Organic Row Crops in a Diversified Farm Portfolio

by

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This paper estimates and compares the net returns of an organic row crop rotation to the returns of a conventional row crop rotation in the Midwest, and explores some of the sources of risk associated with organic row crop production. The study concludes modeling the optimal land use of a risk-averse producer assuming a producer is able to grow both organic and conventional row crops. The results indicate that the expected net returns of organic row crop production can be competitive with traditional corn and soybean production, however, the variation in returns can be nearly twice those of conventional production. The land use model indicates that organics is part of an optimal portfolio for producers with low levels of risk aversion. Land use changes to conventional corn and soybean production as risk aversion and farm size increase.

INTRODUCTION

Growth in organic sales has increased 25 to 30 percent annually in the European Union, Japan, and the United States (Lohr), compared to only three to five percent for food sales as a whole (Murphy). The recent debate over genetically modified foods raises questions and concerns for many consumers, and often sparks an interest in organic crops. At the same time, companies, such as General Mills, move forward with their organic breakfast cereal lines. The combination of these issues will likely further the demand for organic grains. This growing demand for organic commodities provides producers opportunities to fill a niche market. However, many producers are hesitant to enter the market unsure of the short- and long-term economic viability of an organic crop rotation.

To become a certified organic farm, producers face a three year transition period, where they are restricted from using chemicals and synthetic fertilizers, but are not eligible for the full organic price premiums. In addition, restrictions on the use of synthetic chemicals and fertilizers and the additional labor requirements for mechanical weed control add an additional component of risk in producing organic crops.

Research by several land grant universities yields conflicting results when comparing the profitability of organic verses conventional grain cropping systems in the Midwest. Knoblauch, Brown and Braster found that the difference in profitability among organic systems can be as large as the difference between organic and conventional systems.

Most associations that grant organic certification require that an entire farming operation be converted to organic production within a specified period of time. However, exceptions to this rule (depending on the certifying agency) are typically granted to producers with different operating units as defined by the Farm Service Agency or different landlords. For example, a producer with different landlords may become organically certified for one farming operation while maintaining the other farms in conventional practices.

This paper estimates and compares the net returns of an organic row crop rotation to the returns of a conventional row crop rotation in the Midwest, and explores some of the sources of risk associated with organic production. The study concludes modeling the optimal land use of a risk-averse producer assuming a producer is able to grow both organic and conventional row crops.

THE ECONOMICS OF ORGANICS

Organic row crop production can be economically competitive with conventional row crop production, however, the returns can vary substantially. Using production data from Western Illinois University's Allison farm, information from other research institutions, and interviews with organic producers, agribusiness firms, and organic commodity handlers, budgets for conventional and organic production are estimated. In Table 1, the enterprise budget for conventional corn and soybean production is compared to enterprise budgets for organic rotations of corn-soybeans-wheat/clover using the average of conventional tillage and ridge-till. As seen in the budgets, organic production can be competitive with conventional production. If no premium were available on wheat or corn, the average premium on organic soybeans to yield the same net revenue per acre as conventional corn and soybean production would be $9.04 per bushel. Diebel, Williams, and Llewelyn find that organics tend to be more competitive in drier regions of the United States, which concurs with Dobbs that organic systems are more competitive outside the corn belt (Welsh).

Research at other universities examining the economics of organic row crop and small grain production, outlined by Welsh, finds similar results. While the majority of these studies demonstrate that organic net returns can be competitive, the amount of variation in an organic rotation relative to conventional rotations varies. These sources of variation come from all areas of the profit equation including prices, yields, and costs.

Prices

Price premiums help keep organic production competitive in the Midwest. Table 2 outlines the average annual prices of conventional and clean organic commodities and the monthly variation in prices. Soybeans have the greatest price premium and also the largest variation in the net price received by producers. Corn maintains a substantial premium if producers are able to secure a contract, however, soft red winter wheat, which is the least profitable enterprise in the rotation has limited market opportunities and premium as an organic crop. Thus, while price premiums are substantial, producers may not be able to get the higher premiums for several reasons. The number of contracts are limited. The preliminary results of a survey of handlers of organic row crops in the region indicate that the number of producers having a contract prior to planting varies greatly from year to year ranging from over 90% in 1996 to only 65% in 1999. This is due in part to the increase in organic acreage which doubled between 1991 and 1995 according to Klonsky and Tourte.

