

Integrating Organic Soybean Production following Conservation Reserve Program (CRP) Land into Sustainable Farming Systems

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Introduction

Organic farming has increased to an \$8 billion industry in the United States and continues to expand approximately 20% annually. In Iowa alone, organic acreage has increased from 13,000 acres in 1995 to 150,000 in 1999. Across the North Central region, there has been great interest in planting organic soybeans on Conservation Reserve Program (CRP) land, where up to a 400% premium can be obtained compared with conventionally raised soybeans. Regulation of soil organic matter through additions of plant residues and proper crop rotations will determine the long-term sustainability of the system.

The objectives of this research and education program were to: (1) Establish plots dedicated to organic farming research on CRP land, (2) Implement production and management regimes for opening CRP land and for weed control in organic systems on CRP land, (3) Evaluate the biological and economic outcomes of the different systems, and (4) Promulgate technology transfer through

demonstrations/field days and publications for area farmers and agricultural professionals. The methods adopted for this project included establishment of a long-term agroecological research (LTAR) site at the Neely-Kinyon Farm in southeast Iowa. In 1998, plots were established at Field Site 1, and in 1999 at Field Site 2. All organic soybean systems yielded well above the county average in 1999 and 2000 (average of 56 bushels/acre). We report here the results of the second year after CRP conversion to organic production.

Materials and Methods

Plots were established in 1999 at Field Site 2 at the McNay Memorial Research and Demonstration Farm in a randomized complete block arrangement with four treatments and four replications on land similar to CRP. In 1999, treatments consisted of four primary tillage methods: fall moldboard plowing, fall Kverneland[®] plowing, fall and spring tillage with a Howard Rotavator,[®] and spring moldboard plowing. In 2000, a certified organic rotation was established of corn-soybean-oat/red clover. Thus, beginning in 2000, only oat/red clover plots were either fall plowed (former Kverneland[®] and fall moldboard plots) or spring plowed (former Rotavator and spring moldboard plowing). All fall tillage for the 2001 season was accomplished by December 4, 2000. Winter rye was broadcast on corn plots with a three-point mounted spreader on October 6, 2000, at a rate of 1 bushel/acre to serve as a ground cover to prevent erosion and mitigate weed populations in 2001 soybean plots. The rye was mowed on May 15, 2001, but not disked until June 28–29, due to an extremely wet spring. Manure was applied to all plots going to corn at a rate of 5,000 lb/acre on March 25, 2001. "Blaze" oats and "Cherokee" red clover were

planted on April 25, 2001, at a rate of 2 bushels/acre and 12 lbs/acre, respectively. Soybeans (Pioneer 9305) were planted at a population of 175,000 plants/acre on June 29, 2001. The corn variety Pioneer 35P12 also was planted on June 29, at a rate of 30,000 plants/acre. Corn and soybean plots were rotary-hoed for weed control on July 2 and July 12, and row cultivated on July 27, August 5, and August 27. Soybean plots were "walked" (large weeds removed by hand) on August 27, per local organic practices to remove any potentially staining weeds prior to harvest. Oats were harvested on July 24, 2001. A separate soybean plot was flamed on August 20. Corn and soybeans were harvested with a combine on November 6, 2001. Soil samples (5 random samples/plot) were taken on November 17, 1999; and on May 9, 2000, at depths of 0–4" and 4–8", using methods described by Cambardella (1994) for the Neely-Kinyon LTAR site. Post-harvest soil sampling occurred on November 7, 2001, at the same depths. Crop stand counts were taken on July 17, 2001 (18 days after planting). Weed counts (3 square meter quadrants/plot) were taken on July 17. Weed counts also were taken on August 27, 2001, in the soybean flame weeding trial.

Bean leaf beetles, which are associated with the soybean staining disease complex, were sampled in soybean plots on July 23, 2001, by sweeping 20 times/plot with a 15 inch diameter net. Corn borer populations were sampled by removing 3 randomly selected corn whorls/plot, and recording the number of corn borer feeding holes and actual larvae on July 23. Soybean cyst nematodes were analyzed by sampling 3–6 inch soil cores/soybean plot for presence of eggs on October 19. Corn stalks were collected on October 19 for stalk nitrate analysis. Corn and soybeans were analyzed for protein, carbohydrates, fiber, and oil through the Iowa State University Grain Quality Laboratory in the Department of Food Science. A 250-gram sample of harvested soybeans was analyzed

from each plot for percentage of stained soybeans (soybeans with a tan, brown, or mottled appearance).

