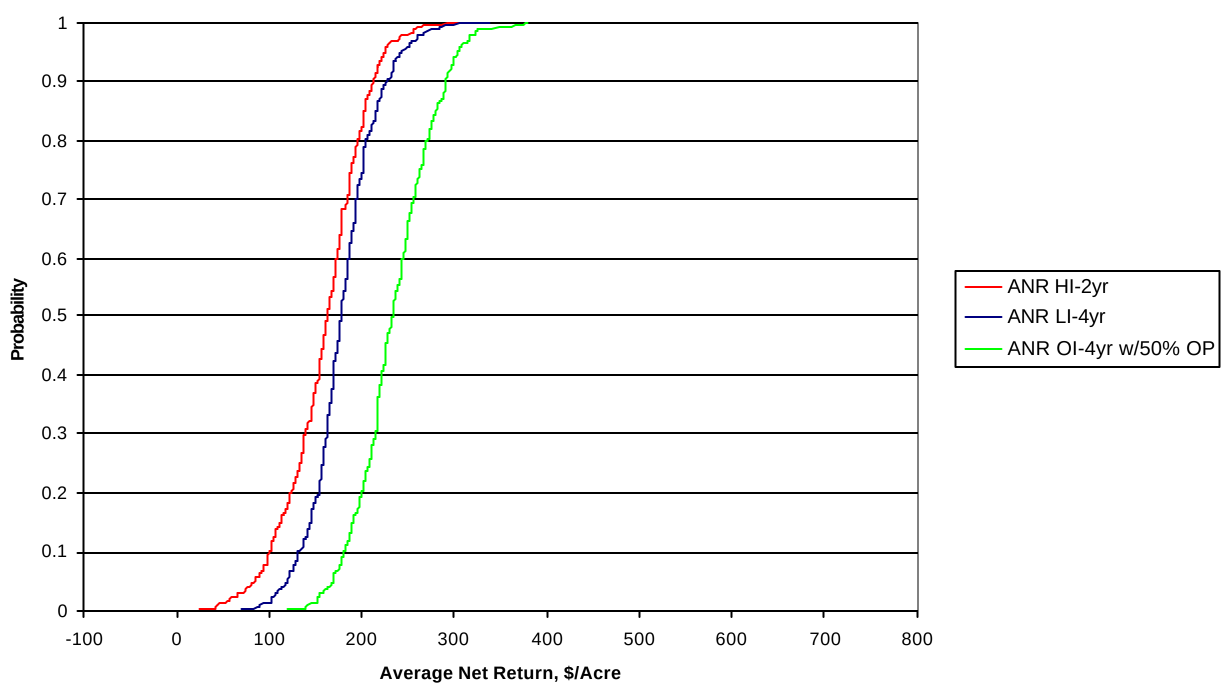


Figure 8. CDF's of HI-2yr and LI-4yr with original conventional market prices, and OI-4-yr with 50% Organic Premium (O.P.)



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