Most contracts specify a quality level for the commodity. For example, soybean contracts (which have the highest premium) require beans to be of a minimum size, in addition to the quality factors of seed coat color, limited percentages of split or chipped beans, foreign matter, etc. Soybeans not reaching the size specification receive a partial feed grade premium, while splits and damaged beans are sold at conventional market price. Meeting the quality standards of the contract can be a substantial challenge. According to the handler survey, factors, such as seed coat stain, keep an estimated 20 percent of soybeans from receiving the food grade premium, and the average clean-out (including small beans) ranges from 5 to 33 percent with most clean-out ranging between 15 and 25 percent for organic soybeans (Hirschi, 2000a).

During the three year transition period, many producers have been able to secure premiums for “pesticide-free” commodities ranging from $0.25 to $.40 per bushel for yellow corn, and $.50 to $1.50 for soybeans. These premiums help reduce the cost of making the transition to organic crop production.

Yields

Corn tends to have the largest yield difference with average organic yields of 79 to 98 percent of conventional corn production (Welsh). Preliminary results of the producer survey finds that organic corn is about 20 to 30 bushels less than conventional production, due in part to the soil fertility of the farm (Hirschi 2000b). In addition, organic producers typically delay planting till the middle of May. The later planting date allows producers to reduce weed pressure prior to planting and increase the likelihood of performing timely tillage practices after planting. Yield differences in soybeans range from 86% of conventional yields up to no yield difference (Welsh). Much of the yield difference in soybeans can be attributed to the lower yields of food grade soybeans. In southern Iowa, the commonly grown Pioneer 9306 had an average yield of 56.4 bushel compared to only 50.1 bushel for the Iowa 3001, for 1997 and 1998 (Iowa State University). The 1999 yield difference between Pioneer 9306 and IA3001 was 18 bushel on the organic ground, and 13 bushel on the conventional ground, with an 8 bushel difference between

Pioneer 9306 grown on conventional ground and IA3001 grown on the organic ground (Vigue, Clayton, Howe). While researchers are attempting to find higher yielding food grade soybeans, they have a significant yield drag. Small grains tend to have less of difference in yields of organic and conventional production.

Costs

While organic producers do not pay for synthetic fertilizers and herbicides, they still incur similar if not greater costs in maintaining soil fertility. Most producers use a green manure cover crop to help in nitrogen fixation. In addition, animal manure is commonly used as an source of soil nutrients, and can often be obtained inexpensively. Other approved fertilizers can be purchased at various costs.

Weed control in organics may include hand and mechanical tillage, and flaming as compared to traditional herbicide costs. The timing of rains greatly influences weed pressures and may cause additional tillage passes to subdue weeds. If weeds get out of hand, manual labor may be required which can increase weed control cost five to six times the normal rates (Stout). While soil fertility and weed control make up the largest variation in costs, other factors such as labor availability, seed costs and availability, also introduce a risk factor.

INSURANCE

Organic producers face an additional factor of risk since they are not able to insure their commodities at their organic price levels. Although contracts provide price protection, they are valid only if producers harvest a crop and meet the quality standards. The insurance products are designed for conventional commodities and are not separate for organic products. American Agrisurance, Inc. has designed a product MPPlus which may raise the guarantee as much as $1.00

per bushel by adding an additional endorsement to an existing MPCI policy. The coverage remains well below the value of the organic commodity and the premium cost is substantial for the additional $1.00 of coverage, since only the MPCI portion is subsidized. Table 3 gives an example of the cost of insurance coverage for the following set of variables in 1999: soybeans; one hundred acre farm located in McDonough County, IL; APH 50 bu per acre; Risk area R07; MPCI price selection of $5.25; and MPPlus price selection of $1.00. While contracts provide producers some price protection (if they are able to meet the quality standards), they still face yield risk as well as the price risk when quality standards are not met.

