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Organic vs. Conventional Farming Systems

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Abstract
Driven by a consumer demand-driven market, interest in organic crop production continues to grow. A study was begun in 1977 to compare organic and conventional farming systems and was modified in 1999. Results from this study have previously been reported in the 1998 Annual Report (ISRF98-13) and the 2005 Annual Report (ISRF05-13).

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Introduction

Driven by a consumer demand-driven market, interest in organic crop production continues to grow. A study was begun in 1977 to compare organic and conventional farming systems and was modified in 1999. Results from this study have previously been reported in the 1998 Annual Report (ISRF98-13) and the 2005 Annual Report (ISRF05-13).

Materials and Methods

The original organic system was two corn-oat-alfalfa (C-O-A) rotations with the alfalfa seeded as a companion crop with oats. A second organic C-O-A rotation without livestock manure was used to demonstrate the benefit of livestock manure as a nutrient source. In 1999, the organic C-O-A rotations were converted to three new organic crop rotations: a corn-soybean-oat-alfalfa (C-SB-O-A), a soybean-oat/annual ryegrass (SB-O/AR) rotation, and a corn-annual alfalfa (C-A) rotation. Soybeans were added because of the market premium paid for organic soybeans and for the nitrogen (N) credit from the legume crop. The annual ryegrass, seeded after oat harvest, is used as a "soil-building" crop. The annual (non-dormant) alfalfa is grown with an oat companion crop and is used as a "green manure" legume crop for the N credit to be used by corn the following year. The conventional crop rotations, continuous corn (C-C), and the corn-soybean (C-SB) rotation remained. Half the conventional C-C receives livestock manure injected in the fall and half receives anhydrous ammonia (NH_3) injected in the spring. The C-SB rotation receives spring-applied NH_3 during the corn year. The conventional rotations receive herbicides, insecticides, and commercial fertilizer as determined by soil analysis. Two corn and two soybean (conventional and food grade) varieties are compared in each farming system. Corn yields shown in Table 1 are an average of the two varieties. Corn residue is chisel plowed in the fall, soybean residue is field cultivated in the spring, and alfalfa is moldboard plowed in the fall. Organic corn and soybeans are rotary hoed prior to emergence weather permitting, followed by three cultivations; the last pass is with hillers attached to the cultivator to bury more weeds in the row. Conventionally grown crops are cultivated once.

Results and Discussion

Soil-test data from 2002, 2005, and 2008 are shown in Table 2. The entire area received lime at a rate of 3.5 tons/acre in 1982. The C-C rotation was limed again in 2002 due to the annual acidifying effects of the NH_3 application, which had lowered the pH to 6.25. The addition of dry livestock manure in the organic system in previous years was not able to increase soil test levels fast enough to maintain crop rotations in the "optimum" soil test range. In 1999, liquid swine manure was used instead and respectable crop yields are being produced in ideal environment growing seasons. Using manure to meet the yearly nitrogen needs of conventional C-C has resulted in very high phosphorous and potassium soil test levels. Yield results by system, crop, and rotation are shown in Table 1. Because these demonstrations are not replicated, (other than through years), no statistical analysis is done. Under favorable weather and growing conditions, comparable yields for corn and soybeans can be achieved from both the organic and conventional systems. Conventional corn following soybeans consistently out yields C-C. Yield potential of new food grade soybean varieties has improved. Weed control by summer row cultivation has kept the 30-in. row centers free of weeds, but in years of water or heat stress on the crop, the weed pressure in the crop rows can compete for moisture and sunlight and reduce crop yields dramatically. Canada thistle continues to reduce organic crop yields because the underground rhizomes are not killed by cultivation and also cause poor quality alfalfa forage. Giant ragweed and perennial sunflower are new weeds that have appeared in the organic plots in the past 3 years that are difficult to control because of their height advantage to the crop. Insect pests—soybean aphid, bean leaf beetles, and potato leafhoppers—have reduced yields some years in the organic plots. Higher yields in C-C using NH_3 rather than manure as the nitrogen source can be partially explained by changes in manure analysis and timely nutrient availability losses from the manure since fall-applied. An economic analysis of organic and conventional farming systems using this and other data are available from Mike Duffy, ISU agricultural economist (mduffy@iastate.edu). Organic crops can gain higher market premiums, but have more risk associated with timing of operations, pests, and the environmental conditions during the growing season, which ultimately affect final quality, yield, and income per acre.

