EFFECT OF ROTATION ON CORN YIELD AND ECONOMIC RETURNS UNDER COMPOSTED MANURE OR FERTILIZER MANAGEMENT

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INTRODUCTION

The benefits of growing corn in rotation with other crops as opposed to continuous corn have been mentioned in numerous research and technical publications. The benefits of adding to the crop mix include improved soil structure (Raimbault and Vyn, 1991) and soil nutrient availability (Copeland and Crookston, 1992), especially from rotations that include legumes such as soybeans or legume cover crops. Other benefits include better weed (Bhowmik and Dow, 1982), insect (Benson, 1985) and disease control (Edwards et al., 1988). Although most corn in Michigan is grown in rotation with other crops, little emphasis has been placed on the economic benefits of crop rotation. In areas of Michigan that support their growth, acreage for soybean and wheat have increased since 1993, and 1995 yields for both crops were record highs.

The Living Field Laboratory (LFL) is a long-term crop rotation experiment which was initiated in 1993 at the Kellogg Biological Station in Hickory Corners. It is designed to test varying combinations of rotation and cover crops under several agronomic management regimes. This report will focus on the productivity and economic viability of corn grown in rotation with soybean and wheat under two management systems; one with fertilizer, the other with composted manure from the dairy at the research site.

MATERIALS AND METHODS

The design is a split-split plot with four replications. Main plots are two levels of agronomic production:

(i) integrated compost management (int comp.)- banded herbicide plus cultivation for weed control; pesticides if needed; dairy manure/straw or sand compost as a fertility source

(ii) integrated fertilizer management (int. fert.)- banded herbicide plus cultivation for weed control; pesticides if needed; commercial fertilizer as a fertility source

Sub-plots are the entry points of a corn-corn-soybean-wheat rotation, plus continuous corn; each crop in the rotation is grown every year. The second-year corn entry point is included (as opposed to the standard corn-soybean-wheat rotation) for research purposes to document a decreasing yield phenomenon in second year corn (Crookston et al., 1991)

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All crops in the rotation are grown with and without an interseeded cover crop except soybeans. Cover crops in corn were sown at second cultivation (stage V-5-6) with a PTO-driven Orbit-air seeder. The cover crop sequence for the entry points is as follows:

(i) first-year corn- legume (hairy vetch in 1993, red clover thereafter) + annual ryegrass
(ii) second-year corn- annual ryegrass
(iii) continuous corn- legume (hairy vetch in 1993, red clover thereafter) + annual ryegrass
(iv) wheat- red clover frost seeded in March

N was applied to corn plots based on 130 bu/acre yield goal and pre-sidedress nitrate test (PSNT) levels. In 1995, a 60 lb N credit was given to first-year corn following wheat that had been frost-seeded with red clover. P & K for all fertilized plots were applied based on soil test lab recommendations. In wheat plots, N was sidedressed at 50-60 lbs in early April. Soybean plots received no fertilizer N. Each year, composted manure from a dairy located near the research site was applied on a dry weight basis to the integrated compost management plots in April (corn and soybeans) and October (wheat) with a manure spreader. An attempt was made to supply N from the compost to meet corn yield goals, assuming 15% N available in the first year of application. Because of the low N availability, the decision was made to apply a larger amount of compost than the 5-10 tons/a commonly used in manure applications. This resulted in an application rate of 25 tons/acre in 1993, 47 tons/acre in 1994 followed by a reduction down to two tons/acre in 1995.

Grain yields were determined for each crop; net returns (gross returns minus variable costs) were calculated using the PLANETOR economic planning program, version 2.0 (1995). Input values used to calculate variable costs are listed in Table 1.

