Organic and conventional beyond transition

by

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Any farmer making a change from one system of food production to another is entering unfamiliar terrain that can be fraught with risks. According to the landmark study published by the USDA in 1980, Report and Recommendations on Organic Farming, farmers were asked about the merits of organic farming practices. Most of them felt that an established organic farm was the best way to go economically and environmentally. However, the big problem was how to get there in the first place. For example, the farmers perceived that lack of nitrogen and excessive weed competition for field crop systems would reduce crop yields to unacceptably low levels during the transition period.

The lack of confidence during this transition period and dearth of practical information seemed to be major obstacles to the advancement of organic agriculture. Therefore, in 1981, a study was initiated at the Rodale Research Center in southeastern Pennsylvania to investigate this transition process.

Initially, there were two basic objectives. The first was to deal with some of the practical management questions confronting farmers:

1) Identifying the factors that limit crop growth and yield during the transition period;

2) Finding cultural techniques and suitable crops and rotations to minimize transitional problems; and

3) Determining net cash returns and economic constraints (e.g., labor availability and seasonal cash flow) during conversion to organic practices.

The second basic objective was to document changes in the physical, chemical, and biological properties of the soil during the transition process.

A 13-acre site was used to carry out this experiment. The site had been "conventionally" farmed (pesticides, commercial fertilizers, no cover crops and moldboard plow tillage) during the 1960s and 1970s in an alternating corn and wheat rotation. Large plots (20 X

200 feet) were used to facilitate farm scale equipment. Initial soil phosphorous levels were high, potassium was medium, pH was 6.7, and organic matter content was 2.4 percent. The soil was mostly a moderately well drained silt loam with a fragi-pan in some areas restricting drainage at 20-35 inches.

Three cropping systems based on five-year rotations were compared during the 1981 - 1985 period. These were:

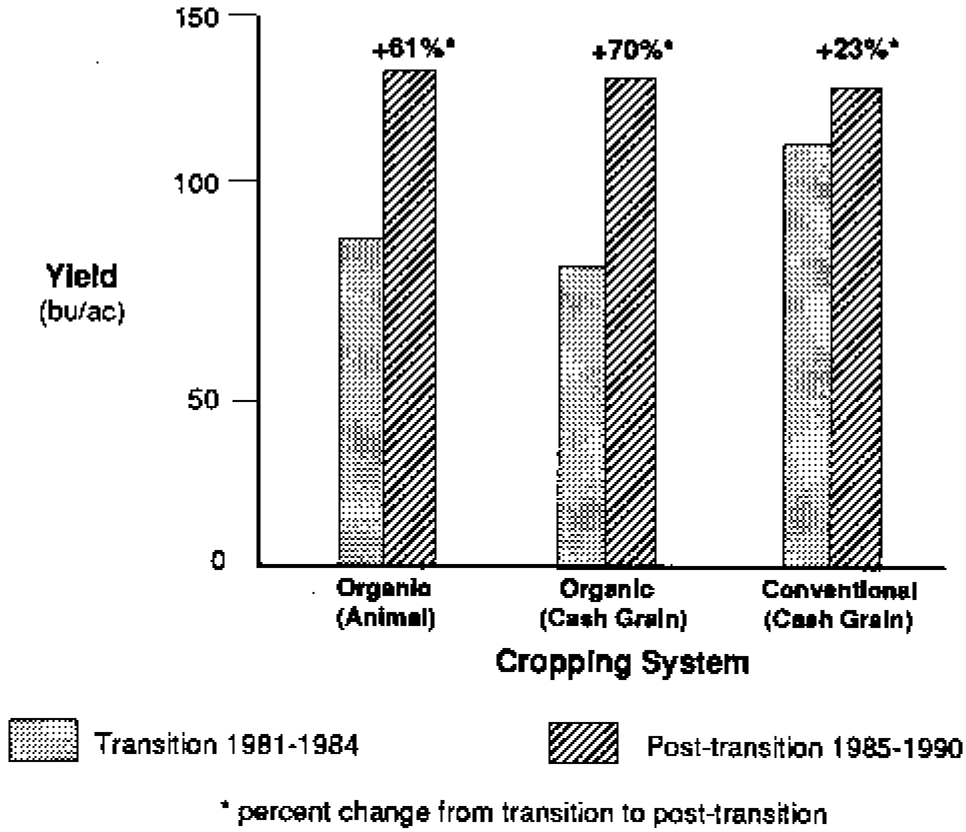
1) Organic animal (ORG-A) system simulating a beef or dairy operation in which hay, corn silage, corn grain, and soybeans were grown. Nitrogen was provided by animal manure and third-year legume hay crops plowed down just prior to corn planting.