CERTAINTY EQUIVALENT

The land use model, maximizes the present value of the certainty equivalent of returns. The certainty equivalent of returns, which is both a unique measure of welfare and a money metric, is used to examine the producer’s portfolio under various levels of risk aversion. The negative exponential utility function is used to allow for the separation of initial wealth and the future income stream (see equation 1). The equation is:

(1)

$$\frac{-e^{-ë(w_o+ç)}}{ç} = \frac{(-e^{-ëw_o})(e^{-ëç})}{ç}$$

where w_o is initial wealth, ç is the farm’s net return, and ë is a non-negative constant. Second, ë can be used as a measure of the degree of absolute risk aversion or, as Robison and Barry propose, an average risk aversion measure. Thus, the results of the certainty equivalent to satisfy Pratt’s local and global risk aversion criteria (Robison and Barry). Using the negative exponential utility function, the utility of the certainty equivalent for the farm is:

(2)

$$U(CE) \;=\; EU(ç) = -\int \frac{e^{-ëç(a_i,K)}}{ë} f(ç(a_i,K)dç$$

where the $-(_{e}{}^{-ëÓç(a,\ K)})$/ë is the utility function, the probability density function is f(ç(a_i, K)) of the certainty equivalent, and the constant, ë, is greater than zero. The net return, $ç_i$ = g(a_i, K), is a function of the selected land use activity (a_i), and the given level of resources (K). Crops may be planted during several time periods, which impacts their yields, costs, and timing of tillage practices.

While the problem is dynamic in nature, it reduces to a stochastic problem where the decision is to choose the optimal activity that maximizes the certainty equivalent of the net returns. The utility of the certainty equivalent can be written as:

(3)

$$U(CE) \;=\; EU(ç(a_i,K)) = \frac{(-\int e^{-ëç(a_i,K)})}{ë} f(ç(a_i,K))dç.$$

Furthermore by taking the inverse of U, the certainty equivalent can be written as:

(4)

$$CE = U^{-1}[EU(ç(a_i,\bar{K})].$$

The present value of the certainty equivalent is then computed by discounting the certainty equivalent over the time horizon of the model.

LAND USE MODEL

The certainty equivalent accounts for the risk aversion of producers and the variation in returns which impact the expected utility of profits. The certainty equivalent is maximized subject to the expected utility of net returns.:

(5)
$$\underset{a_i,h_i}{Max}\ CE=\frac{1-(1+r)^{-3}}{r}(-\frac{1}{ë}\ln(-ë(EU(ç(a_i,\bar{K})|t)))) + \frac{\frac{1-(1+r)^{-(N-3)}}{r}}{(1+r)^{3}}(-\frac{1}{ë}\ln(-ë(EU(ç(a_i,\bar{K})))))$$

where the model is maximized by choosing: the optimal crop to plant in each bi-monthly time period (a_i) and the optimal number of hours of hired labor (h_i) in each time period. The model maximizes the present value of the certainty equivalent during the three year transitional period (t) plus the present value of the certainty equivalent once the farm is certified, if organic certification is optimal. The objective function is subject to the labor constraint in each month (equation 6) and the total land available (equation 7).

(6)
$$\sum_i a_i l_{im} \leq L_m + H_m \forall m$$

(7)
$$\sum_i a_i \leq A.$$

The labor constraint combines the field capacity of the farm’s equipment, the number of employees, hours worked per day, available hired labor, and the workday probabilities for central Illinois.

Data for the cost and return estimates for organic rotations are gathered from the present body of literature, research results of the university's organic farm, machinery cost estimates, Illinois Farm Business and Farm Management records and the preliminary results of the survey of organic producers and handlers in the region. The model assumes a five hundred acre farm, two tractor operators with a value of $12 per hour for labor, a five percent discount rate, and a 30 year time frame. Hired labor costs $10 an hour, and is restricted by the amount of available machinery. Corn in transition receives an average premium of 33 cents per bushel and soybeans receive an average premium of $1.16 per bushel. The three year organic rotation consists of corn followed by rye as a cover crop; soybeans and winter wheat planted in the fall; sweet clover or alfalfa is interseeded in the wheat the following spring as a "green manure" crop. The conventional corn and soybean rotation requires half of each crop produced each year.

Land Use Results

The correlation coefficient between the enterprises are .986 between the corn and soybean rotation and the continuous corn enterprise; .732 between the corn and soybean rotation and the organic rotation; and .663 between the organic rotation and continuous corn. The variance of the organic crop rotation during 1994 to 1999 is nearly 2.5 times greater than the variance of the corn and soybean rotation and 1.8 times greater than the continuous corn. Due to this large variance, organic production only occurs when producers have a low level of risk aversion, as seen in Table 4. The additional labor required with organic production and the necessity to perform tillage passes at specific times, restricts the number of acres a producer could feasibly operate. The additional labor required for organic production and the higher variation in net returns, explain in part why the average organic farms was 188 acres compared to average farm in the U.S. of 469 acres in 1995 (Klonsky and Tourte).

