Improving Weed and Insect Management in Organic Reduced-Tillage Cropping Systems

Progress Report
July 2010 – May 2011

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Project Summary

Our goal is to develop sustainable reduced-tillage organic feed grain production systems that integrate pest and soil management practices to overcome constraints associated with high-residue, reduced-tillage environments. Project research objectives include: 1) test the combined effect of pest avoidance, expressive, suppressive, and supplemental weed management practices and 2) measure the effects of these approaches on early season arthropod pests, soil quality indicators, and economic performance. In the 2010/11 reporting period, we conducted a series of preliminary experiments to support the establishment of the Reduced-tillage Organic Systems Experiment (ROSE). On-farm research trials were implemented in PA, MD, and NC. We held an advisory board meeting to discuss project progress and plans with experienced organic farmers from PA and MD, extension educators from Penn State, and representatives from the seed industry. The project team organized or participated in 12 project-related extension programs and delivered two webinars on organic weed management via eOrganic.org. Extensive early-season insect monitoring and weed sampling programs were initiated in Spring 2011, and the ROSE was successfully implemented at three sites with the no-till planting of organic corn and soybean into a rolled cover crop consisting of hairy vetch and triticale or cereal rye, respectively. Data from these experiments will be used to help explain the effects of different management approaches to crop performance, weed suppression, and economic feasibility of the different strategies. This information will be translated into extension materials and disseminated to diverse stakeholders. Conduct of project activities are consistent with the timeline in the original proposal.

Project goal and objectives: Our overall goal for this project is to develop sustainable reduced-tillage organic feed grain production systems that integrate pest and soil management practices to overcome constraints associated with high residue, reduced-tillage environments. Our outreach goals are to contribute to and disseminate science-based information that supports sustainable organic production and builds capacity to address the needs of organic producers. Our strategic goals are to increase the amount of land at research stations dedicated to organic research and demonstration, and to strengthen collaborative relationships within and among research and extension personnel, the organic farming community, producers considering transition, and organizations that represent organic and sustainable agriculture interests. We propose that replacing soil degrading practices with soil-building practices, coupled with cultural practices to address pest challenges will result in desirable agronomic, environmental, and economic performance in organic crop production systems.

Our project goals are being addressed through the following **research objectives**:

- **Objective 1.** Determine the effects of *expressive* weed management tactics (i.e., stimulate pre-plant weed seed germination followed by control) on pest, agronomic, soil quality, and economic indicators in an organic reduced-tillage feed grain production system.
- **Objective 2.** Determine the effects of pest *avoidance* tactics on pest, agronomic, and economic indicators in an organic reduced-tillage feed grain production system.
- **Objective 3.** Determine the effects of weed *suppressive* tactics (i.e., use living and dead cover crops to physically and chemically suppress weed emergence and growth) on pest, agronomic, soil quality, and economic indicators in an organic reduced-tillage organic feed grain production system.
- **Objective 4.** Determine the effects of *supplemental* weed management tactics on pest, agronomic, soil quality, and economic indicators in a reduced-tillage organic feed grain production system.
- **Objective 5**. Determine the on-farm performance and farmer-acceptability of components of the reduced-tillage organic feed grain production system through farmer-participatory research.

Outreach is a collaborative activity of the research/extension team and farmer-cooperators. **Outreach objectives** include:

- **Objective 6.** Develop new, incorporate existing, and deliver information on organic reduced-tillage crop production systems to growers, extension educators and other trainers, and agriculture-related organizations through field-based education events, workshops, and various media, including *eOrganic.info*/*eXtension.org.*
- **Objective 7.** Create and disseminate easy-to-use decision support materials online and in print to help growers manage crops, cover crops and pests in reduced-tillage organic feed grain production systems.

Progress to Date Project activities over the past year have addressed all of our research and outreach objectives. These activities have focused on conducting research to fine-tune our experiment and sampling protocols, establishing our large-scale field experiment at three sites, extension programs and publications, scientific presentations, and implementing on-farm research.

Reduced-tillage Organic Systems Experiment (ROSE)
The ROSE was successfully implemented at PSU, BARC, and UD in 2010. Baseline soil samples were collected and analyzed, cover crops were planted, and weed seed bank microplots were established in the fall of 2010 (Table 1).

Table 1. Summary of major field activities associated with the ROSE at the three different sites in 2010 and 2011.

Activity	PSU	BARC	UD
Plot demarcation	8/24/10	8/26/10	10/3/10
Baseline soil sampling	8/26/10	9/24/10	10/09/10
Triticale and hairy vetch planted	9/3/10	10/2/10	10/14/10
Rye planted	9/22/10	10/13/10	10/18/10
Wheat planted	10/10/10	10/22/10	10/18/10
Weed seed supplementation	11/11/10	12/17/10	12/16/10
Weed seed bank sampling	4/11/11	4/4/11	4/19/10

Organic corn and soybean grown in the ROSE was no-till planted into a rolled cover crop consisting of with hairy vetch and triticale or cereal rye in May and June 2011. Several strategies related to our research goals are being tested, including pest avoidance by altering the planting date of these cash crops. Corn and soybean are planted at three different dates. Two varieties are planted on each date; one standard variety is planted on all dates and a variable variety that is appropriate for the date is also planted. For example, on the first corn planting date the standard variety and a long-season variety were planted. We are also testing expressive (blue – Figure 1), suppressive, and supplemental (green – Figure 1) weed management.

