



United States
Department of
Agriculture

National Institute
of Food
and Agriculture

INSTITUTE OF FOOD PRODUCTION
AND SUSTAINABILITY

Organic Programs Project Directors Meeting

OCTOBER 2012

A large, stylized graphic of a leaf in shades of yellow, orange, and red, positioned behind the text.

USDA NIFA

NATIONAL INSTITUTE OF FOOD AND AGRICULTURE



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NIFA Project Director Meeting for Organic Agriculture Research and Extension Initiative and Organic Transitions Program

Welcome to our first comprehensive Project Director Meeting for the USDA National Institute of Food and Agriculture (NIFA) programs related to Organic Agriculture. This year's meeting includes awardees of proposals submitted from 2006 to 2011 to the complementary Organic Agriculture Research and Extension Initiative (OREI) and Organic Transitions (ORG) programs. OREI funds high priority research and extension projects that will enhance the ability of producers and processors who have already adopted organic standards to grow and market high quality organic agricultural products. ORG funds projects to support the development and implementation of research, extension and higher education programs to improve the competitiveness of organic livestock and crop producers, as well as those who are adopting organic practices by studying and documenting environmental services provided by organic farming systems in the area of soil conservation and climate change mitigation.

The overall goal of this meeting is to improve post-award management of the competitive grants made by NIFA in the area of organic agriculture. It is the intent that these meetings will enhance communication and interaction between Program Staff and NIFA Awardees. In turn, this will assist Program Staff in identifying success stories resulting from NIFA-sponsored research in this program and facilitate the reporting of important impacts resulting from the most successful research through communications with Congress, the Secretary and Under Secretary of Agriculture, NIFA administrators, the scientific community, commodity groups and other stakeholders, and the general public. It is critical to communicate these impacts in order to maintain funding in NIFA's organic program areas.

A second purpose of this meeting is to foster communication among awardees in these programs. It is anticipated that the sharing of information and the interaction that will occur in this informal setting will allow all awardees to benefit from the experiences of their colleagues and yield greater opportunity for successful completion of their NIFA awards. In addition, it is expected that improved communication among NIFA awardees will result in the development of new beneficial collaborations.

We look forward to a highly successful and productive meeting, and we eagerly anticipate continued progress on your OREI and ORG awards.

Respectfully,

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Agenda for Organic PD Meeting, Fall 2012

Wednesday, Oct 3rd

8:30 – 9:30 Coffee and muffins (breakfast available at café in building)

9:30 – 10:00 Welcome and Opening Remarks

NIFA Director Sonny Ramaswamy
Deputy Secretary Kathleen Merrigan

10:00 – 10:30 Welcome, Review of Schedule, and Introductions around the room

10:30 – 11:10 Oral presentations

1. **Brian Mc Spadden-Gardener, Ohio State University:** Enhancing Productivity and Soilborne Disease Control in Intensive Organic Vegetable Production with Mixed-Species Green Manures
2. **Deanna Osmond, North Carolina State Univ:** Water Quality Evaluation of Long-Term Organic and Conventional Vegetable Production Under Conservation and Conventional Tillage

11:10 – 11:30 Break

11:30 – 12:30 - Oral Presentations

1. **Rob King, Univ of Minnesota:** Tools for Organic Transition: Financial Data and Educational Resources for Farmers and Agricultural Professionals
2. **Thomas Bjorkman, Cornell Univ:** Summer Cover Crops for Weed Suppression and Soil Quality in Organic Vegetable Production in the Great Lakes Region
3. **Kathleen Delate, Iowa State Univ:** Developing Carbon-Positive Organic Systems through Reduced Tillage and Cover Crop-Intensive Crop Rotation Schemes

12:30 – 1:15 Lunch Break (café in building and many options at L'Enfant Plaza)

1:15pm – 2:00 Posters (See list at end)

2:00 – 3:30 Oral Presentations

1. **Victor Cabrera, Univ of Wisconsin:** Strategies of Pasture Supplementation on Organic and Conventional Grazing Dairies: Assessment of Economic, Production, and Environmental Outcomes
2. **Mary Barbercheck, Pennsylvania State Univ:** Improving Weed and Insect Management in Organic Reduced-Tillage Cropping Systems
3. **David Orr, North Carolina State Univ:** Whole farm-level evaluation of field border vegetation on organic management of insect pests and weed seed banks, and on farmland wildlife
4. **Diana Jerkins, USDA:** USDA Organic Portfolio summary project discussion

3:30 – 4:00 Break and Poster session

4:00 – 4:40 Oral Presentations

1. **Mark Gleason, Iowa State Univ:** Sustainable Systems for Cucurbit Crops on Organic Farms
2. **Raul Villanueva, Texas A&M:** Integrating community college students & organic farmers throughout feasibility studies in pest mgmt, & horticulture production in So. TX.

4:40 – 5:00 General Discussion / Questions

5:00 Networking session at Phillips' Happy Hour

Thursday, Oct 4th

8:30 – 9:00 Coffee, muffins

9:00 – 11:00 Oral presentations

1. **Valerie Dantoin, Northeast Wisconsin Technical College:** Process, course design, outcomes and impacts in creating a Technical College Certificate in Organic Agricultural Practices
2. **Amanda Heyman, Farmers Legal Action Group, MN:** Farmers Legal Action Group Production of an Organic Farmers Guide to Contracts
3. **Eileen Cullen, Univ of Wisconsin:** Crop Plant Nutrition and Insect Response in Organic Field Crop Production: Linking Farmer Observation to University Research and Extension
4. **Kevin Murphy, Washington State Univ:** Plant Breeding and Agronomic Research for Organic Hop Production Systems
5. **Charles Shapiro, Univ of Nebraska:** Improving Organic Farming Systems and Assessing their Environmental Impacts across Agroecoregions

11:00 – 11:15 Break/Networking

11:15 – 12:15 Oral Presentations

1. **Pamela Ruegg, Univ of Wisconsin:** Impact of Organic Management on Dairy Animal Health & Well-being
2. **Amy Charkowski, Univ of Wisconsin:** Organic Certified Seed Potato Production in the Midwest

12:15 – 12:45 Closing remarks, questions, comments, complete evaluations

1:00 end

Reports on Projects

Project Title: Enhancing Productivity and Soilborne Disease Control in Intensive Organic Vegetable Productions with Mixed-Species Green Manures

Award number: 2009-51300-05512

Period of funding: 01 SEP 2009 to 31 AUG 2013

Primary Institution: The Ohio State University

Project Director Name and email: Brian McSpadden Gardener (mcspadding-garden.1@osu.edu)

Project Director telephone: 330 202 3565

Co-Project Director Names and emails: Sally Miller (miller.769@osu.edu), Matthew Kleinhenz (kleinhenz.1@osu.edu), George Norton (gnorton@vt.edu), Katelyn Everts (keverts@umd.edu), Susan Meyer (susan.l.meyer@ars.usda.gov), and Christine Smart ([cgs14@cornell.edu](mailto:cds14@cornell.edu))

The purpose of the project: Soilborne and foliar diseases can substantially limit the marketable yields of organic vegetables. The goals of this project are to improve on-farm production efficiency and soilborne disease management through effective and value-driven applications of mixed-species green manures in organic vegetable cropping systems. Specifically, the following objectives were pursued: Objective 1: Evaluate the efficacy and value of mixed-species green manures in contrasting cropping systems, using a participatory approach. Objective 2: Characterize the linkages between microbial community structure and soilborne disease suppression expressed in different organic vegetable systems. Objective 3: Evaluate novel microbial inoculants to enhance the disease suppressive effects of mixed-species green manures. Objective 4: Enhance value-added green-manure adoption by organic growers using multi-criterion decision analysis (MCDA). We hypothesized that the benefits of mixed-species green manures would be conferred by substrate- and inoculation-induced shifts in the structure and activities of soil microbial communities and such shifts could result in the suppression of soilborne and foliar diseases and a concomitant increase in marketable yields. We aimed to test these hypotheses in coordinated field research and to assist in the practical application of results through integrated, user-driven outreach activities based on thorough socioeconomic analyses.

Completed to date: Using field data, we asked the question: Do cover crop treatments affect crop productivity or disease incidence on tomato crops? A three-year multi-state field trial of single and mixed cover crops was conducted. Because of regional differences in prevailing practices used by certified organic growers, some of the mixed cover crop treatments were location specific while others were used across all locations. A total of six locations across two years have been analyzed so far; third year results are in the process of being analyzed. For results presented, each field from each state and year were analyzed separately. A general linearized mixed model was used, with cover crop treatment and cover crop biomass run as fixed effects and block as a random effect. For every factor, the mean and standard deviation of each cover crop treatment effect were generated for comparisons of significant effects using Tukey's test. Total and marketable yields of the cash crop were affected by the biomass of cover crops in just four of twelve comparisons. These data indicate that under typical organic farming conditions, tomato yields could be affected by the use of cover crops and incorporation within four to six weeks of transplanting. When considering which cover crops provided positive benefits to the cash crop, mixtures of rye and vetch generally out performed rye alone (8 of 12 site years), but the difference was not statistically significant. In Maryland, vetch out performed any of the tested mixtures and also outperformed no cover crop addition. Radish did not outperform rye, though in Ohio it provided for a reduced weed pressure in 2011 when it had been well established. A finalized analysis will involve additional site years from 2012 growing season.

Disease category assignments were assigned for 2010 and 2011. For each disease rated, the AUDPC was calculated for the season. The values were placed in order from lowest to highest and divided into thirds in logical increments to designate "Low", "Medium" and "High" disease severity. Across locations early

blight and Septoria blight were affected in a similar number of comparisons. Phytophthora blight affected in two of four comparisons in New York (the only locations where that disease was observed to occur). And, plant parasitic nematodes (PPN) were significantly affected by cover crop in the two Maryland comparisons (the only location where PPN were known to be limiting). These data indicate that under typical organic farming conditions, soilborne diseases could be affected by cover crop incorporation in about one third of the tested site years. When considering which cover crops caused such differences, however, the patterns were generally inconsistent across locations and years. Thus, there is no evidence for enhanced disease suppression with mixed, as opposed to no or single cover crops.

The microbial community profiling work describe under Objective 2 was completed for year 1 and year 2 field samplings. Using microarray data, we asked the following question: Do cover crop treatments affect the pathogen presence in the rhizosphere at four weeks post-transplant? Thirty-one total pathogen species were included in the test and statistical analyses were run for each pathogen if the total detections were greater than 4 out of the total number of plots tested. A general linearized mixed model for binomial data was used to test the presence of individual and total pathogens. Just ten different pathogens were observed to occur more than 5% of the tomato root samples. Of these, *Fusarium oxysporum*, *Alternaria alternate*, *Fusarium solani*, *Phoma destructive*, and *Septoria* spp. were observed most frequently. As expected, highly significant state-to-state variation was observed. In each location, however, the pathogen responding most to treatment varied, indicating that soil pathogen responses were not determined primarily by the composition of cover crop incorporated. Using terminal restriction fragment length polymorphism (TRFLP) analyses of ribosomal sequences, we asked the question: Do cover crop treatments affect the intensity or presence of individual populations detected using TRFLP analysis? For results presented, each field from each state and year were analyzed separately. All T-RFLP data from individual bands were rank-transformed into eight categories and analyzed using rank-based analyses of variance. T-RFLP data for total band fluorescence added from all individual bands were not rank transformed. A general linearized mixed model was used, with cover crop treatment and cover crop biomass run as fixed effects and block as a random effect. For each site year, seven to fourteen different TRF were found to differed significantly by treatment, but none of these varied consistently by site or treatment. However, overall ITS counts were observed to differ significantly in half of the site years; indicating that cover crop treatments do tend to alter fungal population structure in the rhizosphere of the following cash crop. While such changes have yet to be directly linked to the microarray results, they do correlate well with the yield results, indicating that microbial community structure does affect overall plant productivity.

This work also investigated the use of cover crops as a vehicle for delivering bacterial biocontrol agents of soilborne pathogens. We studied the use of a widely used, OMRI-approved biopesticide as well bacteria indigenous to the field sites being studied. Collections of several thousand rhizosphere bacteria were assembled from tomato roots sampled at the three locations using a variety of media. Because no clear associations between crop health and rhizosphere bacteria were made prior to the 2012 planting season, we focused on using *Mitsuaria* isolates. These bacteria were previously associated with mixed cover crops and the suppression of soilborne diseases were recovered from these collections using the marker-assisted approach described under Objective 3. *Mitsuaria* isolates and the commercial biopesticide were introduced prior to and following transplanting in 2012. Parallel studies conducted in the absence of cover crops showed significant foliar disease suppression and plant-growth promotion effects in tomato to both the *Mitsuaria* and commercial inoculation of tomato plants in the greenhouse and in the field in 2012. Responses of the cash crop to microbial inoculation prior to cover crop incorporation and following transplanting are currently being analyzed.

Work on Objective 4 nears completion. The expert model of factors influencing organic vegetable farmer decision-making regarding soilborne disease management was developed and reviewed by peers. This expert model was used as the analytical framework for subsequent companion surveys of organic

vegetable growers to describe and visualize how organic vegetable grower concepts map onto the framework to identify specific opportunities for future research, education, and extension efforts. It is being described in a manuscript that will be submitted before the end of the year. Additionally, a survey was conducted to determine grower knowledge and experience with soilborne diseases, cover crops, and biopesticides. Over eighty percent of certified organic growers indicated that they regularly faced soilborne and foliar disease pressure requiring management, and a similar number reported a need to acquire more information on soilborne disease management. Similar numbers looked to University Extension, organic farming groups, and their peers as trusted sources of information on soilborne disease management. And the majority had used biopesticides for disease control. Responses to some other questions were used to assess factors influencing adoption of specific disease management practices. Information on cost differences by type of cover crop are being used to assess economic impacts of alternative disease management practices. Additional work is being completed on the economic impact assessment and a study on the factors affecting biopesticide adoption. A new study will be completed that will assess the value of environmental benefits of the mixed species green manure practice as compared to single species cover crops, with an emphasis on the value of carbon captured in the soil. A journal article manuscript will be prepared for that work as well.

Extension and/or education activities completed or upcoming: Results of this project were presented to growers in person and over the Internet during the past three years. Grower presentations include oral presentations and workshop presentations given by McSpadden Gardener, Kleinhenz, Miller, Everts, and Smart in their respective states of Ohio, Maryland, and New York. Two project-related fact sheets have been posted to eOrganic and one more has been submitted for review. Additionally, two different project-related webinars were presented through eOrganic by Drs. Miller (Jul 2010) and McSpadden Gardener (Mar 2012), and an additional presentation is planned for 2013.

Educational activities included the involvement and training of three post-doctoral researchers, five graduate students, and a visiting scholar. These junior scientists learned about organic farming through involvement with research on certified organic land, engagement with eOrganic, and interactions with growers. The outputs of the junior scientists (post docs and graduate students) included contributions to the development of fact sheets mentioned above as well as posters presented at the Ohio Ecological Food and Farming Association conference and the annual meeting of the American Phytopathological Society over the past two years.

Websites, patents, inventions, or other community resources created: The research on this project contributed to our understanding of the diversity, distribution, and activities of a new class of bacterial biocontrol agents patented by The Ohio State University (Patent# PCT/US2009/051828). Specifically, this work provided additional isolates of and efficacy data for *Mitsuaria* spp. that can be used to suppress plant diseases.

The significance of your findings to organic agriculture: The fundamental and applied research conducted in this project will be used to enhance the productivity and sustainability of certified organic vegetable production. Specifically, the project contributed to the development of a thorough synthesis of a) the value and effects of mixed-species green manures on organic tomatoes and b) the gaps in grower, extension agent, and researcher knowledge related to soilborne disease management in organic vegetable production. The results of the proposed research and extension program will substantially improve the ability of stakeholders to develop more effective Organic System Plans related to management of cover crops, soil quality and disease management. Specific products of the proposed research will include: a) research papers describing how green manures alter rhizosphere microbial community structure and the extent to which such substrate-based changes can be used to promote natural biological control; b) innovative extension materials (articles, webinars, fact sheets) and short courses (tailored for farmers or Extension staff and other professionals) that will provide practical advice regarding the impacts, costs,

and benefits of using different green manures (with and without microbial inoculants to enhance efficacy) in organic vegetable systems; and, c) a comprehensive economic assessment of the aggregate benefits of using green manures and microbial inoculants for soilborne disease control in organic vegetable crops.

Other comments or recommendations for future work: Positive responses of vegetable crops to mixed rye and vetch cover cropping over eight of twelve site years were worthy of note. However, the variability of responses by site and year do not yet provide compelling evidence for recommendations of mixed as opposed to single species cover crops for the enhancement of organic tomato production at all locations. What is clear, however, is that under standard organic management, soilborne and foliar diseases were NOT consistently suppressed by the use of cover crops even though diseases did present a significant limitation on marketable yields in most site years examined. The occurrence of site years where negative responses were noted in 2010 and 2011 indicate that unmeasured and/or poorly controlled factors (e.g. prevailing temperatures, soil moisture, and timing of incorporation) present challenges to the productive use of cover crops for the enhancement of crop health. Future applied work will require the use of more site years of study and detailed measurements of soil temperature and moisture (as well as cover crop biomass) to determine how manageable and unmanaged soil variables affect cash crop productivity on organic farms.

Despite conducting one of the most thorough analyses of rhizosphere microbial community structure to date, only one consistent pattern has so far emerged as a predictor crop health; that of total fungal/oomycete population size. It will be interesting to see if qPCR analyses of the same samples provide supporting evidence for such an observation. Overall, our community data indicate that multiple populations contribute to disease and biological control on individual plants, and the multiplicity of such active populations can obscure the relationships between individual populations and plant health and productivity. Additionally, more detailed multivariate analyses of the microbial community data obtained in this study will be need to be conducted in the coming year to determine which subset of detected components matter most and the extent to which they contribute to variance in marketable yields. Furthermore, it will be interesting to see if the supplementation of cover crops with bacterial biocontrol agents, such as the *Mitsuaria* strains used in this study, provide meaningful enhancements to either disease control or marketable yields when used in combination with cover crops. Such analyses will be completed before the end of 2012. If such analyses show that microbial biopesticides can be used effectively in combination with cover crops, future work should focus on determining which combinations of microorganisms and plant species provide the most consistent beneficial responses to cash crop health and productivity in certified organic farming systems.

Project Title: Water Quality Evaluation of Long-Term Organic and Conventional Vegetable Production and Conservation and Conventional Tillage

Period of funding: September 2009 – August 2012 (currently with a 1-year no-cost extension for an ending date of August 2013)

Primary Institution: NC State University

Project Director Name and email: Deanna Osmond (Deanna_osmond@ncsu.edu)

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The purpose of the project: The purpose was to compare water runoff, nutrient and sediment loads, yield, and soil physical and carbon properties from conventional and organic management and conventional and conservation tillage in order to determine the environmental impacts of these agricultural systems: conventional management/conventional tillage (plow chemical), conventional management/conservation tillage (no-till chemical), organic management/conventional tillage (plow organic), organic management/conservation tillage (no-till organic), control (plow with no amendments).

Completed to date: Twenty plots (five treatments of 4 replications each) were established in a long-term experiment (> 15 years) where organic vs conventional management and conservation- vs conventional-tillage treatments were maintained. Crimson clover and wheat cover crops were planted in the organic management treatments and wheat cover crop in the conventional management treatments. Sweet corn was planted yearly (May to June timeframe) and harvested in August. Under conventional management, synthetic pesticides and chemical fertilizers were used; weeds were controlled by either herbicides (no-till treatment) or cultivation (plow treatment). Organic insecticides and pelleted poultry litter were used in the organic management plots; weeds were controlled by either a rototiller (plow treatment) or a lawn mower (no-till treatment).

Since a major objective of this study was to determine water quality effects (rather than yield), we tried to add the same amount of total nitrogen (N; 180 lb ac⁻¹) to both organic and conventionally produced sweet corn and to follow traditional farming practices for both systems. Fertilizer was applied to the conventional plots (100 lb N ac⁻¹ at planting and 80 lb N ac⁻¹ at layby) and cover crop N + pelleted chicken litter was applied to the organic plots at planting. For the conventional management, N supplied from the cover crop was not considered in the N fertilizer rate. Thus less total N was applied to the organic plots partly because of differential accounting of N in the cover crop and due to lowered N availability from the pelleted chicken litter during the sweet corn growing season (~80% availability). Although we tried to apply the same amount of N to both management systems, in reality there was at least 40% less effective N applied to the organic plots.

Sweet corn yield, cover crop biomass and N, and other agronomic characteristics have been measured for three years (2010 – 2012; only two years of data are presented) and yields were approximately 3-times greater for the conventional management system relative to organic management due in part to weed pressures (no-till organic). Although weed pressure clearly reduced yields in the 2011 plow organic treatment, reduced N rates probably affected yield in 2012 because < 80% of the applied 180 lb N ac⁻¹ pelleted chicken litter N was available and conventional systems do not account for the N added from cereal cover crops.

Wood boards around the perimeter of the plots eliminate surface water flow from entering the plots as well as retain internal flow to down slope weirs to which Isco samplers were attached. Water volume was measured and water samples were collected on a flow-proportional basis during storm events. Concentrations of nitrate+nitrite nitrogen ($\text{NO}_x\text{-N}$), ammonium (NH_4), total Kjeldahl N (TKN), total dissolved nitrogen (TDN), total phosphorus (TP), orthophosphate ($\text{PO}_4\text{-P}$), total carbon (C), particulate organic matter (POM) and sediment (TSS) were measured. Using volume of water and constituent concentrations, total yearly loads were calculated. Sediment and most nutrient losses were greater for plowed treatments (conventional > control > organic) than the no-till treatments, which were very low and resembled each other irrespective of management system (conventional = organic). Two nutrients were the exception to the above pattern. Significantly greater losses of dissolved P were measured in the organic systems (7- to 3-fold greater than the conventional systems) and more $\text{NO}_x\text{-N}$ was found in the soil (2-fold greater) in the conventional management system. These results were not surprising in that organic fertilizer materials (organic treatments) increase soluble P losses and the pelleted poultry litter added P that was not applied to the conventionally managed treatments. Likewise, as there was 40% more available N in the conventional system, it was reasonable that there were higher soil $\text{NO}_x\text{-N}$ concentrations.

Additionally, microbial biomass, particulate organic matter, and bulk densities measurements were made. Surface soil core samples 7.5cm deep were used to measure bulk density. Particulate organic matter was determined using a density fractionation, while microbial biomass was measured using a chloroform-fumigation extraction protocol. Microbial biomass measurements were greatest in the organic management/conservation tillage system; the other systems were similar to each other, except the chemical plow, which produced the lowest microbial biomass numbers. Although there were differences in soil bulk density among treatments, there was no relationship between yield and greater bulk densities. In fact, the no-till organic plots had the lowest bulk densities (1.47 g cm^{-1}) and the lowest yields, while no-till conventional had the highest bulk densities (1.65 g cm^{-1}) and the greatest yields. Plowed systems, particularly chemical plow treatments, lost the highest quantities of total carbon through surface runoff as compared to no-till treatments. Although sediment from no-till organic and no-till chemical treatments contained extremely high percentages of carbon across all sampling dates, these systems lost very little sediment overall, suggesting tillage to be a dominant factor in reducing sediment loss. Percent carbon in sediment was highest in the no-tillage treatments, likely due to the large proportion of carbon found on the soil surface that was prone to surface losses, such as surface applied pelleted chicken litter and cover crop residues.

Extension and/or education activities completed or upcoming:

Extension

1. Producer Training. Fresh Market Tomato and Vegetable Field Day: An Update, Mountain Horticulture Research Station Field Day. 2012. Enhancing Soil Organic Matter in Alternative Production Systems. Erika Larsen, Julie Grossman, Deanna Osmond, and Greg Hoyt. Department of Soil Science, NC State University
2. Producer Training. Fresh Market Tomato and Vegetable Field Day: An Update, Mountain Horticulture Research Station Field Day. 2012. Effects of Organic and Conventional Production Systems on Water Quality. Deanna Osmond, Joshua Edgell, Dan Line, Greg Jennings, and Greg Hoyt, Departments of Soil Science and Biological and Agricultural Engineering, NC State University.
3. Producer Training. Fresh Market Tomato and Vegetable Field Day, Mountain Horticulture Research Station Field Day. 2011. Enhancing Soil Organic Matter in Alternative Production Systems. Erika Larsen, Julie Grossman, Deanna Osmond, and Greg Hoyt. Department of Soil Science, NC State University

4. Producer Training. Fresh Market Tomato and Vegetable Field Day, Mountain Horticulture Research Station Field Day. 2011. Effects of Organic and Conventional Production Systems on Water Quality. Deanna Osmond, Joshua Edgell, Dan Line, Greg Jennings, and Greg Hoyt, Departments of Soil Science and Biological and Agricultural Engineering, NC State University.
5. Producer Training. Fresh Market Tomato and Vegetable Field Day, Mountain Horticulture Research Station Field Day. 2010. Effects of Organic and Conventional Production on Water Quality. ~100 producers, agriculture agents, and others.
6. Producer Training. Fresh Market Tomato and Vegetable Field Day, Mountain Horticulture Research Station Field Day. 2010. Alternative Vegetable Production Systems; Maintaining Yields and Improving Soil Productivity. ~ 100 producers, agricultural agents, and others.

Teaching

1. A one-hour graduate-level reading class composed of 7 students who meet weekly to discuss literature that compared organic systems to conventional systems relative to their affects on water quality. End-of-semester survey determined that class was highly effective in exposing the students to the most current research (or the lack thereof) and their analytical skills increased.

The significance of your findings to organic agriculture: It was critical to find the best systems to sustain food production and protect the environment, including our water resources. The intent of our research was to compare conventional management to organic management that included both conservation and conventional tillage. Water quality variables, yield, agronomic characteristics, microbial biomass, soil carbon, bulk density, infiltration and other variables were measured.

Although no-till organic had statistically higher microbial biomass, total C, light and heavy POM, and the lowest bulk density and fastest infiltration rates, sweet corn yields were 28- to 5-fold greater for the other production systems. Thus the significantly higher biological activity in the no-till organic treatment did not translate to yield due to weed competition. The no-till organic corn required weekly mowing, which although labor intensive, provided a “grass-like matt” in the system but could not affect inter-row weed competition; the weeds were higher than the corn both years.

Typical farmer systems are usually conservation tillage conventional management (no-till conventional) or conventional tillage with organic management (plow organic). When yields, nutrient losses, and other characteristics were compared between these two management systems, microbial biomass, total C, and POM were similar, although bulk density was lower in the conventional tillage organic management (1.51 g cm⁻¹) than the conservation tillage conventional management (1.65 g cm⁻¹). Sweet corn yields, however, were 66% lower (average 2011 and 2012) and nutrient loads were greater from the plow organic than the no-till conventional treatments. Since there were significantly greater nutrient and sediment losses and lower yields in conventional tillage (plow) organic systems than conservation tillage (no-till) conventional management system, the most environmentally protective and best yielding system, therefore, was conventional management with conservation tillage.

Project Title: Tools for Transition: Financial Data and Educational Resources for Farmers and Agricultural Professionals

Award number: 2010-51300-21401

Period of funding: 09/01/2010 to 08/31/2014

Primary Institution: University of Minnesota

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Co-Project Director Names and emails: Helene Murray (hmurray@umn.edu)

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Website: <http://eorganic.info/toolsfortransition>

The purpose of the project: The transition from conventional to organic production systems is a critical process within the evolution of the organic sector, yet it is a process about which available information is largely anecdotal. The Tools for Transition (TFT) Project is an integrated four-year research and extension project that will yield new insights about the economics of organic transition; create unique data resources for farmers, other agricultural professionals and lenders; and inform policymakers of the potential economic barriers to organic certification. The project has two inter-related long-term goals that are sharply focused on addressing the need for farm-based information about enterprise and whole-farm financial performance during the transition from conventional to organic production:

1. To collect data on farm performance measures during the transition to organic production and develop resources such as an online database and benchmark reports for row crop and dairy enterprises and whole farm performance during and shortly after transition.
2. To develop web-based and print materials to address the informational needs of farmers transitioning to organic production and the education needs of agricultural professionals who advise them.

There are few published studies on the economics of organic transition, and there is very limited availability of multi-year farm record data on production costs and returns during and after transition. Such data are needed by farmers developing transition plans, by lenders evaluating business plans and loan applications from transitioning producers, and by policymakers assessing program needs.

Completed to date: During the first two years of the project, team members have recruited 37 transitioning and recently certified farmers to participate in the project by enrolling in the state's Farm Business Management (FBM) program (<http://www.mgt.org/>). Scholarships, worth up to 90 percent of FBM program tuition, are offered to transitioning and recently certified dairy and field crop farmers who enroll in the program.