RESULTS

Yields for soybean and wheat are listed Table 2, corn yields are listed in Table 3. The position in rotation had a significant effect on corn yield in 1994 and 1995. In 1994, first-year corn following wheat yield was 187 bu/acre, at least 24% higher than both entry points of corn following corn (Fig. 1). In 1995, first-year corn yield was 155 bu/acre, 14% higher than second-year and continuous (third year) corn (Fig. 1). In 1995, the benefit of corn following wheat was enhanced by red clover frost-seeded into wheat the previous year. The first year-corn with cover yielded 163 bu/acre, compared with 146 bu/acre for first-year corn with no cover (Fig. 2). Compost greatly reduced yields of corn following corn in 1994, but produced high first-year corn yields (Fig. 3).

Net economic return data for each year are summarized for both fertility systems in Tables 4a and 4b. Under both fertility management systems, and in both years , first-year corn produced higher net returns than corn following corn. In 1994 in the integrated compost system, first-year corn net returns were at least as $143.00/acre higher than net returns from corn following corn.

Table 1. Input values for calculation of variable costs used in PLANETOR.

Inputs		Units	Price
Compost application		$/acre	15.00
Fuel		$/gal	0.90
Seed			
	Corn	$/acre	24.00
	Soybean	$/acre	12.00
	Wheat	$/acre	5.00
	Ann. ryegrass	$/acre	7.50
	Red clover	$/acre	12.00
Fertilizer			
	N	$/lb	0.18
	P	$/lb	0.10
	K	$/lb	0.10
Herbicide			
	Corn	$/acre	8.52
	Soybean	$/acre	5.42
Insecticide			
	Corn	$/acre	13.00
Operating interest		$/acre	10.00

Table 2. Wheat and soybean yield means within each year by fertility management type, and cover.

	1993	1994		1995	
	no cover	no cover	cover	no cover	cover
		yield (bu/acre) Standard deviation in parentheses			
Wheat					
Integ. compost	23 (2.6)	48 (5.5)	46 (3.1)	58 (7.4)	48 (3.1)
Integ. fert.	18 (1.9)	47 (2)	47 (3.9)	66 (6.3)	57 (5.1)
Soybean					
Integ. compost	50 (6)	50 (3)	43 (14.6)	37 (5.2)	39 (3.4)
Integ. fert.	45 (4)	40 (12.2	38 (12.1)	32 (10.5)	34 (9.1)

Table 3. Corn yield means for each year by fertility management type, entry point, and cover.

	1993		1994		1995	
	no cover	cover	no cover	cover	no cover	cover
			yield (bu/acre) standard deviation in parentheses			
Integ. compost						
1st yr corn	134 (7)	131 (12)	186 23)	187 (3)	140 (19)	169 (16)
2nd yr corn	128 (9)	131 (14)	127 (23)	108 (9)	130 (5)	126 (16)
cont corn	120 (36)	132 (19)	118 (10)	125 (6)	125 (6)	130 (9)
Integ. fert.						
1st yr corn	157 (8)	157 (11)	185 (11)	191 (10)	152 (4)	158 (13)
2nd yr corn	166 (15)	156 (17)	178 (6)	157 (9)	140 (11)	133 (25)
cont corn	158 (24)	153 (13)	137 (30)	141 (34)	139 (6)	139 (7)

Figure 1. Effect of corn entry point within each year on corn grain yield (1993-1995).