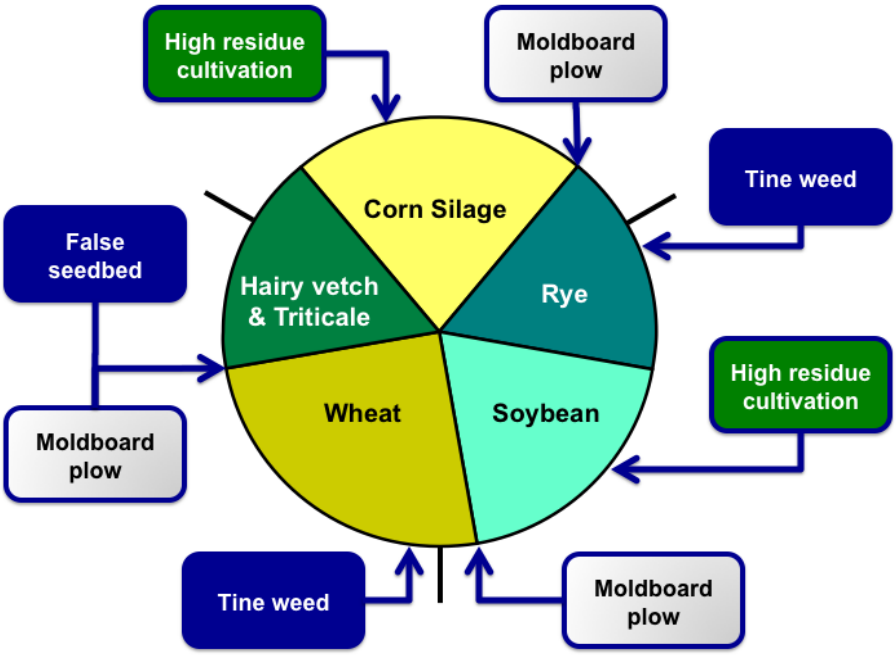

Figure 1. Crop rotations, tillage events, and management treatments in the ROSE.

A rigorous crop, soil, and pest sampling schedule has been initiated in 2011 in the ROSE. We have an extensive insect monitoring program aimed at identifying and quantifying early-season insect pests, including black cutworm, true armyworm, and seed corn maggot. These pests are attracted to the environment created by using cover crop residues for mulch to suppress weeds in organic no-till planted cash crops. Insect sampling will continue throughout the summer and will be used to help explain variation in crop performance and weed suppression. Insect monitoring began with the installation of pan traps for seedcorn maggot, and pheromone traps for black cutworm and true armyworm moths. The contents of both types of traps are currently collected twice weekly. Corn bait traps were installed in the corn (standard variety) plots for the detection of wireworms. Emergence traps for seedcorn maggots are being placed in plots with corn and soybean for the detection of emerging flies and sentinel traps containing insect prey are being used to assess potential predation by arthropod natural enemies.

In addition to insect sampling, we are measuring cover crop performance and weed suppression in the ROSE. We will quantify cover crop biomass at each of the three corn and soybean planting dates, and determine how this relates to weed suppression and crop establishment. Weeds sampling started with extracting soil cores that will be elutriated so that our three target species (common ragweed, giant foxtail, and smooth pigweed) can be quantified. These samples were collected from ROSE plots in April (Table 1) at all sites. Samples will be elutriated and seeds will be quantified over the summer of 2011. Weeds will also be sampled at several points throughout the crop rotation to determine the effectiveness of expressive, suppressive, and supplemental weed management. All crops will be harvested to assess their performance and to determine the economic feasibility of the different strategies that are being tested.

Supporting Research 2010-2011 (Objectives 1-4)
A series of experiments were conducted in 2010 and early 2011 to test different management practices and sampling protocols that will be used in the ROSE. Summaries of these experiments are provided below for each site.

Organic short-season corn variety trial. Ten short-season organic corn varieties were tested at Penn State in 2010 to help investigators decide what varieties to include in the ROSE. We evaluated their performance under both organic and conventional management. We found that the earlier-maturing varieties yielded as well as later-maturing varieties, and they also had lower grain moisture levels at harvest (Figure 2). This challenges the popular notion that earlier-maturing varieties do not perform as well as later-maturing varieties, and suggests that short-season varieties can help reduce costs associated with drying corn grain.