Collectively, at the start of project participation, these 37 farms managed 3,815 acres in transition and 990 recently certified acres. They cultivated 5,868 acres that had been certified for three years or more and an additional 4,850 acres of conventional land. They had a total of 507 dairy cows in transition, 583 recently certified dairy cows, 455 certified organic dairy cows, and 90 conventional dairy cows.

Detailed financial and production data collected through farmers' participation in the FBM program are a primary data source for this project. Participating farmers sign a release to grant access to this information. Data also are being collected through administration of two surveys. The first is an intake survey that elicits baseline information on farmer characteristics, farming experience, business management practices, transition motivations, and transition expectations. The second is an annual survey of all participating farmers that includes questions about transition challenges, transition benefits, marketing strategies, on-going business management practices, future expectations and FBM Program experiences.

Financial and production data for the 2011 calendar year were made available to project team members in May 2012. For many TFT farms that were already participating in the FBM program, we also have financial and production data from prior years. Although confidentiality restrictions limit our ability to release enterprise and whole-farm financial performance results for farms during transition until more

data have been collected, analysis of data has yielded interesting preliminary results for dairy farms. Prior to initiating organic transition, compared to Minnesota state average dairy farmers, TFT participants:

- had **smaller dairy operations** (TFT farms milked an average of 94 cows before transition compared to the state average of 120 cows.),
- had **lower production per cow** (Annual conventional dairy production among TFT farms averaged 17,300 lbs/cow compared to nearly 21,000 lbs/cow for dairy producers statewide. Those TFT farms that already have certified their herds, average 13,300 lbs/cow of organic milk.), and
- were **equally as profitable** (Despite lower per cow production, TFT farms were able to achieve nearly equal rates of return on assets as the state conventional dairy average.).

It also is possible to make some qualitative observations from the data about transition strategies. Transitioning farmers enrolled in the TFT project generally fall into four groups:

- **conventional dairy farmers** who represent mostly small farms with a median herd size of 80,
- **conventional crop farmers** using a diversified three- or four-year rotation prior to beginning transition (Very few of the farmers in our study practiced a two-year corn-soybean rotation prior to transition.),
- **certified organic crop farmers** who are expanding by transitioning newly purchased or rented land or by transitioning additional acreage from conventionally managed cropland, and
- **absentee landowners and part time farmers** who are transitioning land that was previously fallow or enrolled in the Conservation Reserve Program (CRP).

Among these transitioning farmers, we observe the following transition management strategies.

- Dairy farmers almost universally **transition land first before transitioning the herd**. The majority of dairy farmers keep land planted in alfalfa or other forage crop throughout the transition period.
- Crop farmers **transition land gradually**. Several farms have had two or three distinct transition periods for different fields, thereby remaining in some stage of organic transition for many years. This gradual transition is undertaken as a deliberate strategy in order to “experiment” with management alternatives.
- Most farmers – both livestock and crop producers – **plant land to alfalfa throughout the transition period and establish a rotation of row crops and small grains once certification is earned**. This allows for effective weed control throughout the transition period and a high-value corn crop to be planted in the first year that the land can be certified organic.
- Landowners with acreage in long-term pasture or coming out of the Conservation Reserve Program are able to **certify land immediately** without an actively managed transition period. These farms have often changed ownership or are undertaking a significant shift in overall farm strategy.

According to the intake survey, a large percentage of TFT farmers purchased equipment, animals, or land and/or increased their use of hired labor and consultants when beginning to transition land. Some transitioning farmers increased the amount of rental land. The decision to transition was motivated largely by:

- **environmental/conservation reasons**
- **price premiums**
- **health/safety reasons**
- **personal satisfaction, and**
- **philosophical/ethical reasons**

Annual Survey results for 2011 indicate that cash flow management and access to capital are the most important management challenges for TFT farmers. Cost and availability of inputs and weed management are the most important production problems. Finding buyers, proximity to markets, organic price volatility and high prices for conventional crops are the most important marketing challenges.

Analysis of farm record data is being complemented by the development of the dynamic programming model featured in the poster being presented at this workshop. This model currently uses yield, return,

and cost data from long-term experiments at the Southwest Research and Outreach Center in Lamberton, MN, but data from the farm records of TFT participants will be integrated into the model in the future. At present, the model focuses on cropping operations, but it will be adapted to model transition decisions for dairy operations. This model can provide insights on the economic forces that shape the transition decision and on the effects alternative conservation and risk management policies may have on farmers' decisions to transition. It shows that the cost of transition is a significant barrier to expansion of organic production.

Extension and/or education activities completed or upcoming: In January 2012 we organized a preconference

workshop for TFT project participants at the Minnesota Organic Conference. The workshop included presentations on survey results and on financial performance results for certified organic producers who participate in the FBM program. Time was also set aside for small group discussion among project participants with a focus on transition challenges. These discussions were moderated by project team members. Planning is underway for a pre-conference workshop at the 2013 Minnesota Organic Conference.

In March and April 2012 Gigi DiGiacomo, Rob King, and Dale Nordquist conducted a series of four business planning workshops with managers from two participating farms. These workshops were the first step in developing business planning materials for transitioning farmers that will complement general purpose farm business planning materials in the widely used second edition of *Building a Sustainable Business: A Guide for Developing a Business Plan for Farms and Rural Businesses*. A second round of workshop sessions is planned for 2013.

We prepared two profiles of transitioning farm operations that have been published in the project newsletter and posted on the project web site. The first profile also was published in *Organic Broadcaster*, the bi-monthly periodical of MOSES. The second profile will be published in a forthcoming issue. These profiles are "real-life" stories about the challenges and rewards of the transition process, and we believe they will be a very effective educational resource for farmers considering transition to organic production. We plan to publish a profile each quarter for the remainder of the project.

Project team members have been invited to organize and present a 90 minute workshop on transitioning to organic production at the 2013 MOSES Organic Farming Workshop. The workshop will combine presentation of survey results and farm record data analysis with short presentations by farmers participating in the TFT project.

Websites, patents, inventions, or other community resources created: We have a project web site on eOrganic (<http://eorganic.info/toolsfortransition>). Most of the web site can be accessed by the public, but some portions of the site are used for internal project team communication and so have limited access. The web site provides public access to survey results, project newsletters and farmer profiles. As other educational materials are developed, the web site will be an important channel for their dissemination.

The significance of your findings to organic agriculture: The transition from conventional to organic production systems is a critical process within the evolution of the rapidly growing organic sector, yet very little is known about this process. The Tools for Transition Project is generating findings that yield new insights about the economics of organic transition in field crop and dairy production that will help farmers, lenders and other agricultural professionals and policymakers better understand this process. Results to date highlight the diversity of farmers who are choosing to transition to organic production and help to characterize the transition strategies they are using. Transition almost always is done in stages. This facilitates learning and affords some risk management. Findings based on model results also reveal how difficult it will be for growth in the supply of organic food products to keep pace with growth in demand. High prices for conventional crop and livestock products dampen incentives for producers to transition land to organic production, and they can provide strong incentives for some certified organic producers to revert to conventional production.

Other comments or recommendations for future work: We have several other comments and observations.

1. Transitioning farmers are difficult to identify because current standards do not require any formal contact with certifiers prior to certification. Several of our project participants have expressed a desire to meet with a certifier at least once during the transition process. There is some preliminary discussion in Minnesota about offering cost-share funds for such meetings.

2. Our findings to date suggest that there may be much to be learned from experimental trials on alternative strategies for transitioning crop land. Should long term trials comparing conventional and organic cropping systems be continued, experiments could be designed using several treatments for transitioning the conventional plots to certified organic status. Findings from the TFT Project may yield insights on what transition strategies should be considered. While most of our participants are planting alfalfa on transitioning land, we do have examples of other strategies.

Project Title: Summer cover crops for weed suppression and soil quality in Organic Vegetable Production in the Great Lakes Region

Award number: 2009-51300-05557

Period of funding: Sept 2009 – August 2013

Primary Institution: Cornell University

Project Director Name and email: Thomas Björkman, tnb1@cornell.edu

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Co-Project Director Names and emails: Dan Brainard, brainar@msu.edu
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The purpose of the project: We aim to have organic vegetable growers in the Great Lakes Region use cover crops routinely to meet management goals for which their other tools are insufficient. Weed management is a constant challenge, and appropriate cover crops can reduce the expense and labor by reducing the amount of seeds and extent of germination. Soil quality is fundamental to organic production, whereas vegetable production often degrades that quality. Cover crops grow well in the summer and are a crucial part of retaining that quality. Growers need to know when to use specific covers for each purpose, and when they can be deleterious. They need to assess the value and cost of using cover crops. They need to be able to purchase certified organic cover crop seed at reasonable cost and relatively short notice.

Completed to date:

What value do organic vegetable growers place on cover crops?

This part of the project was conducted by Prof. Brent Gloy and graduate student Shasha Li at Purdue.

The decision to adopt summer cover crops depends on the value growers perceive. In a survey of organic vegetable growers in the Great Lakes region, we asked about the value they placed on summer cover crops. The perceived value was higher than we expected, but also very difficult to estimate concretely. There is likely a substantial educational opportunity to help producers determine how cover crops impact their use of fertilizers and weed management.

Table 3. Assessment of Six Different Potential Categories of Cover Crop Benefits, (n=30)

Benefit Category	Yes	No
Increase the yields of cash crops?	87	13
Let you purchase less quantity of fertilizer inputs?	80	20
Effectively decrease the weed population in organic vegetable production?	97	3
Effectively reduce plant diseases?	80	20
Effectively improve soil conditions?	97	3

Increased Cash Crop Yields. About 87% of the respondents agreed that using summer cover crops can increase the yields of fall cash crops. The cash crops most frequently planted after the cover crops included tomatoes, lettuce, garlic, squash, wheat, and soybeans. The cover crops most frequently reported were rye and clovers. Fourteen respondents provided 39 estimates of the yield increases for up to three most important cash crops on their field after cover crops. Of these 24 were increases from 0 to 10%. An additional 15 were increases between 10 and 54%.

Reduced Fertilizer Purchases. Summer cover crops were seen by 80% of growers to reduce the quantity of purchased fertilizer. Relatively few respondents provided responses for the quantity reductions. Many of those that did reported no decrease in either category, making it difficult to estimate the actual benefit

associated with this feature. This result would suggest that although many farmers perceived reducing fertilization to be a benefit of cover crops, they had difficulty in determining the actual amount.

Weed Control. An overwhelming 97% thought using cover crops effectively decreases the weed population in organic vegetable production. Only ten farmers provided estimates; 7 of them placing the benefit between \$0 and \$25 per acre, the other three ranged from \$200 to \$5,000 per acre. Most farmers have a difficult time valuing this benefit, although more are willing to value it than the fertilizer savings.

Reducing Plant Disease. About 80% of the respondents agreed that using cover crops can effectively reduce plant disease. Yet, 8 of 11 respondents placed the value at only between \$0 and \$25 per acre.

Improving Soil Conditions. Ninety-seven percent of the respondents agreed that using cover crops could reduce soil compaction, and 68% of the respondents thought using cover crops allowed them to decrease the intensity of tillage. However, when asked whether these benefits allowed them to save costs, only 55% agreed. Finally, six respondents (20%) estimated the savings, which ranged from \$0 per acre to \$1,000 per acre.

Reducing the Population of Insect Pests. Respondents were asked several questions about their perception of how cover crops influenced insect pests. While 63% thought summer cover crops helped reduce the population of insect pests, the dollar value attributed to insect control was usually \$0.

What is the best way to manage summer cover crops in this region?

We conducted three seasons of coordinated research-farm experiments in three states to determine the planting window that will provide sufficient growth and weed suppression to be of value. In spring plantings, two mustard species have essentially the same performance; season and weather determine their value. There is a distinct planting-time window in early May when mustard establishes quickly enough to suppress cool season weeds in the period before late vegetables are planted.

The late-summer planting window following vegetable harvest is a prime time for weed escape and seed production. Three target cover crops for that window had an abrupt end, early August for sudangrass and buckwheat, late August for mustard. Grower education has focused on clarifying the importance of timely planting.

The appropriate fall management for late-summer sudangrass and buckwheat were determined. Fall tillage after vegetables allows weeds to establish, but that weed pressure is greatly reduced by cover crops or by spring tillage. Doing fall tillage after a cover crop reduced in-row weed control by 10 h/ac relative to leaving ground bare after peas.

What impact did out on-farm trials have?

This component was conducted mainly by extension specialists Vicky Morrone, MSU; Maurice Ogutu, Illinois; Laura McDermott, Cornell with interpretation provided by Morrone.

The trials to incorporate summer cover crops into growers' rotations provided lessons and increased the impact of other outreach.

We encouraged participating farmers to drill cover crops instead of broadcasting. Those who did became believers in drilled cover crop seed because they saw the tremendous catch and even stand. They concluded that they wasted far less seed and effort. This practice is easily adopted in counties where NRCS has drills for rent, but is difficult if rentals are unavailable.

Adding a summer cover crop required great flexibility because the opportunity to plant was substantially affected by weather. Growers needed contingency plans, with the seed available for each contingency, if they were to be consistent about changing summer fallows to summer cover crops.

Growers who are limited by their land base generally have rotations that lack fallow windows that can be filled with cover crops. Those tight rotations may be deleterious to long-term crop health. Identifying problem rotations can have great preventive value.

Crucifer cover crops have substantial value in the fall, but are generally not an attractive option for market gardens because so many crucifers are in the cash crop mix. Larger scale growers often raise popular cole crops such as cabbage, broccoli and mustard greens, as well as kale, the familiar CSA box filler for cool seasons.

Cooperating educators' experience with the on-farm trials allows these educators to offer relevant and real-life advice. References to on-farm research greatly builds trust and a relationship between the educator and farmers.

Locally grown organic cover crop seed

This component was performed by Dr. Elizabeth Dyck of the Organic Growers Research and Information Network.

Vegetable growers not only can more easily access cover crop seed if it is locally grown, but they also seem to respond to the "locally grown" label and the concept of supporting their fellow organic field crop producers. This good will should help ensure a good price for buckwheat cover crop seed, even if catalog/large seed-house prices fall in future years.

For farmers to be successful at marketing cover crop seed, they need to use several market channels and sell to many customers, rather than in bulk to one "commodity" buyer.

The project worked with six organic seed growers across New York. This region has substantial demand and is an excellent environment for raising quality buckwheat seed. The primary motivation of the farmers recruited for the project was the good price (\$60/lb) cover crop seed could fetch. The farmers were also aware of the benefits of including a buckwheat crop in their rotation, and they valued the opportunity to provide their fellow growers with seed that is essential for sustainable organic production.

To ensure that organic farmers would receive high-quality, weed-free seed and to comply with NY State seed law, buckwheat growers participating in the project submitted a sample of cleaned seed to the NY State Seed Testing Lab for germination and purity testing. None of the farmers had had seed tested previously and were apprehensive that their seed quality would be found to be subpar. To facilitate the seed testing and reduce growers' risk, the project paid the growers' seed testing costs. All of the seed lots tested had germination above 90% and met the state criteria for purity. Germination and purity information from the seed testing was then included on the farmers' buckwheat labels.

Several approaches were tried to make buckwheat seed readily available to vegetable growers. **Grower Group.** The most successful marketing approach has been to a grower group. The farmer sold over a ton of seed to 10 growers in a two-week period to a grower group of 75 farmers, the majority of them vegetable growers. The grower group model appears to work well because 1) these groups are used to buying seed and farm supplies together to cut costs, 2) they have already established email lists, making for easy and fast communication with their members, and 3) they hold events throughout the year where seed may be delivered and distributed. **Farmers Market.** While the seed growers were not regular

farmers-market vendors, they were able to market through existing vendors at local markets. Vegetable farmers who bought buckwheat seed at market commented that this was an excellent way for them to access cover crop seed: after having sold produce, they had cash in hand to buy and room in their trucks for the seed. They also avoided the substantial shipping cost. To take advantage of potential sales to both grower vendors and farmers' market customers, two growers packaged their seed in 2, 5, 25, and 50 pound bags. The small bags proved popular with organic gardeners shopping at the markets. A significant obstacle was the time required to get market permission to sell cover crop seed, which resulted in availability only in the last week of the planting season. That barrier can be overcome in future years now that the relationships exist. **Retail farm supply store.** Two farmers sold buckwheat seed at \$0.60/pound to farmer/gardener seed/supply stores in nearby cities. One store has since requested seed of other cover crops from the farmer. **Farmer Conferences.** The project will rent a booth at winter conferences at which buckwheat from all participating growers will be for sale. Customers will be sold seed of the grower that is closest their location. A flyer will be available that lists the growers' contact information plus any other seed crops that they sell so that customers can contact them directly for seed in future.

Extension and/or education activities completed or upcoming:

Outreach talks,

The initial results were disseminated to growers at Great Lakes Expo, Empire State Expo, New England Berry and Vegetable Conference. The NOFA-NY Winter Conference and NOFA-MA Summer Conference.

Websites, patents, inventions, or other community resources created:

Improvement in the cover crop selection tool for New York (covercrop.net)

Contribution to Midwest Cover Crop Council's cover crop selection tool for vegetables.

Björkman, T., D. Brainard, J. Masiunas, C. Lowry, J. Shail, and D. Anderson . 2011.

Planting Opportunities for Successful Establishment of Summer Cover Crops Integrated Into Organic Vegetable Production Systems in the Great Lakes Region. ASHS Annual Meeting, Sept 2011

The significance of your findings to organic agriculture:

Organic vegetable growers particularly value weed control and soil quality improvement by cover crops. However, they don't generally put a dollar value on that benefit in making the decision to use the cover crop. There is a great need for research-based estimate of these benefits, and grower education on making these estimates for themselves.

Our research results have identified practices essential for successful application of useful cover crop methods, such as dates when the cover crops can productively be planted and incorporation practices that reduce weed pressure and enhance soil quality and crop growth.

We have facilitated a regional industry in producing organic buckwheat cover crops seed, that supplies high-vigor seed to growers and enhances the local organic economy in each production area.

Project Title: Effect of Cover Crops, Soil Amendments and Reduced Tillage on Carbon Sequestration and Soil Health in a Long-Term Organic Vegetable System

Award number: 20105110621857

Period of funding: 09/01/2010 to 08/31/2013

Primary Institution: Iowa State University (with University of Florida)

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Websites: ISU Organic Ag Website: <http://extension.agron.iastate.edu/organicag/> and UF website: <http://www.hos.ufl.edu/faculty/xzhao>

The purpose of the project:

This multi-disciplinary, multi-state project addresses critical stakeholder needs for improving organic vegetable farming practices to optimize pest management, crop quality, and profitability, while enhancing soil quality to help mitigate global climate change. The long-term goal is to provide organic producers with decision-making tools to enhance environmental services (increased carbon sequestration, mitigation of groundwater pollution, effective biological control) derived from the use of mulches, compost, cover crops, and reduced tillage in organic vegetable systems.

Completed to date:

Site establishment and data collection

In 2010, experiments were established in two states (Iowa and Florida) across two contrasting soil types (high vs. low fertility) and climatic conditions (temperate vs. sub-tropical) using vegetable rotations appropriate for the region (tomatoes and onions in Iowa; tomatoes and lettuce in Florida). Cover crops (hairy vetch/rye) were planted in both states for the 2011-growing season, but for the 2012 season, rye only was used in Florida, due to rootknot nematode problems associated with hairy vetch (see below). Two long-term rotation sequences were established at each site. Two crops could be grown in Florida (e.g., tomatoes followed by lettuce), while weather allowed only one crop (tomatoes or onions) per season in Iowa. In 2011, sunn hemp and sorghum-sudangrass were planted in August and terminated in October prior to fall production of 'Tropicana' green loose-leaf lettuce in Florida (see photo). In 2012, peppers and sweet corn were grown in Iowa, and squash and zucchini in Florida. Six cropping system treatments with different management practices were examined at each site: four treatments using cover crops (CC) and two without CC. Of the four CC treatments, two were treated as organic no-till (cover crop rolled) and two were tilled prior to vegetable crop planting/transplanting. Compost and mulch were applied to a subset of these treatments to test the effect of these potential soil amendments. Plant growth, yields and pest (weeds, diseases, nematodes) were assessed throughout the season. Fourteen parameters associated with soil quality were measured at the start of the experiment and at the end of every field season at each site. Lysimeters were established in each plot to measure NO₃ leaching as an indicator of water quality.

Results to date

Plant performance: In Iowa, the organic no-till system was more successful in 2012 when adequate preparation occurred, than in 2011. In 2011, several factors impacted organic no-till production: delay in planting due to wet spring soil conditions and inability to use the mechanical transplanter because of transplants that were too large for the machine due to the delay in planting. Hand-transplanting then suffered from inadequate preparation of planting area. Additionally, re-growth of the hairy vetch/rye

cover crop and weeds in no-till plots impacted production. Organic no-tillage yields (tomatoes: 317 kg/ha; onions: 281 kg/ha) failed to compete with mulched and tilled tomato and onion yields. Tilled and mulched organic yields were excellent, with tilled onion plots producing 2,215 kg/ha, and mulched onions yielding 2,266 kg/ha. Cover crops and compost offered no advantage in terms of increasing onion production. Tilled tomato plots averaged 16,831 kg/ha, while mulched tomatoes averaged 12,170 kg/ha, compared to 10,905 kg/ha without mulch. While the tilled tomatoes and onions were more productive, the mulched and no-till vegetables had higher quality fruit, due to the straw or mulch barrier affording greater protection from soil particles. Weed populations were higher in no-till plots but much of this resulted from poor vegetable crop planting and establishment. In 2012, higher-than-normal winter temperatures led to greater cover crop biomass for rolling/crimping. Peppers were successfully mechanically transplanted into the crushed cover crop mulch and organic no-till yields performed better than in 2011, averaging 6,433 kg/ha compared to tilled treatments at 10,018 kg/ha (Table 1). Weed management was greatest in mulched plots, but the dead cover crop mulch in organic no-till plots provided the same level of management as seen in tilled plots. The greatest benefits from cover crops appear to be related to improvements in soil and water quality (see Soil and Water Quality results below).

In Florida, the organic no-till system performed better than in Iowa, but any novel system will be difficult to compete with the performance of crops grown with plastic mulch, due to intense weed pressure under sub-tropical conditions. Plastic mulch treatments resulted in the highest tomato yields in 2011, but in 2012, organic no-till squash yields were not significantly different from tilled plots (Table 1). In both years, cover crops did not significantly increase yields. No-till tomato yields, however, were similar to tilled plots without mulches in 2011, and weed populations were reduced compared to tilled plots. Winter cover crops in Florida did not provide expected biomass and nutrient quantities, possibly due to slow establishment. As a result of colder weather impacting biomass production, cereal rye mulch was added to no-till plots to simulate a mulch cover in lieu of actual cover crops. Overall, root-knot nematode galling was lowest in plots without cover crops. In Fall 2011, the total marketable yields of lettuce were higher in treatments with plastic mulch. Populations of grass and annual broadleaf weeds did not differ among treatments, but higher populations of perennial broadleaf weeds were observed in treatments without plastic mulch. Use of plastic mulch in tilled plots and the no-till treatment reduced the nutsedge weed population, demonstrating a benefit of organic no-till.

Table 1. Marketable yield of organic 'Yellow Crookneck' summer squash, Citra, FL (April-June, 2012) and 'Olympus' peppers, Greenfield, IA (May-September, 2012).

Cropping system	Marketable fruit yield (kg/ha)	Marketable fruit	
		number (fruit/ha)	yield (kg/ha)
		Florida	Iowa
NCC-T-M	7,749.1a	41,371a	11,281a
CC-T-M	5,167.4a	26,613a	9,924ab
NCC-T	8,100.9a	33,428a	8,850b
CC-T	4,110.0a	24,879a	6,079c
CC-NT	6,750.7a	32,863a	6,433c
P-value	NS	NS	0.05

Legend: NCC-T-M: No cover crops, tilled, with mulch (plastic: Florida; straw-Iowa); CC-T-M: With cover crops, tilled, mulch; NCC-T: No cover crops, tilled, no mulch; CC-T: With cover crops, tilled, no mulch; CC-NT: With cover crops, no-till.

Soil quality

In Fall 2011, after the first season, in tomato plots in Iowa, soil nitrate (NO₃) was lower under cover crop treatments than in plots without a cover crop (Table 2). Without a cover crop, the non-mulched tomato treatment had more nitrate than the mulched plots. In the onion plots, the non-mulched plots had more nitrate for both cover crop and no cover crop treatments. In both the tomato and onion plots, there was

more phosphorus (P) in tilled vs. no-till treatments, probably due to tillage stimulating the mineralization of organic P from added compost. Both P and electrical conductivity (EC) were lower in the no compost treatments. In Florida, soil quality differences were observed in Rotation 2 in 2011 and 2012, where mulching in the absence of a cover crop resulted in higher microbial biomass carbon (MBC) compared to the no mulch treatment. This suggests that the mulch may be stabilizing soil microclimate (i.e., cooler and wetter) in these relatively un-structured soils to favor the accumulation of microbial biomass carbon, an easily decomposable form of biologically active organic matter. The importance of biologically active organic matter in these very sandy soils is demonstrated by the observation that particulate organic matter carbon (POC) represents on average 43.6% total soil organic carbon compared to Iowa soils, where POC accounted for 15.4% of total SOC averaged across treatments.



Photo caption: Sunn hemp cover crop rolled in Florida plots (L); Mechanically transplanting vegetables (hairy vetch/rye cover crop rolled plots to the left of the transplanter) in Iowa (R).

There was a trend toward increasing soil quality from 2011 to 2012 in Florida, where total N (TN) increased in this time frame and soil C:N ratio decreased because of the change in TN. Extractable P and Ca also increased from 2011 and 2012. The Florida soils have relatively low amounts of potentially mineralizable nitrogen (PMINN), an important indicator of biologically active soil organic N, compared to the Iowa soils. PMINN increased from 2011 to 2012 in the Florida soils, suggesting that the organic management practices encourage accumulation of labile organic N even in these very sandy Florida soils.

Overall, soil quality temporal patterns observed from 2011 to 2012 for Florida soils suggest enhanced cycling and storage of soil N and soil nutrients in the organically managed vegetable rotation sequences.

Table 2. Soil quality (0-15 cm) treatment means in Fall 2011 after tomato season, Greenfield, IA.

Soil quality parameter	NCC C T M Treatment 1	NCC C T NM Treatment 2	CC C NT NM Treatment 3	CC C T M Treatment 4	CC C T NM Treatment 5	CC NC NT NM Treatment 6
SOC g kg ⁻¹	27.03ab*	27.46ab	27.25ab	27.38ab	27.69a	26.11b
TN g kg ⁻¹	2.53bc	2.73a	2.68ab	2.61abc	2.73a	2.50c
POC g kg ⁻¹	3.54ab	5.13a	4.24ab	4.06ab	4.88ab	2.99b
PON g kg ⁻¹	0.36bc	0.60a	0.48abc	0.45abc	0.57ab	0.31c
MBC mg kg ⁻¹	354	373	364	339	378	375
PMINN mg kg ⁻¹	50.94b	57.93ab	54.16ab	59.19a	54.77ab	50.91b
NO ₃ mg kg ⁻¹	4.50b	16.38a	3.19b	3.53b	5.14b	2.85b
P mg kg ⁻¹	40.25a	44.00a	32.75b	38.00ab	44.25a	25.25c
K mg kg ⁻¹	375	405	387	406	374	284
Mg mg kg ⁻¹	356ab	361ab	344b	393a	356ab	365ab
EC μS cm ⁻¹	291a	329a	293a	285a	360a	147b
pH	6.05	5.90	5.91	6.11	6.13	6.07
Aggs %	21.88c	24.60bc	29.43abc	22.08c	32.43ab	36.58a
BD g cm ⁻³	1.02b	1.02b	1.06ab	1.06ab	1.09a	1.09a

*Means in the same row followed by the same lower case letter are not significantly different at $p \leq 0.05$.

Lysimeter results: Lysimeter data in Iowa showed that the seasonal average root zone nitrate N concentrations under organic tomato and onion were similar and did not exceed the drinking water standard of 10 ppm. In tomato plots, cover crops were associated with decreased nitrate-N in lysimeters compared to plots with no cover crops, particularly in August 2011, when nitrate-N levels in cover cropped plots averaged 5 ppm compared to 15 ppm in plots without cover crops (Fig. 1). The concentration of leached N was also consistently lower under onion with a cover crop. No-tillage did not decrease nitrate-N in lysimeters under onions, possibly due to the shallow rooting pattern of the onions. Mulch responses were highly variable under onions and tomatoes, with no obvious benefit in terms of reducing nitrate-N in lysimeters from applying straw mulch. The benefits of cover crops in the first season of this project were primarily from reducing nitrate-N in lysimeters, which could be extended to groundwater protection.