Results and Discussion

An extremely wet spring in southeast Iowa resulted in a very late planting date. Consequently, lower-than-normal yields were obtained throughout the region. Plant populations were reduced significantly by tillage operations in both corn and soybeans. Although there were no significant differences among treatments in corn stand counts at 18 DAP, there were significant differences among tillage treatments in soybean stand counts, with fall-plowed plots retaining higher plant populations than spring-plowed plots. It is not clear if these differences were the result of differential rotary-hoeing in the plots or soil texture changes from spring plowing. Early weed counts in corn and soybeans demonstrated no significant differences among treatments in grass or broadleaf weed populations. Late-season weed populations in soybean showed significantly higher levels of grasses in Rotavator[®] treated plots compared with all other treatments. No significant yield differences were determined among treatments in oat or soybean plots. Organic oats averaged 62 ± 2.7 bushels/acre, and soybeans averaged 27 ± 5.3 bushels/acre, which were comparable to county averages. Significantly greater corn yields were obtained in Rotavator[®] plots (113 ± 4 bushels/acre) compared to the fall plowed (73.5 ± 15) and spring plowed plots (94 ± 7.6).

Propane flame burning significantly decreased grass weed populations in soybean plots. Corn borer populations were below economic threshold levels in 2001. Bean leaf beetle populations were below 2000 levels (averaging 1 beetle/plot), with no overall significant differences among treatments. Soybean staining (8–13%), caused by bean pod mottle virus and other fungi, did not differ among treatments. There were no significant differences among

treatments in corn in 2001 (protein average: 7.5%) or in soybean grain quality in 2001 (protein average: 36%). There were no soybean cyst nematode eggs detected in any samples. Soil quality analysis identified that moldboard plowing released five times more particulate organic matter carbon (POM-C) than the other two tillage treatments, with pre-plowing levels at ~4.0 Mg/ha POM-C and three weeks later reaching ~ 20.0 Mg/ha. In the other tillage methods, POM-C was two to three times higher at that time. Soil quality parameters for 2001 are currently undergoing analysis.

Results from the CRP experiments demonstrated excellent production of high quality organic soybeans on land following CRP in 1999 and 2000. Corn and oat yields also were above average. All crops in the area suffered from a wet spring in 2001, which led to organic systems yielding similarly to county averages. We were pleased to obtain excellent yields and grain quality in soybean plots that were spring plowed as opposed to fall plowed. Spring plowing will allow for a vegetative cover during the winter and avoidance of soil erosion associated with fall plowing. Organic farmers in the Midwest, however, prefer fall plowing because of several reported reasons:

- Farmers normally have more time for plowing in the fall than in the spring, when other tillage, planting and compost-spreading activities occur.

- Fall plowing allows for a more complete break-up of soil through freezing and thawing in winter.
- Wet springs may preclude spring plowing.

For these reasons, we will continue this experiment, using funds from the USDA, in order to determine yield and weed differences in the case of poor weather in the spring. Flame burning significantly lowered grass weed populations, but there was no effect on yield. We have seeded foxtail in selected plots to monitor exact weed populations in 2002.

Current economics (2001) dictate the superior economic value of certified organic soybeans (\$14/bu) compared to organic corn (\$3.20/bu) or organic oats (\$2.25/bu). In addition, compared with corn crop demands, soybeans can produce adequately on poorer soil, typical of CRP land. Corn yields were excellent in 2000, however, with returns for certified organic corn totaling \$830/acre (before costs). Returns for certified organic soybeans in 2001 were 180% above conventional soybeans. Complete economic analysis for all crops is being conducted by ISU economists Mike Duffy and Craig Chase.

Excellent yields in 1999 and 2000 demonstrated favorable N mineralization to support corn and soybean crops, which may have increased during tillage operations. N-mineralization and nitrate-N rates remained adequate during the conversion period from CRP to crop production.