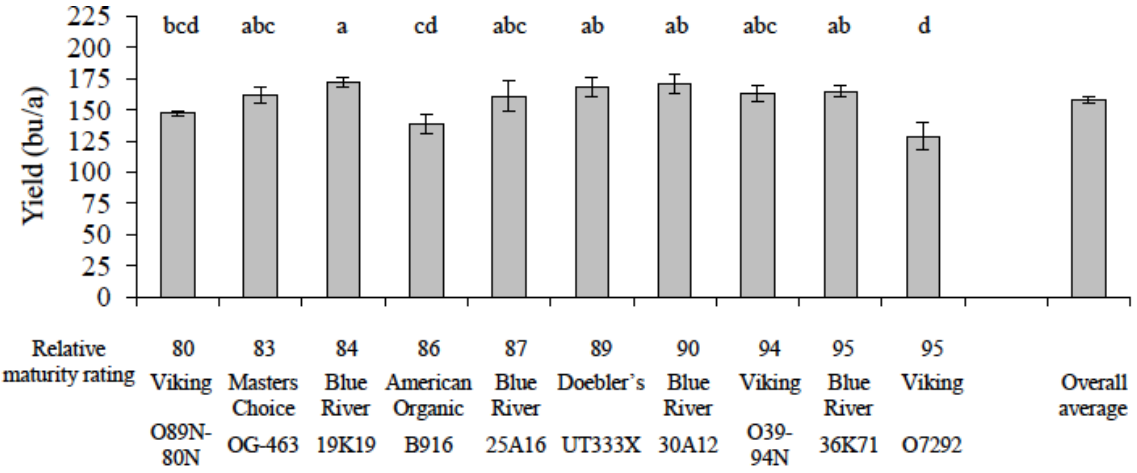

Figure 2. Average corn yield across varieties for the organic and conventional Rock Springs sites combined. Relative maturity ratings (days to maturity) are listed above variety names. Similar lowercase letters above bars indicate no significant difference ($P \geq 0.05$). Error bars are standard error of the mean.

In addition to supporting the ROSE, this trial provided farmers with useful information. We created a detailed report of the variety trial, posted it on the Penn State Department of Crop and Soil Sciences website, and submitted summary articles to several farmer organizations, including the Pennsylvania Certified Organic Winter 2011 newsletter *Organic Matters*. An article on our trial also appeared in our local agricultural newspaper *Lancaster Farming*. This added publicity put our results in the hands of farmers during the time of the year when they were making decision about variety selection for 2011. We received a tremendous amount of feedback on the trial from farmers who were interested in our results and the practices that we used to grow the corn.

In 2011, we are repeating the organic short-season corn variety trial to test the same 10 varieties along with 15 others. We will also be evaluating 10 early-maturing organic soybean varieties in 2011. Due to the overwhelming support for this research, we will be expanding the performance assessment and will be taking more intensive and frequent

measurements to elucidate grain maturation and moisture dynamics. These trials will provide more robust information to help farmers select short-season corn and soybean varieties, and will help to answer questions about relationships among relative maturity ratings, maturation patterns and performance.

Weed seed production. To accurately assess weed suppression in the ROSE, seeds of three common weed species were applied at all sites. These seeds were grown under local conditions to ensure an adequate test of the system. In 2010, common ragweed, giant foxtail, and smooth pigweed were cultivated at each of the experimental site and seed was collected.

Insect identification. Researchers at all sites have been working on honing their insect identification skills so they can accurately identify early season insect pests in the ROSE. PI Barbercheck and PI Weber have developed an identification guide for seed corn maggot. Although this insect pest has long been problematic in corn production, an effective and accurate guide to identify it in the adult stage was not available until now. In summer 2010, PI Weber evaluated seedling damage in organic field corn plots established by PI Mirsky, and determined that death of growing points on many of the plants was caused by above-ground, within-stem larval infestation by southern corn rootworm (*Diabrotica undecimpunctata* howardi), a type of damage that is not often observed in our region, but is known as "corn budworm" in South Carolina and some other southern states. This observation will aid in identifying causes of damage in our crop stand evaluations for ROSE.

Optimizing cover crop termination. PI Mirsky conducted an experiment to test different methods of using a roller–crimper for controlling hairy vetch cover crops prior to corn planting. The methods that were tested included different sequences of rolling and planting, and the use of a disk to facilitate the termination of the hairy vetch cover crop. PI Mirsky tested: 1) disk then planting, 2) disk and plant on same day, 3) roll then roll and plant on the same day, 4) roll and plant on the same day, 5) roll and plant on the same day and then roll again. Results from this research showed that rolling the hairy vetch a week before rolling and planting improved vetch termination and weed suppression. This method will be used to maximize weed suppression in ROSE at the BARC and UD sites.

Cover crop mixtures. PI Mirsky also conducted an experiment that tested planting different ratios of hairy vetch and triticale for improved weed suppression. A mixture of hairy vetch and triticale is currently being used in all of the ROSE sites based on this research. This not only serves to increase the weed suppression from the rolled cover crop, but is also used as a fertility management tool. Including triticale in the hairy vetch cover crop ties up soil nitrate that would otherwise reduce biological nitrogen fixation from the hairy vetch cover crop.