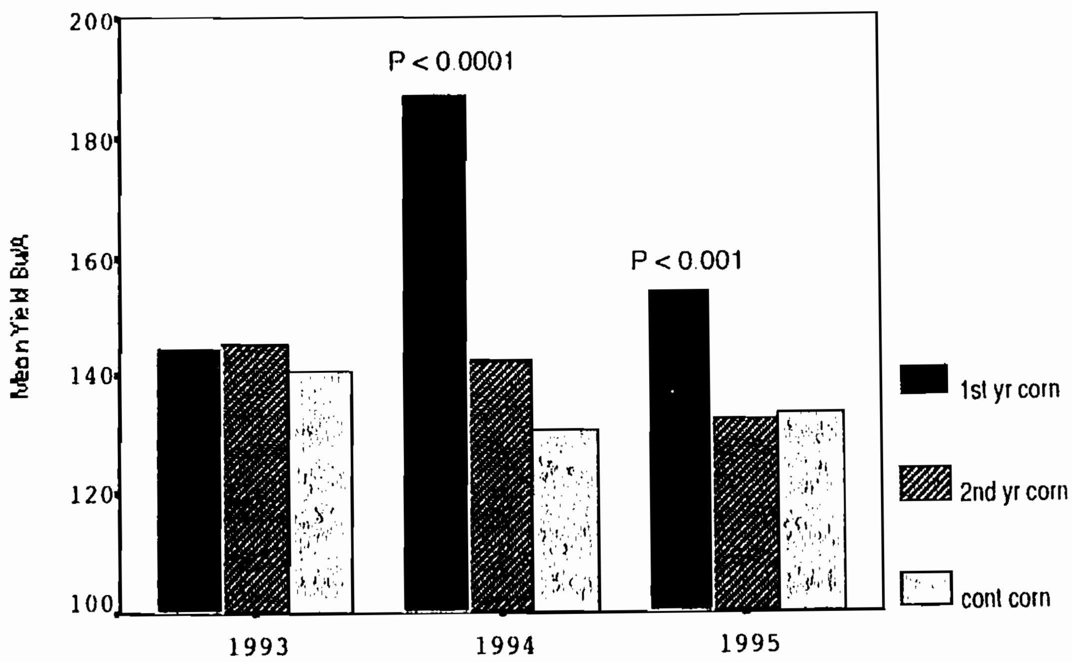

Figure 2 . Effect of corn entry point and cover on corn grain yield in the third year of the rotation (1995).