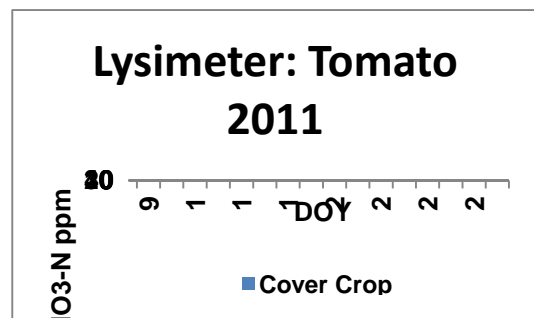


Figure 1. Nitrate levels in lysimeters under tomato plots with and without cover crops, 2011, Greenfield, IA.

Extension and/or education activities completed or upcoming:

Results from this project were disseminated to a broad audience through four field days, 16 conference and grower meeting presentations and six classroom presentations in Iowa and Florida. In Florida, a presentation on the project was delivered in an organic systems workshop organized by Florida Certified Organic Growers and Consumers in 2011. Activities planned for Winter 2012-13 include sessions at the Iowa Organic Conference on November 19, 2012, and at the Midwest Organic and Sustainable Education

Services (MOSES) annual conference, which attracted 3,200 attendees in 2012.

Websites, patents, inventions, or other community resources created:

Publications (peer-reviewed journal and Extension publications) have been created as a result of this project (see CRIS reports); an Organic No-Till website is under development at the national e-Organic website: <http://eorganic.info/node/7681>.

The significance of your findings to organic agriculture: Organic farmers are under increasing pressure—both internal and external—to reduce fertilization and weed management energy use, minimize nutrient leaching, reduce soil erosion, and build soil quality. This multi-disciplinary, multi-state (Iowa and Florida) project is investigating the development of organic reduced-till and soil amendment strategies that improve soil quality, reduce weed management and off-farm costs, and facilitate producer access to the rapid growth in the organic industry. Results from this project to date have shown excellent organic vegetable yields with improvements in soil and water quality with the use of cover crops. While vegetables produced with tillage (in Iowa) and plastic mulch (in Florida) have generally out-yielded organic no-till systems, results from the second season (2012) suggest that, with adequate cover crop biomass and weather conditions permitting vegetable planting on normal dates, organic no-till systems can provide excellent weed management and lower energy costs compared to tilled systems. Anticipated outcomes from this project include development of improved organic no-till techniques to advance organic farming in the U.S. and ensure soil quality enhancement on organic farms.

Other comments or recommendations for future work: Because organic no-till is still considered a novel technique, funding should be supported for the many researchers working to perfect this system across the U.S. A network of organic no-till researchers has been established to share advances in roller technology/timing and side-dressing of organic fertilizer within the no-till system.

Project Title: Strategies of Pasture Supplementation on Organic and Conventional Grazing Dairies: Assessment of Economic, Production and Environmental Outcomes

Award number: 2010-51300-20534

Period of funding: 2010 -2014

Primary Institution: University of Wisconsin-Madison

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The purpose of the project:

Organic and grazing farms may have additional economic, production and environmental challenges when growing or purchasing supplemental feeds for grazing dairy herds. Organic and grazing dairy producers have expressed the need for more information on use of pastures in combination with feed supplement ingredients and their impacts on production, economics and environment. Therefore, this project is working to find organic and grazing dairy farms' best management strategies that concurrently optimize production, economics, and environment with a focus on feeding supplementation practices. We are analyzing in-depth data we collected from 131 dairy farms in Wisconsin. Analyses are expected to yield take-home messages of best management strategies and assist in the development of practical user-friendly decision support aids for producers and decision makers.

Completed to date:

Characterization of Wisconsin certified organic farms was performed using information from 70 farms that indicated to be certified organic out of a total of 131 farms interviewed. It has been found that the average certified organic Wisconsin dairy farm has the following characteristics: It has been certified organic for 6.7 years but utilizing grazing for twice as long. It operates 121 ha with one-third of the land being in pasture. Its herd consists of 69 cows and 59 female young stock. Its milk production is 6,272 kg/cow per year with fat and protein contents of 3.98% and 3.15%, respectively. Cows in this average organic farm first calve at 26.1 months of age, calve every 13 months afterwards, and remain in the herd for 4.51 lactations. Cows have an estimated dry matter intake (DMI) of 19.8 kg/cow per day with an estimated 69.3% of intake coming from pasture during the peak grazing season. However, these farms varied widely in farm characteristics, feeding regimes, and animal production (Table 1). Awareness of these characteristics and their extreme variations should help design extension programs and agricultural publications better suited to meet the educational needs of this growing dairy sector.

Table 1. Characteristics of 70 Wisconsin certified organic dairy farms.

	Minimum	Average	Maximum	SD
Years certified organic	0.7	6.7	20	4.7
Years utilizing grazing	0	14.7	90	13.4
Total land, ha	17.6	121	766	130
Total pasture, ha	6	39.4	144	31.2
Number of cows	12	69.2	650	85.8
Number of heifers	9	59.3	600	80.5
Milk production, kg/cow per year	2,360	6,272	10,286	1,805
Milk fat content, %	3.47	3.98	5.19	0.35

Milk protein content, %	2.82	3.15	3.67	0.18
Age of first calving, months	23	26.1	36	2.72
Calving interval, months	10	13	20.3	1.25
Number of lactations before culled	2	4.51	7	1.16
Total dry matter intake (DMI), kg/cow per day	11.8	19.8	28.2	3.7
Peak pasture intake, % of total DMI	1	69.3	100	26.1
Grazing rotation frequency, days	0.21	1.81	14	2.61
Length of grazing season, days	122	184	244	29

A cluster analysis using complete linkage was conducted on 20 farms out of a total of 131 farms interviewed as preliminary analysis. Four farms were organic (O), 4 were graziers (G), and the rest, 12, were non-organic and non-graziers (C). The analysis resulted in 3 clusters. Cluster 1 included 1 O, 2 G and 6 C farms; cluster 2 included 4 C and 1 G farms; and cluster 3 included 3 O, 1 G and 2 C farms. Cluster 1 included farms with the largest land base (114 ha) but intermediate values for milk production (7,083 kg/cow per year), milk composition (3.78% fat and 2.99% protein) and milk price (\$0.37/kg). Although estimated DMI during the winter was the highest (23.6 kg of DMI/cow per day), percentages of each diet ingredients in winter were intermediate compared with farms in clusters 2 and 3 (20% grass silage (GC), 32% hay, 12% corn silage (CS) and 36% concentrates (CO)). Farms in cluster 1 can be defined as “*intermediate farms*” with an income over feed cost (IOFC) of \$5.97/cow per day. Cluster 2 included farms essentially similar to cluster 1 in terms of number of cows (71) and land base (94 ha). The estimated DMI during the winter was intermediate on those farms compared with farms in cluster 1 and 3 (20.4 kg of DMI/cow per day). Milk production (10,787 kg/cow per year) and percentage of concentrate in the diet (46%) were the highest, while milk composition (3.55% fat and 3.03% protein) and milk price (\$0.35/kg) were the lowest. Farms in this cluster can be defined as “*productive efficient farms*” with an IOFC of \$8.09/cow per day. Cluster 3 included farms with the smallest land base (53.2 ha) and the fewer number of cows (48). Milk composition (4.36% fat, 3.25% protein) and price (\$0.48/kg) were the highest, while milk production (4,155 kg/cow per year) and estimated DMI during the winter (17.7 kg of DMI/cow per day) were the lowest. Forages were the main constituents of the winter diet of the cows on those farms (17% GS, 54% hay, 5% CS). Farms in cluster 3 can be defined as “*low input farms*” with an IOFC of \$5.22/cow per day. Each cluster included farms from different systems. Farms in each cluster are more similar to those in the same cluster than to other farms with the same system in another cluster. Consequently, preliminary results suggest that the farm system is not a good predictor of net income over feed cost. Variables such as milk production, milk price, or feeding management practices play a more important role in describing dairy farms’ net income over feed cost.

A combination of farm data and model-based predictions with the Integrated Farm System Model was used to derive predicted greenhouse gas emissions (PGE) on one O, one G, and one C farms. The objective was to test the impact of animal density (AD) on PGE. Each surveyed farm had a herd size of about 80 cows, 133 ha of forage land, and 0.6 cows/ha. At the current AD (CAD), the PGE were 0.53, 0.70 and 0.77 kg of PGE (CO₂eq)/kg of milk for the C, O and G respectively and the main source of PGE was from housing facilities (47, 39, and 31% of total PGE on C, O and G, respectively). The indirect emission sources (manufacture or production of fuel, electricity, machinery, fertilizer, pesticide, and plastic) accounted for 21, 12, and 30% of PGE on C, O and G, respectively. Other important PGE sources at CAD were feed production on C (19%), and grazing on O and G (35 and 14%, respectively). Doubling the AD (DAD, 1.2 cows/ha of forage land) increased PGE by 22.9% on C, mainly due to 48% increase from indirect sources. The emissions from feed production and indirect sources increased by 38 and 29%, respectively on O, but the emission from grazing and housing facilities decreased by 5 and 1.3%, respectively, which led to a 6.4% net increase. Finally, PGE decreased by 3.1% on G as the net result of a decrease in emissions from manure storage and fuel consumption (41 and 20%, respectively) but 8% increase in indirect sources. These results demonstrated that the impact of AD on PGE was different on the 3 selected farms because of different farm management practices such as feeding, manure storage, and

housing facilities. Although increasing AD might have a beneficial effect in reducing PGE per unit of milk on the selected G farm, results predicted a slight negative effect in the O farm and a more substantial negative effect on the C farm. Although the scope of the study is limited to the 3 selected farms, combining farm data with model-based predictions may be useful to study the changes in farm-level management practices on PGE.

Extension and/or education activities completed or upcoming:

- Focus groups with organic and grazing dairy producers to better guide project advancement were conducted during 2010.
- A comprehensive 50-page, 10-section survey instrument to collect data from organic and grazing dairy farms was developed. Questionnaire section include: A) Farm business structure and decision makers; B) people working on the farm; C) dairy herd and management; D) feeding management; E) pasture management; F) land management and cropping operation; G) manure and nutrient management; H) farmer to farmer interactions; I) economic information; and J) assessment of farm management and satisfaction.
- Questionnaire was improved based upon feedback from personnel from the USDA National Agricultural Statistical Service, Wisconsin Field Office.
- A 2-day training workshop was conducted to educate enumerators and students in the data collection procedure with the survey.
- The most complete database of Wisconsin organic and grazing dairy farms information has been created and it is being used for analyzing these systems.

Websites, patents, inventions, or other community resources created:

- Project webpage with snapshot information is available at: <http://dairymgt.uwex.edu/projects/orei.php>.
- A benchmarking decision support online tool (<http://DairyMGT.info>: Tools: Dairy Extension Feed Cost Evaluator) has been prepared to receive data from the surveys and perform seasonal analyses on the studied farms of income over feed costs and their relationships with feed supplementation. Farmers, whether they are participating in the study or not, have free access to it. An increasing group of farmers are using this tool for practical decision-making.
- A spreadsheet decision support tool (<http://DairyMGT.info>: Tools: Income Over Feed Supplement Cost) is available for participant and non-participant producers alike to optimize the use of feed supplements (concentrated) on lactating dairy cattle diets.
- An online tool (<http://DairyMGT.info>: Tools: Corn Feeding Strategies) is available to strategize the inclusion of corn grain usage levels based upon market price relationships between corn and milk.
- An online tool (<http://DairyMGT.info>: Tools: Income Over Feed Supplement Cost) is available to assess the net return to different levels of supplementation diets according to cows' lactation stages and dependent on market price conditions.

The significance of your findings to organic agriculture:

A more complete characterization of Wisconsin certified organic dairy farms has been completed thanks to project support. Awareness of organic dairy farm characteristics and their extreme variations are crucial for the designing of effective extension programs, producing target publications better suited to meet educational needs, and developing subsequent research studies. Preliminary results of a selected group of farms that included organic, non organic grazing, and comparable non-organic non-grazing farms suggests that the farm system alone is not a good predictor of net income over feed cost. Variables such as milk production, milk price, or feeding management practices play a more important role in describing a dairy farm's net income over feed cost rather than the overall production system to which they belong. Nonetheless, environmental analyses seem to indicate that the farm system would help to explain farm nutrient balances such as green house gas emissions. Follow up integrated assessments that incorporate economic and environmental variables together with model-based assessments would

elucidate organic and grazing dairy farms' best management practices conducive to long-term sustainability.

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

Award number: 2009-51300-05656

Period of funding: 10/2009 – 9/2013

Primary Institution: The Pennsylvania State University

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The purpose of the project: The overall goal of our multi-institution, multi-disciplinary project is to develop sustainable reduced-tillage organic feed grain production systems (corn-soybean-wheat) that integrate pest and soil management practices to overcome production constraints associated with high residue, reduced-tillage environments. We established three-year experiments on three research stations (Penn State University, USDA ARS BARC, and University of Delaware) to test four approaches: 1) *expressive* weed management—stimulating pre-plant weed seed germination followed by control; 2) *pest avoidance* – altering cash crop planting date to avoid early-season insect pests and weeds; 3) *pest (weed) suppression* – using living and dead cover crops to physically and chemically suppress weed emergence and growth; and 4) *supplemental* weed control – shallow high-residue cultivation to remove weeds that emerge through cover crop residues. Effects of these approaches on arthropod communities and soil quality are also being measured. This project is based on active collaborations between the research/extension project team and participating farmer-researchers. Components of the proposed experiment are being investigated on five organic farms in PA, MD, and NC to determine performance and farmer acceptability. In addition to on-farm research, extension activities include on-site meetings and regular communication between the research/extension team and farmers, extension articles, and extension events dedicated to co-learning with farmers.

Completed to date:

The Reduced-tillage Organic Systems Experiment (ROSE) was initiated at Penn State, The Beltsville Agricultural Research Center (BARC) in Maryland, and the University of Delaware. The ROSE examines soil quality, weeds and early-season insect pests in a cover crop-based, organic rotational no-till corn, soybean and wheat rotation. In the 2010-11 production year, we completed one full cycle of the crop rotation and harvested the first organic no-till planted corn and soybean crop. Cover crop management and cash crop planting occurred on three dates - early, middle, and late – to test the effects of planting dates on pest management and yield.

Cover crops were terminated at all sites starting at anthesis, which occurred in cereal rye on May 2 in DE, May 3 in MD, and May 26 in PA. Cover crops in the Middle and Late plots were terminated approximately 10 and 20 days later, respectively. Cover crop biomass increased with termination date at all sites, except with hairy vetch-triticale in PA. We suggest that the hairy vetch-triticale cover crop reached near maximum vegetative biomass by the Early termination date in PA, and therefore no significant increase in cover crop biomass was observed with delayed termination. At the PA site, mean (standard error) of hairy vetch-triticale biomass was 6,404 (153), 6,500 (198), and 6,458 (204) kg ha⁻¹ for the Early, Middle, and Late termination dates. At the PA site, mean cereal rye biomass was 6,576 (208), 6,719 (225), and 8,574 (389) kg ha⁻¹ for the Early, Middle, and Late termination dates, respectively. At the MD site, mean hairy vetch-triticale biomass was 4,152 (126), 5,593 (175), and 6,680 (189) kg ha⁻¹ for the Early, Middle, and Late termination dates, respectively. At the MD site, mean cereal rye biomass was 5,130 (735), 7,456 (762), and 7,636 (1,468) kg ha⁻¹ for the Early, Middle, and Late termination dates, respectively. At the DE site, mean hairy vetch-triticale biomass was 3,975 (272), 5,619 (218), and 7,630 (426) kg ha⁻¹ for the Early, Middle, and Late termination dates. At the DE site, mean cereal rye biomass was 6,690 (286), 7,990 (340), and 8,795 (408) kg ha⁻¹ for the Early, Middle, and Late termination dates, respectively. For both cover crops and across all sites, efficacy of the roller-crimper increased with termination date. Cover crop regrowth was sampled at PA site two weeks after the final corn planting date to capture the gradient of regrowth produced by the different rolling dates. A steep decline in regrowth was observed as termination date was delayed for both cover crops. Mean (standard error) regrowth for Early and Late termination dates were: hairy vetch-triticale 1,219 (393) kg ha⁻¹ Early, 159 (46) kg ha⁻¹ Late; cereal rye 412 kg ha⁻¹ (48) Early, and 9 (1) kg ha⁻¹ Late. Cover crop regrowth was also sampled at all sites in 2012 to determine if cover crop regrowth behaves similarly across sites, but 2012 results are yet to be processed.

In PA, cash crop planting dates were later than the predicted presence of cutting stages of black cutworm and true armyworm larvae, and noctuid larvae numbers and crop seedling damage were very low. Emergence of seed corn maggot flies was low, but greater from corn on the first two planting dates compared with the third planting date, and from soybean for all three planting dates. Captures of predatory staphylinid beetles in emergence traps were equal to or greater than captures of seedcorn maggot fly. Activity-densities of arthropods collected in pitfall traps increased over the season, and were generally higher in corn than in soybean. Predators were the dominant trophic group, with carabid beetles dominating. Predation rates on sentinel larvae were greater for the Early and Middle planting dates of corn and soybean than for the Late planting dates. Fungal infection rates of sentinel insects increased over the growing season. Crop damage from herbivores increased with planting date.

Despite the lack of differences in hairy vetch-triticale biomass, weed biomass in corn decreased with termination date in PA. In the absence of high-residue cultivation, weed biomass in corn was 164 (63) g m⁻² in the Early date and decreased to 60 (16) g m⁻² in the Late date plots. This trend was also present at the MD site, where total weed biomass in the absence of high-residue cultivation was 371 (31) g m⁻² in the Early date and 243 (33) g m⁻² at the Late hairy vetch-triticale termination date plots. Interestingly we observed the opposite trend in weed biomass in soybean at these two sites. In the absence of high-residue cultivation, mean weed biomass in soybean at the Early termination date was 17 (7) and 79 (21) g m⁻² for the PA and MD sites,

respectively. Whereas at the Late cereal rye termination date, weed biomass was 38 (10) and 391 (80) g m⁻² for the PA and MD sites, respectively. Weed biomass in corn and soybean averaged 88 (18) and 277 (34) g m⁻², respectively, at the DE site, but interpreting trends was more difficult at this site because of severe crop damage that released weeds from crop competition. High-residue cultivation consistently reduced weed biomass in corn at the PA and MD sites, resulting in 47 (16) and 260 (32) g m⁻² with cultivation and 101 (23) and 375 (32) g m⁻² without for the PA and MD sites, respectively. High-residue cultivation in soybean was more effective at the PA compared to the MD site. When averaged across the three soybean planting dates, high-residue cultivation resulted in a 90% reduction in weed biomass at the PA site compared to only a 43% reduction at the MD site.

At the PA site, mean corn silage yield was greatest in the Middle planted variable cultivar plots (31,795 kg ha⁻¹) and lowest in the Late planted variable cultivar plots (23,815 kg ha⁻¹). High-residue cultivation did not affect corn silage yield. At the MD site, corn grain yield was greatest in the Early planted standard cultivar plots (8,778 kg ha⁻¹) and lowest in the Late planted variable cultivar plots (6,902 kg ha⁻¹). High residue cultivation did not increase corn yield at the PA site, but in Late planted corn it resulted in a 40% increase in corn at the MD site. Although high-residue cultivation reduced weed abundance and did not affect corn yield at the PA site, soybean yields were 12% lower in plots that received high-residue cultivation compared to those that did not at the PA site. This was likely due to mid-summer drought and greater soil moisture retention in uncultivated plots. The greatest mean soybean yields at the PA site were in Early planted soybean that were not cultivated (3,452 kg ha⁻¹) and the lowest yields were in Late planted soybean that were cultivated (2,406 kg ha⁻¹). Unlike corn, soybean variety did not affect soybean yield at the PA site. At the MD site, the greatest mean soybean yield was in Middle planted, variable variety, that was cultivated (4,706 kg ha⁻¹) and the lowest yield was in the Early planted, standard variety, that was not cultivated (2,122 kg ha⁻¹). No Delaware yield data are reported due to early season drought stress and insect damage resulting in no harvestable corn or soybean.

On-farm research is being conducted in PA, MD, and NC. In PA, triticale, hairy vetch, and crimson clover were planted on a 5-acre field in fall 2010, to compare inversion tillage with no-till planting into rolled/crimped cover crop. The resulting cover crop stand was poor, and excessive rainfall delayed tillage and rolling/crimping. Planting was unsuccessful, resulting in poor stands in both the no-tilled and the conventionally tilled plots, and the farmer tilled the entire area and replanted with short season corn. Rye was planted on a second PA farm. However, heavy rains and wind caused much of the rye to lodge several weeks ahead of rolling or tillage. Even so, soybean stands in both treatments were good. The in no-tilled beans (41.7 bu/ac) outperformed the conventionally tilled beans (37.1 bu/ac) by 4.6 bu/ac. Both farms intend to investigate no-till soybean production during 2012. In MD, a rye cover crop was planted on farm during October 2011. Soil was sampled on farm during mid January 2012 and cover crop biomass, corn yield and population collected the previous summer and results were presented at the farmer advisory board meeting in March 2012.

Extension and/or education activities completed or upcoming:

Numerous outreach events and extension materials were used to engage our stakeholders and discuss our project and results. On-farm research and a summary of our third Advisory Board

meeting at BARC in March, 2012 are summarized in the project newsletter, “The ROSE Review” (<http://agsci.psu.edu/organic/research-and-extension/rotational-no-till/publications/organic-reduced-tillage-times>).

In 2010 and 2011, the project team participated in 17 and 19 extension/outreach events, respectively, focused on various soil and pest management topics related to reducing tillage in organic crop production systems. This included two webinars delivered via eOrganic. In 2010 and 2011, the team produced 12 and 14 project-related extension articles, respectively, including several articles for eOrganic. In 2010 and 2011, the team delivered 13 and 15 project-related presentations at scientific meetings, respectively.

In 2010 and 2011, PSU faculty, cooperative extension, post-doctoral researchers, and graduate students came together to meet one other, share ideas, and discuss ways to foster collaboration between three groups working on sustainable cropping systems research and extension projects at Penn State, including this project, at an Annual Sustainable Cropping Systems Symposium.

Websites, patents, inventions, or other community resources created:

<http://agsci.psu.edu/organic/research-and-extension/rotational-no-till>

The significance of your findings to organic agriculture: Pest and soil management remain top priorities for organic growers nationally, and are consistently listed near the top of organic growers’ concerns. The most common tactics for managing weeds and soil fertility in organic systems are tillage, crop rotation, and cover crops. Results from the proposed project will facilitate the adoption of practices that minimize adverse impacts of agriculture on the environment by reducing production constraints posed by weeds and insect pests, negative impacts on soil, and energy use associated with inversion tillage; while at the same time promoting the conservation of beneficial organisms and soil quality. This project will strengthen the regional research and outreach capacity for serving organic growers. Developing approaches for farmers to produce high value organic crops may provide farmers sufficient income to succeed on small and medium-sized farms, and support production of organic animal-based products.

Project Title: Whole farm-level evaluation of field border vegetation on organic management of insect pests and weed seed banks, and on farmland wildlife

Award number: 2008-51106-04384

Period of funding: July 1, 2008 – June 30, 2012

Primary Institution: North Carolina State University

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The purpose of the project:

Section (b)(2) of the National Organic Program standard § 205.206 (Crop pest, weed, and disease management practice standard) lists “Development of habitat for natural enemies of pests” as a management practice, yet growers have had little practical knowledge or direction on how to accomplish this development. This project addressed habitat development on a small farm scale, and examined the effects on ecological services provided by not only beneficial insects but also farmland wildlife. In addition to conducting the large scale study, we worked directly with a variety of growers to design, plant and develop habitats by looking at their entire farms and considering wildlife in addition to beneficial insects.

Completed to date:

INSECTS

Weed seed predation was studied in nine organic crop fields (between 2.5 and 4 ha each) (three fields each of corn, soybeans and hay) each surrounded by four field border treatments (planted native grass and prairie flowers, planted prairie flowers only, fallow vegetation, or mowed vegetation) from September to November 2009 and 2010. We used predator exclusion cages to determine the amount of weed seed removal caused by invertebrates (control cages had <1mm openings and insect accessible cages had 12.7mm openings). Twenty-five seeds of three common weed species (redroot pigweed [*Amaranthus retroflexus*], broadleaf signalgrass, [*Urochloa platyphylla*], and sicklepod [*Senna obtusifolia*]) adhered to individual cards were placed inside each cage once a month for two weeks. Activity density of invertebrate weed seed predators was measured with pitfall traps. Results show that field border treatments had no effect on seed removal rates but that crop species heavily influenced both weed seed predation and invertebrate seed predator activity density. Weed seed predation was highest in the dense, perennial hay fields and lowest in the more open corn fields. Activity densities for field crickets (*Gryllus* sp.) and the ground beetle *Harpalus pennsylvanicus* were also high in the hay fields and low in the corn fields while the red imported fire ant seemed to prefer the open corn fields. These results show that increasing vegetative diversity in field borders is not an effective method for conserving weed seed predators, but that higher quality habitat inside the crop field can be achieved by increasing ground cover. Seed removal under natural (high *Solenopsis invicta* population) and treated conditions (*Solenopsis invicta* removed with Amdro® [hydramethylnon]) were monitored in an Eastern North Carolina soybean field during October 2011. 30 meter by 30 meter plots were established and ant populations were estimated with hotdog/test-tube traps and pitfall traps. High resolution video monitoring equipment was used to determine what organisms were responsible for weed seed predation under the high and low ant conditions. Five seeds of three common weed species (redroot pigweed [*Amaranthus retroflexus*], broadleaf signalgrass [*Urochloa platyphylla*], and sicklepod [*Senna obtusifolia*]) were monitored for three hours during the day and for three hours at night for three consecutive days. *Solenopsis invicta* was not

seen removing or consuming any of the three weed seed species. Instead, field crickets (*Gryllus* sp.) and house mice (*Mus musculus*) were the predominant weed seed predators. Carabid beetles, such as *Harpalus pennsylvanicus*, which are common weed seed predators in temperate areas, were rarely seen in the videos or in the pitfall traps. House mice were especially common in the plots where ants had been removed. These results show that while *Solenopsis invicta* has become a dominant insect in the Southeast United States, they do not contribute to weed seed predation ecosystem services in agricultural settings. Instead, they may weaken this service by displacing other seed eating organisms such as mice and beetles.

WILDLIFE

Field borders are an effective conservation strategy for providing northern bobwhite (*Colinus virginianus*) brooding habitat and providing habitat to overwintering sparrows, while the value of border to small mammals is not well understood. However, traditional fallow field borders lack sufficient pollen and nectar sources required to sustain beneficial insect populations, and therefore, borders planted to a mix of native prairie flowers and grasses may be needed if increases in beneficial insect populations are desired. Although the value of fallow borders to birds has been established, little is known about the value of these beneficial insect habitats for farmland wildlife. The experimental area used is the same as described above. Each of the wildlife groups studied is presented below.

Methods, Results and Discussion

Northern Bobwhite Quail. We used groups of 6 human-imprinted bobwhite chicks as a bioassay for comparing 4 different border treatments (planted native grass and prairie flowers, planted prairie flowers only, fallow vegetation, or mowed vegetation) as bobwhite brood habitat from June-August 2009 and 2010. All field border treatments (0.33 ha each) were established around 9 organic crop fields. Groups of chicks were led through borders for 30-minute foraging trials and immediately euthanized, and their crops and gizzards were later dissected and eaten arthropods were identified, measured, and counted. We used allometric equations to calculate a mean foraging rate for each border treatment (g of arthropods consumed/ chick/ 30 min). We determined arthropod prey availability within each border treatment using a modified blower-vac to sample arthropods at the vegetation strata where chicks foraged. Foraging rate did not differ among treatments in 2009 or 2010. Total arthropod prey densities calculated from blower-vac samples did not differ among border treatments in 2009 or 2010. Our results suggest beneficial insect habitats may maximize the biodiversity potential of field border establishment by providing suitable habitat for beneficial insects and bobwhite young.

Small Mammals. In October-November 2009, we trapped small mammals in 4 field border treatments (planted native-warm season grasses and prairie flowers, planted prairie flowers only, fallow vegetation, and frequently mowed vegetation) replicated around 9 organic crop fields, and developed closed population models in Program MARK to estimate density in each border. We also measured vegetation cover within each border treatment from June-August 2009. We captured 512 individuals of only two species, the hispid cotton rat (*Sigmodon hispidus*) and house mouse (*Mus musculus*). Cotton rat density was higher in borders planted for beneficial insect habitat, which likely was influenced by greater vegetation density and availability of preferred foods in these border types. Total small mammal density was lower in mowed borders, emphasizing the importance of available non-crop vegetation for supporting small mammal communities within intensive agricultural areas. Field borders planted to promote beneficial insects may be a useful tool for maximizing the ecological services provided by non-crop vegetation.

