United States Department of Agriculture

NRCS Natural Resources Conservation Service

Soil Quality Institute

Soil Quality and Vegetable Production

One Farmer's Experience

No-till is increasingly common in areas of commodity row crops. Is it feasible and profitable, however, for vegetable growers? Absolutely yes, according to a Pennsylvania farmer who has been successfully combining no-till, cover crops, and crop rotations that include vegetables for over a decade. This technical note describes how he combines these components and how he gets more reliable yields, higher levels of organic matter, lower input costs, and enhanced soil and water quality.

Cedar Meadow Farm

Steve Groff's 175-acre family farm, Cedar Meadow Farm, is in Holtwood, Pennsylvania (Lancaster County, in the southeastern part of the State). The dominant soil is Chester loam (a fine-loamy, mixed, mesic Typic Hapludult). It has slopes of 3 to 17 percent. The farm income is derived mainly from the sale of vegetables (table 1).

Table 1.—Crops grown on Cedar Meadow Farm

	Approx. acreage
Pumpkins	25
Sweet corn	25
Processing tomatoes	22
Fresh tomatoes	5
Peppers	1
Cauliflower	1
Fall broccoli	1
Corn for livestock feed	35
Soybeans, hay, small grain, cover crops for seed, and other crops	61

Technical Note No. 15

October 2002

This is the fifteenth in a series of technical notes about the effects of land management on soil quality.

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The desire to control erosion was Steve's first motivation to begin no-till in the early 1980s. Prior to that time, the Groff farm had visible gullies and was losing an estimated 14 tons of topsoil per acre each year, despite the use of a contour stripcropping system.

Steve began experimenting and finding the best combinations to maintain yields. He learned from experience and suffered some yield reductions in the beginning. In 1991, after several years of successes with no-tilling soybeans, small grain, and corn, Steve used his no-till experience and added cover crops and no-till to his vegetable operation. Cover crops were added because vegetables produce little residue and leave the soil vulnerable to erosion.

Steve calls his pioneering approach the "Permanent Cover Cropping System." This system of annual cover crops, no-till, and effective crop rotation keeps the soil continuously covered with living plants and residues. This cover aids in weed control, has virtually eliminated soil erosion on the farm, and has improved soil and water quality.

The cover crop no-till system

In 1991, Steve began his system of growing cover crops within his rotations. His goals were to have something growing nearly all the time, produce as much biomass as possible, feed the soil organisms, increase the content of organic matter, decrease the hazard of erosion, improve productivity, and produce safe, high-quality food.

The first component of Steve's system is effective crop rotation. Because of the diversity of crops, he did not need to add any new crops to create a good rotation. Skilled management was needed, however, for him to adjust the fields to his desired combinations while ensuring about 4 years between tomato crops and fall vegetables. Corn is grown no more than 2 years in a row. The rotation helps to suppress weeds, diseases, and insects. A typical rotation is tomatoes, a cover crop for seed, corn, pumpkins, wheat, alfalfa for 4 years, and corn.

A second component is Steve's cover crop system. The combination of cover crops planted depends on the succeeding cash crop. Before transplanting vegetables, Steve plants 25 lbs/acre of vetch along with 30 lbs/acre of rye. Before directly seeding pumpkins, he plants 30 lbs/acre of vetch along with 120 lbs/acre of rye. Before early planting of tomatoes, he plants rye alone because the vegetables are planted too early for vetch to contribute any biomass. Before planting sweet corn, he plants hairy vetch or crimson clover.

The rye has finer roots than the vetch, and its residue lasts longer into the season. Vetch and crimson clover have higher nitrogen contents, decompose quickly, and provide more readily available nitrogen. Steve credits 50 lbs/acre nitrogen for the vetch-rye mixture and 75 lbs/acre for the vetch alone. He supplements nutrients with surface applications of manure and ammonia sulfate when extra nitrogen is required. Nutrient applications are based on crop needs and occur at the time when the crops can take up the nutrients.

Rolling rye cover crop with the stalk chopper.

Steve Groff and the rolling stalk chopper.


No-till transplanting of tomatoes into residue.


No-till vegetable transplanter.

For the early planted crops, such as tomatoes and sweet corn, the rye is killed with a glyphosate herbicide when it is about 18 inches tall. For later planted crops, the rye is allowed to head out and the vetch or crimson clover can begin to flower before killing occurs. One pass by a modified rolling stalk chopper stops the growth. A second pass terminates the cover crop so there is no regrowth. Herbicide is applied at low rates to completely kill the rye and vetch.