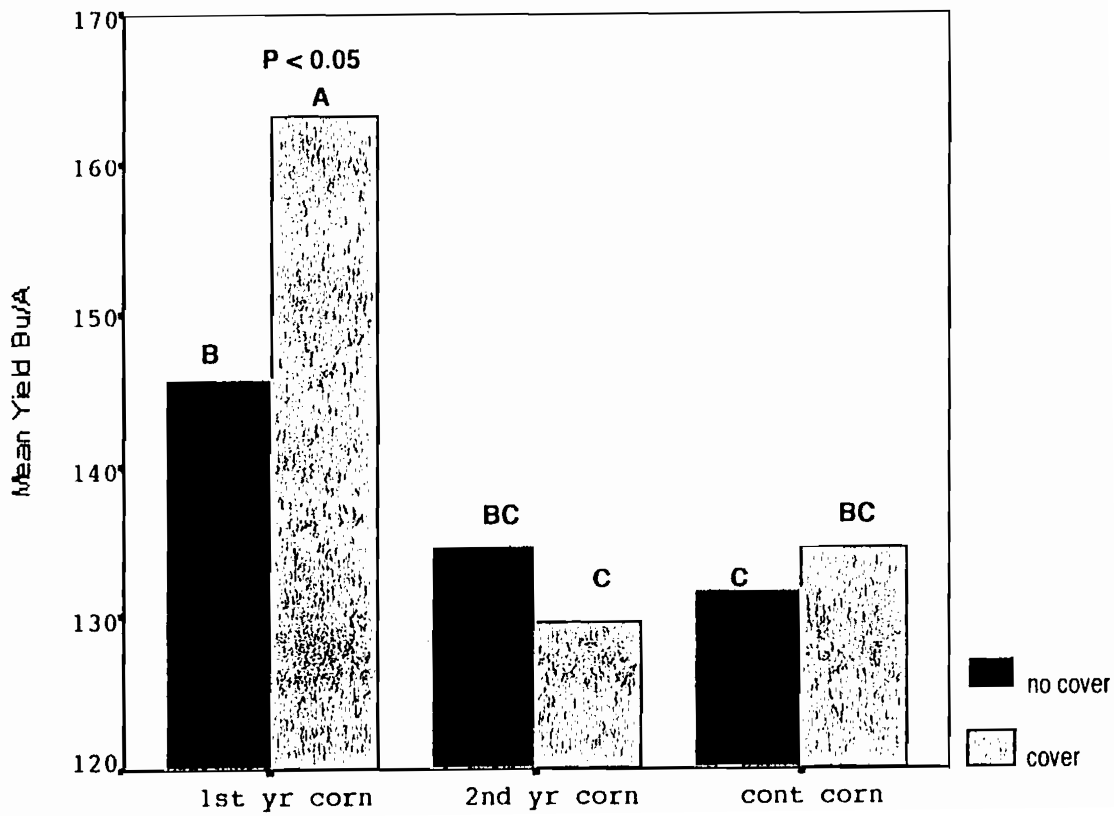

Figure 3 . Effect of corn entry point on grain yield under integrated compost and integrated fertilizer management in the second year of the rotation (1994).

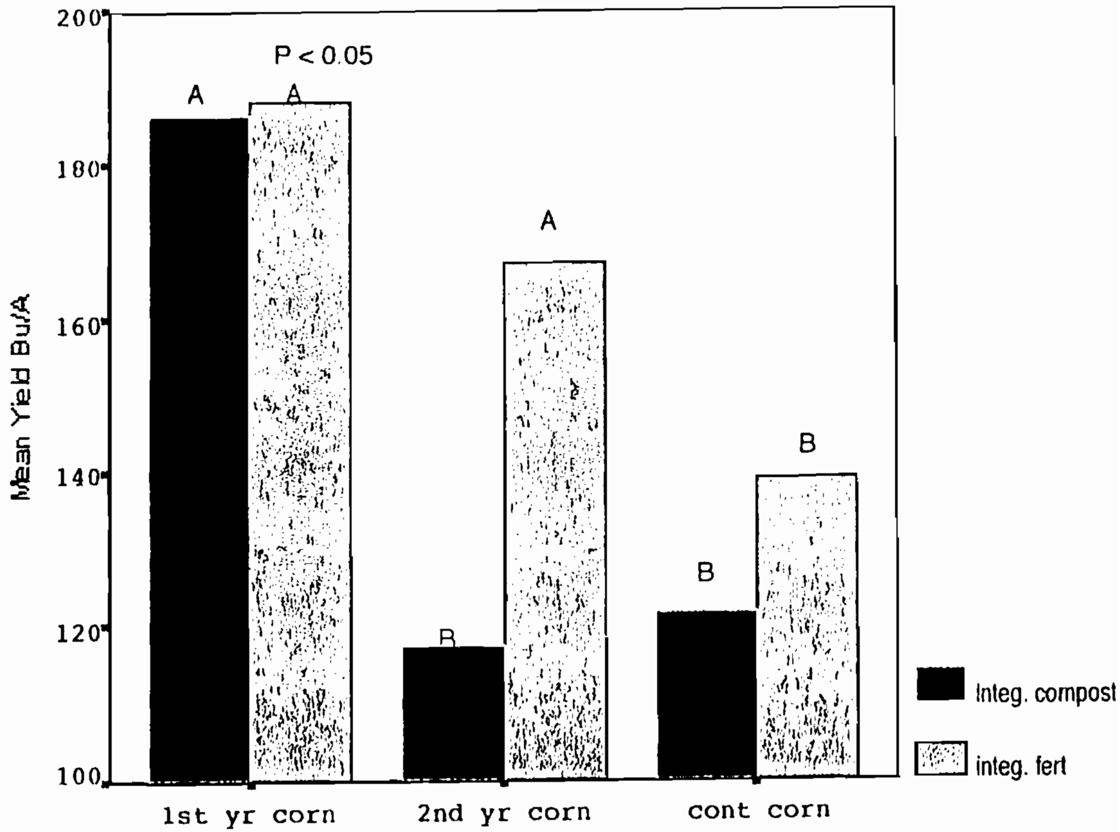

Table 4a. Product income, variable costs, and net economic return per acre for all crops under integrated compost management, 1993-1995

