Farming with Fewer Chemical Inputs: The Case of Organic Agriculture in Ohio

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Agricultural chemical input use is under attack. Consumers, environmentalists, scientists and even farmers are beginning to question the wisdom of our current intense use of agricultural chemicals in farming. Concern about environmental degradation is evident in legislation impacting farmers. Sod- and swamp-buster provisions of the current farm bill, soil conservation program compliance, and U.S. Department of Agriculture programs supporting research and education in sustainable agriculture are but a few examples. Most likely there will be continued pressure from groups previously not closely aligned with agriculture to reform farming practices.

There are a number of important issues related to the sustainable agriculture/farm chemical use debate. For instance, what is the cost to society arising from off-farm sedimentation of eroded soils or contamination of surface and ground water with agricultural fertilizers or pesticides? To what extent could these damages be reduced if a new system of farming was widely adopted? What would be the economic consequences to farmers if there were a change in the prevailing farming system? And, what would be the consequences of such a change for rural communities and consumers? The focus of this article is limited to one of these issues: evaluation of farm profitability.

There are several farming systems which may use fewer agricultural chemicals than typically are used on farms today. Generally, these systems employ substitution of more traditional inputs (e.g., labor, cultivation, and crop rotation) for chemical pesticides and fertilizers. The following discussion shall be limited to a comparison of organic and conventional agriculture. Organic agriculture represents the extreme in substitution of traditional for petrochemical inputs in that organic producers strive to eliminate rather than merely reduce chemical pesticides and inorganic fertilizers. Furthermore, many of the cultural practices used by organic farmers may be adopted by other "sustainable systems". Thus, implications of this study may be instructive as new systems are designed. Finally, organic agriculture is well defined, at least as it relates to Certified Ohio Organic food producers.

A Study of Ohio Certified Organic Producers

In order to gain insight into the relative profitability of organic versus conventional agricultural systems, Ohio data are utilized to compare these systems in terms of inputs, outputs, and prices received. Two producer groups are identified and sampled. Comparisons of various measures are then made between these samples.

Since 1988, food commodities produced in Ohio and marketed as "organic" must be certified to be organic. Inspection and certification of organic produce is done by the Ohio Ecological Food and Farm Association under authority of the State of Ohio. Organic farmers can not use petrochemical fertilizers, pesticides, or herbicide materials. Certification requires that detailed records be maintained for each farm field, with all applied inputs identified. Farm production can only be certified as organic after three years with no use of petrochemical inputs. In 1990, 90 farms were certified to produce organic commodities. All of these farms received mailed questionnaires in December, 1990. A total of 71 percent responded to the survey.

In order to compare the responses from this survey with a "typical" or "conventional" set of farms, a bench mark is required. The Ohio Farm Household Longitudinal Survey (OFHLS), a scientifically drawn sample of all Ohio farm households, is used to represent the prevailing farming system. The most recent Ohio Farm Longitudinal Survey year, 1990, is used in these analyses.

In the following sections, measures of gross returns and costs will be compared for certified organic and OFHLS farms. These analyses will be limited to a comparison of OFHLS and certified organic field crop producers. Although 25 organic farms produced field crops, six also had large conventional operations as well. This latter group was excluded from the following comparisons of yield, input use, and farm income.

Total Farm Revenue

Total farm revenue is a function of output prices, yields, farm size, the proportion of land producing a marketable commodity and payments from government programs. Organic farmers, if they market their products as differentiated "organic" products through special markets, can achieve premium prices relative to their conventional farm counterparts. The price premium exists because 1) some consumers are willing to pay more because of the organic character of the product and 2) the supply of organic product available is small relative to demand. On the other hand, organic commodities can be marketed through "regular" markets without differentiation. In this case, no market premium is earned.

Prices received by Ohio certified organic farmers for field crop commodities are presented in table 1. Corn and hay were most frequently sold to organic livestock producers who require organic feeds as inputs into their livestock activity. Corn prices ranged from $3.50 to $4.00 per bushel, with a mean of $3.60. The average corn price received by all Ohio farmers in October, 1990 was $2.16 per bushel. Thus, the average organic corn price premium for 1990 was $1.44 ($3.60 - $2.16) per bushel. The best marketer was able to gain a price advantage of $1.84 per bushel ($4.00 - $2.16).

Table 1. Prices received by Organic Field Crop Farmers.

