7-2012

Diversifying Corn-Soybean Rotations

Leopold Center for Sustainable Agriculture

Diversifying Corn-Soybean Rotations

Abstract
This brochure describes the yields, profitability and sustainability of low-input, high-diversity cropping systems from a long-term research project at the ISU Marsden Farm.

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

How do more diverse cropping rotations improve sustainability?

The addition of small grains (triticale or oat) and perennial forage legumes in the rotation minimizes the need to use synthetic fertilizers, herbicides and fossil fuels. Diverse rotations also enrich the soil with plant-available nitrogen and organic carbon, break disease and weed cycles, and diminish erosion by putting living roots and cover on the ground. They protect nearby waterways from pollution and reduce the risk of creating herbicide-resistant weeds. These environmental benefits improve over time. After nine years, herbicide inputs in the diverse rotations were 7 to 10 times lower, and herbicide-related freshwater toxicity 200 times lower, compared to the conventional system. Diverse rotations used 48 to 51 percent less energy per acre per year compared to the conventional system. Most of the energy was consumed in fertilizers, propane for drying grain, and fuel for farm equipment.

Yields for corn and soybean (bushels / acre)		
2-year rotation	194	51
3-year rotation	202	55
4-year rotation	204	57

Returns to land and management ($ / acre / year)	
2-year rotation	318
3-year rotation	315
4-year rotation	308

Data averaged from 2003 - 2011

Yields are statistically different between diverse and conventional systems ($P < 0.05$)

Net returns are statistically equivalent

Learn more

Chase, C.A., K. Delate, M. Liebman and K. Leibold. 2008. Economic Analysis of Three Iowa Rotations. Iowa State University Extension PMR 1001. Online: http://www.extension.iastate.edu/Publications/PMR1001.pdf

Gomez, R., M. Liebman, D.N. Sundberg, and C.A. Chase. 2012. Comparison of crop management strategies involving crop genotype and weed management practices in conventional and more diverse cropping systems. *Renewable Agriculture and Food Systems.* Online: doi: 10.1017/S1742170512000142

Liebman, M., M.J. Helmers, L.A. Schulte, and C.A. Chase. In press. Using biodiversity to link agricultural productivity with environmental quality: Results from three field experiments in Iowa. *Renewable Agriculture and Food Systems.*

Leopold Center Competitive Grant Project E2010-02: www.leopold.iastate.edu/grants/e2010-02

Get involved

Cost-share funding offered by Practical Farmers of Iowa (PFI) through the Walton Foundation helps Iowa farmers experiment with diversifying corn-soybean rotations and documenting performance and profitability. Contact Sarah Carlson at (515) 232-5661.

LEOPOLD CENTER

209 Curtiss Hall
Iowa State University
Ames, Iowa 50011-1050
(515) 294-3711 phone
(515) 294-9696 fax
leocenter@iastate.edu

July 2012

Funding for this work was provided by the Leopold Center for Sustainable Agriculture, U.S. Department of Agriculture National Research Initiative, Iowa Soybean Association and Organic Center.

Diversifying Corn-Soybean Rotations

Higher diversity and lower inputs create more resilient farms for Iowa

LEOPOLD CENTER

Iowa State University
Marsden Farm

Diverse Rotations for Healthy Farms

What is the experiment?

Cropping systems designed with higher diversity minimize the use of fossil fuels and protect ecosystem health without forfeiting yields and profits. Low-Input-High-Diversity (LIHD) rotations, also called Low-External-Input (LEI) rotations, allow farmers to achieve yields and profits by replacing purchased inputs with combinations of ecological processes and human inputs: farmer knowledge, labor and production management skills. In 2002 researchers established replicated plots at the Iowa State University Marsden Farm in Boone County, Iowa to study the performance of the following cropping systems:

- Conventional corn-soybean (2 year)
- Corn-soybean-small grain/red clover (3 year)
- Corn-soybean-small grain/alfalfa-alfalfa (4 year)

What have researchers found?

Diverse rotations have higher yields

Corn and soybean yields in the diverse rotations exceeded yields in the conventional system, with corn yields on average four percent greater and soybean yields on average nine percent greater.

Similar profits produced

Diverse rotations produced similar profits compared to the conventional system during both the transition years (2003 – 2005) and established years (2006 – 2011). Net returns to land and management were calculated assuming that diverse rotations received manure from on-farm or nearby livestock and incurred costs for labor and machinery for spreading manure, but not for the material itself. Diverse rotations are less vulnerable to changing input costs, and may become more profitable if fossil fuel costs rise substantially relative to crop prices.

Weed control effective with less herbicide

Diverse rotations received an average of 88 percent less herbicide compared to the conventional system. Herbicide was applied in the diverse rotations during the corn and soybean years in 15-inch bands rather than broadcast spraying, and inter-row areas were cultivated. The small grain and forage legume crops required no herbicides. Weed seed banks decreased in all three cropping systems, and reduced herbicide rates did not lead to weed problems.

Nutrient management improved

The diverse rotations, which received clover and alfalfa residues and composted cattle manure, received much less synthetic nitrogen than the conventional rotation. Data from 2003 to 2011 showed that synthetic nitrogen use was 80 percent lower in the three-year rotation and 86 percent lower in the four-year rotation compared to the conventional system.

Does crop variety matter?

Researchers compared genetically engineered (GE) and non-GE corn hybrids and soybean varieties in the different cropping systems. The results indicate that GE crops offer higher net returns if used in conventional corn-soybean systems. However, with diverse rotations, farmers can choose between GE and non-GE without jeopardizing net returns. Diverse rotations outperformed conventional in yield regardless of the crop variety.

Soybean disease

Farmers Steve Barry and Ron Brunk inspect soybeans damaged by Sudden Death Syndrome, a disease caused by a soil-borne fungus. In 2010 SDS severely affected the soybean plants in the conventional system, infecting 97 percent of the non-genetically engineered plants and 27 percent of the GE plants. By contrast, less than nine percent of the soybean plants in the diverse rotations were affected, and those plants had significantly less defoliation, resulting in higher yields.