Songbirds. Using single-observer transect surveys, we compared overwintering sparrow densities among 4 field border treatments (planted native warm season grasses and prairie flowers, planted prairie flowers only, fallow, and mowed) replicated around 9 organic crop fields from November-March 2009-2010 and 2010-2011. Sparrow densities were 5-10 times lower in mowed borders than in other border treatments in 2009-2010 and 2010-2011, but did not differ among planted and fallow borders in either year. Planted field borders may be a useful conservation practice for providing habitat for both overwintering sparrows and beneficial insects.

Extension and/or education activities completed or upcoming:

In addition to working directly with growers to design and plant habitat on 12 organic farms, the following training sessions were provided:

- Establishing Beneficial Insect Habitat in Orange County. Thursday, May 31, 2012, Whitted Bowers Farm in Cedar Grove, NC (44 attendees; evening workshop)
- Establishing Beneficial Insect Habitat in Nash County. NCSU Organic Grain Project's Nash County Organic Canola Field Tour. May 30, 2012, Hickory Meadows Organics in Whitakers, NC (33 attendees; part of evening workshop)
- Habitat for Multiple Ecological Services. CEFS Seasons of Sustainable Agriculture Series Workshop, CEFS, Goldsboro, May 23, 2012. (37 attendees; half-day workshop)
- Beneficial Insects and Field Borders. NCWRC, Field Borders and North Carolina Farms workshop, Kenansville. Feb 23, 2012. (58 attendees; 25 minute presentation as part of half day workshop).
- Beneficial Insects: Their Identification, Value and Encouragement. Plants, Pests & Pathogens Broadcast, NCSU June 28, 2011. (40 minute talk)
- Farmscaping For Pest and Wildlife Management. CEFS Seasons of Sustainable Agriculture Series Workshop: CEFS, Goldsboro, May 25, 2011. (all-day workshop)
- Beneficial Insects and Their Habitat Needs. CCCWE Habitat Steward Workshop, Raleigh, April 15, 2011 (1 hr. presentation)
- Designing and Providing Habitat For Beneficial Insects and Farmland Wildlife. Carolina Farm Stewardship Association (CFSA) annual conference, Winston-Salem, Dec. 5, 2010. (2 hr. workshop).
- Farmscaping For Pest and Wildlife Management. CEFS Seasons of Sustainable Agriculture Series Workshop: CEFS, Goldsboro, July 14, 2010. (all-day workshop)
- On-Farm Habitat for Beneficial Insects. Farm Tours and Presentations, Orange, Chatham and Wilson counties, April 27, 29, 2010. (all day tours and presentations with NCSU, NRCS and Xerces Society personnel).
- Establishing Habitat for Beneficial Insects. Webinar for eastern US NRCS, Raleigh, Feb 24., 2010 (1.5 hr. webinar)
- Landscaping for Beneficials. Nash County Master Gardeners, Nashville, Jan 25, 2010 (1.5 hr. presentation)
- “Organic Pest Management and The Future of Organic Agriculture”. Encore class in Organic Agriculture, Raleigh, November 30, 2009. (1 hr. presentation).
- “Alternative Pest Management, Biological Control, and Beneficial Insect Habitat”. CCA Training, Forsyth County Extension Center, Nov. 17, 2009. (1 hr. presentation).
- “Cover Crops and Beneficial Insects”. CEFS Seasons of Sustainable Agriculture Series, Summer Cover Crop Demonstration Workshop: Sandhills Research Station, July 15, 2009. (20 minute presentation)
- “Establishment, Maintenance and Value of Prairie Forbs and Grasses” Workshop: “Native Forbs and Grasses: What’s available and how to establish and maintain plantings”, Smithfield, Aug. 19, 2009. (30 minute presentation).
- “Farmscaping For Beneficial Insects”. CEFS Seasons of Sustainable Agriculture Series Workshop: CEFS, Goldsboro, July 15, 2009. (all-day workshop)
- “Large Scale Implementation of Agroecosystem Habitat to Enhance Ecological Services”. NRCS East Coast Administrative Representatives, CEFS Tour. Goldsboro, May 14, 2009. (30 minute presentation).
- “On-Farm Habitat For Multiple Ecological Services”. Duplin/Sampson counties Advisory Panel. Faison, April 7, 2009 (2 hr. presentation).
- “On-Farm Habitat For Multiple Ecological Services”. Nash/Wilson counties Advisory Panel. Red Oak, April 2, 2009 (2 hr. presentation).
- “Field Borders and IPM”. Wildlife and Water Quality Workshop at the Murphy-Brown CURE (Cooperative Upland habitat Restoration and Enhancement) area, Ammon, Sept. 11, 2008. (three 20 minute presentations).

Websites, patents, inventions, or other community resources created:

<http://www4.ncsu.edu/~dorr/index.html>

The significance of your findings to organic agriculture:

Results of this study have provided the opportunity to work directly with dozens of organic growers to help them effectively design and establish habitat on their farms to meet National Organic Program standard § 205.206(b)(2) and maximize ecological services from the habitat for not only pest and weed management, but also farmland wildlife.

Other comments or recommendations for future work:

A future project may try to incorporate economic values into habitat development. For example, selecting habitat plant species that could also be used for cut flower production may provide growers with a greater incentive to plant and maintain habitat to support ecological services.

Project Title: Sustainable systems for cucurbit crops on organic farms

Award number: 2009-51300-05581

Period of funding: September 1, 2009-August 31, 2012 (currently on one-year no-cost extension)

Primary Institution: Iowa State University

Project Director Name and email: Mark Gleason (mgleason@iastate.edu)

Project Director telephone: 515-294-0579

Website: Organic Cucurbit Growing Community (<http://organiccucurbit.plp.iastate.edu/>)

The purpose of the project: The project's goals were: 1) determine how spunbond row covers, compost fertilizers, and plant-growth-promoting bacteria can be integrated into practical and profitable organic production of muskmelon and butternut squash in Iowa, Kentucky, and Pennsylvania; 2) develop weather-based models to help predict key risk periods for cucumber beetles, squash bug, and squash vine borer; 3) find out how floral provisioning strips affect bee traffic and yield, and quality in adjacent squash and muskmelon fields; 4) determine how landscape diversity near farms affects bee visits to cucurbit crops; 5) calculate profitability of the integrated management strategies that were trialed in the project (goal 1); and 6) share the findings with organic vegetable growers in the Midwest, Mid-South, and Mid-Atlantic Regions.

Progress to date:

1) Integrating row covers, compost, and plant-growth-promoting rhizobacteria in muskmelon and butternut squash. Replicated field trials were conducted for 3 years on university farms in IA, KY, and PA. The trials compared the standard organic grower practice of removing row covers at anthesis (when female cucurbit flowers start to appear) with delaying their removal until 10 days later. For the delayed-removal treatments in IA, we compared opening the row cover ends at anthesis with placing bumble bee hives (Koppert, Inc.) under the covers. A treatment with no row cover protection was used as a control. KY trials included an "on-off-on" row cover treatment that removed row covers for approximately 2 weeks during fruit set, then replaced them for the rest of the season; PA initially also included a full-season row cover treatment on butternut squash with bumble bees underneath, and IA trialed an on-off-on strategy for squash in Years 2 and 3. Initially, the trials also incorporated two levels of locally sourced composted organic matter each year as fertilizer, representing assumed 10% and 30% N mineralization rates of the compost; commercial bagged fertilizer (Fertrell, Inc.) served as a control. In addition, the trials included a treatment that incorporated a plant-growth-promoting rhizobacteria product (Kodiak) in growing media during transplant preparation. OMRI approved insecticides (mainly Pyganic) and fungicides as needed. Populations of the key insect pests (cucumber beetles, squash bug, and squash vine borer) were monitored, as well as the incidence of plants damaged or killed by these insects and by bacterial wilt (carried by cucumber beetles), along with marketable and cull yield.

RESULTS varied among states and years, but several trends emerged.

Muskmelon. In all 6 site-years where there were appreciable cucumber beetle populations, delaying row cover removal significantly suppressed incidence of bacterial wilt – by up to 38% - compared to the no-row-cover control and row cover removal at anthesis. Bumble bees under row covers for 10 days did not affect yield in Iowa, so this was discontinued after Year 1. The on-off-on row cover strategy suppressed bacterial wilt, but results varied widely. For example, the strategy worked well in Year 1 in KY, in a very dry season, except for an unanticipated pest problem: voles sheltering under the row covers ate holes in melons before harvest. Year 2 had relatively low cucumber beetle pressure in KY, and Year 3 saw a near-complete wipeout of the squash crop, even under row covers, due to extremely high squash bug populations. In PA, delaying row cover removal by 10 days consistently suppressed bacterial wilt in years with significant cucumber beetle populations, and improved marketable yield compared to either the

standard-practice control (row covers removed at anthesis) or the non-covered control. There were no consistent differences in marketable yield associated with compost treatments. Similarly, adding Kodiak PGPR bio-inoculant during transplant preparation had no consistent impact on either the incidence of bacterial wilt or marketable yield. Frequency of insecticide and fungicide sprays was generally lower in row-covered than non-covered plots, and the on-off-on treatment required the fewest sprays.

Bottom line: Delaying row cover removal by 10 days, supplemented with Pyganic sprays based on scouting, has good potential to help Midwest and Mid-Atlantic growers control bacterial wilt with less need for insecticide use. Under heavy cucumber beetle pressure such as in KY, the on-off-on row cover strategy has promise but some problems (vole damage to fruit) need to be worked out. Compost use delivered commercial yields at lower application rates, which is consistent with our hypothesis of higher N-mineralization rates of compost under row covers. This finding has strong potential for reducing input costs associated with compost when working with row covers. Kodiak did not look promising as a bio-activator.

Butternut squash. We found no consistent yield advantage by extending the row-covered period for either 10 days after anthesis or the entire season compared to removing them at anthesis, but the latter treatment (the standard grower practice) often out-yielded the non-covered control. The on-off-on row cover treatment sometimes resulted in the lowest yield. Yields with compost treatments were often comparable to those with Fertrell and exceeded the no-fertilizer control. Kodiak had no consistent impact on yield. Under extremely high late-season squash bug and cucumber beetle pressure in IA in 2012, most unprotected squash plants died due to insect pest feeding before fruit had matured, leaving the full-season (on-off-on) row cover treatment as the only one with substantial marketable yield.

Bottom line: Row cover removal at anthesis was usually the best option for marketable yield on butternut squash. Delaying row cover removal for longer periods – either for 10 more days, or then replacing it until harvest – had variable results, sometimes reducing yield but in other site-years preserving yield when other management options failed under high squash bug pressure. Results for compost addition and Kodiak were similar to those for muskmelon.

2) Developing degree-day models for cucumber beetles, squash bug, and squash vine borer.

Early-season recruitment. Beginning in early spring of 2010, 2011, and 2012, prior to the time of when growers plant their fields, we deployed a flat of ‘Blue Hubbard’ squash seedlings at each of 10 sites on university farms in IA, PA, and KY to monitor for early-season recruitment of cucumber beetles and squash bugs, using yellow sticky cards and visual inspection three times per week for at least 5 weeks.

Phenology strips consisted of two adjacent 50-ft-long rows each of butternut squash and muskmelon that had no insecticide applications, from which 10 plants per crop were inspected twice per week until harvest for squash bug adults, eggs and nymphs as well as adult cucumber beetles using vacuum aspiration. This provided biofix data (time of colonization of a crop) and population dynamics data,

Pheromone traps. Monitoring for squash vine borer was done using pheromone lures suspended from Hartstack traps. Two traps per farm were checked twice per week for adult moths from late May until mid-August.

RESULTS.

Striped cucumber beetle. We focused on this species since it occurs in all 3 states and is the main vector for *Erwinia tracheiphila*, which causes bacterial wilt. Results from 6 site-years in KY and PA showed that overwintering adult beetles (a primary source of the bacterium early in the season) started their recruitment to cucurbits at 150 (range of 140-160) degree-days (base 55° F) after January 1. This biofix – the first ever developed for the overwintering generation of striped cucumber beetle - is important because it can be used to alert growers to start protection measures against this major pest and estimate generational times at a farmscape or landscape level. Using 30-year climatology data, we can narrow the window to approximately 11 calendar days in PA, and 10 calendar days in IA and KY. We also successfully modeled recruitment rate to trap-flats as a classic Gompertz equation, and used that, plus the measured biofix (time-of-colonization in the phenology strip) to predict time of emergence of a 2nd and subsequent generation in the phenology strip. Initial efforts to validate the current-season model with

population dynamics data from the phenology strips met with variable results, mainly because it was difficult to distinguish which adults came from reproduction within the phenology strip versus continued immigration from the farmscape. Nevertheless, all replications among states and years showed very good agreement between predicted and observed emergence of new adults when we used biofixes to assume when egg-laying was initiated, and advanced the population from eggs to adults with temperature-dependent development rates.

Bottom line: The early-season recruitment model provides a powerful new tool to warn growers about the start of high-risk springtime periods for striped cucumber beetle, which can be used to optimize trap-cropping efforts, and when to couple trap-cropping with late planting as a management tool. The whole-season phenology model can determine the number of generations per year that will occur in a given year and location.

Squash bug. In KY and PA, squash bug adults began to appear on trap flats about 140 to 175 degree-days (base 60° F), which was surprisingly early compared to the literature.

Bottom line: Early-stage research set the foundation for future development of a degree-day model for squash bug.

Squash vine borer. Six site-years of monitoring in IA, KY and PA resulted in a threshold for capture of late-stage pupae of squash vine borer of 1,080 degree-days, base 50° F, since January 1. However, the variation in the threshold degree-day level among site-years was substantial. We concluded that numerous additional site-years of data are needed before proposing a practical degree-day model for squash vine borer.

Bottom line: More field data are needed before a reliable degree-day model for squash vine borer can be developed.

3) Find out how floral provisioning strips affect bee visitation and yield in nearby squash and muskmelon fields.

In spring 2010, we transplanted 10 species of native flowers in a randomized pattern in double 120-m-long strips at a university farm in each state. In 2010, 2011, and 2012, 6-row subplots (10 m long) of muskmelon and butternut squash were planted parallel to and on either side of the floral provisioning strip. The control plot, located at least 500 m from the floral provisioning plot on the same farms, consisted of same-size subplots of muskmelon and butternut squash, but with a grass or bare-earth strip replacing the floral provisioning strip. The study was thus replicated by state rather than by farms within states, and repeated for 3 years. The cucurbit crops were protected with row covers until anthesis. We sampled populations of bees weekly on flowers in both the floral provisioning strips and the cucurbit crops; bees were identified to major taxa and counted during visual surveys, and also collected from the floral provisioning strips and cucurbit crops using Bug Vac aspirators. Bee samples from the Bug Vacs were identified to species in almost all cases, and to genus for *Lasioglossum*. Marketable and cull yields were recorded for each cucurbit row individually. In addition, seeds from a subsample of muskmelon and butternut squash per row were counted as a measure of pollination .

RESULTS.

The spatial pattern of harvestable yield with distance from the floral provisioning strip varied with site, year, and cucurbit crop. Similarly, the yields of cucurbit crops adjacent to the flower strip vs. the control (grass) strip also had a variable trend. The 2012 butternut squash harvest was completed in late September in IA, and 2012 data analysis is ongoing. Identification of the 2010 and 2011 bee collections has been completed, and bees from 2012 will be identified by December 31.

4) Determine how landscape diversity near farms affects bee visits to cucurbit crops.

Eight farms were selected in each state, representing a continuum of landscape diversity from simple to complex. During the summers of 2010 and 2011, each farm was visited twice. During each farm visit, bees in muskmelon and winter squash flowers found in 40 one-m² quadrats were observed and identified

to morpho-species (broad groups of similar-looking species). Bees were then collected by two individuals for 15 minutes (30 minutes total collection) in the cucurbit field. The bees were killed using kill jars and placed in a freezer until they could be pinned and later identified to species. In addition, 15 bee bowls (plastic bowls filled with water, dish detergent, salt and propylene glycol) were set out in the cucurbit field for a week (five bowls each of yellow, blue and white color). The insects captured in the bowls were collected a week later, stored in 70% ethanol solution, and refrigerated until they could be pinned and later identified to species, mainly by Dave Biddinger at Penn State University.

Digital maps of the landscape surrounding each farm were downloaded from USGS National Land Cover Database 2006. A 3-mile-diameter perimeter was drawn around each farm (digitally on the computer using Geographic Information System (GIS) tools) and the land cover type/category was visually verified by researchers in the field following each summer of bee observation and collection. Qualitative and quantitative land cover summaries were performed using GIS tools in ArcMap. Statistical analysis of the landscape data in relation to bee diversity and abundance is ongoing.

5) Calculate profitability of the integrated management strategies that were trialed in the project.

We are using a partial budget analysis to assess costs and returns for the management options in the field trials integrating row covers, compost amendments, and Kodiak in muskmelon and butternut squash production. Results from IA, PA, and KY are being analyzed separately due to divergence of field experiments in Years 2 and 3 in response to regional differences in pest pressure and other factors. The analysis, which includes all three field years (2009-2011 in PA, and 2010-2012 in IA and KY), is ongoing.

6) Share the results with organic cucurbit growers.

Advisory Panel. The project has been advised by a 12-grower Advisory Panel, including 4 organic growers from each state. The Advisory Panel has participated in each of the project's 10 teleconferences over a 3-year period, and provided timely feedback for interpretation of results as well as vital reality checks on experimental design modifications.

The **project website** (<http://organiccucurbit.plp.iastate.edu/>) is becoming the centerpiece of the project's long-distance outreach. It includes information on all the project PIs and graduate students, digests of project results, numerous images of project activities as well as pest and insect damage on cucurbits, and field day reports and relevant extension bulletins, as well as scientific papers related directly to the project's purposes. Topics range from pest, disease and crop management to growing techniques. The site has interactive capability, allowing growers to comment on its content and be part of a community through the use of social media tools (Facebook, Twitter and YouTube). The site was beta-tested in 2011 by four Iowa organic cucurbit growers, who made several very useful suggestions to improve the site's usefulness to growers. The suggested improvements were incorporated and additional resources, graphics and pictures added.

The Penn State PIs and collaborators have developed an **interactive web-based decision tool** that allows growers to determine when they should begin watching for striped cucumber beetles in their fields. The site is based on a site-specific temperature grid for eastern North America that allows a grower to click on his/her farm location on a map to obtain the latest degree-day totals along with an indication of how close they are to the threshold for overwintering adult beetles to fly to cucurbit fields. This web-based tool is in a final design phase and will be available for testing by growers in spring 2013.

Extension and/or education activities completed or upcoming:

Field days. Eight field days in 2010 - two in Iowa (June 29 at Muscatine; July 29 at Gilbert), four with University of Kentucky PIs (two in Lexington, KY on June 16 and July 22, one at Carl Benson's farm in Forkland, KY on August 10, and one in Knoxville, TN, on August 19), and two in Pennsylvania (July 8 at

Rock Springs, and July 16 at Limestoneville and Harleton). An additional 8 field days in 2011 were held as follows: one in Iowa (July 19 at Gilbert); four in KY (one in Lexington (September 6), one in Frankfort (September 27), one in Murray (March 16), and one in Princeton (August 19); and three in Pennsylvania (July 12 in Liverpool, July 18 in Loganton, and July 27 in Fleetwood). An additional three field days, one per state, featured the project's field trials in summer 2012.

Grower meetings. We have shared findings with growers through publication of research summaries in handouts to growers at indoor meetings of grower groups in 2010 including Practical Farmers of Iowa (January 9 in Marshalltown), Iowa Fruit and Vegetable Growers Association (January 29 in Des Moines), Pennsylvania Association for Sustainable Ag (PASA) (February 5-6 in State College), and the regional Pollinator Short Course (July 29 in University Park, PA), and the Kentucky Fruit and Vegetable Conference (Jan 4-5). Four additional meetings were held in Kentucky during the winter of 2011 and at a two-day Vegetable Growers Academy on January 31-February 1 and February 15-16, 2012.

On-farm demonstration trials. Nine organic growers (three each in Iowa, Pennsylvania, and Kentucky) gained hands-on experience with using row covers to protect melons and squash during on-farm trials coordinated by the project team in 2010. The number of the project's on-farm trials was reduced to six for the 2011 and 2012 growing seasons.

Websites, patents, inventions, or other community resources created:

Website. Organic Cucurbit Growing Community (<http://organiccucurbit.plp.iastate.edu/>)

The significance of our findings to organic agriculture:

- We showed that spunbond row covers have can allow for organic muskmelon and butternut squash production that otherwise would have been difficult to impossible by providing timely protection from key pests and diseases as well as environmental extremes.
- Our degree-day model for timing the early-season activity of striped cucumber beetle will help cucurbit growers to take timely counter-measures against this extremely damaging pest. An easy-to-use website will give all U.S. growers ready access to the model's advice.
- Results of our pollinator field studies will help cucurbit growers to decide whether adding flowering perennials to their farms and increasing habitat diversity can safeguard the bees that pollinate their crops and thereby protect their yield.
- The website will extend the project's impact after its completion. Growers will be able to keep using and adding to the existing resources through the social media tools that were created.

Other comments or recommendations for future work:

- Our study reinforced the impression that integrated organic management systems for cucurbit crops must be customized to regional conditions, including pest and disease pressure, climate, and soils. What works for Kentucky growers is unlikely to be the best answer for Pennsylvania or Iowa. Given the wide divergence of outcomes in our integrated-management field studies even among years on the same farm, it is also clear that row covers need further investigation over more years per site to understand the full range of their positive and negative impacts on marketable yield and profitability.
- The use of row covers needs to be streamlined and made more efficient if their benefits are to reach growers with more than an acre or two of crops to be covered. The primary needs are: 1) a labor-efficient and affordable way to deploy, remove, store, and re-deploy them; 2) a Life Cycle Analysis that indicates the energy costs associated with their use; and 3) a set of guidelines that help growers to maximize the useful lifespan of row covers, in order to reduce waste and cost. The project team is currently engaged in two additional USDA-funded projects to meet these needs.
- Our development of a degree-day model to predict the timing of striped cucumber beetle activity during the critical early period of the cucurbit growing season needs to be validated by additional

years of monitoring in several eastern U.S. states in addition to IA, PA, and KY, to insure that it is generalizable over as broad a geographic region as possible.

Project Title: Integrating community college students and organic farmers throughout feasibility studies in pest management, and horticulture production in South Texas

Award number: OTP-NIFA-USDA Grant No. 2010-51106-21803

Period of funding: September 2010 to August 2013

Primary Institution: Texas A&M AgriLife Extension Service

Project Director Name and email: Raul T. Villanueva (email: rtvillanueva@ag.tamu.edu)

Project Director telephone: (956)968-5581

Co-Project Director Names and emails: Luis Ribera (laribera@ag.tamu.edu), Debbie Villalon (dvillalon@southtexascollege.edu), and Barbara Storz (b-storz@tamu.edu).

Website: Sites developed by South Texas College for students awarded with grant

<http://biologygrants.southtexascollege.edu/org-farm/>

<http://news.southtexascollege.edu/?p=5157>

The purpose of the project:

This project has two main objectives, the first is to provide growers with technical tools in horticulture, pest management, and economic analysis to develop organic agricultural production, and the second is to educate and integrate local college students with organic farmers from the Rio Grande Valley through studies conducted at grower's farms and with the advice of Texas A&M AgriLife Extension faculty. The project includes studies on cultural practices, crop protection, insect pollinators and economic analysis. Here we are providing preliminary results of studies conducted by some of the South Texas College students, and Texas A&M faculty. All studies were conducted in four farms in the Rio Grande Valley.

Completed to date:

Mulch effect on pests and predators: In this study, we evaluated if different types of mulch have any effect on populations of insect pests or their natural enemies. We used non-woven 100% polypropylene (Preen Landscape Fabric®) and woven polypropylene (Sunfilm Taffeta Mulch) like mulch. Watermelon plants were inspected weekly over the course of two months. This study was not destructive; the pest and beneficial insects were not removed from the plants. Data were analyzed with an ANOVA and differences were separated with LSD ($p < 0.05$).

Results: The predatory insect population in watermelon was similar under the two types of mulch (Fig. 1). However, insect pest populations were more abundant on nonwoven compared with woven mulch. Populations of leafminers and whiteflies were greater in the nonwoven polypropylene than woven mulch (Fig. 2). We can hypothesize that light reflectance or temperatures may have an impact on the pest abundance on the nonwoven mulch compared to the woven mulch however, further studies are necessary.

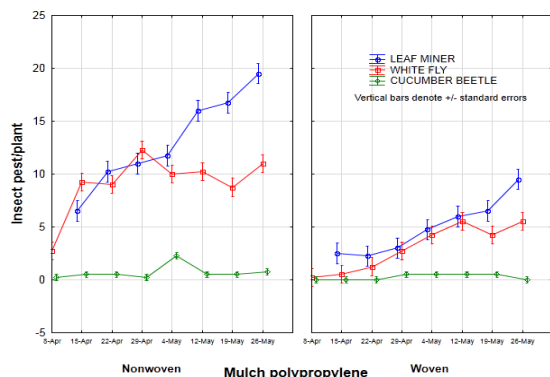


Figure 1. Mean insect predator population (±SEM) on

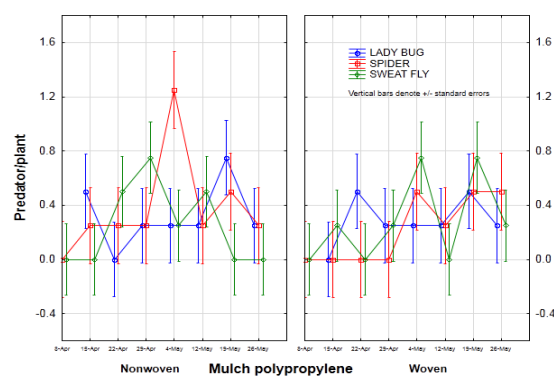


Figure 2. Mean insect pest populations (±SEM) on

organic watermelon with nonwoven and woven mulch

organic watermelon with nonwoven and woven mulch

Damage evaluation of leaf cutting ants in Black Spanish (Lenoir grapes) *Vitis aestivalis*: A two-year

old black Spanish grape was evaluated for this study. Registered organic pesticides were used to protect the vineyard from leaf eating insects. The products used were Surround® (kaolin), Surround Purshade® (kaolin), Oroboost® (citrus oil), and Spintor Down-Entrust® (spinosad). Although leaf cutting ants were not forecasted as pest, this species caused large defoliation to the vines. The damage was rated on all treated plots as: 0 = no defoliation 1 = little defoliation, 2 = light defoliation, 3 = medium

defoliation and 4 = heavy defoliation. In addition, yield of grapes for all treated plots was obtained at harvest (fresh grapes; lb). In addition, yield data of all treatments was completed for all plots. A descriptive analysis for damage levels rates and yield was made using ANOVA with homogeneous groups with LSD ($p < 0.05$).

Results: Only, leaf cutting ants (*Atta texana*) were found causing large defoliation to the vines. Although, spinosad was not used with the purpose of controlling leaf cutting ants, we found that vines sprayed with this product have less defoliation compared with the two formulations of kaolin or citrus oil (Fig. 5). Apparently, the application of spinosad had a positive effect on the yield in 2011. A study by Nyamukondiwa and Addison (2011) showed that spinosad 0.01% bait (dissolved in 25% sucrose solution) had potential for the control on two ant species *Anoplolepis custodiens*, and *Crematogaster peringueyi*. However, studies conducted in 2012 with low and high doses of spinosad did not show similar results. Furthermore, damage analysis of leaf cutter ants showed that 60% defoliation damage by leaf cutter ants can cause a >90% reduction on grape yield.

Pollinators on organic farms: In this study we used yellow sticky traps placed on 2-m wood poles at 1.5 m heights in organic fields. The study was completed between February 27 and June 5, 2011. Traps were changed every two weeks and identification of insects was made using a stereoscope, quantifying the numbers of pollinators (bees, wasps, beetles, butterflies, moths, flies, and midges) per trap.

Results: Six insect families of pollinators were found in the organic farm on South Texas. There were 1.9 honey bees (Apidae) per trap across all dates, others important pollinators were sphecid, chrysid wasps and sweat bees (Halictidae) (Figure 6). In addition, we found several beetles and moths (Syrphidae, and Sphingidae). The hymenopteran species were cuckoo, red, paper, mud dauber, and threadtail wasps.