On September 4, 2009, PI Curran seeded hairy vetch at 20 lb/a in combination with either 30 or 60 lb/a triticale. Additional treatments included the same strategy using crimson clover and triticale and a three-way mixture of hairy vetch, crimson clover, and triticale. Cover crop biomass was sampled on May 19, 2010 and the cover crops were rolled. In

the six treatments tested, dry matter ranged from 4071 to 5231 lb/a. The only two treatments to exceed 5000 lb/a were hairy vetch plus triticale at 20 plus 30 lb/a and the three-way mixture that included 60 lb/a triticale. The other treatments yielded between 4000 and 4350 lb/a. Doubling the seeding rate of triticale to 60 lb, while keeping the hairy vetch seeding rate constant, reduced hairy vetch biomass over 1500 lb/a and increased triticale dry matter by about 800 lbs.

Manure application. Different manure application methods were tested at PSU, BARC, and UD in 2010. At PSU, liquid dairy manure was applied to growing cover crops (hairy vetch and crimson clover with and without triticale) to determine the impact on cover crop growth and development. On April 13, 2010, 4000 gal/a liquid dairy manure was broadcast applied to a selected area within each cover crop treatment. A second application in a different location was made on May 21, 2010 after the covers were rolled. Corn was planted about 7 days after the last manure application. The April manure application severely injured the hairy vetch cover crop. The primary injury occurred due to the heavy weight of the manure tank spreader and associated wheel traffic. The late May application which occurred immediately following cover crop rolling not only compacted the soil surface which stunted the corn, but also reduced the integrity of the cover crop mulch. These events lead us to conclude that liquid manure cannot be effectively applied after hairy vetch establishment without compromising the cover crop mulch and subsequent weed suppression, a critical component of our organic rotational no-till system. Secondly, although crimson clover added to the diversity of the cover crop mix and could potentially increase ecosystem services, it did not affect weed suppression. Finally, adding 30 lb of triticale to our hairy vetch cover crop treatment in corn achieved one of the highest biomass levels, while maintaining the hairy vetch contribution necessary for N-fixation. The addition of the triticale to hairy vetch seemed to improve the integrity and persistence of the cover crop mulch.

In the ROSE, we are seeding 30 lb/a each of hairy vetch and triticale in late August or early September. At Rock Springs, we are applying manure prior to this late summer seeding. At BARC, poultry litter application methods using a dry-injection prototype were tested. At UD, several manure spreaders were tested to determine the best approach for applying pelleted poultry manure in the ROSE.

On-Farm Research (Objectives 5 and 6)

In NC, PI Reberg-Horton conducted on-farm research on using legume and rye cover crop combinations for weed suppression in organic no-till planted corn. Legume and rye varieties whose bloom date matched up (determined from previous year data) were planted at each on-farm site as a cover crop mixture. All cover crop plots were evaluated. Legume and legume/rye mixes were roll-killed in early to mid April 2010 and planted with corn. Rye plots were roll-killed in mid to late May 2010 and planted to soybeans. Most sites had good emergence but drought conditions limited yields. Corn was harvested in September 2010 and approximate yields were 55.5 bu/a under hairy vetch, 41 bu/a under crimson clover, and 91.4 bu/a under the hairy vetch/rye mix.

Unfortunately on-farm trials slated for 2011 in NC were compromised due to excessive rainfall. However, there are ongoing on-station trials for both organic no-till soybeans and corn with three locations for each. These were replanted after the damaging rainfall events. Soybeans will be planted into rolled rye mulches at three row spacings, 7.5, 15, and 30 inches. Two types of planting scenarios will be investigated. Roll and plant on the same day versus roll and wait for soil moisture recharge before planting. The trial will be implemented at three locations. Corn will be planted into two types of cover crop mulches, rye/winter pea and rye/hairy vetch. The planting scenarios are also being tested in corn with roll and plant on the same day versus roll and wait for soil moisture recharge before planting. The trial will be planted at three locations.

In PA, on-farm research is being conducted at two farms to test practices being evaluated in the ROSE. Elvin and Charlotte Ranck own and operate Charvin Farm located near Mifflintown, Juniata County. Charvin Farm includes nearly 950 acres of certified organic crop and pastureland. Approximately 180 acres is owned and the balance is leased from approximately a dozen nearby farms. They milk 175 cows and raise 150 heifers. Kirby Reichert is the owner/operator of Sunshine Farms, a cash grain and hay operation headquartered near Grantville, Dauphin County. Sunshine Farms consists of 750 total acres of grains and forages. Nearly 250 acres are certified organic, and the remaining 500 acres are managed conventionally.
The on-farm experiments for both farms include comparisons of traditional tillage systems with no-till. The no-till treatment will rely on fall-planted cover crops to suppress weeds. For 2011, both farms will investigate the effectiveness of rolling cereal rye before no-till planting or drilling soybean. Treatments will be replicated four times at each farm, and cover crop biomass, weed biomass, and crop yields will be measured at appropriate times during the growing season.
Aaron Cooper, on-farm research collaborator in MD, is growing a half-acre of cereal rye and a half-acre of hairy vetch and is planning to roll the cover crops prior to planting soybeans in the rye and corn in the vetch. PI Mirsky will be working closely with Mr. Cooper on establishing the trial and collecting associated data.