Economics

Steve credits the permanent cover crop system with savings of $675/acre in the production of tomatoes. Nearly $500 of the cost reduction is from the material, labor, and time saved by eliminating plastic mulch. The rest is from reductions in the use of pesticides. In his other vegetables, no-till leads to savings of $50/acre from reduced tillage passes and $125/acre from reductions in the use of pesticides (averaged over the last 4 years). For corn and soybeans, savings on the use of pesticides are $7/acre. Increased costs associated with cover crops are $50/acre for establishment and seed and $10/acre for terminating cover crops. In addition to reducing costs, Steve has increased yields by 10%, according to his conservative estimate. Figure 1 shows increases in yields related to the length of time in no-till and cover crops. Other soil quality benefits include:

- Increased organic matter levels
- Topsoil savings from reduced erosion
- Increased available water
- Increased soil biological activity
- Pesticide reductions of 50%
- Better infiltration.

Soil quality improvements

The content of organic matter has increased significantly on the farm because of no-till and the Permanent Cover Cropping System. In the top 4 inches, it increased from 2.7 to 4.3% over the entire farm; in one field it is 5.8%. Other soil quality improvements are shown in table 2. The most dramatic improvement is a decrease in soil loss from an estimated 14 tons/acre to almost nothing.

Figure 1.—Yields under long- and short-term no-till and cover crops*

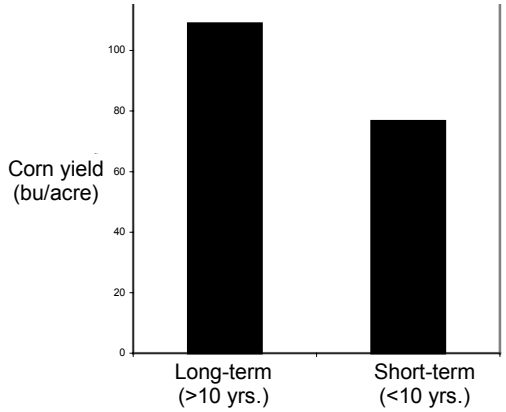

Table 2. —Soil quality indicators*

Yrs. not tilled	2	3	10	15	30
Bulk density (g/cm^3)	1.35	1.28	1.25	1.18	1.06
Microbial biomass (mg/g soil)	0.064	0.076	0.098	0.093	0.160
Aggregate stability %	19.4	24.5	24.0	68.2	87.3

* Data for figure 1 and table 2 are from the University of Maryland's research and are available on Steve Groff's Web site (http://www.cedarmeadowfarm.com/).

National implications

Compared to commodity crop production, vegetable production presents unique technical challenges to the no-tiller. Steve's experience shows that no-tilling vegetables is profitable and that the equipment and methods are available.

Several lessons can be transferred from this Pennsylvania farm to other parts of the country. First, much of Steve Groff's success results from his view that soil-improving practices are essential to the profitability of a farming operation. Second, improvements in soil quality and productivity depend on a three-pronged strategy that integraties no-till, crop rotation, and a cover crop system that ensures that some plants or plant residues are always on the surface. Third, the use of leguminous cover crops has reduced the need for manufactured fertilizers. Finally, using the rolling stalk chopper significantly reduces the need for pesticides. The use of a roller to kill cover crops is relatively new to the U.S. and should be tried in other regions.

Steve's system has resulted in remarkable changes in soil quality, including less compaction, better soil structure, and a doubling of organic matter levels. The soil improvements have led to greater yields, higher profits, cleaner water, and a healthier environment.

The Bottom Line

How does Steve Groff's "Permanent Cover Cropping System" compare to his previous, conventional approach?

Yield: Estimated 10% improvement.

Weed and pest control: Lower herbicide rates needed. Lower pesticide rates save $125/acre in areas used for vegetables and $7/acre in areas used for corn or soybeans.

Cost of cover crops: $50/acre to establish and maintain; $10/acre to terminate.

Savings in the production of tomatoes: $500/acre saved by eliminating plastic mulch.

Erosion: No more gullies despite steep slopes.

Field work: $50/acre saved through reduced tillage passes.

For more information. . .

Cedar Meadow Farm:
http://www.cedarmeadowfarm.com

No- tillage and cover crops for your region:
Visit your local Soil and Water Conservation District office.

Knife roller technology:
Agronomy Technical Note 13, 2002,
http://soils.usda.gov/sqi/files/13.pdf