When farm acreage is increased to 750 acres the optimal land use for the 82% in conventional corn and soybeans and only 18 percent in organics, when the absolute risk aversion coefficient is 0.000000001. At an absolute risk aversion coefficient of 0.00001, the optimal land use is entirely conventional corn and soybean production.

Discussion

Although the organic market continues to grow and the expected net returns of organic production are competitive with that of conventional corn and soybeans, the additional risk faced by organic producers will keep many producers out of the organic row crop market. Obtaining a premium for organic production is critical to remaining competitive, however, organic markets are relatively thin and producers often find it hard to locate a contract (Hirschi, 2000a). Finding a more profitable small grain would also help boost the profitability of the organic rotation. Furthermore, the location of the farm can have a significant impact on the yields and quality of the organic crops (Hirschi, 2000a).

With growing demand, organic production is here to stay. Producers whose organic production competes economically with conventional production will likely supply the market along with those whose production decisions are not purely profit based. The large variation in returns will keep many producers from entering the organic market. While many producers viewed the organic market as “their knight in shining armor,” the competitive market of production will drive the economic profits towards zero.

Table 1: Cost and Return Estimates of Conventional and Organic Row Crop Production

	Conventional		Organic*		
	Corn	Soybeans	Corn	Soybeans	Wheat
Price	2.68	6.65	3.50	14.26	3.35
Quantity	150.00	52.00	120.00	45.00	55.00
Total Revenue	402.00	345.80	420.00	641.54	184.25
Variable Costs	229.40	131.42	198.81	202.74	220.32
Fixed Cost	40.91	34.28	46.27	44.30	31.71
Total Cost	270.31	165.70	245.08	247.04	252.03
Net Revenue	131.69	180.10	174.92	394.50	-67.78

* Using the average of conventional tillage and ridge-till.

Table 2: Average Conventional and Organic Prices per Bushel and Variation of Monthly Prices.

	1994	1995	1996	1997	1998	1999	Average
Corn - Illinois							
Mean	2.45	2.61	3.71	2.70	2.30	1.97	2.62
Variance	0.11	0.08	0.51	0.01	0.08	0.02	0.14
Organic Corn - yellow							
Mean	3.27	3.40	4.80	4.38	4.17	3.42	3.91
Variance	0.07	0.14	0.50	0.13	0.04	0.52	0.23
Soybeans - Illinois							
Mean	6.21	5.96	7.41	7.55	6.05	4.68	6.31
Variance	0.41	0.16	0.19	0.44	0.34	0.09	0.27
Organic Soybeans - Clear Hilum							
Mean	NA	12.60	12.77	17.48	18.13	14.69	15.13
Variance	NA	0.45	2.47	3.50	5.92	1.90	2.85
Organic Soybeans - Vinton							
Mean	NA	18.31	17.60	19.60	21.08	17.04	18.73
Variance	NA	1.42	0.68	0.64	1.42	2.83	1.40

Source: USDA-NASS and Organic Food Business News.

Table 3. An Illustration of Crop Insurance Premiums for a McDonough county farm with an APH of 50 bu/acre, risk rating of R07, and a MPCI price selection of $5.25.

Coverage Level	Guarantee Per Acre	MPCI Per Acre Premium	MPPlus Per Acre Premium	MPPlus+MPCI Premium Per Acre
50%	25 bu	1.37	.79	2.16
55%	28 bu	1.70	.91	2.61
60%	30 bu	2.28	1.17	3.45
65%	33 bu	2.22	1.41	3.63
70%	35 bu	3.27	1.84	5.10
75%	38 bu	4.84	2.48	7.31

Source: Hirschi and Bunch, 1999

Table 4. Present Value of Certainty Equivalent Values of Sample Farm and Optimal Land Use.*

Absolute Risk Aversion Coefficient	Present Value of the Certainty Equivalent	Percent of Land Use		
		Organic Rotation	Conventional Corn and Soybeans	Conventional Continuous Corn
0.000000001	1,212,402	86.4	13.6	00.0
0.00000001	1,121,305	86.4	13.6	00.0
0.000001	1,201,374	86.4	13.6	00.0
0.00001	1,151,688	00.0	100.0	00.0

* Excludes a land charge

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