2) Organic-cash grain (ORG-CG) system in which no animals were present and a cash grain (corn, soybeans, oats, or wheat) was produced every year. Nitrogen was provided by short-term hay and green manure crops. Weed control for both ORG-A and ORG-CG systems was achieved with the rotary hoe and sweep cultivators.

3) Conventional cash grain(CONV) system in a simple corn/soybean rotation using Penn State fertilizer and pesticide recommendations.

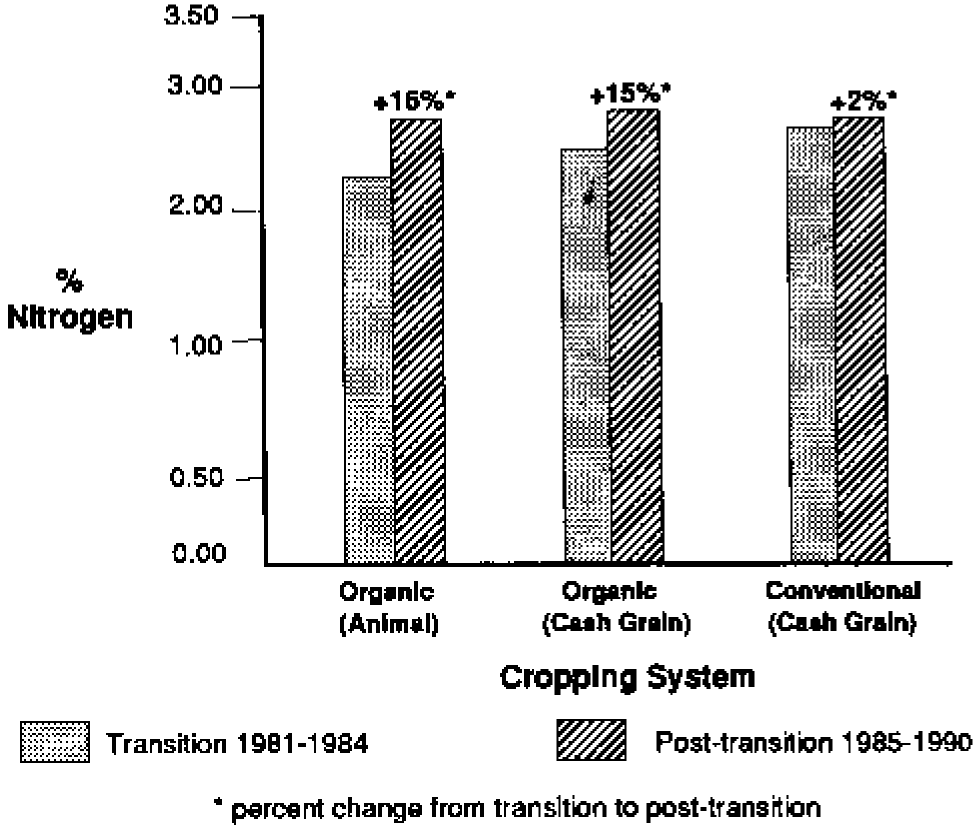
Traditional tillage practices (mold board plow, disk, harrow, and cultipacker) were used in all three cropping systems. The primary differences between systems were that the organic systems used animal and/or green manures, rather than commercial N (ammonia-based) fertilizer, avoided herbicides, had more diverse crop rotations, and had more live plant cover throughout the year than the conventional cash grain system. Many of the findings from the first five years of this trial corroborated the farmers' responses in the USDA report. A biological transition, i.e., a change in the dynamic equilibrium between soil processes and plant growth, was observed in the two organic cropping systems during the first four years of the trial. Corn in both organic systems yielded about 75 percent of the conventionally grown com. Since 1985, corn in all systems has yielded equally (figure 1).