Advisory Board Meeting (Objectives 5 and 6)
On March 7, 2011, PI Mirsky and PI Weber hosted our annual project advisory board meeting at the Beltsville Agricultural Research Center (BARC) in Beltsville, MD. We spent the day discussing project progress with advisors consisting of experienced organic farmers from PA and MD, extension educators from Penn State, and representatives from the seed industry. We reviewed the three-year corn, soybean, wheat rotation and different pest management strategies that are being tested such as avoidance (planting dates), expressive (false seedbed), suppressive (cover crop mat), and supplemental (high residue cultivation) weed management. Our farmer-advisors compared and contrasted their crop rotations and management plans to those implemented in the ROSE. Aaron Cooper, from MD, uses Austrian peas for N fertility rather than hairy vetch because he is concerned about hairy vetch showing up as a weed in his wheat. Kirby Reichert, from PA, inter-seeds red clover with his spelt. Michael Ranck, from PA, considered that in some ways, their rotation is similar to the ROSE rotation. The final activity of the day was a field tour, led by PI Mirsky. The group visited a hairy vetch variety trial, a cover crop density

trial, and checked out some farm equipment.

At our next advisory board meeting, we will compare results from soil tested at different laboratories that focus on different aspects. For example we will compare the Cornell Soil Heath test to the standard Penn State Agriculture Analytical Lab test. All tests will be done on soils collected from our advisors' farms. We're also going to conduct a weed seed germination assay on the soils to determine the community composition and density of the weeds present on their farms. Soils will be collected from fields from each of the 6 farms in September, in plenty of time to receive the soil and test it before we meet again.

Project Newsletter
The ROSE Review! We bring real-time news and research results from our project. The purpose of our newsletter is to connect project collaborators and stakeholders so that we can share information and learn from each other.

ROSE Review, Fall 2010. http://agsci.psu.edu/organic/research-and-extension/Rotational%20No-till/publications-1/organic-reduced-tillage-times/Fall2010.pdf/view

ROSE Review, Spring 2011. http://agsci.psu.edu/organic/research-and-extension/Rotational%20No-till/publications-1/organic-reduced-tillage-times/Spring%202011%20ROSE%20Review.pdf/view

An article about this project was written up in the NC State e-newsletter in:

December 2009 (*Fertility and Weed Control in No-till Organic Production;* http://www.organicgrains.ncsu.edu/Newsletters/Dec2009.htm).

December 2010 issue (*Rolled Rye Mulches for Weed Control in Organic No-till Soybeans*; http://www.organicgrains.ncsu.edu/Newsletters/December2010.htm).

Published Manuscripts

Gareau, T. L. P., R. G. Smith, M. E. Barbercheck, D. A. Mortensen. 2010. Spider Plots: A Tool for Participatory Extension Learning. Journal of Extension. Volume 48(5): 5TOT8, http://www.joe.org/joe/2010october/tt8.php

Ryan, M. R., S. B. Mirsky, D. A. Mortensen, J. R. Teasdale, and W. S. Curran. 2011. Potential synergistic effects of cereal rye biomass and soybean planting density on weed suppression. Weed Science 59:238-246.

Smith, A. N., S. C. Reberg-Horton, G. T. Place, A. D. Meijer, C. Arellano and J. P. Mueller. 2011. Rolled rye mulch for weed suppression in organic no-tillage soybeans. Weed Science 59:224-231.

Smith, R. G., M. E. Barbercheck, D. A. Mortensen, J. Hyde, A. Hulting. 2011. Effects of cover crop and tillage system on crop yields, weed abundance and net returns during the transition to organic feed grain production. Agronomy Journal 103:51-59.

Trauger, A., C. Sachs, M. E. Barbercheck, N. E. Kiernan, K. Brasier. 2010. 'The Object of Extension': Agricultural Education and Authentic Farmers in Pennsylvania, USA. Sociologia Ruralis 50:85-103.

Ward, M. J., M. R. Ryan, W. S. Curran, M. E. Barbercheck, D. A. Mortensen. 2011. Cover crops and disturbance influence activity-density of weed seed predators *Amara aenea* and *Harpalus pensylvanicus* (Coleoptera: Carabidae). Weed Science 59:76-81.