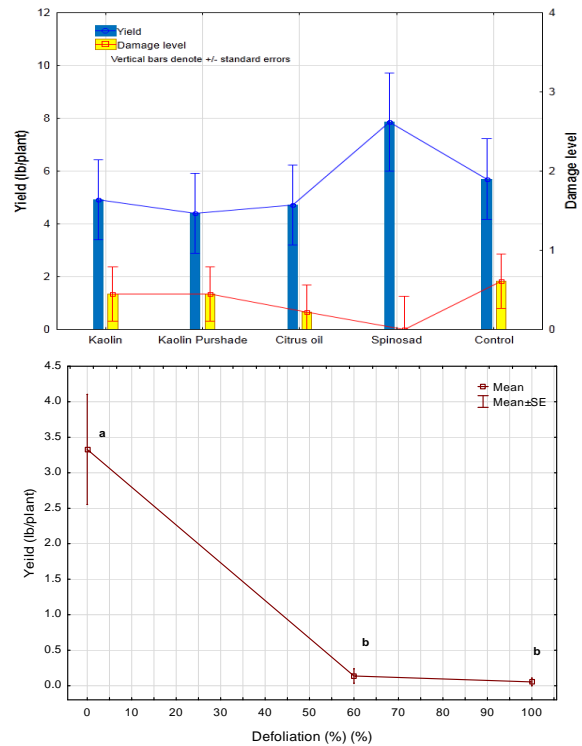


Figure 3. Top: Mean yields (\pm SEM) per vine and damage levels of leafcutting ant mean (\pm SEM) in a 2-yr old Black Spanish organic vineyard in 2011. Bottom: Grape yield decrease under different levels of defoliation in 2012

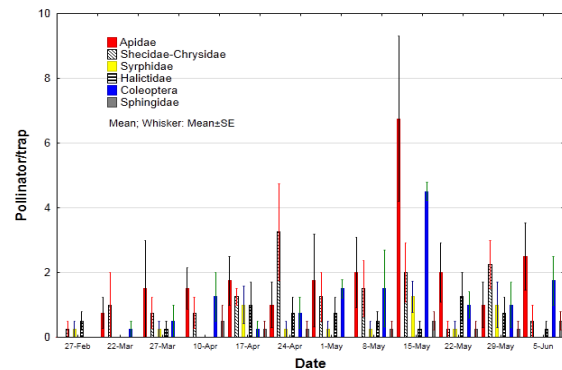


Figure 6. Mean (\pm SEM) distribution of pollinator populations per yellow trap in an organic farm

Economic feasibility of small organic vegetable farms: In this study we developed a representative/virtual farm based on the information provided by a panel of three local small acreage organic producers in the Lower Rio Grande Valley. The study examines the 2011 revenue stream on this three-acre produce operation that relies on three income streams: a Community Supported Agriculture (CSA) Program, farmers markets, and sales to local restaurant establishments. The farm produces about 30 to 50 different vegetable crops on an 11-month growing season, August to June. Under normal growing conditions, each acre of vegetables can supply about 40 to 50 CSA members. The production is used to supply the CSA (80 percent), and farmers market and restaurant sales (10 % each). The farm is not certified organic, but follows strict organic production practices.

The farm's CSA fee is \$15/week for 24 weeks. Members pay a \$50 membership fee at the beginning of the season for the opportunity to share in the CSA's bounty for the duration of the season; membership fee is waived if entire season is paid in full at the beginning. The farm's current production is assumed to support an average of 100 CSA members, and an estimated 10 percent of members pay in full at the beginning of the season.

Based on average income levels, the farm's gross receipts from the CSA are estimated at \$40,500. On average, the CSA generates 63.6 percent of the farm's total cash receipts. In addition to produce distributed through the CSA arrangement, sufficient quantities are available to supply farmers markets and restaurants. Based on 2011 levels, sales to farmers markets in Harlingen and McAllen, Texas accounted for sales of \$18,021 (28.3 percent of total cash receipts). Income is higher from January to June because leafy greens are a favorite among farmers market patrons; no leafy greens are produced from August to December due to unfavorable growing conditions, thus farmers market sales are lower in those months. Restaurant sales to local establishments account for \$5,185 per year in receipts for the farm.

Table 1. Sensitivity Analysis of the Contribution of CSA Members vs. Farmers Markets and Restaurant Sales on Farm's Net Cash Income. Shaded areas represent returns above cash expenses (green) and below cash expenses.

Net Cash Income											
Reduction in CSA Members	Reduction in FM and Restaurant Sales										
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	\$41,318	\$38,998	\$36,677	\$34,356	\$32,036	\$29,715	\$27,395	\$25,074	\$22,754	\$20,433	\$18,113
10%	\$37,268	\$34,948	\$32,627	\$30,306	\$27,986	\$25,665	\$23,345	\$21,024	\$18,704	\$16,383	\$14,063
20%	\$33,218	\$30,898	\$28,577	\$26,256	\$23,936	\$21,615	\$19,295	\$16,974	\$14,654	\$12,333	\$10,013
30%	\$29,168	\$26,848	\$24,527	\$22,206	\$19,886	\$17,565	\$15,245	\$12,924	\$10,604	\$8,283	\$5,963
40%	\$25,118	\$22,798	\$20,477	\$18,156	\$15,836	\$13,515	\$11,195	\$8,874	\$6,554	\$4,233	\$1,913
50%	\$21,068	\$18,748	\$16,427	\$14,106	\$11,786	\$9,465	\$7,145	\$4,824	\$2,504	\$183	\$(2,137)
60%	\$17,018	\$14,698	\$12,377	\$10,056	\$7,736	\$5,415	\$3,095	\$774	\$(1,546)	\$(3,867)	\$(6,187)
70%	\$12,968	\$10,648	\$8,327	\$6,006	\$3,686	\$1,365	\$(955)	\$(3,276)	\$(5,596)	\$(7,917)	\$(10,237)
80%	\$8,918	\$6,598	\$4,277	\$1,956	\$(364)	\$(2,685)	\$(5,005)	\$(7,326)	\$(9,646)	\$(11,967)	\$(14,287)
90%	\$4,868	\$2,548	\$227	\$(2,094)	\$(4,414)	\$(6,735)	\$(9,055)	\$(11,376)	\$(13,696)	\$(16,017)	\$(18,337)
100%	\$818	\$(1,502)	\$(3,823)	\$(6,144)	\$(8,464)	\$(10,785)	\$(13,105)	\$(15,426)	\$(17,746)	\$(20,067)	\$(22,387)

Actual costs of production were utilized in 2011 and were estimated at \$20,063. Labor cost accounts for about 62.2 percent of the total cost of production as two part-time workers are needed to help (red), mainly on the production side of the farm. Not included in the cost of production is the labor provided by the owner which is assumed to work full time. The farm experiences positive net cash income in 2011 of \$41,318. Net cash income is defined as total cash receipts minus total cash expenses. This figure does not reflect profit, as principal payments on loans, and employment and income taxes must be paid from this value. Moreover, results of a sensitivity analysis examining the contribution of the CSA vs. farmers markets and restaurant sales to the farm's net cash income are reported in Table 2. This sensitivity

analysis assumes a constant cash expense. On the vertical axis, reductions on CSA members are shown in increments of 10 percent, while on the horizontal axis reductions on farmers markets/restaurant sales are shown with the same incremental reductions. To illustrate, when both CSA members and farmers markets/restaurant sales present no reduction, the net cash income is \$41,318 as shown previously. However, if there are no CSA members, meaning the only source of revenue is the farmers markets and restaurant sales, the net cash income is only \$820. Conversely, if the only source of revenue were the CSA, then the net cash income would be \$18,113, thus demonstrating the importance of the CSA to the farm's profitability.

Extension and/or education activities completed or upcoming:

- Presentations to community: 16 (2 in 2010, 8 in 2011, and 6 in 2012)
- Scientific meeting presentations: 7 (1 in 2010, 2 in 2011, and 5 (2 projected in Nov) in 2012)
- Conferences organized: 2 in 2011 (Science conference at STC and 1st Joint Organic Conference STC-Texas Agrilife Extension in Weslaco
- Upcoming Conferences in 2012 and 2013: 2
- Publications: 1 (Economic Feasibility of a Small Acreage Organic Vegetable Farm in South Texas), 3 in progress and many handouts provided .

The significance of your findings to organic agriculture:

Farmers are starting to utilize some of the tools provided such as the use of mulch (due to intense heat some mulch types last only one year), t-tape for water efficacy, pest management for control of pests and expanding their farms, or starting new farms by relatively young farmers.

- Farmer Markets: in 2009 there was only one in the valley in Brownsville, Since then there are 8 new farmer markets across the RGV: McAllen, Weslaco, Harlingen, Edinburg, Brownsville, San Juan, Mission
- Yahweh Farm continue with CSA and move into providing land for a CSA'type community garden, now including animals and projected opening of a farm market.
- Two former collaborators started to move into Organic farming , now using tools developed in program
- Citrus organic: a farmer that has 12 organic acres is moving toward expand their orchard into organic farming production almost tripling the acreage.

Regarding the results, these studies represent a compendium of preliminary findings on pest and beneficial insects in transitional organic farms in the Rio Grande Valley; mulch type affected directly insect pest population, spinosad prevents the ant defoliation on vines, and finally the insect pollinator species will be identified later. Finally, a three-acre organic vegetable farm can be profitable averaging \$41,318 in net cash income per year.

Students of STC were able to develop knowledge and discipline to carry on systematic data recording. Involving these students in research is a contribution not only in their professional development but also in research conduction where labor and basic knowledge is scarce. Below are some noticeable examples on how this project contributed to the development of these students:

- David Garza presented at the national meeting, and now moved to UT San Antonio
- Antonio Martinez winner of the 1st organic conference presentation, and moved to Texas A&M Kingsville. He had chosen a major in Agriculture
- Guadalupe Alaniz: recently accepted to participate as a National Community Aerospace Scholar, once a nursing major, now Biology major since gaining the experience of both Microbiology (in class)
- Juan Enciso: Co Author of first publication (see above) an recently moved to continue studies in Economy at UT Pan-American in McAllen

Other comments or recommendations for future work:

- Texas case, planting season opposite to the rest of country, an extension to complete project will be requested
- Students award numbers might need to be reduced and stipend increased if new award is provided

Project Title: Northeast Wisconsin Technical College (NWTC) Organic Agriculture Program

Award number: 2008-51300-04307

Period of funding: 07/01/2008 through 06/30/2012

Primary Institution: Northeast Wisconsin Technical College (NWTC)

Project Director Name and email: Amy Kox, amy.kox@nwtc.edu

Project Director telephone: (920) 498-6908

Co-Project Director Names and emails: Valerie Dantoin , valerie.dantoin@nwtc.edu

Website: <http://www.nwtc.edu>

The purpose of the project:

The Northeast Wisconsin Technical College's (NWTC) Organic Agriculture Program was designed to improve resources available to farmers and land conservation professionals in northeast Wisconsin by offering educational and networking opportunities. The goals of the program were to: 1) Increase the quantity, productivity and profitability of organic farming in northeast Wisconsin; and 2) Establish NWTC as a regional resource center in organic farming.

Completed to date: 06/30/2012

Extension and/or education activities completed or upcoming:

Project Outputs:

1. A 12-credit Organic Agricultural Practices Certificate was developed and offered. Certificate course options include: Organic Food and Ag: Practices and Issues (2 credits); Organic Soils, Nutrients and Composting (1 credit); Organic Agronomic Crops (1 credit); Organic Ruminant Livestock (1 credit); Organic Produce (1 credit); Organic Specialty Animals (1 credit); Organic Ag and Food Marketing (1 credit); Organic Farm: Applied (1 credit); Organic Ag: Independent Study (1 credit); Managed Grazing (1 credit); Permaculture, Edible Landscapes (1 credit); Organic Poultry (1 credit); Small Farm Machinery and Tools (1 credit); and Food Nutrition and Preservation (1 credit).
2. Throughout the grant period, the Organic Program Coordinator facilitated/co-hosted seminar/workshop events with an organic agriculture or local food focus. The Organic Program Coordinator provided presentations on different aspects of organic farming and information about NWTC's Organic Agriculture Certificate Program at events throughout northeast Wisconsin. NWTC also hosted several workshops including one for the Wisconsin Association of Agriculture Educators, another for farmers focused on grant programs, and a third for entrepreneurs focused on food safety. NWTC has become a regional resource center for organic agriculture.

Websites, patents, inventions, or other community resources created:

Faculty developed summary papers and presentations to help students understand topics in Organic Agriculture. Reading these papers were part of required course work for students. They are stand-alone documents which could be given out as fact sheets to the community. NWTC Organic Agriculture Program Report Page 2

The significance of your findings to organic agriculture:

The Organic Agriculture Program provides the resources needed to encourage, support, and expand organic farming in northeast Wisconsin and beyond. The grant allowed NWTC to create and implement a 12- credit Organic Agricultural Practices Certificate available on campus and via the internet for farmers considering and/or transitioning to organic farming. This certificate provides farmers with the knowledge and resources needed to be successful, including a farm assessment with recommendations based on current best practices.

Farmers played an important role in the development and implementation of program

In October 2008, a Developing A Curriculum (DACUM) Process was conducted to identify the essential technical skills and knowledge needed to effectively farm organically. As part of this evidence-based process, a panel of 15 organic agriculture experts brainstormed/organized content for organic agriculture courses. Their work played a critical role in the development and design of the curriculum. Farmers also serve on the advisory panel for the program, which meets bi-annually to review and track the progress of the program and make recommendations.

Year-to-date impact of NWTC's Organic Agriculture Program

Three conventional farms have transitioned to organic through this program.

One person has purchased land to start an organic vegetable farm using an FSA loan for which he qualified because of his enrollment.

Approximately 50 growers have incorporated organic practices into their operations.

Ten beginning farmers are currently exploring options for creating new organic farms.

Two students secured jobs on organic farms.

In 2009-2012, the courses in the Certificate program had a total enrollment of 293. There were 152 individuals taking courses. The Certificate is designed to teach the skills and processes necessary to gain USDA organic certification, increase farm and garden productivity, and increase profitability. The Technical College Certificate courses help farmers increase environmental services of organic and sustainable farms including better water quality, nutrient management, wildlife habitat, and access to USDA programs.

Over 600 people in northeast Wisconsin have attended presentations with experts in organic and sustainable agriculture like Dr. Temple Grandin, Dr. Don Huber, Will Winter DVM, and faculty.

The College has been able to partner with the Oneida Tribe of Indians of Wisconsin on a variety of sustainable farming projects including securing a USDA–OAO grant for underserved farmers to host a Food Sovereignty Summit.

Other comments or recommendations for future work:

Complete a methodology/framework for evaluating organic, small farm, and sustainable farm “success.” This will be similar to benchmarks and financial statements developed for conventional farms.

Partner with private organic education groups and businesses to offer more credentialed courses including offering an Associate Degree in Sustainable Food and Agricultural Systems.

Project Title: Farmers' Guide to Organic Contracts

Award number: 2010-51300-21445

Period of funding: 09/01/2010 to 08/31/2012

Primary Institution: Farmers' Legal Action Group, Inc.

Project Director Name and email: Lynn A. Hayes, lhayes@flaginc.org

Project Director telephone: 651-223-5400

Co-Project Director Names and emails: Amanda N. Heyman, aheyman@flaginc.org

Website: www.flaginc.org

Farmers' Guide to Organic Contracts available for download at:
<http://www.flaginc.org/topics/pubs/organic.php#FGOC>

The purpose of the project:

The *Farmers' Guide to Organic Contracts* can assist farmers with all types of agricultural contracts, but the guide's primary purpose is to serve farm operations certified as organic under U.S. Department of Agriculture (USDA) National Organic Program (NOP) regulations. Specific suggestions and information for certified organic operations are highlighted throughout the guide, which features a color-coded symbol system designed to enhance reader understanding.

One major goal of the *Farmers' Guide to Organic Contracts* is to encourage an organic marketing system in which organic producers and organic buyers can thrive together. The organic sector uses written contracts at a much higher rate than the conventional agricultural sector. However, until now, organic farmers had little independent, reliable legal information available to them when presented with—or when proposing—a marketing contract for organic crops, dairy, livestock, or other organic farm products.

This new resource for the organic community can help organic farmers evaluate, negotiate, and manage contract agreements with buyers of organic farm products. This plain-language legal guide includes:

1. An overview of contract laws important to farmers;
2. A Quick Organic Contract Checklist and practical toolkit farmers can use to review and negotiate contract offers;
3. Highlighted sections illustrating how federal organic regulations interact with organic contracts;
4. Examples and discussion of over 100 types of organic contract provisions; and
5. Detailed information about solving the types of contract disputes that commonly arise in the organic market.

Farmers can use the guide as a reference tool to answer questions related to organic contracts. The guide's main Table of Contents, Quick Organic Contract Checklist, and individual chapter tables of contents allow readers to easily find topics of interest. Furthermore, each chapter's table of contents highlights some of the useful contract-related tips found throughout the guide.

Completed to date:

The *Farmers' Guide to Organic Contracts* has been officially released. It is available for free download at www.flaginc.org, and is also available for purchase in hard copy form at FLAG's online publisher: <http://www.lulu.com/spotlight/flagpublications>. The 319-page guide is available in both color and black and white (to allow a significantly lower price point).

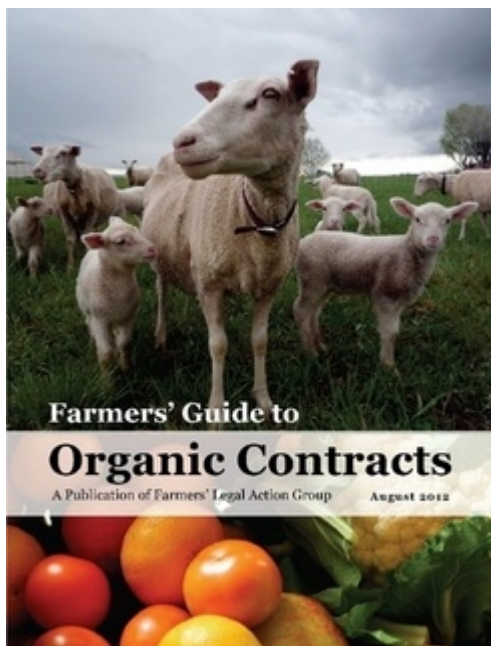
FLAG has also widely circulated a press release about the guide to FLAG's extensive database of contacts as well as via FLAG's Facebook and Twitter social media outlets. The press release is available at <http://www.flaginc.org/topics/news/index.php#20120910a>. In addition, the guide has been featured within the websites, social media outlets, and newsletters of many prominent farm organizations, including Farm Aid, MOSES, California FarmLink, Center for Rural Affairs, and Oregon Tilth. It was also highlighted on ATTRA's website, eOrganic's newsletter, Minnesota's organic listserv, and other media outlets.

Finally, a nonpartisan Minnesota think tank, MN2020, excerpted a large portion of the guide's introduction on its website as part of a commentary on the state of the organic farm products market, entitled "Organic Growers Muscled Out," available at <http://www.mn2020.org/issues-that-matter/organic-growers-muscled-out>.

Extension and/or education activities completed or upcoming:

FLAG will continue outreach activities via email, social media, phone calls, presentations, and other methods as appropriate.

Websites, patents, inventions, or other community resources created:



The *Farmers' Guide to Organic Contracts* has been registered with Publisher's Cataloging-in-Publication and been assigned an ISBN number (9781890508142).

Heyman, Amanda N.

Farmers' guide to organic contracts / written by
Amanda N. Heyman ; edited by Lynn A. Hayes, Karen R.
Krub.

p. cm.

ISBN-13: 978-1-890508-14-2 (color version)

ISBN-10: 1-890508-14-4 (color version)

ISBN-13: 978-1-890508-17-3 (black and white version)

ISBN-10: 1-890508-17-9 (black and white version)

1. Organic farming. 2. Contracts, Agricultural.
I. Hayes, Lynn A. II. Krub, Karen R. III. Title.

S605.5.H49 2012

631.5'84
QBI12-600158

The significance of your findings to organic agriculture:

The goal of the *Farmers' Guide to Organic Contracts* is to help farmers make informed decisions when evaluating, negotiating, and managing contract agreements with buyers of organic farm products. While fair contracts share benefits and burdens equally between two parties, agricultural contracts in many sectors have historically placed unequal burdens on farmers. Some agricultural buyers deal fairly with farmers, but others take advantage of their superior bargaining power and access to more widespread market information to pressure farmers into signing unfavorable agreements.

This guide aims to help farmers create contracts that allow for stability and predictability within the farmer-buyer relationship, while at the same time avoiding contracts that unfairly benefit organic buyers. To that end, the *Farmers' Guide to Organic Contracts* provides farmers with a reference tool to answer questions related to organic contracts. The guide's Quick Organic Contract Checklist and Practical Contracting Toolkit provide a resource for farmers who must make swift contract decisions, while the bulk of the guide provides detailed analysis and examples of over 100 types of contract provisions common in organic contracts for more thorough study. Finally, the guide's system of symbols and tips makes this legal guide accessible to the non-lawyer reader.

Other comments or recommendations for future work:

We believe that, as news of the guide and its usefulness becomes more widespread, there will be many opportunities to conduct future workshops and trainings to broaden the impact of the guide. In addition, based on our experience in gathering information for the guide and the responses we have received to-date, we believe that many farmers who have entered or are entering into organic contracts need legal information and advice on their particular contracts. Those farmers rarely can afford a private attorney; future funding to Farmers' Legal Action Group to provide that information and advice could help stabilize many family farm operations in the organic sector.

Project Title: Crop plant nutrition and insect response in organic field crop production: Linking farmer observation to university research and extension.

Award number: 2010-51300-21282

Period of funding: 09/01/2010 to 08/31/2014

Primary Institution: University of Wisconsin – Madison

Project Director Name and email: Eileen Cullen (cullen@entomology.wisc.edu)

Project Director telephone: (608) 261-1507

Co-Project Director Names and emails: Phillip Barak (pwbarak@wisc.edu), Paul Whitaker (paul.whitaker@uwc.edu), Kevin Shelley (kshelley@wisc.edu)

Website: <http://labs.russell.wisc.edu/cullenlab/research/insect-management-in-organic-farming-systems/>

The purpose of the project: Our project is designed to develop and disseminate information on how soil fertility practices and crop plant nutrition contribute to insect integrated pest management (IPM) in organic field crop production. Under NOP standard 205.206 (crop pest, weed, and disease management standard), growers must rely first on crop rotation and *soil and crop nutrient management practices*, along with sanitation, pest resistant crop plant selection, and biological control to suppress insect pests. Only when a combination of these preventative practices fails to adequately suppress insect pests can an organically acceptable insecticide be applied. A growing body of literature on soil-plant-insect interactions compares organic to conventional systems with a primary focus on nitrogen. However, there is a lack of research on other soil test parameters, plant tissue analyses, and insect response specifically comparing organic management approaches. This makes it difficult for organic growers and university researchers to fully understand how organic soil and crop nutrient practices affect insect pest dynamics in the field. In turn, this creates a challenge for farmers writing an organic systems plan for certification and researchers developing IPM recommendations for organic systems.

We are addressing the problem by combining (1) on-farm observations from organic farmers, (2) an organic systems trial; and (3) greenhouse and laboratory experimental approaches. We are comparing two organic fertility management systems in a four-year grain crop rotation (alfalfa-alfalfa-corn-soybean). Under the Standard Organic Fertility (SOF) system, nitrogen and other crop nutrients are supplied by dairy manure and alfalfa hay in the rotation. The Soil Balance (SB) system incorporates an off-farm input approach with application of gypsum as a calcium soil amendment to achieve target proportion of Calcium, Magnesium and Potassium as a percentage of the soil's cation exchange capacity. Organic farmers are divided on the economic value of this nutrient balancing approach and existing data are inconclusive with regard to the effect on insect pest dynamics. This project is trying to help by combining entomology and soil science university research expertise with a "train the researcher" approach in which organic farmers from across Wisconsin participate in designing and informing the research. We are focusing on soybean aphid IPM in organic soybean, and European corn borer and western bean cutworm IPM in organic corn, respectively, grown under the two organic fertility systems.

Additionally, we are building a multi-institutional education/research partnership providing organic agriculture curriculum and mentored research internships to undergraduates at two UW-Colleges freshman/sophomore campuses with a smaller student body (<1,000 students) located in rural areas away from the UW-Madison campus. This is a partnership between Wisconsin organic farmers, UW-Madison, UW-Marathon County, UW-Fox Valley and UW-Extension that extends the land-grant university mission to organic production systems. Much of existing entomology and pest management theory and application can be transferred to organic systems. However, additional research and education are needed specific to organic systems (see above) and the topical relevance and dissemination of information must be intentionally targeted to reach organic farmers. This multi-institutional partnership is addressing the

problem by providing improved systems-based educational training and experiential learning about IPM in organic agriculture to the next generation of farmers, researchers and agricultural professionals.

Completed to date:

Organic Systems Trial: Field data have been collected from an organic systems trial at the Arlington Agricultural Research Station, Arlington, WI. The organic systems trial compares two different organic soil fertility systems for their impact on insect pests as described under Project Purpose above. The standard organic fertility (SOF) system relies on dairy manure and alfalfa in the rotation for nitrogen and other crop nutrients as determined by UW soil test recommendations. The soil balance (SB) system employs these same practices, but also includes a gypsum (calcium sulfate) soil amendment previously applied spring 2007, spring 2008 and fall 2009 during establishment and organic transition phase of the organic systems trial. There are thirty-two 0.77-acre plots, 16 of each fertility system, SOF and SB, and each plot is in a four-year rotation of alfalfa/forage grass established with oats – alfalfa/grass – corn – soybean. Thus, all four phases of the crop rotation are in place each year and each crop is represented in both SOF and SB systems in a completely randomized block design. (The experiment was certified organic in fall 2009). Field experiment data collection from the organic systems trial in 2010 include:

- Soil tests of physical and chemical properties including organic matter, pH, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and potassium (K) and micronutrients. Additionally, percent base saturation values were obtained for Ca, Mg and K to assess proportions of these nutrients as a percentage of the soil cation exchange capacity (CEC).
- Plant tissue analyses for corn and soybean including concentration of N, P, K, Ca, Mg, S, Zn, Mn, B, Cu, Fe, Al and NA.
- Soybean aphids were sampled from the SOF and SB soybean plots, and an adjacent conventional check, weekly from June through August. (At the suggestion of organic farmer advisors to the project, a set of conventionally managed corn and soybean plots in an adjacent field of the same soil type was included for comparison. These plots receive urea and other synthetic fertilizers as determined by UW soil test recommendations for corn or soybean. They also receive preplant application of herbicides but no insecticides. Rather than comparing organic and conventional systems, the purpose of the adjacent conventional check plots is to help determine over the long term whether any plant-mediated effects on insect pests levels observed in the organic systems trial are a function of organic management in general as opposed to the soil balance organic system in particular).
- Natural enemy insects (minute pirate bug and lady beetle) were sampled from the SOF, SB, and conventional check soybean plots weekly from June through August.
- A caged experiment was conducted in the organic SOF and SB, and conventional check soybean plots. Natural enemy exclusion cages were placed on vegetative stage soybean prior to soybean aphid field infestation and after careful removal of any visible insects from foliage. Soybean plants were infested with 10 aphids per plant and caged with wire mesh left on the plants for 2 weeks. During the natural enemy exclusion period, soybean aphid populations increased at differential rates according to organic systems, SOF or SB, and conventional check soil treatments. After 2 weeks, netting was removed and aphids counted on plants.
- Data from 2010 are being analyzed and compared with similar data taken in 2008 and 2009 during the organic transition period to compare plant-mediated effects on soybean aphid during organic transition versus a newly established organic system.

Greenhouse Experiment: To complement the organic systems trial on soybean aphid, we completed a greenhouse experiment. The study involved rearing two different insects, soybean aphid and beet armyworm larvae, on soybean plants grown in soil modified in the laboratory to a range of different Ca:Mg cation exchange base saturation ratios.

- Soil was collected from the organic systems trial in plots from the standard organic fertility system that have not received Ca (gypsum) amendment. Soil cation ratios were modified in the laboratory to obtain a control soil with a Ca:Mg ratio of approximately 2:1, representative of the standard organic fertility (SOF) system in our field study. Two modified soils were obtained with Ca:Mg ratios of approximately 3:1 and 4.5:1, representative of medium and high Ca:Mg ratios similar to what growers using the soil balance approach attempt to achieve, and representative of the soil balance (SB) treatment in the organic systems trial.
- Soybeans were grown in pots under controlled greenhouse conditions in the three Ca:Mg ratio soil treatments replicated in a completely randomized block design.
- Soybean plant tissue was analyzed for each treatment for macro and micronutrients and calcium oxalate, a measure of calcium stored in plant tissues and correlated with calcium level in the soil.
- Two separate studies were conducted with soybean aphids and beet armyworm larvae caged on plants grown in the respective control and modified soil treatments. Soybean aphids were monitored until they died to determine longevity, and fecundity (number of offspring) on each plant. Beet armyworm was monitored for survival and weight at final instar prior to pupation (survival and development time).