Table 1. Crop yields for organic and conventional farming systems.

System	2008	2007	2006	06-08 avg	00-05 avg
Organic C-SB-O-A rotation					
Corn	165.2	192.0	196.4	184.5	163.7
Conventional soybean variety	49.8	45.8	19.5	38.4	42.2
Food grade soybean variety	51.0	39.2	12.8	34.3	34.2
Oats	87.3	51.9	76.3	71.8	91.5
Alfalfa	5.2	5.7	5.8	5.4	4.2
Organic SB-O/AR rotation					
Conventional soybean variety	38.7	45.8	38.1	40.9	37.0
Food grade soybean variety	46.3	36.2	26.1	36.2	28.2
Oats/annual rye	92.0	60.4	76.0	76.1	82.2
Organic C-A rotation					
Corn	135.4	166.3	195.6	165.8	146.4
Oats/Annual Alfalfa	63.6	52.8	81.6	66.0	86.6
Conventional C-SB rotation					
Corn	193.5	193.1	197.4	194.7	177.6
Conventional soybean variety	49.7	60.8	57.9	56.1	50.2
Food grade soybean variety	48.7	51.4	45.6	48.6	36.8
Conventional C-C					
Cont. corn (NH_3)	163.5	174.7	169.1	169.1	156.0
Cont. corn (manure only)	103.1	137.9	179.5	140.2	159.6

Table 2. Soil test results from organic and conventional farming system plots.

System	2008	2005	2002
Organic	6.29 pH, 4.98% OM	6.63 pH, 5.05% OM	6.65 pH, 4.77% OM
C-SB-O-A	21.4 (H) ppm B-P	17.5 (Opt) ppm B-P	20.1 (Opt) ppm B-P
	153.0 (Opt) ppm K	132.3 (Opt) ppm K	140.9 (Opt) ppm K
Organic	6.73 pH, 5.05% OM	6.90 pH, 5.00% OM	6.86 pH, 4.70%OM
SB-O/AR	30.8 (H) ppm B-P	26.3 (H) ppm B-P	17.8 (Opt) ppm B-P
	148.0 (Opt) ppm K	143.3 (Opt) ppm K	134.0 (Opt) ppm K
Organic	6.79 pH, 4.63% OM	6.88 pH, 4.90% OM	6.82 pH, 4.90% OM
C-A	21.3 (H) ppm B-P	22.0 (H) ppm B-P	22.5 (H) ppm B-P
	162.8 (Opt) ppm K	140.8 (Opt) ppm K	159.3 (Opt) ppm K
Conventional	6.43 pH, 3.88% OM	6.84 pH, 3.95%OM	6.98 pH, 3.73%OM
C-SB	16.0 (Opt) ppm B-P	19.8 (Opt) ppm B-P	33.8 (VH) ppm B-P
	173.3 (H) ppm K	130.5 (Opt) ppm K	132.3 (Opt) ppm K
Conventional	6.80 pH, 5.25% OM	6.90 pH, 5.75% OM	6.80 pH, 5.65% OM
C-C w/NH_3	10.0 (L) ppm B-P	17.0 (Opt) ppm B-P	25.5 (H) ppm B-P
	131.5 (Opt) ppm K	145.5 (Opt) ppm K	161.5 (Opt) ppm K
	6.95 pH, 5.25% OM	7.15 pH, 6.10%OM	6.98 pH, 5.55% OM
C-C w/manure	55.5 (VH) ppm B-P	73.5 (VH) ppm B-P	55.5 (VH) ppm B-P
	214 (VH) ppm K	258.0 (VH) ppm K	215.0 (VH) ppm K