Manuscripts *In Press* for Refereed Journals

Barbercheck, M., N. E. Kiernan, A. G. Hulting, S. Duiker, J. Hyde, H. Karsten, E. Sanchez. 2011. Meeting the "multi-" requirements in organic agriculture research: Successes, challenges, and recommendations for multifunctional, multidisciplinary, participatory projects. Accepted, revision submitted to Renewable Agriculture and Food Systems. Ms. No. RAFS-D-10-00104R2

Greenwood, C., M. E. Barbercheck, C. Brownie. 2011. Short term response of soil microarthropods to application of entomopathogenic nematode-infected insects in two tillage systems. Ms. Ref. No.: PEDOBI-D-10-00096R1.
doi:10.1016/j.pedobi.2011.02.003

Jabbour, R., M. Barbercheck. 2011. Soil microarthropod response to the application of entomopathogenic nematode-killed insects in maize and flower strip habitats. Pedobiologia In Press, Ms. Ref. No PEDOBI-D-10-00195R2.
http://dx.doi.org/10.1016/j.pedobi.2011.04.001

Lewis, D. B., J. P. Kaye, R. Jabbour, and M. E. Barbercheck. 2011. Labile soil carbon accumulates under reduced tillage during agroecosystem transition into organic management. Submitted to Renewable Agriculture and Food Systems Manuscript Number: RAFS-D-10-00073R1.
http://journals.cambridge.org/action/displayJournal?jid=RAF

Mirsky, S. B., W. S. Curran, D. M. Mortensen, D. L. Shumway, and M. R. Ryan. 2011. Timing of cover crop management effects on weed suppression in no-till planted soybean using a roller-crimper. Weed Science. In-Press. WS-D-10-00101R1.

Ryan, M. R., W. S. Curran, A. M. Grantham, L. K. Hunsberger, S. B. Mirsky, D. A. Mortensen, E. A. Nord, and D. O. Wilson. 2011. Effects of Seeding Rate and Poultry Litter on Weed Suppression from a Rolled Cereal Rye Cover Crop. Weed Science. In-Press. WS-D-10-00180R1.

Ryan, M. R., D. A. Mortensen, J. R. Teasdale, R. G. Smith, S. B. Mirsky, and W. S.

Curran. Quantifying interactions between cultural weed management practices. Weed Research. WRE-2011-0087.

Smith, R. G., T. Gareau, D. Mortensen, W. Curran, M. Barbercheck. 2011. Assessing and visualizing management practices: A multivariable hands-on approach for education and extension. Weed Technology, Ms. No. WT-D-10-00156.

Scientific Conference Presentations

Barbercheck, M. E. 2011. Peering into the black box: Building an understanding of the population biology of entomopathogenic nematodes. Invited symposium presentation. Society of Nematologists 50th Anniversary Meeting, July 17 – 21, Corvallis, OR.

Barbercheck, M. E. 2011. Entomopathogenic Nematodes: Their Biology, Ecology, and Application. A Tribute to the Dynamic Career of Harry K. Kaya. Invited Member Symposium presentation, Entomological Society of America, Reno, NV, 13-16 November 2011.

Barbercheck, M. E. 2011. The real dirt: Harry Kaya's influence on entomopathogenic nematode ecology. Invited presentation for cross-divisional symposium: "The careers of Harry Kaya and Lerry Lacey: High impacts on science and scientists. Aug. 8-11, 2011. International Congress of Invertebrate Pathology & Microbial Control, Halifax, Nova Scotia

Curran, W. S., S. B. Mirsky, D. A. Mortensen, and M. R. Ryan. 2011. Integrating a Hairy Vetch Cover Crop for Improved Weed Management in No- Till Corn. Proceedings Northeastern Weed Science Society of America. 66:97.

Mirsky, S. B. 2010. Reducing tillage in organic grain production. Invited presentation. Department of Crop and Soil Sciences. Washington State University, WA.

Mirsky, S. B., J. R. Teasdale, W. S. Curran, D. A. Mortensen, M. R. Ryan and J. Moyer. 2010. Reducing tillage in mid-Atlantic organic grain production. Proceedings Agronomy Society of America Meeting.181-1.

Reberg-Horton, S. C., J. M. Grossman, W. C. Johnson, T. S. Kornecki, A. Meijer, A. J. Price, G. T. Place and T. M. Webster. 2010.Utilizing cover crop mulches to reduce tillage in organic systems in the Southeast. ASA-CSSA-SSSA International Annual Meetings. Long Beach, CA.

Reberg-Horton, S. C., M. S. Wells, A. N. Smith, J. M. Grossman, M. C. Parr, and G. T. Place. 2011. Weed management impacts of roll-killed cover crops for organic corn and soybeans. Annual Meeting of the Northeastern Weed Science Society. Baltimore, MD.

Ryan, M. R., S. B. Mirsky, D. A. Mortensen, J. R. Teasdale, and W. S. Curran. 2011. Synergism between cereal rye mulch and soybean planting density. Penn State, University Park, PA. Proceedings Weed Science Society of America. 51:249.

Ryan, M. R., D. A. Mortensen, J. R. Teasdale, W. S. Curran, R. G. Smith, and S. B. Mirsky, 2011. Synergism Between Cultural Weed Management Tactics. Penn State, University Park, PA. Proceedings Northeastern Weed Science Society of America. 66:67.