Organic Agriculture Research/Education Initiative: A 3-credit course, Social & Scientific Aspects of Organic Agriculture is offered each fall semester through this project at UW Marathon County. Co-PI Paul Whitaker designed and teaches the course with UW-Marathon County rural sociologist and farmer Kat Becker. This course begins with an introduction to organic agriculture – its origins, philosophical and biological science assumptions, and current practice under regulation by the USDA’s National Organic Program. The course content is organized around “issues” in organic agriculture including social and scientific challenges to the principles of organic agriculture that have arisen as consumer awareness and market share have increased. Positions on both sides of these issues (pro- and anti- or unaware about organic production) are often aired publicly, but are not always well supported by research data. This course explores some of these issues in order to understand social and scientific foundation of organic agriculture production methods and systems-based thinking.

Highlights to date:

- Interdisciplinary, so students can take as BIO or SOC, biology or sociology, requirements.
- Course exceeded UW Colleges requirements for Writing Emphasis, so WE was added in 2012.
- Taught face-to-face at Marathon County campus, and simultaneously via live video to Fox Valley campus.
- 2010 (35 students), 2011 (35 students), 2012 (28 students).
- Four guest instructors each semester: a district conservationist from USDA-NRCS, an organic agriculture researcher from UW-Madison, a certified organic vegetable farmer, and a non-certified, rotational grazer.
- Co-PI Paul Whitaker mentors undergraduates in organic agriculture research internships. Questions developed in consultation with local organic farmers (Wausau County, WI).
- 2-4 students mentored each summer in field studies on organic farms with some lab research.
- 2010: 3 students. Research Question: Can soil drenches with neem oil protect greenhouse grown cucurbit seedlings from striped cucumber beetle damage after transplanting?
- 2011 and 2012: 4 students. Research Question 1: Can soil drenches with neem oil protect greenhouse grown Brassica seedlings from flea beetle damage after transplanting? Research Question 2: Are active ingredients of neem oil absorbed by plants (systemic activity?) and if so, are concentrations sufficient to repel insects during seedling establishment in the field?

Extension and/or education activities completed or upcoming: Based on a mail survey of Wisconsin organic farmers (n=252; 60% response rate), we launched a new publication series through University of Wisconsin-Extension Cooperative Extension Publishing titled ‘Insect IPM in Organic Field Crops’. To

overcome information constraints on IPM in organic systems, the first publication in the series addresses seedcorn maggot cultural control in organic corn and soybean following spring incorporation of a green manure cover crop. The organic system trial was used to validate the seedcorn maggot phenology model within an organic system context. A second fact sheet in the series is being prepared on soybean aphid IPM in organic systems, including results from the field and laboratory soybean-soybean aphid work described above.

We partnered with eOrganic, the eXtension Community of Practice for organic agriculture, to increase farmer and extension educator engagement with insect IPM for organic grain crops. We presented a webinar on March 29, 2011, through the eOrganic program. The 75-minute program was co-taught by project director Eileen Cullen, graduate student Robin Mittenthal, and Christine Mason, a farmer on the organic advisory board to our OREI project. The webinar presented preliminary research results from this project and related IPM recommendations for organic field crops, as well as farmer experience and IPM approaches to minimizing insect pests on organic farms. A total of 127 participants attended our webinar from all U.S. regions, and Canada, Greece and Chile. Our audience was comprised of farmers (22%), extension personnel (13%), university researchers (8%), non-profit or government organization staff (3%), agricultural professionals (23%) and the remainder others (Master Gardeners, students, etc.). Sixty-three percent of participants improved their understanding of IPM in organic agriculture, and 69% intend to apply this new knowledge to their work in organic agriculture.

Websites, patents, inventions, or other community resources created: Our webinar ‘Integrated Pest Management in Organic Field Crops’ was selected by eOrganic as one of two presentations in the 2011 series approved for Certified Crop Advisor (CCA) continuing education credit through the eXtensionCampus website (Category Agriculture & Animals/Sustainable Agriculture): <http://www.extension.org/pages/60988/how-to-earn-cca-credit-for-watching-eorganic-webinar-recordings> CCAs may visit the site, attend the archived webinar presentation and then take an exam for 1 continuing education unit.

The significance of your findings to organic agriculture: Findings from this project address a lack of scientific research and extension delivery comparing different organic fertility management approaches widely practiced by U.S. organic field crop producers. This project will assist organic farmers in whole farm planning and improve ability of researchers to document effectiveness of soil and crop nutrient management practices as a contributing insect pest management strategy. This is especially important as the current National Organic Program standard for crop pest, weed and disease emphasizes soil and crop nutrient management systems-based approaches to suppress pest damage, but specific recommendations for crop-pest interactions are lacking. This work will contribute to improved organic grain crop farm net revenue and profitability because of increased farmer capacity to make decisions about allocating off-farm input costs (organic soil fertility amendments) in the most effective ways. Our undergraduate research and education initiative provides improved systems-based training about pest management science in organic agriculture to the next generation of farmers, researchers and agricultural professionals.

Other comments or recommendations for future work:

- Summary of field operations, corn and soybean yields, and weed species composition and abundance during organic transition phase compared to established organic system (end point) in the two soil management systems. Transition data has been collected previously (2008 and 2009), 2013 field season data will be added as established end point data set for publication.
- Nematode and soil microbial assessment will be added to 2013 and 2014 field data collection based on Eileen Cullen’s 2011-12 sabbatical work in Europe learning similar techniques.
- Field and laboratory studies on corn and European corn borer and western bean cutworm will be the focus of 2013-2014. These data will complement soybean-soybean aphid data described above. Postdoctoral associate Ebony Murrell was hired June 2012 for this work. She is currently conducting

a greenhouse experiment examining European corn borer preference and larval performance on plants grown in soil from the organic systems trial modified to a range of Ca:Mg ratios.

- 2012 greenhouse results will be used to inform field study design with organic farmer advisory board.

Project Title: Plant Breeding and Agronomic Research for Organic Hop Production Systems

Award number: 2009-01383

Period of funding: September 1, 2009 to August 31, 2013

Primary Institution: Washington State University

Project Director Name and email: Kevin Murphy, kmurphy2@wsu.edu

Project Director telephone: 509-335-9692

Co-Project Director Names and emails:

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Dr. Heather Darby, heather.darby@uvm.edu

Dr. Rob Serrine, serrine@msu.edu

The purpose of the project:

The recent worldwide hops shortage has led to an increase in the price of hops has spurred an increase in conventional hop plantings; however, due to numerous agronomic obstacles, organic hop acreage and varietal availability lags far behind that of conventional hops. Sales of organic beer have been increasing even faster than the organic industry as a whole at a rate of 30-40% per year and many breweries using organic hops currently import organic hops from Germany and New Zealand. Anheuser Busch and smaller microbreweries including New Belgium, Odell and many others are interested in purchasing locally produced organic hops and are making a concerted effort to recruit local growers and support research into organic hop production. Unfortunately, the availability of organic hops is functionally non-existent. Hops are a perennial, high-value crop that, under current production standards, requires large quantities of pesticides and nitrogen fertilizer to achieve high yields and good quality. In response to increasing demand for organic hops and the rising costs of fertilizer and crop protection chemicals, hop growers in the Pacific Northwest (PNW) and elsewhere have begun to plant organic hops. Hop yields, however, often show dramatic decreases under organic or low-input management due to increased insect and disease pressure. Aphids, mites, weeds, downy mildew, powdery mildew and other fungal diseases can be difficult to control without repeated and expensive application of pesticides and herbicides. Since the accidental introduction of powdery mildew in the late 1990's, conventional growers have spent up to \$300/acre controlling mildew diseases. Meeting nitrogen needs can be difficult without high inputs of nitrogen fertilizers, especially in varieties with low nitrogen-use efficiency. Research into organic systems is needed to identify suitable hop cultivars; and develop systems based nutrient management plans that improve soil health, supplement nitrogen fertility needs, suppress weeds, provide habitat for beneficial insects, and improve the productivity and quality of hops.

Driven by farmer and organic hop industry needs, the long term goals of this project include:

- 1) Identify and develop high quality hop varieties optimally adapted to low-input and organic production systems;
- 2) Develop cover crop management options for hop growers that suppress weeds and enhance the productivity and quality of hops;

- 3) Evaluate differences in soil microbial abundance and diversity among eight cover crop treatments in organic hop systems;
- 4) Develop educational materials, training days and tools for Cooperative Extension personnel;

Completed to date:

Goal 1: We have made significant strides in our goal to identify which leading hops varieties will perform best in organic systems. This has had immediate impacts in helping farmers transitioning to organic hop production decide which varieties to plant. In addition, this information is being utilized by hop breeders in the selection of parents for use in organic breeding efforts. Variety trials are entering their third year (two years with data – Year 1 was the establishment year) on three organic farms in Washington State and two organic farms in Vermont and Michigan. Seventeen varieties were tested on multiple farms for cone yield and quality (see table below as an example). In addition to the data below, soil samples, disease incidence, chlorophyll measurements have all been taken.

Variety	Location	# of strings	Green Weight	# of Cones	Cone Weight (green gm)	Cone Weight Dry	lb per string	lb per hill	mg/cone	UV Alpha	UV Beta	H.S.I.
Cascade	PFI	7.0	10.9	100	114.5	28.8	1.761	3.52	1144.5	5.19	5.80	0.239
Cascade	Roy	11.0	12.3	50	40.7		1.106	2.21	813.3	4.24	5.02	0.242
Centennial	PFI	10.0	16.8	100	101.9	31.1	1.674	3.35	1019.3	8.73	3.17	0.290
Centennial	Roy	9.3	11.8	50	57.8		1.278	2.56	1156.7	6.95	3.04	0.297
Chinook	PFI	8.0	19.3	100	114.3	29.1	2.399	4.80	1143.0	10.55	4.47	0.242
Chinook	Roy	13.0	41.1	50	61.6		3.238	6.48	1232.0	9.39	3.44	0.247
Cluster	PFI	4.0	8.1	100	95.3	29.9	2.145	4.29	953.3	5.71	3.84	0.233
Cluster	Roy	12.3	23.2	50	46.1		1.885	3.77	921.3	5.99	4.32	0.214
Fuggle	PFI	8.3	8.5	100	75.3	21.4	1.015	2.03	753.3	4.35	2.72	0.249
Fuggle	Roy	10.3	5.3	50	37.8		0.516	1.03	756.7	3.81	2.70	0.229
Galena	PFI	8.7	15.7	100	116.8	34.7	1.746	3.49	1168.3	11.74	7.41	0.240
Galena	Roy	9.3	20.3	50	56.5		1.912	3.82	1130.7	10.60	7.26	0.234
Glacier	PFI	9.7	23.9	100	69.9	20.7	2.467	4.93	699.1	4.91	7.91	0.224
Glacier	Roy	10.3	30.0	50	37.2		2.892	5.78	744.0	5.98	8.99	0.204
Mt. Hood	PFI	8.7	10.1	100	79.5	25.5	1.194	2.39	794.7	5.23	7.39	0.209
Mt. Hood	Roy	10.3	30.0	50	37.2		2.892	5.78	744.0	5.98	8.99	0.204
Newport	PFI	8.0	18.2	100	112.1	28.7	2.219	4.44	1121.0	12.23	8.06	0.222
Newport	Roy	9.0	18.7	50	62.7		2.028	4.06	1254.0	8.01	5.68	0.247
Nugget	PFI	5.3	10.4	100	168.9	42.4	1.979	3.96	1689.3	13.57	4.98	0.246
Nugget	Roy	11.0	16.3	50	64.6		1.424	2.85	1292.0	10.20	4.14	0.260
Perle	PFI	5.0	4.4	100	94.5	27.7	0.850	1.70	944.7	8.49	4.49	0.256
Perle	Roy	10.7	4.8	50	37.8		0.456	0.91	756.0	6.90	4.03	0.273
Saaz	PFI	3.7	4.3	100	109.6	27.7	1.353	2.71	1095.7	5.13	5.81	0.237
Saaz	Roy	11.5	2.2	50	29.0		0.193	0.39	580.0	3.50	3.71	0.237
Santiam	PFI	5.0	6.1	100	127.9	29.1	1.333	2.67	1279.0	3.71	6.72	0.220
Santiam	Roy	11.3	7.3	50	62.2		0.616	1.23	1244.0	3.18	5.50	0.234
Sterling	PFI	2.5	2.4	100	68.6	15.8	0.917	1.83	686.0	5.12	4.39	0.243
Sterling	Roy	8.0	3.3	50	33.3		0.439	0.88	666.0	3.52	3.44	0.247
Tettnang	PFI	8.0	8.9	100	76.6	23.0	1.107	2.21	766.3	5.23	2.99	0.269
Tettnang	Roy	10.3	3.8	50	33.3		0.357	0.71	666.7	4.53	2.76	0.259
Vangaurd	PFI	7.0	10.6	100	93.8	28.3	1.380	2.76	937.7	5.08	6.36	0.216
Vangaurd	Roy	9.3	5.7	50	35.9		0.567	1.13	717.3	4.44	6.41	0.216

Willamette	PFI	6.7	12.5	100	86.3	25.5	1.937	3.87	863.3	10.96	4.41	0.246
Willamette	Roy	12.0	7.6	50	43.9		0.633	1.27	878.7	4.77	3.59	0.262

Goal 2: This experiment was set up at using a RCBD consisting of four main plots (hop variety), eight sub-plots (cover crop treatment) and three replicates. Hop cuttings were established in summer 2010 and cover crops were established in summer 2010, and spring 2011 and 2012. Percent ground cover estimates were taken at 3-week intervals May to August for cover crop and weed species. Plant counts were taken in mid-August and biomass samples were taken in October, again for cover crop and weed species. Hop yield and quality data was taken annually after harvest. Preliminary data will be presented at the PD meeting, including the effect of cover crop on hop yield per hill (see table below).

Treatment	kg/hill	LSD (P<.05)
Tillage Only	1.67	A
Rye/Vetch/Buckwheat	1.64	A
Fescue and White clover mix	1.34	AB
Peas, Beans, Vetches and Oat	1.33	AB
Clover Mix	1.27	B
Medic Mix	1.27	B
No Management	1.24	B
Perennial Rye/Clover	1.10	B

Goal 3: Soil microbial abundance and diversity for each cover crop x variety treatment in our cover crop trials (one in Washington State and one in Michigan) is currently being evaluated by Dr. Lori Hoagland at Purdue University. Results are tentatively scheduled to be available in February of 2013.

Goal 4: We have held multiple field days, trainings, workshops in Washington, Vermont and Michigan. We have numerous given talks and presented posters at local, national, and international conferences geared towards both farmers and scientists. In addition, we have published in Extension Bulletins, a peer-reviewed academic journal (with several more in progress) and farmer newsletters. For a sampling of these, please see the Extension section below.

Extension and/or education activities completed or upcoming:

Field Days: PI's and graduate students host and participate in several field days each year in Washington, Vermont and Michigan. These field days attract a wide range of farmers, from beginning hop growers in non-traditional hop growing regions to 3rd generation hop farmers from the Yakima Valley in Washington. We also try to incorporate brewers as much as possible during these field days. For example, Rob Sirrine organized a 2011 Hops Field Day and tour in conjunction with the Michigan Restaurant Association and Michigan Brewers Guild dedicated to advancing hop production and marketing and developing farmer-retailer relationships for hops in Michigan.

Undergraduate Education: We engaged with undergraduate students in the Organic Agriculture major at WSU in a teaching activity to develop a small-scale, student-run hop yard in 2010. Hops from this hop yard were planted, tended, and harvested by WSU students.

Poster Presentations: Results from one component of our research, that of weed suppression in organic hop yards, was presented in poster format at the ASA-CSSA-SSSA International Meeting in San Antonio, Texas and at the Washington Tilth Producers Annual Conference in Yakima, Washington in 2011. Updated results of this same trial were presented in 2012 at the International Humulus Symposium in the Czech Republic.

Webinar: Rob Serrine of Michigan State University and Brian Tennis of Michigan Hop Alliance produced a webinar titled 'Starting up Small-Scale Organic Hop Production' through eOrganic.

Workshops: Heather Darby and Rosalie Madden of University of Vermont Extension conducted five workshops in 2011 on organic hop production in Vermont.

Presentations: PI's have given over 15 talks at a diverse range of meetings across the northern US over the past three years. For example, Heather Darby gave a presentation titled 'Building a Hops Industry in New England' at the New Hampshire Farm and Forest Conference and Kevin Murphy has given talks at the American Hop Convention in Yakima, Washington and at the EUCARPIA Low-Input and Organic Plant Breeding Conference in Paris, France. Rob Serrine provided consultation to over 50 farmers and potential new farmers in Michigan to assist in their start-up hop production and marketing enterprises.

The significance of your findings to organic agriculture: At present, organic hops are not required for the production of organic beer. However, in 2010, the National Organic Standards Board voted to sun-set the organic exemption for hops, and beginning in January 2013, brewers must use organic hops in all USDA-certified organic beer. Growers and brewers expect a significant increase in demand for organic hops as a result of the ruling, and considerable growth, both in total production and in number of varieties available, will be critical for the organic hop industry to meet this new requirement. Results from this study will help guide organic hop growers by providing vital information on specific varieties that perform well under organic conditions and on cover crop mixtures designed to improve soil quality characteristics and weed suppression in organic hopyards. Our group has hosted dozens of field days, workshops, seminars, webinars and trainings over the past three years to help educate farmers, brewers and consumers on organic hop agronomy and varietal selection.

Project Title: Improving Organic Farming Systems and Assessing their Environmental Impacts across Agroecoregions

Award number: 2009-51300-05603
Period of funding: 10/01/2009 to 09/30/2013
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The purpose of the project:

The purpose of the Nebraska Organic Program has been to focus on supporting organic farmers with research based information. Our current project is the second phase of our efforts, the first, also supported by OREI was to establish certified organic farm ground on four of University of Nebraska agricultural research farms within three of the four ecoregions found in Nebraska for researchers to conduct organic experiments. Our second project was to build on the first with emphasis in two parts, first to address production problems, and second, to investigate the agroecology activity of organic farming systems. We have, from the beginning, worked closely with the organic community to identify their production needs. We have an Organic State Advisory Group (OSAG) that meets annually, who came up with their vision statement:

"The University of Nebraska-Lincoln Organic Working Group will develop strategies for transition from conventional agriculture to organic whole farming systems and work with established organic farms so that they are ecologically self-renewing, socially responsible and profitable, and that will provide nutrient-dense foods, ecosystem services and education to current and future generations."

UNL has developed the Organic Working Group (OWG) team of 28 persons: soil scientists, entomologists, weed scientists, an economist, and extension educators, technicians that work in Extension, Research and Teaching. Subgroups have applied for and received grants to continue and expand organic program and research in Nebraska. For instance, we have recently invited an economist to help farmers develop budgets and an economic profile of their organic system farm plans; we have cooperated with an organic wheat breeding effort, and reached out to bakers and members of the health community to develop a farm to plate perspective.

The goal of this project is to provide research-based organic farming systems support and information applicable to local and regional organic farm systems. We are focused on four aspects of organic farming systems that were identified as crucial by our OSAG: 1) nutrient and weed management, 2) antioxidant production in organic grains and seeds, 3) biodiversity conservation and farm assessment, and 4) on-farm research capability. The first aspect addresses current production problems, the second and third address more broad concerns about the value of organic farming systems, and the last aspect helps

develop organic farmer ability to conduct their own research, and broaden the questions we can address with research, and respond to organic farmer needs. Specific research and extension activities associated with these broad objectives follow:

Soil fertility: Determine the effect of organic amendments on crop performance under organic production on organic farms; determine the interaction between general fertility levels and integrated weed control; assess nutrient balance on farms; use extension outreach to raise knowledge within the organic community on exported nutrients.

Weed control: Evaluate an integrated organic approach for weed control based on mechanical cultivation and/or flaming in corn and sunflower.

Antioxidant properties: Determine the effects of organic farming practices on antioxidant levels of organically grown crops across four Nebraska Agroecoregions.

Biodiversity conservation: Quantify the effect of organic management on breeding success of regional farm bird populations and institute long-term ecological monitoring on organic farms. Develop and deliver a model, Healthy Farm Index, for farm assessment and structured decision making in organic farm management.

Farmer research: Establish and provide the guidance, encouragement, and technical support required for the sustainability of organic farmer research groups in Nebraska.

Completed to date:

Extension and/or education activities: Many on our team conduct extension activities, but we will report what the coordinator has done in the last year to demonstrate the breath of these activities. Ms. Sarno is responsible for communicating with the OWG which has 15 members statewide; she coordinates a Western Sustainable Crop and Livestock conference that meets following the OWG meeting and attracts over 100 producers from western Nebraska. She has delivered 26 presentations around the state to diverse audiences, with over 1200 contacts. She organized 3 farm tours during the summer of 2012, works with urban gardens, writes for several newsletters, coordinates with the Nebraska Indian College that is trying to develop organic farming practices on their grounds. She led the organizing and was a co-author on four NebGuides on organic farming. She also makes contacts and provides technical guidance to the on-farm research component of the project.

Dr. Stevan Knezevic and his team research and extension accomplishments focus on weed management with flaming weeds. The flaming project is world renown and has attracted several other funding sources, particularly from the propane industry. In conjunction with Dr. George Gogos there is a patent pending. They have developed a flamer with improved torches and hood which is safer, spreads the heat more evenly, and most importantly has reduced the effective dose of (kg/ha) of propane needed to control weeds. The pending patent is entitled "System and Method for Flaming Pests and Weeds."

The four research sites cover three agroecozones (Western Corn Belt, Central Great Plains, and Western Great Plains). Each has a unique contribution to the project.

Haskell Ag Laboratory: Developed 33 acres of certified organic ground for research on wheat fertility, cover crops and crimping, and weed x nutrient interactions. In addition is the site for most of the flaming research. Variability in weather from year to year showed that cover crop production after winter wheat is not always successful, crimping of plants was not adequate to produce corn or soybean crops at the

production level of spring disking. Further research is being conducted to try and fine-tune and improve the success of using a crimper. Soybeans did yield relatively more than corn relative to disking.

Agricultural Research Development Center: Has 51 acres of certified organic ground. Research at this site is focused on understanding and creating an effective legume understudy to supply more nitrogen to future corn crops and provide other benefits in the rotation. The Organic Wheat-Clover Intercropping Study at ARDC in 2012 was the second of three years. Because establishment is uncertain when planted after the winter wheat is harvested undersowing clover into existing winter wheat has the potential to increase the likelihood of the clover producing enough growth to be beneficial. Analysis of the first year winter wheat shows that the clovers did not affect winter wheat production. The following corn crop harvest has not been accomplished yet.

South Central Ag Lab: Has 22 acres of certified organic farm ground and 17 acres are laterally irrigated field plots. This is the only site that is irrigated and it is in the transition zone between the rainfed corn/soybean eastern side of Nebraska, and the winter wheat/rangeland in western Nebraska. This organic site has 20 acres of sprinkler irrigated land with a crop rotation of field corn, popcorn (added value crop), soybeans, wheat/vetch, popcorn, and alfalfa established in 2006. In fall 2010, sheep manure was applied to two strips across all fields, leaving two strips untreated, to evaluate the value of animal manure to the cropping system. In 2011 grain yields were field corn; 155 bu/acre in non-manured plots, 140-155 bu/acre in manured plots; soybeans; 38 bu/acre in non-manured plots, 30-35 bu/acre in manured plots, and popcorn; 4170 lbs/acre in non-manured plots and 4060-4100 lbs/acre in manured plots. In 2011, a new rotation was initiated to provide higher levels of nitrogen nutrition to wheat to promote higher protein levels. Two extension education tours showed organic research studies at South Central Ag Lab, in 2011. Crop rotations were changed to study the effects of hairy vetch and radish and interseeded into winter wheat to increase yields.

High Plains Ag Lab: The moisture regime changes across Nebraska agroecozones is illustrated by the three-year study investigating the use of green manure peas and various rates of composted manure on winter wheat yield and grain protein content that was completed in 2011. Winter wheat grain yield was reduced following green manure fallow compared to traditional black fallow in two out of three years. These differences can be attributed directly to reduced soil water at wheat seeding following green manure fallow. In 2011, there was no difference in soil water at wheat seeding between green manure and black fallow treatments and there was no difference in grain yield. The peas used water that would not be available to the following wheat crop, so unless ample precipitation is received following termination of the green manure crop and prior to winter wheat seeding, winter wheat yields will likely suffer following green manure fallow in this semi-arid climate. Grain protein was increased by 0.5% following green manure fallow in 2011, a year with high grain yields as a result of excellent seasonal precipitation. Likewise, spring applications of approved N top dress treatments did not affect winter wheat grain protein in two of three years. A manuscript entitled “Nitrogen fertility in semiarid dryland wheat production is challenging for beginning organic farmers” reported this information and is the process of being published by *Renewable Agriculture and Food Systems*.

In 2012, three studies were conducted on the certified organic fields. These were: 1) flaming for weed control in sunflower, 2) winter wheat variety testing and 3) measurement of greenhouse gasses comparing organic farming to reduced-tillage.

Variety and Environment Effects on Grain Antioxidants: Samples representing 4 commodities and grown at four locations, under various stress conditions, were collected: HAL (19 lines of wheat at two nitrogen levels); HAL (2 fertility treatments and two weed pressures with blue and yellow corn); HPAL (2 varieties of sunflowers at 2 soil nitrogen levels); ARDC (2 soybean varieties at 2 nutrient levels); ARDC (20 wheat varieties at 3 nitrogen levels); SCAL (2011—19 wheat varieties at 2 manure levels); and SCAL (2012—1 wheat variety at three weed pressures and three nutrient levels). All were analyzed for total

phenols, flavonoids, and antioxidant content. Multiple varieties (20+) of corn, soybeans, and sunflowers were pre-screened to determine which cultivars had most potential for elevated antioxidant levels. Tests are in progress for proximates on all samples, anthocyanins/proanthocyanins on the corn, and total phenols and flavonoids on the single wheat variety under different weed pressures and nutrient levels. All other tests are complete and are in various stages of statistical analysis and interpretation.

Biological Conservation: In 2010-2011, 332 nests from 19 species were found and monitored. Nest success differed between years declining from 28% in 2010 to 14% in 2011, likely because of a cold wet spring across the region. Nests of three species; American Robin, Brown Thrasher, and Gray Catbird were found most frequently. While cursory examination of nesting success suggests many species are nesting in organic farmland, the absences of nests from a number of small passerines, including the Bell's Vireo, was of concern. In addition, these data suggest that nesting success within organic systems is lower than expected. Thus to compare nesting success in organic systems to other land use types, in 2012, with support from the Nebraska Bird Partnership, the project added non-organic and natural areas for comparison. A total of 295 nests of the three target species (Bell's Vireo, Brown Thrasher, Gray Catbird) were found during searches conducted between May 1 and Aug 1. The most nests were found in protected areas for all species. More Bell's Vireo and Brown Thrasher nests were found on organic than non-organic farms. Nesting success for Brown Thrashers did not appear to vary between land use. However, nesting success was lower in organic farm systems compared to protected areas for Bell's Vireo and Gray Catbird. Thrasher and catbird nesting success in organic farmland was greater in 2012 than 2010 and 2011.

Agroecological Assessment: The Healthy Farm Index is a tool to incorporate environmental impact into farm scale decision making. In particular the HFI focuses on biodiversity and ecosystem services, a management consideration often missing at the farm scale. To address this need, and better monitor environmental impacts of local farm practices, the HFI provides a farmer friendly decision making tool to aid farmers in managing biodiversity for the benefit of their farm and the larger landscape. In the last year, significant progress was made developing and implementing a web-based application of the Healthy Farm Index. A demo of the HFI interface is available at <http://goo.gl/IBEr3>.

The significance of your findings to organic agriculture:

Soil Fertility: A combination of small plot research and on-farm research to investigate the interaction of enriched soil fertility, through manure application, and a range of weed control levels is presently being summarized. The Masters student on this project is expected to graduate in December. The on-farm research has found that for the most part organic farmers have sufficient fertility and weed control to achieve similar yields to researcher imposed extra fertility and weed control. The only exceptions were where there were identified limiting factors that predicted potential response (low soil tests, poor weed management.) This is significant because organic farmers are criticized for being weak in both weed control and fertility management. This research shows that most organic farmers are able to develop systems that overcome these obstacles.