Figure 1. Corn Yield - Transition vs. Post-transition



This result was primarily attributed to a lack of plant-available nitrogen from the organic inputs (animal and/ or green manure) in the early years when most of the N was cycled within the microbial biomass. Over time, as N accumulated and microbially-induced nutrient transformation stabilized, enough nitrogen was released for healthy plant growth and resulted in increased corn leaf nitrogen (figure 2).

Figure 2. Corn Ear Leaf Nitrogen - Transition vs. Post-transition



Greater weed pressure in the organic systems may have also caused yield declines, but the evidence is not particularly convincing. Weed levels in the organic corn treatments have not decreased substantially since the transition years, yet the corresponding crop yields have greatly increased (equal % to conventional corn). Furthermore, plus/minus weed subplots have shown that since 1986, weeds have caused a reduction in corn yield in only two out of 11 organic corn treatments. Recommendations for minimizing these transitional problems include:

1) Begin the conversion process with a leguminous hay or soybeans (nether of which was adversely affected by the transition) or in a field with a high nutrient status and good soil structure;

2) Avoid starting the conversion with corn or any crop with a high nitrogen demand;

3) Allow a three to five year transitional period for yields to stabilize (depending on the starting crop and the condition of the field);

4) Include legume green manures in the new rotation;

5) Reduce external inputs (e.g. pesticides and commercial fertilizers) gradually (in this study, external inputs were removed suddenly);

6) Alternate cool season crops (e.g. hay and small grains) with warm season crops (e.g. corn and soy beans) to interrupt weed cycles;

7) Perform field operations such as plowing, cultivation, and overseeding in a timely manner.

Obviously, these recommendations should be somewhat modified for different crops, climates, and soil types. If P and K soil levels had not been adequate on this field site, then soybeans may have suffered during the transition. The best approach is to experiment on a small scale to see what does and does not work. This also allows you time to become more familiar with a new practice such as interseeding or rotary hoeing without risking your entire farm operation.

Another important aspect of the transition process is that it cannot be done successfully simply by substituting one input for another (say, manure for ammonium nitrate). A transition must involve some kind of structural or fundamental change in the farm operation.

In this trial, the mix of crops and rotations in the organic systems were altered because a corn/soybean system with no cover crops probably could not be managed organically, at least not without great difficulty. Even more important, this conventional cash grain system would not be desirable in terms of its vulnerability to soil erosion and pesticide and nitrate leaching, and its inefficiency in resource utilization.

Another aspect of primary concern to farmers (besides identifying the causes of and the corresponding technical solutions to biological problems during transition) is economic viability during transition.

Net returns over variable costs for the first five years were calculated by assuming that all crops were marketed commercially (Duffy et al., 1989). Average annual net returns were highest for the organic animal system ($462/ha) and lowest for the organic cash grain system ($329/ha). The conventional cash grain return was intermediate. Starting the transitional rotation with corn grain produced the lowest returns for the organic systems, while beginning with an oats/red clover mixture was the most profitable after five years.

A second study used the Rodale data to determine profitability, liquidity, solvency, and risk on a representative commercial grain farm over the 1981-1989 period. This analysis only compared the organic (referred to as low-input) cash grain and conventional cash grain systems. The most important findings included:

1) The government programs favoured the conventional farmer with a large-base acreage of corn (i.e. crop diversification and rotation were discouraged).

2) If cross-compliance restrictions are ignored, the organic/low-input scenario is nearly as profitable as the conventional.

3) Risk (the degree of variability of profits from year to year) was considerable less in the low-input system because of greater crop diver sity and lower cash inputs. 4) The profits in the low-input system were greater than the conventional from 1985-1989, yet the conventional was still more profitable over the whole nine-year period. This is because the low-input farmer was still paying off interest on the debt incurred during the transition years, 1981-1984. The biological transition for a farmer who goes organic "cold turkey" may only take four years, but the economic transition can be more than double that time within the present economic structure.