	1993		1994		1995	
	Cover	No cover	Cover	No cover	Cover	No cover
	$/acre		$/acre		$/acre	
First yr. corn						
Product income @ $2.50/bu	327.50	335.00	467.50	465.00	422.50	350.00
Variable costs	102.69	80.19	111.10	79.60	107.20	75.70
Net economic return	**224.81**	**254.81**	**356.40**	**385.40**	**315.30**	**274.30**
Second yr. corn						
Product income @ $2.50/bu	327.50	320.00	270.00	317.50	315.00	325.00
Variable costs	87.69	80.19	87.10	79.60	83.20	75.70
Net economic return	**239.81**	**239.81**	**182.90**	**237.90**	**231.80**	**249.30**
Continuous corn						
Product income @ $2.50/bu	330.00	300.00	312.5	295.00	325.00	312.50
Variable costs	102.69	80.19	99.10	79.60	108.20	88.70
Net economic return	**227.31**	**219.81**	**213.40**	**215.40**	**216.80**	**223.80**
Wheat						
Product income @ $4.00/bu	--	92.00	184.00	192.00	192.00	232.00
Variable costs	--	41.39	39.97	39.97	39.72	39.72
Net economic return	--	**50.61**	**144.03**	**152.03**	**152.28**	**192.28**
Soybean						
Product income @ $6.25/bu	--	312.50	268.75	312.50	243.75	231.25
Variable costs	--	51.99	50.47	50.47	50.71	50.71
Net economic return	--	**260.51**	**218.28**	**262.03**	**193.04**	**180.54**

Table 4b. Product income, variable costs, and net economic return per acre for all crops under integrated fertilizer management, 1993-1995

	1993		1994		1995	
	Cover	No cover	Cover	No cover	Cover	No cover
	$/acre		$/acre		$/acre	
First yr. corn						
Product income @ $2.50/bu	392.50	392.50	477.50	460	395.00	380.00
Variable costs	135.38	115.88	152.76	121.26	154.63	123.13
Net economic return	**257.12**	**276.62**	**324.74**	**338.74**	**240.37**	**256.87**
Second yr. corn						
Product income @ $2.50/bu	390.00	415.00	392.50	445.0	332.50	350.00
Variable costs	123.38	115.88	128.76	121.76	130.63	123.13
Net economic return	**266.62**	**299.12**	**263.74**	**323.24**	**201.87**	**226.87**
Continuous corn						
Product income @ $2.50/bu	382.50	395.00	352.50	342.50	347.50	347.50
Variable costs	135.38	115.88	140.76	121.76	155.63	136.13
Net economic return	**247.12**	**279.12**	**211.74**	**220.74**	**191.87**	**211.37**
Wheat						
Product income @ $4.00/bu	--	72.00	188.00	188.00	228.00	264.00
Variable costs	--	53.68	56.76	56.76	44.80	44.80
Net economic return	--	**18.32**	**131.24**	**131.24**	**183.20**	**219.20**
Soybean						
Product income @ $6.25/bu	--	281.25	237.50	250.00	212.50	200.0
Variable costs	--	36.99	47.75	47.75	35.71	35.71
Net economic return	--	**244.26**	**189.75**	**202.25**	**176.79**	**164.29**

CONCLUSION

In consecutive years of transition from continuous corn to corn in rotation, first-year corn following wheat produced the highest yield and net economic return. This effect occurred under both compost and fertilizer management. In the second year of transition, the advantage of corn following wheat was enhanced by interseeded red clover in the wheat, especially under compost management. Because this experiment will have the same comparisons each year, we will determine if the beneficial effect of preceding clover in wheat will continue to boost productivity of first year corn.

In a cropping system where manure is available, or is a by-product of a livestock operation. the integrated compost system that utilizes first-year corn following wheat/red clover may prove to be advantageous. The data suggest that the second year of corn in the rotation should be removed from this system.

When growing crops in rotation with cover several factors must be taken into consideration, such as the extra planting and harvesting equipment needed for different crops, and a higher degree of crop management with respect to planting of cover crops. Nutrient needs must be monitored when rotating from one crop to the next. The additional crops create more opportunities for fluctuation in profits and this is further affected by crop price ratios. As this experiment enters its second four-year rotation, economic and agronomic evaluation of these scenarios will continue.

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