Integrated Weed Management: The intensive research area developed by Dr. Knezevic was described in the previous section. The impact of his accomplishments are beginning to be felt at the farm level and internationally (see <http://www.bbc.co.uk/news/science-environment-1958341>). He has cooperated with several farmers who are using the machines on their own farm and has spoken around the world to audiences that excited about the improved weed control, with minimal energy usage, reduced tillage, and no use of herbicides. The primary weed management studies were conducted in 2010 and 2011 where they determined the level of weed control and response of organic corn grown with and without manure application to flaming. There were no significant differences in weed control, crop injury, and yield between the manure and no manure treatments, field corn

recovered well after flaming with less than 10% injury at 28 DAT. Cultivation and banded flaming caused 70% weed control. Highest yields were obtained in the weed-free control (10.0 t/ha) and the flamed/cultivated treatment was close (9.4 t/ha). Similar results were observed in 2011. Sunflower in 2010 and 2011 at the HAL had cultivation alone, flaming alone, and combination flaming/cultivation. Sunflower had excellent tolerance to broadcast flaming with less than 5% crop injury at 28 DAT in 2010. Best weed control (75%) was obtained from plots flamed twice. Highest yields were in the weed-free control (2.1 t/ha) and plots flamed twice (1.6 t/ha). In 2011, banded flaming plus cultivation twice was the most promising treatment, which resulted in with 90% weed control and 10% crop injury. We believe that satisfactory weed control could be achieved in sunflower when flamed twice, at the VC and V12 stages.

Anti-oxidant research: In preliminary tests in 2010 at HAL, with 19 varieties and experimental lines of wheat, top-dressing with 20 lbs. N/acre with an OMRI-approved liquid fertilizer was correlated with lower yield and higher protein content for most wheat lines and was interestingly also correlated with increased levels of total phenols. There were also marginal differences in phenol content among entries ($p = 0.1020$). Of note, 'McGill' was one of only three lines in the 2010 HAL experiment that had both higher yields and higher protein content where top-dressed. In complementary research in 2010 and 2011, at HPAL, grain yield accounted for 26% of the variation in total phenols and 15% of the variation in flavonoids. At SCAL, grain yield accounted for 21% of the variation in total phenols, but there was no correlation between flavonoids and grain yield. Grain yield accounted for less than 5% of the variation in flavonoid content at HAL and was not correlated with phenol content. The variety 'McGill' had the highest total phenols and flavonoid content across the four organic locations in 2010 and 2011. Interpretation of correlations between fertility treatment and other variables (grain yield, protein content, total phenols and flavonoids) will be possible with recent data from additional 2011 field replications at SCAL and ARDC. Increased stress from leaf-spotting diseases was associated with lower yields in the top-dressed treatments of the 2010 HAL trial. Other stresses that impact yield may affect phenol content in a different manner than diseases. We chose 'McGill' for an experiment in 2012 at SCAL to assess the impact of yield as affected by weed pressure and N fertility levels on antioxidant content. Variable infestations of the winter annual, pennycress, in a two-acre field of 'McGill' allowed us to site plots in areas of high, medium and low pennycress density within each of three fertility treatments: no previous manure, previous manure and previous manure plus an application of 20 lbs N/acre in the form of Chilean nitrate. Antioxidant analysis of this experiment will be completed this winter.

Biological conservation: Nesting success was lower than expected in organic systems. The expand research effort (with non-organic and protected areas included) should provide better data to guide management in organic systems. With the new web interface, researchers will be able to better monitor who uses the HFI and more importantly how. In addition, because the HFI is now a web-based tool, we have the capacity to assess the decision making process of individual farmers. Lastly, the capacity to collect data on regular basis provides the necessary infrastructure to help guide interested farmers towards positive environmental impacts.

On-farm research summary: Meetings are held in winter meetings to present the previous year's results and to plan for the following year's research and introduce new farmers to research protocols. Most of these projects were replicated and randomized to a degree, many farmers report learning even when the trial did not produce the expected outcome. The following are examples the types of research conducted and the results:

1. Forage Teff grass as a cover crop to enable no-till planting of corn the following year was ineffective in suppressing weeds compared with pre-plant tillage; corn growth was poor, and the farmer concluded that this is not a likely practice.
2. Varietal resistance in soybean aphid management was evaluated in 2010 and 2011; aphid pressure was low in 2010 and yield was less with the resistant compared with the non-resistant variety.

3. Bio-char as a soil amendment on silt loam was applied in spring, 2010; soybean yield was >60 bu/ac in 2010 but bio-char did not affect yield.
4. No-till planting of soybean in 2010 into crimped winter rye cover crop was evaluated by comparing drill and 30" row planting of soybean. The cover crop plant residue suppressed weeds into July but foxtail density became high in August with both planting treatments. In 2011 following winter wheat harvest, several cover crop species and mixes were planted (diverse blend of cover crops with Sun hemp, Sun hemp as a monocrop, Sun hemp with radish, and soybean as a monocrop).
5. Intercropping hulless barley and flax was evaluated. Hulless barley was the main crop of interest but yields are low and it often lodges. It was hypothesized that flax could add to productivity while supporting the barley. The farmer did not request assistance and mixed things up at harvest.
6. A cheese dairy tested whey application on pasture in 2011. Grass yield was 18% more without whey applied with the first grazing period and not affected with the second grazing period; BRIX, indicating sugar and other soluble carbohydrate concentration in the sap, was 46% and 12% more with no whey applied for the 1st and 2nd grazing period.
7. Raw milk and fish slurry were evaluated as a starter 'fertilizer' for corn in 2011. Yield was not affected.
8. Three farmers compared various cover crops with crops following winter wheat harvest including: sun hemp, sun hemp plus radish, a cover crop mixture of oats, radish, turnip, spring forage pea and common vetch and no cover crop. Biomass yields and nutrient contents were determined.
9. Three farmers experimented with flaming field corn to develop cultural practices on timing and methods to use a flamer.

Other comments or recommendations for future work: The long term nature of organic systems makes it difficult to do timely, publishable and fundable work since the important issues and practices take time to evaluate. We need to develop models to evaluate complex farming systems. The work with flammers for agronomic crops is very applicable and could be modified for market gardeners. In addition developing the flamer other equipment should be investigated to help farmers and market gardeners to control weeds. The complexities of conducting agronomic research has made it difficult for us to incorporate livestock in our systems, but an emphasis on integrated organic livestock production is needed. The sustainability of our established sites depends on continual grant efforts, which takes resources away from doing the research extension and teaching.

Additional educational publications are needed: Cover crop usage and crop sequences within the various ecoregions, holistic management for livestock, and evaluation of soil fertility for organic farming system.

Project Title: Impact of Organic Management on Dairy Animal Health & Well-being

Award number: 2008-51106-19463

Period of funding: Oct 1, 2008- Sept 30, 2012- no cost extension until Sept 30, 2013.

Primary Institution: University of Wisconsin, Madison

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The purpose of the project: Organic dairy farming is a small but growing segment of the overall US dairy industry. Standards for certification as an organic dairy farmer are contained in the rules listed in the National Organic Program (NOP). According to the NOP, organic dairy producers may not administer any antibiotics nor synthetic substances. Producers are prohibited from withholding necessary treatments from sick or injured animals but products from animals that receive a prohibited medication may not be sold as organic. Thus, if prohibited treatments are administered those animals must be removed from organic production. These standards are unique compared to Canada and European countries which allow limited usage of necessary antibiotics or synthetics for treatment of sick animals provided that veterinarians diagnose the disease and that producers observe an extended withdrawal period. This is the first study conducted to evaluate the potential impact of these unique NOP rules on management and treatment practices used by US organic dairy farmers. Specific issues of interest include determination of how organic dairy producers perceive disease, how they utilize veterinarians and how they identify and treat diseases of dairy cows. Outreach to organic dairy producers is integrated throughout the design of the research and extension aspects of this project.

Completed to date: This study was designed as a prospective, cross-sectional multistate study that enrolled both organic (ORG; n = 192) and similarly sized conventional (CON) farms that utilized both grazing (CON-GR; n = 36) and confinement systems (CON-NG; n = 64). Farms were enrolled between April 2009 and April 2011 from dairy herds located in New York, Oregon, and Wisconsin. Criteria for enrollment in the study were minimum herd size of 30 lactating cows and ORG herds had to have been shipping certified ORG milk for a minimum of 2 years. Each farm was visited once by one of 3 trained study personnel who administered a 45 page animal health questionnaire that included questions about: case definition of selected diseases; methods and frequency of disease detection, treatments used for defined case scenarios, usage of veterinarians, and methods used to evaluate results of treatments. Data on the incidence, severity and economic consequences of selected diseases was collected during a period of 120 days. Retrospective data for the previous 60 days before the farm visit was collected during the farm visit while prospective disease data was collected using pre-defined data collection forms completed by the farmer during the 60 days following the farm visit. Indicators of overall herd health were collected by retrieval of farm records and by observations of a representative selection of animals including scoring of body condition, udder hygiene,

lameness, calf nesting scores and calf health scoring. Bulk milk samples and individual cow milk samples from each farm were submitted for microbiological and molecular analysis. After the farm visit, each farm received a comprehensive report of their results and comparisons to peer-groups. Statistical analysis of questionnaire data, animal observations and biological samples is being used to address the study objectives. Key results of specific analyses that have been completed are as follows:

Differences in Dairy Animal Management among ORG, CON-GR and CON-NG:

About 30% of herds in each of the 3 participating states participated, indicating that the sampled herds were representative of targeted herds in the regions. Annual milk production per cow for ORG herds was about 25% and 37% less than production of CON-GR and CON-NG herds, respectively. The distribution of breeds, animal housing and hours spent outside varied based on management type. The average lactation of animals on ORG and CON-GR farms was 2.6 lactations, which was slightly greater than CON-NG farms (2.3 lactations). A greater percentage of first lactation heifers were found on CON-NG and CON-GR farms than ORG farms. Facilities used by adult animals were not different among the management systems. Cattle on CON farms were fed approximately twice as much grain as cattle on ORG farms, and had greater milk production. Little difference was found for the average reported somatic cell count (SCC) and standard plate count (SPC), suggesting that milk quality did not vary based on management system. While some disease prevention measures were commonly utilized on ORG farms, (such as keeping a closed herd and having a written record of treatments administered to the animals), the use of outside support and vaccinations were found to be less prevalent on organic farms than CON-GR or CON-NG farms.

Use of Veterinarians

Multiple correspondence analysis was used to assess relationships among herd management factors and selected measurements of veterinary usage (rate of veterinary visits per 100 cows per 30 days, rate of routine veterinary visits per 100 cows per year, likelihood of calling a veterinarian to examine an off-feed cow, and veterinary examination of cows during the data collection period). Regardless of management type, intensive practices such as use of a nutritionist, use of vaccinations, use of pregnancy checks, having Holstein as the predominant breed, and exclusive use of artificial insemination for breeding cows were closely associated with frequent usage of veterinarians. Intensity of management was more closely associated with frequency of veterinary usage as compared to association with organic status. This outcomes suggests that veterinarians should consider other management practices (rather than organic management) when identifying herds most likely to utilize their services. Economic factors create a large barrier to utilization of routine veterinary services on small farms. The cost of routinely scheduled per unit of milk produced was much greater on small farms as compared to large farms, which is a likely reason why small farms (regardless of management system) are less likely to have routinely scheduled visits. More dialogue between veterinarians and small dairy farm owners is needed to identify mutually beneficial preventive programs for animal health management.

Risk factors for Selected Diseases

Poisson regression & negative binomial models were used to assess risk factors for rate of farmer-identified and recorded cases of clinical mastitis, ketosis, and pneumonia for small ORG, CON-GR & CON-NG dairy herds. Contagious mastitis pathogens were found more frequently in bulk tank milk obtained from ORG dairy farms. Approximately 30% of all farmers (regardless of management system) could not provide a definition of subclinical mastitis. An increased rate of clinical mastitis was associated with use of CON management, more sensitive detection (removal and observation of foremilk during milking), presence of contagious pathogens in the bulk tank culture, proactive detection of mastitis in postpartum cows, and use of stall barn housing. The application of pre-dip teat sanitizers was associated with reduced rate of clinical mastitis. An increased rate of ketosis was associated having a more

sensitive definition of ketosis (anorexia), using stall barn housing, and feeding a greater amount of concentrates. An increased rate of pneumonia was associated with herds that did not use grazing, herds that were of small or medium size (rather than large herd), and presence of Jersey cattle as the predominant breed. Overall, disease definitions and perceptions were similar among the management systems and regardless of management system, the disease definitions that farmers used influenced the rate of detection of clinical mastitis, ketosis and pneumonia. Continued educational programming is needed to ensure that farmers of all management systems understand how to detect and prevent the occurrence of mastitis, and other common diseases of dairy cattle.

During the farm visit, study personnel observed and scored individual cows for lameness and hock lesions. Farmers were also instructed to record the occurrence of lame cows during the 120 day disease collection period. The prevalence of lameness as scored by study personnel was only weakly correlated with the rate of lameness that the farmers reported. Researchers frequently observed lame cows on farms where the farmers perceived that lameness was not occurring. An increased rate of lameness events (recorded by farmers) was associated with several management factors such as an increased prevalence of hock lesions, use of ORG management, small herd size, and presence of a breed other than Holstein or Jersey. An increased prevalence of cows observed as lame by study personnel was associated with an increased prevalence of hock lesions, use of CONNG management, and routine utilization of a footbath. Differences between the multivariate models for rate of farmer-identified and recorded lameness events and prevalence of cows scored lame may be due to duration of disease or because of the perception of disease by dairy farmers. Decreasing incidence of lameness on farms requires both increasing farmer perception of lameness and managing risk factors for lameness.

Herd Level Risk factors for positive tests of bulk milk for Johne's disease (MAP)

Bulk milk samples were taken from each farm for Mycobacteria avium paratuberculosis enzyme-linked immunosorbent assay (ELISA) and other testing, (including somatic cell count and E. coli culture). Statistical models were constructed with MAP ELISA score as the outcome variable and the herd characteristics as independent variables. Herds could have high bulk milk ELISA due to either a high prevalence of MAP infected cows or by having a few infected cows that produce large quantities of antibodies. The concentration of antibodies against MAP in bulk milk varied seasonally. Farms which had livestock enter the herd in the 12 months prior to the study, had lower ELISA than closed farms, which had no entering livestock. Conventional herds that contained more thin cows were more likely to have lower MAP ELISA than CON herds that contained fewer thin cows. Body condition score of cattle was not associated with the ELISA values for bulk milk of ORG farms. New York herds had higher ELISA values, compared to Oregon and Wisconsin herds. This likely reflects a difference in MAP prevalence between regions. Overall, bulk milk ELISA values were associated with regions, contact with other farms and season but were not associated with management system.

Ongoing Work

Data analysis is continuing to evaluate factors influencing milk quality, indicators of animal wellbeing and practices that contribute to enhanced dairy animal wellbeing. We expect all analyses to be completed by Sept 30, 2013.

Extension and/or education activities completed or upcoming:

All 300 farms received extensive reports that detailed the results of the animal observations, bulk milk testing and results of individual milk samples. The reports included individual results and comparisons to peer groups. Results of this study have also been presented annually in research sessions at the National Mastitis Council, and in workshop format at the MOSES Organic Conference. Numerous presentations of preliminary data have been presented at state and national veterinary meetings and at producer meetings organized within each state. An advisory group has met to review the data and provide input of

how to best impact end users. A series of factsheets presenting results of the recently analyzed data are currently being prepared and will be distributed to key stakeholders and extension services.

We expect to publish at least 6-7 manuscripts in peer-reviewed scientific journals. One paper is currently accepted for publication in the Journal American Veterinary Medical Association, and 2 papers have been submitted in revised format to Journal of Dairy Science and are currently being peer reviewed. Two other papers are close to submission and there are at least 2 additional papers that are being prepared for submission. Data from each of the accepted papers is being used in the preparation of extension materials (see next section).

Websites, patents, inventions, or other community resources created:

The questionnaire and preliminary results of some of the analyses are available for review on the project website: <http://milkquality.wisc.edu/organic-dairies/> . A Youtube video that describes animal health regulations for organic dairy farms has been created and viewed by >350 people

<http://www.youtube.com/watch?v=jPczIYiksH8&feature=youtu.be> . The project website also contains an area that allows producers to input current data for benchmarking against self selected peer-groups.

<http://milkquality.wisc.edu/milking-management/comparison-tools/scc-comparison-tool/> . More extension materials will be released as the scientific papers are accepted by peer reviewed publications.

The significance of your findings to organic agriculture: Outcomes of this project indicate that dairy animal well-being is not compromised by use of organic management practices. The small to medium sized organic dairy herds enrolled in this study produced less milk but used similar definitions and disease detection strategies as compared to similarly sized conventional dairy herds. Organic dairy producers identified fewer production related diseases in their cattle as compared to similarly sized conventional herds located in the same regions. In general, although approved treatments are limited for organic dairy producers, mortality rates and culling of cattle on organic dairy herds are similar to similarly sized conventional dairy herds and there is no evidence that milk quality or animal health is adversely impacted by the use of organic management. While the occurrence of many diseases is relatively infrequent, organic dairy producers could use more resources to prevent and effectively deal with several animal diseases that are caused by bacterial infections (such as pneumonia and subclinical mastitis). Within the guidelines of the NOP, management practices used by organic dairy producers range from very extensive to fairly intensive and use of veterinarians by organic dairy producers is associated with adoption of more intensive management strategies. For most diseases risk factors for development of disease were similar for ORG and CON farmers. There is a need to increase communication between dairy veterinarians and the organic dairy farming community.

Other comments or recommendations for future work:

This project provides a baseline for animal health on small and medium sized dairy herds that use organic and conventional milking practices. The results of this study indicate that more educational programming is needed to help dairy producers better understand and control subclinical diseases (such as mastitis).

Additional research is also needed for treatment and preventive strategies for bovine respiratory disease.

Project Title: Organic production of certified seed potatoes in the Midwest - increasing access and diversity

Award number: 2009-51300-05582

Period of funding: 2009-2012 (requested no-cost extension to spring 2013)

Primary Institution: University of Wisconsin-Madison

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The purpose of the project: Potatoes are produced by approximately 250 organic farms in the Midwest and are a staple that is always found at farmers' markets, co-ops, and other retail markets that sell organic produce. Organic farmers in the Midwest face a severe shortage of organically produced certified seed potatoes, especially for heirloom and specialty varieties suited to organic production systems. The long-term goals of our project are to support the growth of the organic certified seed potato industry in the Midwest region of the United States, to support organic potato growers in raising healthy and profitable potato crops, and to increase availability of heirloom and specialty potato varieties suited to organic production.

Completed to date:

Increased availability of heirloom and specialty potato varieties

1. Worked with Seed Savers Exchange to cure over 80 heirloom and specialty varieties from pathogens so that disease-free seed may be produced. Disease-free seed of these varieties has not been previously available. Our target was 100 varieties; some are still in progress and we were unable to clean some varieties chosen for this project.
2. Trained Seed Savers Exchange staff in how to cure potato varieties of pathogens and how to use ELISA to confirm that plantlets are disease-free (two training sessions).
3. Wrote a comprehensive manual on potato tissue culture and pathogen-curing methods for potato.
4. Developed an on-campus hydroponic system to produce high numbers of specialty variety seed for organic research trials. We are training a local farmer who is interested in starting a hydroponic business in how to manage this system.
5. Trained one organic farmer in two methods of seed potato minituber production. This is the first generation of potato grown for seed and until 2012, minitubers had not been produced on organic farms in the Midwest.

Gained production knowledge about heirloom and specialty potato varieties

1. Performed replicated on-farm trials of over 40 specialty varieties on 12 organic farms. Potato yields on conventional farms are greatly impacted by fertilizers and pesticides, so yields across varieties within market classes, such as russets or reds, are not statistically different when the varieties are grown under the same conventional management practices. However, when grown with organic management, yields vary widely. We identified varieties in each market class that performed robustly on a wide range of farms across years, so are now able to recommend varieties likely to perform well to organic farmers in the Midwest.

2. Performed smaller trials of another over 50 specialty varieties and breeding lines on organically-managed research plots and farms in order to identify additional varieties likely to perform well on organic farms.
3. Identified diseases and pests that cause greater losses on organic farms than conventional farms, such as silver scurf, black dot, and leafhoppers. Potato varieties were screened for resistance to these diseases. A breeding line and a recently released white potato (Megachip) were found to be resistant to silver scurf. Lines were also rated for resistance to leafhoppers and leafhopper resistant lines are now being used in a small project focused on breeding potatoes for organic production.
4. Trialed methods for control of *Potato virus Y* (PVY). This virus is the most common and problematic disease in seed potato production. We trialed plastic mulch, mineral oil sprays, row cover, UW-blocking nets, and vine cutting to determine which methods most effectively controlled spread of PVY in potato. We also identified varieties and breeding lines with resistance to PVY and these lines are being used in our current organic potato breeding project.

Provided information about potato production to farmers and consumers.

1. Held regular meetings with regional organic farmers who grow potato to work toward a sustainable solution to seed potato availability. These meetings included regular discussions at the MOSES meeting in La Crosse Wisconsin and these MOSES meetings have proven to be a useful way to recruit new farmer collaborators and to discover the main problems faced by farmers in production of potato and other vegetative crops. We provided regular project reports to the farmers on disease control methods and variety performance at these meetings. Because of interactions at the 2012 MOSES meeting, we were able to establish research plots on two organic farms runs by tribal colleges. In 2013, we hope to trial early generation seed potato production at one of these farms since they are isolated and well-suited for seed production. This may provide a source of income for their farmer training program and a source of heirloom and specialty variety seed for organic farms.
2. Conducted two economic analyses of organic certified seed potato production, using a whole-farm planning approach. One analysis, focusing on organic potato production, has been published. The second, which focuses on the costs of early generation seed production, is in progress.
3. Conducted trials to identify potatoes with superior taste and nutritional qualities, including starch and antioxidant properties.

Extension and/or education activities completed or upcoming:

1. Regular reports on variety performance and disease control have been provided to all of our farmer-partners after each growing season. Discussions with farmers helped us identify other similar high value crops that they produce, most notably sweet potato, which was historically a major crop in the Great Lakes region.
2. Results from this project were presented at MOSES, Wisconsin Potato and Vegetable Grower Association, Potato Association of America, and the American Phytopathological Society meetings throughout the course of this project. We are slated to give a session with our farmer collaborators at the MOSES meeting (1.5 hrs) in 2013.
3. Potatoes from our most recent crop season are being distributed to various community groups, such as UW Slow Food to increase awareness of specialty and heirloom varieties.
4. A nascent collaboration has been initiated with a student farm group, F. H. King, and a residential learning center, Green House, on the UW-Madison campus.
5. A new course on organic and urban agriculture was offered in 2011 and will be offered again in 2013.
6. Students participating in this project have gone on to jobs in agriculture, including working on organic farms, managing breeding programs for commercial seed production companies, working on urban farms in Chicago, and working in tissue culture labs for commercial potato production companies.

Websites, patents, inventions, or other community resources created:

1. Manuals for potato tissue culture and seed potato production have been written. We are in negotiations with a publisher for this material and working with a website designer to place some of this information online.

The significance of your findings to organic agriculture: Potatoes are produced by approximately 250 organic farms in the Midwest and these farmers face a severe shortage of organically produced certified seed potatoes, especially for heirloom and specialty varieties suited to organic production systems. Because many serious potato diseases are seed-borne and these diseases, such as late blight, can easily spread long distances to numerous organic and commercial farms, provision of healthy seed protects all conventional and organic potato farmers in a region. We increased availability of disease-free heirloom and specialty varieties, identified varieties that perform well on organic farms, identified pests and diseases that are the largest constraints to organic potato production in the Midwest, tested control methods for some of these diseases, and identified varieties that are superior in taste and nutrition. This information is being published in peer-reviewed articles, online, and as a production manual. High-performing varieties are being used as parents in an organic breeding project. We are working with local organic farmers to try to develop a self-sustainable seed production and breeding program for organic farmers and to increase communication between organic farmers and university researchers.

Other comments or recommendations for future work:

1. There are many similarities in production of vegetative crops, including common crops such as potato, garlic, strawberry, and sweet potato and very high value specialty crops, such as wasabi. Finding ways to leverage production and breeding expertise across these vegetatively-propagated crops would be useful for organic farmers.
2. Organic potato farmers face large losses each year from pests and pathogens that are currently easily controlled on conventional farms, such as late blight, silver scurf, black dot, and leafhoppers. Even on conventional farms, pest or pathogen resistance to pesticides could result in loss of control in the future. Continued breeding for resistance to these pests and diseases will benefit both organic and conventional farmers.
3. Production of early generation planting material and breeding of vegetative crops still remains largely in the public domain because of its high risk nature and requirement for highly trained personnel and expensive specialized equipment. Cuts in agricultural funding for research and plant breeding and cuts in state funding for universities have put these breeding and seed production programs at great risk, both because the programs are not functioning robustly due to very tight budgets and because we can no longer afford to train students in these areas due to severe cuts in faculty numbers in agricultural departments and teaching budgets. Potato farmers do provide much support, but because healthy seed is a public good because it reduces waste in land, water, and chemical resources, it is appropriate for government to support these endeavors. I fear that both future staffing needs and future infrastructure for seed production are now at risk.

Additional Project Reports

Project Title: Carbon Sequestration, Nutrient Bioavailability, and Environmental Services from Organic Agriculture

Award number: 20105130021620

Period of funding: 9/1/10 – 8/31/14

Primary Institution: Washington State University

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Website: http://csanr.wsu.edu/pages/Organic_Farming_Footprints/

The purpose of the project: This project (nicknamed “Organic Farming Footprints” or “OFoot”) addresses needs of 3 stakeholder groups: organic producers, organic certifying agents and agencies, and purchasers/traders of carbon credits. These groups need a scientifically sound yet simple estimation of the carbon and nitrogen sequestration and net greenhouse gas (GHG) balance likely in a given organic cropping system scenario.

Both a research model and a Life Cycle Analysis (LCA) tool will be developed through this project. The LCA tool will evaluate the impacts (contribution or mitigation) of organic farming methods on climate change. Currently, LCA is the purview of academics and consultants. Working with organic producers to develop a generally useful LCA tool could lead to organic farming methods and systems that maximize soil carbon storage, minimize greenhouse gas production, minimize total carbon footprint, and thereby contribute further to critical ecosystem services including global temperature moderation. A small set of “Focus Farms” will be involved in shaping the contents and format of the LCA tool, serving as validation sites for the model outputs, and as assessment sites for system-level LCA analysis.

Producers and the public will benefit from identifying significant sources and possibilities to reduce greenhouse gases and embedded energy within organic food production. If a carbon market comes back, it will benefit by access to a validated model for carbon sequestration in organic systems. Environmental benefits will accrue from the sequestration of carbon, minimizing of greenhouse gas emissions, and efficiency of nutrient utilization that will all be improved by using the outputs of this project as farm management planning tools.

Completed to date:

- Significant data has been collected and is undergoing final analysis to parameterize and validate the CropSyst program. CropSyst is a model of crop growth and soil carbon cycling. At the start of the OFoot project CropSyst was suitable primarily for cereal grain production systems. Ten new crop types have been added to the model, making it better suited to diverse crops and diversified farms. Data has come from working organic farms and field plots.
- Field plots have been managed in central and western Washington in 2011 and 2012. Four treatments are dairy manure, green manure, chicken litter compost, and control. Soils, crops, and gas production have been monitored. Modeling of C and N transformations is underway.

- Soil samples have been collected from 40 sites among the organic Focus Farms. A replicated subset of these samples are undergoing analysis using standard extractants and ionic resin probes. This comparison will allow informed deployment of resin probes for more timely tracking of nutrient availability and needs.
- Inputs, equipment, labor, and outputs have been documented from five organic focus farms. This data is the first input into the developing LCA tool.

Extension and/or education activities completed or upcoming:

- The PI team meets biannually with our focus farmers to review the role of agriculture in greenhouse gas production, and the progress of the OFoot project.
- At the 2010 annual conference of the Tilth Producers of Washington, a special evening session was held to introduce the issue and project to one of our target populations. The Tilth Producers of Washington conference draws approximately 500 of the state’s organic, sustainable, and progressive growers.
- A webinar was produced through eOrganic: [Greenhouse Gases and Agriculture: Where Does Organic Farming Fit?](#) In this webinar, the presenters discuss these roles of agriculture in greenhouse gas production, how management affects them, and ways in which organic farming systems in particular may influence greenhouse gases.
- Life Cycle Analysis: One of the major products of this project is a user-friendly Life Cycle Analysis program. This program is in development. Our focus farms have been studied as model systems and their data input into the evolving LCA. Currently the laboratory and field research data are being incorporated to parameterize and validate the soil component of the program. The LCA tool will become available in 2013 and will be introduced to the Tilth Producers of Washington at the 2013 annual conference.