Crop	Units	Mean	Minimum	Maximum
Organic Marketings:				
Corn	Bushel	3.60	3.50	4.00
Soybeans	Bushel	9.90	7.50	12.60
Wheat	Bushel	5.35	4.70	6.00
Hay	Ton	101.50	78.00	125.00
State Average Prices:[a]				
Corn	Bushel	2.16		
Soybeans	Bushel	5.74		
Wheat	Bushel	2.28		
Hay	Ton	104.00		

a Ohio Agricultural Statistics Service, Ohio Farm Report, January, 1991.

Organic soybeans were typically sold to processors or in international markets. Wheat was sold for processing. Average commodity price premiums for soybeans and wheat, respectively, were $4.16 and $3.07 per bushel. Although organic commodity prices were substantially higher than conventional marketings, organic farmers did not sell all commodities as organic. On average, 69 percent of all farm marketings were to organic markets.

Yields often are suggested to be lower on organic than conventional farms. Although nitrogen is supplied by legumes or green manures in the rotation, less nitrogen typically is available for organically grown crops. Crops with a strong response to nitrogen are expected to perform relatively more strongly under conventional agriculture. Similar arguments could be made with respect to yield limitations imposed by weed and insect pressures in years when the organic controls fail.

Crop yields for certified field crop producers were lower for all reported crops than for the average Ohio farm (table 2). Reported corn yields ranged from 60 to 110 bushels per acre with an average of 84.7. This compares to an average yield for OFHLS farms of 111.7 bushels; or about 24 percent lower for organic farmers. Average organic yields for soybeans, wheat, and oats were 76, 70, and 83 percent, respectively, of conventional farm yields.

Often it is argued that organic production systems are more constrained with respect to farm size than are conventional systems. The reliance on mechanical tillage to replace chemical herbicides increases the number of operations that must be accomplished within a limited number of work days. Given fixed labor and equipment capacity, farm size is constrained. This translates to fewer units of commodity sales, and thus less contribution to profit. Larger sized farms also may be better able to capture economies of size, and thus have lower per unit costs of output.

Table 2. Crop Yields for Organic Field Crop and OFHLS farms.

		Certified Organic Farms			OFHLS
Crop	Units	Mean	Minimum	Maximum	Mean
Corn	Bu/acre	84.7	60.0	110.0	111.7
Soybeans	Bu/acre	31.9	17.0	40.0	41.9
Wheat	Bu/acre	41.5	27.4	65.0	59.3
Oats	Bu/acre	58.1	30.0	80.0	70.0
Hay	Ton/acre	3.9	2.0	8.0	5.7

Comparison of the organic field crop and OFHLS farms reveal that organic farms indeed are smaller. Average farm acreage was 254 and 318 for the organic and OFHLS farms, respectively. The proportion of acreage that was in crops was nearly equal for the two farm types. The largest organic farm was about 700 total acres with 559 acres in crops.

Another factor which may reduce total receipts for organic farms is the acreage and relative value of commodities in the rotation. The backbone of the organic system is a purposeful crop rotation. The rotation provides plant nutrition, weed and pest control, and other agronomic benefits. Thus, the rotation chosen is the one that works best as a system. However, the rotation may include nonharvested crops (e.g., green manure plowdowns), or low-value crops (e.g., hay crops or small grains). This substitution of lower-valued for higher-valued commodities, all else equal, will reduce total farm receipts.

Average crop mix for organic farms and longitudinal farms in 1990 are reported in figure 1. Soybeans and wheat have about the same relative importance in crop plantings on organic farms as for the typical Ohio farm. Corn, however, plays a smaller role on organic farms with only about 13 percent of crop acreage in corn as compared to 34.5 percent for the longitudinal survey. Hay and other crops are relatively more important for organic producers than for typical farmers.

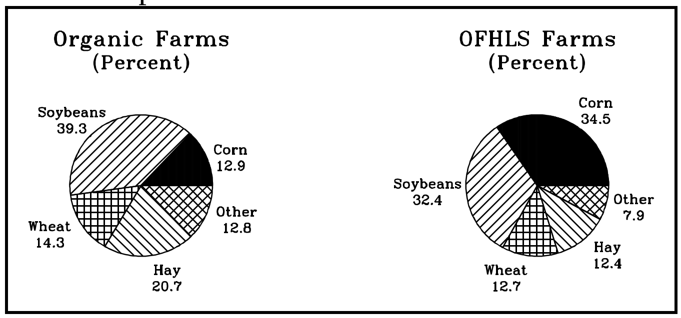

Figure 1 Crop Mix for Certified Organic and OFHLS Farms.