Ryan, M. R., R. G. Smith, D. A. Mortensen, S. B. Mirsky, and R. Seidel. 2010. Weed community assembly in long-term organic and conventional management systems. Ecological Society of America. COS 36-10.

Wells, M. S., S. C. Reberg-Horton and A. N. Smith. 2010. Nitrogen immobilization in a rye (Secale cereale L.) roll-killed system. ASA-CSSA-SSSA International Annual Meetings. Long Beach, CA.

Wells, M. S., S. C. Reberg-Horton and A. N. Smith. 2011. The effect of rye roll-killed mulch on N-immobilization. Annual Meeting of the Northeastern Weed Science Society. Baltimore, MD.

Extension presentations (Objective 6)

- Barbercheck, M. E. and C. White. Soil Assessment and Management. PASA Preconference Workshop. February 3, 2011. 24 attendees, 10 women.
    - Evaluation: Did you learn anything today that you think might make your operation more profitable in 2011? (N=26) 73% - yes, 0% - no, 15% - not sure, 12% - not applicable. As a result of attending today's workshop, do you plan adopt any new soil management or assessment practices? (N=26) 92% - yes, 0% - no, 4% - not sure, 4% - not applicable. Number of participants who increased their knowledge of a given number of 16 soil management and assessment topics that were discussed (N=26): 13-16 topics - 10 people, 10–12 topics – 7 people, 7-9 topics – 4 people, 4-6 topics – 4 people, 0 topics – 1 person. Number of participants who increased their likelihood to do a given number of 8 soil management and assessment practices that were discussed at the workshop (N=26): 7-8 practices – 3 people, 5-6 practices – 11 people, 3-4 practices – 4 people, 1-2 practices – 6 people, 0 practices – 2 people.

- Barbercheck, M. E. and W. Esbenshade. Hands-On Biocontrol. New Holland Vegetable Day. New Holland, PA. January 17, 2011. 50 attendees, 45 Amish, 5 women.

- Barbercheck, M. E., D. A. Mortensen, and J. Kaye. Organic Cropping Systems Research. Ag Council Legislative Tour. Russell E. Larson Ag Research Center. September 23, 2010. 120 attendees.

- Barbercheck, M. E. Reading the Farm: Insects. 3-day on-farm workshop, August 9-11, 2010. 32 participants. Chambersburg, PA. 32 individuals participated in the workshop.

    - Thirty increased their knowledge in how one or more farm system components interacted with other farm system components. Twenty-five increased their knowledge of how 6 or more farm system components interacted with other farm system components. Twenty increased their awareness of how of how recommendations about one part of a farm system could affect other parts of a farm system. Twenty-five reported that they would change how they make recommendations to farmers.

- Barbercheck, M. 2010. An Ecological Look at Pest Suppression in Organic Systems. Annual Meeting of the Midwest Organic and Sustainable Education Service. LaCrosse, WI. February 25, 2010. (Invited Symposium/Research Forum speaker) 150 attendees. p. 25

- Barbercheck, M., T. Pisani Gareau, R. Smith, D. Mortensen, J. Kaye, N. E. Kiernan, J. Harper. 2010. Weed management, environmental quality and profitability in organic feed and forage production systems. The Organic Research Forum at the MOSES 21st Annual Organic Farming Conference. February 24-27, 2010, La Crosse, WI. p.25

- Mirsky, S. B. Reduced-till organic. Maryland Organic Food and Farming Conference. February 19, 2011.

- Reberg-Horton, C. Organic no-till production using a roller. Pocosin Farms in Hyde County. June 8 2010.
    - Over 20 farmers and farm advisors attended. Responders said they were planning to implement some aspect of what they learned at the workshop.

- Reberg-Horton, C. Organic no-till production using a roller. Piedmont Research Station in Salisbury, NC. July 15, 2010. Over 20 farmers and farm advisors (including NRCS personnel) attended.

- Ryan, M. R. and D. A. Mortensen. Break out the hoe: Making sense of contrasting philosophies on organic weed management. Pennsylvania Association for Sustainable Agriculture Conference. February 5, 2011.

- Ryan, M. R. and D. A. Mortensen. Grower learning circle: weed management. Gap, PA. December 15, 2010.

- Weber, D. What's New in Ecological Pest Management: News That You Can Use in Your Fields Today. 2011 Southern SAWG conference held in Chattanooga, TN in January 19-22, 2011. The total attendance was between 150 and 200.

Webinars on eOrganic (Objective 6)
Mirsky, S. B., W. S. Curran, and B. Mason. The evolution, status, and future of organic no-till in the northeast US. March 31, 2011. http://www.extension.org/pages/33063/the-evolution-status-and-future-of-organic-no-till-in-the-northeast-us-webinar.

Ryan, M. R. and W. S. Curran. Using cover crops to suppress weeds in Northeast US farming systems. Dec. 2, 2010. http://www.extension.org/pages/30856/cover-cropping-to-suppress-weeds-in-northeast-us-farming-systems-webinar.