5) The quality of the soil will greatly determine the future profitability of these systems, and this analysis didn't directly factor in any differences in soil properties that occurred as a result of the different management practices. In other words, this analysis is still incomplete in evaluating the true worth of ecologically sound farming practices.

Beginning in 1986, the experimental objectives of the study were modified, since it was assumed that the transition phase (at least biologically) was completed. Emphasis shifted toward evaluating the long-term reliability of organic/low input techniques and their impact on the soil ecology.

Corn and soybeans (the only crops common to all three cropping systems) have yielded nearly the same in each system since 1985. An important exception to this occurred in 1988 when the conventionally managed corn yielded significantly less. That season was particularly dry from May to July, and the conventional corn showed obvious signs of drought stress.

This is the clearest indicator we have that the soil environment was poorer for plant growth under conventional management. This finding also supports the belief that ecologically managed soil will enable plants to withstand the extremes of weather.

The physical, biological, and chemical measurements of soil taken from 1985 to 1990 indicate improved conditions in the organic systems. In 1985, the soil in the organic cash grain corn plots, following a plowdown of hairy vetch, had greater water stable aggregates (which are important for movement of water through the soil and for facilitating good plant root growth), more rapid water infiltration rates, greater microbial activity), and more earthworms, mites, collembola, and other soil invertebrates than did soil in the conventional system. Although it resulted in a slightly lower level of stable soil humus, the conventional system actually returned more total biomass (crop residues and weeds) to the soil during this period than did the organic. This indicates that more of the carbon was being retained in the soil under organic management.

The nitrogen budget of the organic cash grain system appears to be Working better than predicted by our scientific assumptions. Both the organic animal and conventional cash grain systems have only slight N deficits after 10 years (112 to 168 kg/ha) and would appear to be providing enough nitrogen to maintain crop productivity without depleting soil N reserves. In contrast, the organic cash grain system is operating at a large N deficit (over 56 kg/ ha), yet as soil likely has adequate organic carbon, which is a good indication that it has at least the same or higher N content as the soil in other systems.

Supporting evidence comes from a study from 1987 to 1989 in which the isotope N-15 from organic (red clover) and inorganic (ammonium sulphate) sources was used to trace the relative amounts of N found in the plant, remaining in the soil, and lost from the system. The conclusion was that the inorganic N inputs primarily contribute to aboveground plant biomass, while the organic N inputs contribute mainly to the soil. Furthermore, the loss of N is higher from the inorganic N inputs. In addition, soil from the organic system, incubated in a laboratory for 200 days, had a higher N mineralization potential than the conventional (inorganic) soil. For reasons not yet understood, the organic cash grain system appears to be accumulating N and the plant/soil system is functioning quite efficiently.

Another interesting trend concerns potassium inputs and outputs. After 10 years, the organic cash grain system has more than twice the deficit (inputs minus outputs) of K as the conventional, yet in most years the potassium content of corn ear leaves at Bilking was higher in the organically grown corn. Perhaps these deficits are not really critical because of the high potassium supplying ability of this particular soil. However, soil test results have indicated a steady decline in exchangeable potassium in both organic and conventional systems from 1981 to 1989. This fnay be evidence that, as potassium availability (at least according to a standard soil test) decreases, the winter cover crops present in the organic systems become increasingly important for scavenging normally unavailable potassium and making it available for the subsequent carp.

While the organic cropping systems in this trial are operating fairly reliably, improvements will continue to be made. One goal is to maintain a live plant cover for the entire year by overseeding and relay cropping. Other improvements could include: 1) Reducing tillage to increase soil protection and lower energy costs. This would, however, require modification of present equipment or purchasing or borrowing different equipment. Increased surface residues may also require different strategies for controlling insects and diseases.

2) Increasing the diversity of crop species.

3) Altering the size or type of livestock on the farm to correspond more closely to the new crops being grown.

4) Co-composting, i.e. combining on-farm manure resources with urban "wastes", such as leaves and grass clippings, to create a stable and abundant soil amendment.

5) Growing and harvesting your own cover crop seed.

6) Adding trees to the farming system through strip cropping hardwoods with cash grains, conservation plantings to stabilize stream banks, and cropping nitrogen fixing trees for mulch.

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