Finally, government commodity program payments add to gross receipts. Farm programs tend to lock growers into intensive cropping patterns dominated by the major program crops. Because a diverse crop rotation usually is the cornerstone of organic agriculture, organic farmers have less flexibility to participate in government commodity programs and to "protect" acreage bases for specific crops. In turn, this reduces their government payments and the associated risk protection they provide.

In 1990, Ohio organic farms participated in government programs much less frequently and to a lesser extent than did farmers in the OFHLS. Twenty-two percent of organic crop farms participated in government programs compared to 48 percent for the all Ohio farmers. Organic farmers diverted an average of 17.1 acres, compared to 33.4 acres for conventional farms.

Expenditures

The types of inputs employed on conventional and organic farms differ substantially. For instance, the organic farm's reliance on herbicide, pesticide, and fungicide materials is significantly less. Organic farms also are expected to use less purchased fertilizer material than their conventional farm counterparts. However, organic fertilizer and pesticide materials, if used, may be more expensive.

Chemical herbicide and pesticide usage are diminished on organic farms through substitution of other inputs. Usually, tillage is an important component in weed control. The increased number of tillage operations performed are expected to increase variable tillage costs (fuel and other operating expenses) for organic relative to conventional farms. Labor expense per acre also is expected to increase due to the increased labor associated with tillage operations.

Data available in the OFHLS and certified organic farm surveys provide some indication of the inputs used on a whole farm basis. In table 3, input expenditures are summarized by input category, both for all farms within each sample and for the largest farms.

Chemical inputs and fertilizers both differed markedly between the organic and OFHLS samples. Chemical expenditures amounted to pennies per acre for the organic producers; $1.17 per crop acre for all organic field crop producers and 4 cents per crop acre for organic producers larger than 275 acres of crops. Chemical expenditures per crop acre for the OFHLS were $15.81 and $16.98 for all and the largest crop producer category, respectively. Fertilizer expenditures per crop acre averaged $9.88 for the organic producers: about one-third the expenditures for OFHLS farms. The largest organic farmers indicated fertilizer expenditures of $13.33. The largest conventional crop farmers reported an average of $28.71 per crop acre, or 2.15 times that of their organic counterparts.

Table 3. Measures of Farm Input Use for Organic Field Crop and OFHLS farms.

		Certified Organic		OFHLS	
		All Crop Farms	Larger than 275 Crop Acres	All Farms	Larger than 275 Crop Acres
Crop Acres		181	403	235	672
		Per crop acre			
Chemical Pesticides	($)	1.17	0.04	15.81	16.98
Fertilizers	($)	9.88	13.33	29.05	28.71
Depreciation	($)	35.76	25.90	73.68	31.32
Total Machinery Investment	($)	355.12	232.76	651.85	226.15
Operator Labor	(hours)	15.70	5.55	33.20	5.25

Because increased tillage is used to replace chemical weed control, it was hypothesized that both machinery and labor costs would be higher on organic farms. The survey data did not allow estimation of fuel and other variable machinery costs. However, the surveys included measures of total machinery investment and depreciation. Both measures can be viewed as indications of the amount of machinery investment on the farm and serve as a proxy for the fixed costs of machinery. When the full samples were compared, both depreciation and machinery investment (per acre of crops) were smaller for the organic producers. Comparison of farms with more than 275 crop acres yielded per acre investment and depreciation values that were essentially equal. The data do not include ideal measures of labor use. Only operator labor hours are comparable between the samples. Comparison of farms larger than 275 crop acres revealed that organic producers had a small (0.3 hours per crop acre) additional use of operator labor.

Profitability

The profitability of the organic system relative to the conventional systems will depend on relative magnitudes of changes in prices, yields, farm size, crop mix, and input costs. Unfortunately, the survey data do not include comparable measures of farm profits. However, enough information concerning these farms is available to construct profitability estimates for hypothetical farms of a given resource base.