Extension materials (Objective 6)
Barbercheck, M. 2011. Organic Grower Network Focuses on Organic Grain Marketing. Sustainable Agriculture Newsletter 8(2): Spring 2011. http://extension.psu.edu/susag/news/2011

Barbercheck, M. 2011. Organic Growers Meeting on Markets. Field Crop News Vol. 11, Issue 3, March 8, 2011. http://fcn.agronomy.psu.edu/2011/fcn1103.cfm#e

Barbercheck, M. 2011. Sign-up for NRCS funding program for organic farming underway. Field Crop News Vol.11, Issue 7, April 26, 2011

Barbercheck, M, B. Curran, J. M. Dillon. 2010. Organic Crop Production, Ch. 11 in: The Agronomy Guide. PSU COAS. http://extension.psu.edu/agronomy-guide/cm/sec11

Carvalho, C., T. P. Gareau, M. E. Barbercheck. 2010. Ground and Tiger Beetles (Coleoptera: Carabidae) Carabidae). Entomology Fact Sheet. http://ento.psu.edu/extension/factsheets/ground-beetles

Dempsey, M., Schipanski, M., Barbercheck, M. 2011. Penn State Organic Variety Trial. Organic Matters, PCO Quarterly Newsletter Winter 2011, pp. 9 – 10.

Dempsey, M., Schipanski, M., Barbercheck, M. 2011. Penn State Organic Corn Variety Trial. Sustainable Ag Newsletter, January 20, 2011. http://extension.psu.edu/susag/news/Jan-2011/4-organic-corn-variety-trial

Dempsey, M., Schipanski, M., Barbercheck, M. 2011. Penn State Organic Corn Variety Trial. Field Crop News Vol. 11, Issue 1, January 11, 2011. http://fcn.agronomy.psu.edu/2011/fcn1101.cfm#g

Schipanski, M., Sandy, D., Barbercheck, M. 2011. Organic Corn yields in a Drought Year. Organic Matters, PCO Quarterly Newsletter Winter 2011, pp. 11, 22.

White, C., Barbercheck, M. 2010. UF024-Agroecology in Practice: Introduction to Organic Farming: A Growing Opportunity for Pennsylvania Farmers.
This is a full color, 4 panels; 1 sheet prints both sides 5 1⁄2 X 8 1⁄2. This full-color publication, part of the Agroecology in Practice series, discusses the benefits and challenges of organic farming and provides information on understanding the NOP

regulations, considering your product and market for organic production, deciding whether to become certified, and steps to certification.
http://pubs.cas.psu.edu/FreePubs/pdfs/uf024.pdf

Reberg-Horton, C. Two extension bulletins on *organic no-till corn and soybeans* will be published in summer 2011 by NC State University in a new organic no-till section at www.organicgrains.ncsu.edu.

Penn State Organic Agronomy Guide (Objective 6)
Several project team members at Penn State are working on a comprehensive production guide on organic management of agronomic cropping systems. PI Barbercheck is coordinating a chapter on insect management and PI Curran is coordinating a chapter on weed management. The anticipated release date for the guide is Winter 2012.

Personnel
Several staff members have been hired at PSU, BARC, and UD over the past year to support our project. During spring 2011 at BARC, PI's hired two technicians, Marie Raboin and Lauren Young, and a student worker, Michael Fizdale.

Clair Keene joined our team in August 2010 as a PhD student in Agronomy advised by PI William Curran at Penn State. Clair will be working with PI Curran and post-doctoral researcher Matt Ryan on weed population and community dynamics within the ROSE. Clair and Curran will also conduct an experiment to evaluate the efficacy of different cultivation strategies during the 2011 field season to compliment the supplemental weed control work being done in ROSE. This experiment will use a shallow high-residue cultivator in soybeans planted into plots with and without rye residue present to test the effects of soil moisture and cultivation timing and frequency on weed control. Clair has also gathered preliminary data to compare methods of measuring percent ground cover in rye cover crops with the goal of testing each method's ability to predict rye biomass at termination before cash crop planting. This information will be used to address **Objective 7** of our project, which is to develop decision support tools to help farmers with cover crops management.

Future Work Statement Summary
Over the next year (2011-2012), our project team will continue with research and outreach activities as outlined in our original proposal. Researchers at Penn State (PSU), the Beltsville Agricultural Research Center (BARC), and the University of Delaware (UD) will maintain and collect data in the Reduced-tillage Organic Systems Experiment (ROSE). Data collection in the ROSE will focus on determining the efficacy of expressive, suppressive, and supplemental weed management practices and elucidating interactions between early-season insect pests and weed population dynamics. On-farm research will be conducted in PA and MD to determine the transferability of practices being tested in the ROSE.

Anticipated dates of project activities for the 2011/2012 reporting period.	
Activity	Date
ROSE sampling and data collection	Ongoing
On-farm research	May – Oct. 2011
ROSE researcher summit	Nov. 2011
eOrganic webinar	Jan. 2012
Present results at grower conference	Feb. 2012
Advisory board meeting	Mar. 2012
Field day at Penn State	May 2012