Hypothetical farms were constructed so as to be representative of those organic and conventional farms larger than 275 crop acres. The organic farm is assumed to include 403 acres of crops. A four crop rotation of corn, soybeans, wheat, and alfalfa hay is assumed. Such a rotation is typical for the organic farms surveyed. Crops were combined in the same mix as represented in figure 1, but with other crops removed. Thus, corn, soybean, wheat and hay acreage represented 15, 45, 16, and 24 percent of cropped acreage, respectively. Organic farms were assumed to sell 69 percent of their commodities as organic, and thus received premium prices on only this share of marketings. Because data were not available as to what proportion of each commodity was marketed as organic, the 69 percent was applied to each crop individually. Average organic yield for each crop was used in profit calculations. The conventional farm modeled contained 672 acres of crops. A three crop rotation was assumed, again following the crop mix in figure 1: 43 percent of crop land was in corn, 41 percent in soybeans and 16 percent in wheat. Yields and prices are the same as those listed in tables 1 and 2 for conventional farms.

Livestock enterprises were excluded from these analyses because insufficient information was available to allow good estimates of livestock enterprise impacts on farm profitability. This exclusion is not considered to be important, however, as many organic practitioners do not raise livestock.

Chemical input and fertilizer expenditures derived from the surveys (table 3) were used. However, the level of use of other inputs used under the two production regimes was not known. Cost data from OSU enterprise budgets were used for these unknown input costs and are assumed identical for both systems. Although fuel and other costs associated with tillage likely differ for organic and conventional agriculture, there is little reason to believe that seed costs, transportation and similar costs differ between systems. Returns to land, fixed investment, and management were estimated to be $54,802 and $49,358 for organic and conventional farms, respectively (table 4).

Table 4. Calculated Profitability for Representative Organic and Conventional Farms.

Return to land, fixed capital and management:	
Organic Farm	$ 54,802
Conventional Farm	49,358
Difference	5,444
Source of Differential Return:[a]	
Price Premium	$ 34,880
Yield Penalty	-29,189
Reduced Government Program Payments	- 2,786
Reduced Farm Size	-19,758
Reduced Chemical Input Expenditures	13,025
Crop Mix Effect	9,272
Net Effect	5,444

a Positive numbers indicate an advantage for the organic system.

The profit differential between organic and conventional farms is broken into its component parts in the lower panel of table 4. The value of organic price premiums is estimated to be the magnitude of price premium for each commodity multiplied by the organic yield for that crop, and summed over crop acreage. The total value of premium prices was estimated to be $34,880. Similarly, the value of the yield penalty associated with organic farming systems also was sizable, totaling $29,189. The yield penalty was the difference in organic and conventional yields, valued at conventional prices, and summed over crop acreage. The amount of receipts from government commodity price support programs also is smaller for organic farms. This occurs because 1) organic farms have smaller acreage in corn and wheat, the primary program crops, and 2) organic farmers (assuming long term organic production) will have lower ASCS base yields. The difference in program payments, with farm size constant at 403 acres, is $2,786.

The mean farm size for the population of organic field crop producers was significantly smaller than that of the sample of conventional farms. The impact of reduced farm size on profitability, calculated assuming conventional yields, prices, and mix of crops, was $15,466. The reduction in expenditures for chemical inputs for organic farms also is sizable. The average reduction, per crop acre, is $32.32. When summed over 403 acres of crops, this amounts to $13,025 in chemical input cost savings for organic farms.

The final variable in this analysis, affecting both receipts and costs, is the mix of crop enterprises employed. The difference in net returns attributed to crop mix is $9,272. The difference in crop mix favored organic farms in 1990. Organic farmers produced relatively more soybeans and hay than did conventional farmers. These were the two most profitable crops given the costs from the OSU enterprise budgets and prices and yields from this study.

Conclusions

Organic agriculture utilizes a greatly different system of production than that practiced on most Ohio farms. Results of this study suggest that while Ohio certified organic farmers receive premium prices for commodities and have dramatically reduced expenditures for fertilizers and other chemical inputs, they also realize reduced yields and have smaller farm units, and hence have smaller volumes of marketings. This research demonstrates that much of the profitability of the organic system derives from premium commodity prices. A significant increase in the volume of organic marketings, without offsetting increase in the demand for organic commodities, would result in substantial reductions in organic price premiums, greatly reducing or eliminating the advantage revealed here. On the other hand, the farm size penalty estimated may be overstated. Even though the mean size of farms differed in this study, many supporters of organic agriculture argue that, with optimal technology, it is feasible to operate very large organic farms.

Further work is necessary before firm conclusions are drawn. Although yield, price, and chemical expenditure data are good, estimates of costs associated with labor, capital investment, costs of machinery services and other differences in input usage are suspect. Furthermore, these yields, prices and costs may vary substantially across years due to differences in weather and pest pressures.