Websites, patents, inventions, or other community resources created:

Website: http://csanr.wsu.edu/pages/Organic_Farming_Footprints/

Webinar: [Greenhouse Gases and Agriculture: Where Does Organic Farming Fit?](#)

The significance of your findings to organic agriculture:

We did know this before we started, but our findings are supporting the conclusion that organic farming is not immune to production of greenhouse gases or use of excess nutrients. The significance of this project will come when farms – hopefully thousands – use the Life Cycle Analysis tool to track and understand their operation, better matching management inputs to true needs, and reducing “hot spots” of direct or indirect greenhouse gas production. The LCA tool is being developed to meet international LCA standards and will be available openly on the internet for use and improvement by others.

Project Title: Development of Cultivars and IPM Strategies for Organic Cotton Production

Award number: 2010-51300-21268

Period of funding: 09/01/2010 – 08/31/2014

Primary Institution: Texas A&M AgriLife

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The purpose of the project:

This project is geared to address the problem of varietal options and insect pest control in organic cotton production systems on the Texas High Plains. According to USDA-AMS Cotton Program market news report, “Cotton Varieties Planted 2012 Crop” (mp_cn833), over 95% of cotton in the U.S. is grown using genetically-modified (GM) commercial varieties and nearly the entire seed-development infrastructure is geared to provide such. Thus, there is a pronounced lack of planting seed sources for non-GM cotton seed that would be approved for certified organic production. As a result, nearly all of the organic cotton in the U.S. has been grown with only one or two non-GM cultivars no longer commercially available. Growers are, therefore, in need of a greater selection and availability of high-performing, good-quality non-GM cotton varieties. The first goal of this project is to develop and release such varieties, to be provided commercially by a cooperating seed company.

Second, with synthetic insecticide use prohibited by certified organic management guidelines, producers are forced to find alternative, more creative methods of pest control for their organic systems. Thrips (*Thysanoptera: Thripidae*) are the first pests to significantly affect cotton during the growing season and can cause reduced fiber quality and yield and even seedling plant death, given high enough pest pressure. Therefore, another major purpose of this project is to develop and identify non-GM cotton lines with high tolerance to thrips injury that in combination with approved organic insecticides provide effective thrips control. Ultimately, we hope to identify the best combination of both resistant cotton genotypes and approved insecticides which will provide effective integrated thrips control, resulting in optimal productivity and profitability for organic cotton growers on the Texas High Plains. Developing new and improved breeding lines specific for organic cotton production along with molecular markers for thrips resistance is expected to provide the basis for a pipeline of continual varietal improvement that can be available without biotechnology traits.

Completed to date:

Yield Trials:

A variety of field and greenhouse trials have been initiated to date, with preliminary results presented herein. Field trials were initiated in 2011 to evaluate non-GM germplasm previously developed by the Texas A&M AgriLife Cotton Breeding Program. Eight advanced breeding lines and two cultivars (considered commercial standards by organic growers on the Texas High Plains) were planted on a cooperator’s certified organic land near Meadow, TX. A second yield test was planted on non-certified land at the Texas A&M AgriLife Research and Extension

Center near Lubbock, TX and included seven advanced cotton breeding lines and one check cultivar. Each genotype was evaluated for a variety of agronomic and fiber quality characteristics. There were no significant yield differences ($P > 0.05$) among genotypes at both locations (Tables 1 & 2), likely as a result of extreme drought conditions that pervaded the 2011 growing season. However, it is worth noting that all genotypes were statistically equivalent to FM 958, the standard organic cultivar no longer commercially available, under such extreme drought conditions at both locations. There were a number of differences in lint turnout, crop maturity, and storm resistance among experimental lines and cultivars ($P \leq 0.05$). “Lint turnout” is the percentage of a seed cotton sample that is actually useable lint; “crop maturity” is based on a visual estimate of the percentage of open bolls of a specific genotype; and “storm resistance” is a visual rating of advantageous boll structure that would reduce cotton losses to late-season storm events (important in organic production since harvest must wait until after a killing frost). Among these data, lines 07-7-1407CT and 07-14-510FS exhibited the best combination of lint turnout, early maturity, and storm resistance at both locations; however, these lines were statistically equivalent to FM 958 for nearly all of the evaluated characteristics ($P > 0.05$). There were also a number of differences in various High-Volume Instrument (HVI) fiber quality characteristics for the evaluated lines at each location (Tables 3 & 4) ($P \leq 0.05$). Most notable were lines 07-20-1304D and TAM 04WB-33s, which both had excellent combinations of fiber length, uniformity, strength, and elongation values. However, TAM 04WB-33s was only present at the Meadow location in 2011, whereas 07-20-1304D was present at both locations. Lines 07-7-1407CT and 07-14-510FS did not display as high of fiber quality values as 07-20-1304D and TAM 04WB-33s, but were greater for most quality parameters than FM 958. Agronomic and fiber quality data from the 2012 yield tests are not yet available.

Table 1. Yield and harvest data and maturity and storm resistance data for eight advanced cotton breeding lines and two commercial varieties in a certified organic production system near Meadow, Texas in 2011.

Entry	Lint	Lint	Mature	Storm
	Yield	Turnout	Bolls ^a	Resistance ^b
	kg ha ⁻¹	-----%-----		
06-21-519FQ	966 a	24.9 a	48 a-c	5.25 ab
06-45-1104D	995 a	23.0 cd	40 bc	5.75 ab
07-7-1001CT	968 a	23.7 b-d	57 ab	5.00 bc
07-7-1407CT	983 a	25.7 a	65 a	5.25 ab
07-14-205FS	1124 a	22.3 d	61 a	5.50 ab
07-14-510FS	1083 a	25.0 ab	65 a	5.25 ab
07-20-1304D	1094 a	22.6 d	51 a-c	6.00 a
FiberMax® FM 958	977 a	24.7 a-c	63 a	6.00 a
FiberMax® FM 989	1076 a	23.2 b-d	35 c	5.00 bc
TAM 04WB-33s	1089 a	23.4 b-d	55 a-c	4.25 c

Means within a column followed by the same lowercase letter are not significantly different according to pairwise t-tests at $P = 0.05$.

^a Visual estimate of mature bolls.

^b Values based on 1-9 visual rating scale for storm resistance (1 = poor; 9 = excellent).

Table 2. Yield and harvest data and maturity and storm resistance data for seven advanced cotton breeding lines and one commercial variety under conventional management near Lubbock, Texas in 2011.

Entry	Lint Yield	Lint Turnout	Mature Bolls ^a	Storm Resistance ^b
	kg ha ⁻¹	-----%-----		
06-21-519FQ	626 a	26.2 ab	43 abc	5.67 a
06-45-1104D	543 a	23.8 c	53 abc	5.00 a
07-7-1001CT	769 a	24.7 bc	58 ab	4.67 a
07-7-1407CT	931 a	27.7 a	38 bc	5.00 a
07-14-205FS	748 a	24.2 c	33 c	5.67 a
07-14-510FS	680 a	26.3 ab	61 a	5.33 a
07-20-1304D	632 a	25.1 bc	50 abc	6.33 a
FiberMax® FM 958	650 a	26.9 a	60 a	6.00 a

Means within a column followed by the same lowercase letter are not significantly different according to pairwise t-tests at P = 0.05.

^a Visual estimate of mature bolls.

^b Values based on 1-9 visual rating scale for storm resistance (1 = poor; 9 = excellent).

Table 3. High-Volume Instrument (HVI) fiber quality data for eight advanced cotton breeding

Entry	Mic	Length	Unif	Strength	Elong	Rd	+b	Leaf Grade
		cm	%	g tex ⁻¹	%			
06-21-519FQ	3.8 a	2.87 d	82.75 b	33.9 cd	7.20 bc	78.70 a	8.85 a	1.5 bc

lines and two commercial varieties in a certified organic production system near Meadow, Texas in 2011.

06-45-1104D	4.1 a	2.95 bc	82.65 b	34.2 b-d	6.70 de	75.75 a	8.90 a	2.5 ab
07-7-1001CT	4.6 a	2.72 f	82.15 bc	30.7 f	8.10 a	77.00 a	8.55 a	3.0 a
07-7-1407CT	3.7 a	2.79 e	81.40 c	32.5 e	7.35 bc	78.30 a	8.30 a	1.0 c
07-14-205FS	3.8 a	2.97 b	82.85 b	34.9 bc	7.85 a	78.15 a	8.80 a	2.5 ab
07-14-510FS	4.5 a	2.87 d	81.90 bc	31.0 f	6.75 d	78.25 a	8.40 a	1.5 bc
07-20-1304D	3.8 a	2.95 bc	81.75 bc	33.2 de	7.10 c	79.05 a	8.60 a	1.5 bc
FiberMax® FM 958	4.4 a	2.90 cd	82.00 bc	32.5 e	6.40 e	80.20 a	8.50 a	1.0 c
FiberMax® FM 989	4.1 a	2.97 b	84.80 a	38.2 a	7.95 a	75.60 a	9.40 a	1.0 c
TAM 04WB-33s	4.1 a	3.15 a	85.15 a	35.6 b	7.50 b	79.65 a	8.40 a	1.0 c

Means within a column followed by the same lowercase letter are not significantly different according to pairwise t-tests at P = 0.05.

Table 4. High-Volume Instrument (HVI) fiber quality data for seven advanced cotton breeding lines and one commercial variety under conventional management near Lubbock, Texas in 2011.

Entry	Mic	Length	Unif	Strength	Elong	Rd	+b	Leaf Grade
		cm	%	g tex ⁻¹	%			
06-21-519FQ	4.4 bc	2.74 b	81.25 a	32.7 a	7.15 bc	77.10 a	8.50 b ^a	1.5 a
06-45-1104D	4.5 bc	2.82 ab	80.40 a	31.7 bc	6.10 de	76.15 a	9.20 a	1.0 a
07-7-1001CT	4.6 ab	2.67 c	81.35 a	30.2 cd	7.30 b	76.95 a	8.50 b	2.5 a
07-7-1407CT	3.9 d	2.77 ab	80.80 a	32.7 b	6.90 c	77.65 a	8.45 b	1.5 a
07-14-205FS	3.9 d	2.82 ab	81.15 a	34.9 a	7.65 a	76.85 a	8.65 ab	1.5 a
07-14-510FS	4.5 bc	2.84 a	81.25 a	32.1 bc	5.95 e	78.05 a	8.45 b	1.0 a
07-20-1304D	4.9 a	2.77 ab	80.60 a	31.8 bc	7.35 ab	76.60 a	8.50 b	1.0 a
FiberMax® FM 958	4.9 a	2.67 c	79.50 a	29.2 d	6.40 d	76.60 a	8.15 b	1.0 a

Means within a column followed by the same lowercase letter are not significantly different according to pairwise t-tests at $P = 0.05$.

^a Significant at $P = 0.10$.

Thrips Screening:

One symptom of thrips feeding injury is reduced leaf area, resulting from abnormal growth of damaged young leaves. Therefore, whole-plant samples were also collected from each plot at the Meadow location in 2011 and leaves from each sample were analyzed for leaf area. Samples were collected weekly for the first five weeks after planting (WAP). However, leaf area did not differ significantly among genotypes ($P > 0.05$) for any sample date (data not presented). This was likely a result of extremely low ambient thrips pressure, due to drought conditions during the growing season. Also, since we were unable to include chemically-sprayed control plots for each line on our cooperator's land, we were unable to calculate leaf area reduction of the experimental plots compared to a functionally thrips-free control. Thus, we decided to base our future thrips field evaluations for this experiment on visual ratings of thrips feeding injury alone. This would allow us to discriminate among lines without jeopardizing our cooperator's organic certification.

For the 2012 growing season, yield tests were planted in three locations near Idalou, Lamesa, and Lubbock, TX. Visual thrips injury ratings were conducted on all plots at the Lamesa location on 20 June and the Lubbock location on 14 June, 21 June, and 28 June (Table 5). Ambient thrips pressure at the Idalou location was insufficient for adequately discriminating among genotypes. Significant differences among genotypes, however, only occurred in the 14 June ratings at Lubbock ($P \leq 0.05$). Lines 07-7-1001CT and 07-7-1020CT exhibited the highest visual ratings (i.e. the least thrips injury). Both of these lines were originally selected for cold tolerance and have characteristically thicker leaves, which could have also conferred some amount of tolerance to thrips feeding. Visual ratings for leaf hairiness will also be conducted this fall to assess hairiness differences among lines, which could also affect thrips tolerance and/or leaf grade.

Table 5. Visual thrips injury ratings on thirteen advanced cotton breeding lines and three check cultivars for potential in organic production systems near Lamesa and Lubbock, Texas in 2012.

Entry	Visual Injury Ratings ^a			
	Lamesa ^b , June 20	Lubbock ^c , June 14	Lubbock, June 21	Lubbock, June 28
06-21-519FQ	6.9 a	4.4 cd	5.4 a	5.5 a
06-45-1104D	6.8 a	6.3 ab	6.0 a	6.3 a
07-7-519CT	6.4 a	6.1 a-c	6.1 a	6.7 a
07-7-1001CT	6.5 a	7.0 a	6.0 a	6.7 a
07-7-1020CT	6.3 a	6.7 a	6.7 a	6.7 a
07-7-1303CT	7.0 a	6.3 ab	6.7 a	7.0 a
07-7-1407CT	6.0 a	6.3 ab	5.3 a	5.3 a
07-14-205FS	7.0 a	3.7 d	4.7 a	5.3 a
07-14-510FS	7.0 a	4.0 d	5.3 a	5.7 a
07-20-1304D	7.0 a	5.0 b-d	6.0 a	7.0 a
09T#1-1116-FQ	6.8 a	5.0 b-d	6.0 a	5.7 a
All-Tex® Atlas	6.8 a	3.7 d	5.7 a	6.7 a
FiberMax® FM 958	7.5 a	5.7 a-c	6.0 a	6.7 a
FiberMax® FM 989	7.3 a	6.0 a-c	6.0 a	6.7 a
TAM 04WB-33s	6.3 a	3.7 d	5.0 a	5.3 a
Tamcot 73	7.0 a	4.3 cd	5.3 a	6.0 a

Means within a column followed by the same lowercase letter are not significantly different according to pairwise t-tests at $P = 0.05$.

^a Visual ratings were conducted on a 1-9 scale (1 = plant death and 9 = no damage).

^b Lamesa location was on USDA-certified organic land and managed according to certified organic guidelines.

^c Lubbock location was on non-certified land, but managed according to certified organic guidelines.

Mapping Study:

A greenhouse trial was initiated in late 2011 to evaluate the potential for molecular marker development of the thrips resistance trait. A thrips-resistant line ('TX 110') was crossed with an elite cotton line ('CA 2266'). Both parental lines, a thrips-susceptible control ('All-Tex® Atlas'), and an F_1 CA 2266 x TX 110 line were planted in a greenhouse study at the Texas A&M AgriLife Research and Extension Center near Lubbock, TX, along with an F_2 CA 2266 x TX 110 population comprising approximately 240 individuals. The cotton lines were planted following wheat that was grown in small plastic pans to increase thrips pressure in the greenhouse prior to planting cotton. Approximately one week after cotton planting, the wheat was killed with herbicide to force thrips onto the seedling cotton. Sprayed controls of each genotype were also maintained, to ensure calculation of leaf area reduction from thrips injury on the experimental lines. Percent leaf area reduction and visual thrips injury data were collected at the 4-5th true leaf stage. Each cotton line was also washed with a special solution to remove and collect thrips nymphs and adults for later counting. Percent leaf area reduction and visual ratings were

conducted on an individual plant level in the F₂ population. Atlas, CA 2266, and TX 110 all exhibited a statistically greater reduction in leaf area than F₁ CA 2266 x TX 110 ($P \leq 0.05$), likely as a result of some hybrid vigor in the F₁ line (Table 6). However, CA 2266, F₁ CA 2266 x TX 110, and TX 110 all displayed less visual thrips injury than the susceptible Atlas ($P \leq 0.05$). Additionally, CA 2266 had higher levels of thrips nymphs on the actual plants than Atlas and TX 110 ($P \leq 0.10$), but there were too few adults to count (data not presented). These differences, especially among TX 110 and Atlas and CA 2266 were not as pronounced as we have observed in other similar tests, suggesting that the thrips pressure in the greenhouse during the experiment was too low to adequately discriminate resistance/susceptibility among lines. Visual ratings from the F₂ population (Fig. 1) suggest the thrips resistance trait is controlled by multiple genes. Percent leaf area reduction from the F₂ population (Fig. 2) was inconclusive because of significant segregation for leaf area in the sprayed control group. This rendered any accurate determination of leaf area reduction impossible. Additionally, TX 110 is photoperiodic, therefore many of the F₂ individuals didn't produce bolls from which seed could be collected for F₃ progeny testing.

Table 6. Percent leaf area reduction, visual thrips injury ratings, and number of thrips nymphs on two parent cotton cultivars, an F₁ generation, and a susceptible control cultivar in a greenhouse trial near Lubbock, Texas, 2011-2012.

Entry	Percent Leaf Area Reduction	Visual Injury Ratings ^a	Thrips Nymphs Per Entry
All-Tex® Atlas	44 a	4.2 b	2.6 b ^b
CA 2266	38 a	6.0 a	9.8 a
F ₁ CA 2266 x TX 110	20 b	6.4 a	4.8 ab
TX 110	38 a	6.4 a	2.0 b

Means within a column followed by the same lowercase letter are not significantly different according to pairwise t-tests at $P = 0.05$.

^a Visual ratings were conducted on a 1-9 scale (1 = plant death; 9 = no damage).

^b Significant at $P \leq 0.10$.

Figure 1. Frequency density histogram of percent leaf area reduction values from thrips feeding injury for a F₂ CA 2266 x TX 110 population in a greenhouse experiment near Lubbock, TX in 2011-2012.

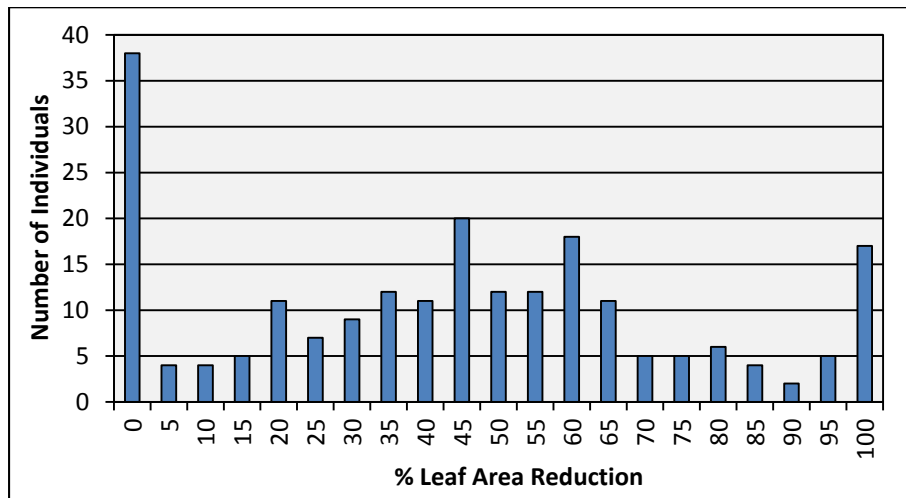
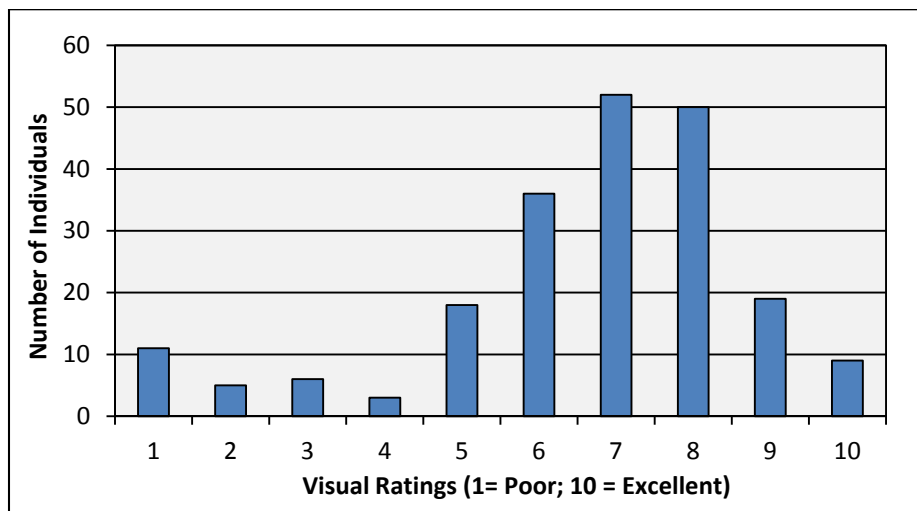


Figure 2. Frequency density histogram of visual thrips injury ratings for a F₂ CA 2266 x TX 110 population in a greenhouse experiment near Lubbock, TX in 2011-2012.



As a result of these issues, a similar trial was developed and planted in the field in 2012. An F₂ mapping population resulting from a cross between resistant ‘Cobalt’ and 07-7-1407CT was planted along with the parental lines, an F₁ line, and resistant (TX 110) and susceptible (Atlas) controls. Cobalt is non-photoperiodic, which will ideally ensure that F₃ seed can be collected for future progeny testing. Visual thrips injury ratings were conducted on the parent, F₁, and control plots and on the F₂ individuals at the 4-5th true leaf stage. Cobalt and TX 110 displayed greater thrips tolerance than Atlas (Table 7) ($P \leq 0.05$). The F₂ values (Fig. 3) did not display a wide variation, and appeared to be normally distributed, but were not normal based on Shapiro-Wilk

normality analysis at $P = 0.05$. Tissue samples were collected from each F_2 individual and work will continue in the lab to assess the potential for molecular marker development of the thrips resistance trait.

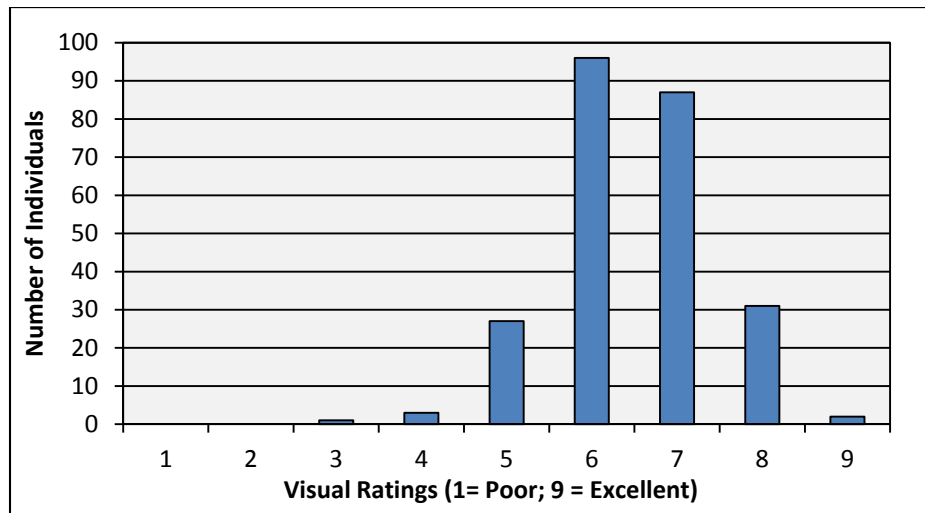
Table 7. Visual thrips injury ratings on two parent cotton cultivars and a susceptible and resistant control cultivar in a field trial near Lubbock, Texas in 2012.

Entry	Visual Injury Ratings ^a
07-7-1407CT	6.1 ab
All-Tex® Atlas	5.9 b
Cobalt	6.7 a
TX 110	6.6 a

Means within a column followed by the same lowercase letter are not significantly different according to pairwise t-tests at $P = 0.10$.

^a Visual ratings were conducted on a 1-9 scale (1 = plant death; 9 = no damage).

Figure 3. Frequency density histogram of visual thrips injury ratings for a F_2 07-7-1407CT x Cobalt population in a field trial near Lubbock, TX in 2012.



Thrips Nursery:

A thrips nursery has also been maintained since 2010 for the development of new varieties with high levels of thrips tolerance. To date, we have planted 13 different crosses in the field and have selected 330 individual plants that exhibited high thrips tolerance or excellent yield and fiber quality. The seed from these selected plants is then planted and subjected to repeated selection over subsequent growing seasons for thrips resistance and agronomic performance. Currently, there are F_2 , F_4 , and F_5 generations planted in the nursery this year. Ideally, the lines

developed in the nursery will be yield-tested at the field level, similar to the aforementioned trials, and high-yielding, thrips-resistant varieties will be identified for commercial release.

Extension and/or education activities completed or upcoming:

4-7 Jan. 2013 – Both oral and poster presentations are planned for the Beltwide Cotton Research and Production Conference in San Antonio, TX.

23 Oct. 2012 – Organic Cotton Field Day, Texas Organic Cotton Marketing Cooperative - This year's field day will be the first to include an official stop at the Texas A&M AgriLife Research and Extension Center near Lubbock to showcase our organic research

3 Oct. 2012 – Jane Dever will introduce via video the Organic Cotton Round Table topic “Seed Security in a Minority Environment” to a diverse group ranging from small to large scale seed projects, brand representatives from organic cotton processors and stakeholders in organic cotton from production to finished product at the Textile Exchange annual meeting in Hong Kong.

9 Aug. 2012 – Received approval from the Texas Tech Graduate School to include Kelly Pepper, manager of TOCMC, as a voting member of graduate student Dylan Wann's advisory committee

22 Feb. 2012 – Research Update on Organic Cotton presented by Jane Dever to growers, ginners and organic dairy/cattle feeder representative at the annual Texas Organic Cotton Marketing Cooperative meeting.

4 Jan. 2012 – Three posters from the project were presented at the Beltwide Cotton Production and Research Conference in Orlando, FL. Posters included results of breeding line performance trials, results of efficacy trials for approved organic insecticides on thrips control, and results of compensation studies following thrips injury.

1. Vandiver, M., D. L. Kerns, B. Baugh, M. N. Parajulee, J. K. Dever and M. D. Arnold. 2012. Managing Thrips Using Organically Approved Insecticides. Proceedings of the Beltwide Cotton Production and Research Conferences. National Cotton Council of America.
2. Wann, D. Q., J. K. Dever, M. D. Arnold and H. D. Flippen. 2012. Field Evaluation of Advanced Breeding Lines for Organic Cotton Production. Proceedings of the Beltwide Cotton Production and Research Conferences. National Cotton Council of America.
3. Shrestha, R. B., W. O. McSpadden, J. K. Dever, M. D. Arnold, D. L. Kerns and M. N. Parajulee. 2012. Potential of Organic Pesticides for Western Flower Thrips Management in Seedling Cotton: Effect of Plant Parameters. Proceedings of the Beltwide Cotton Production and Research Conferences. National Cotton Council of America.

18 Sept. 2011 – Participated in the Round Table discussion “Future of non-GMO Seed Supply” at the Textile Exchange Annual Conference in Barcelona, Spain (Jane Dever – featured speaker)

20 Oct. 2011 – Organic Cotton Field Day, Texas Organic Cotton Marketing Cooperative

7 Oct. 2010 – Organic Cotton Field Day, Texas Organic Cotton Marketing Cooperative

The significance of your findings to organic agriculture

This work has the potential to significantly improve the diversity and availability of productive, non-GM cotton varieties for organic growers on the Texas High Plains. In any production system, it is important for the long-term sustainability of the system to utilize more than one crop variety. Additionally, thrips-resistant cotton varieties have the potential for improving the integrated management of thrips pests in organic cotton systems, which impacts the long-term sustainability and profitability of the system as a whole. This is especially important on the Texas High Plains, where over 95% of U.S. organic cotton is currently grown. These varieties would have dual applicability, since thrips resistance is also beneficial to conventional cotton growers. Not only would organic cotton production be improved by this research, but it could also aid in reducing pesticide use in conventional cotton systems. In the interim, education efforts on seed security for organic cotton production have seen the available varieties increase from 2 in previous USDA-AMS market reports to 5 in the 2012 mp_cn833 report – 3 from our seed company partner, All-Tex, Inc.

Other comments or recommendations for future work:

Our ongoing screening effort to discover native traits within the cotton germplasm collection have revealed thrips resistant lines in the *Gossypium barbadense* species instead of the widely cultivated *G. hirsutum* species. Molecular marker development could aid in introgressing these traits into a day-neutral *G. hirsutum* background, but in the interim, screening efforts have intensified within the target species. The overall goal is to develop a pipeline of planting seed with relevant genetic improvement for organic cotton production, though this first step is specifically to exploit material found to be thrips resistant and integrate an IPM approach with extension colleagues. As more native traits are discovered, and output traits important to organic cotton stakeholders are considered, we hope to expand our breeding program to include more participatory efforts, especially from producer advisors.

We are pleased to include organic dairy and beef producers to the list of stakeholders affected by this project. Cotton is generally not considered a food crop, and the primary stakeholders identified were processors and retailers of organic cotton fiber products. As planting seed security among organic cotton producers improves, more value is coming, both to farmers and dairy/beef suppliers, in the seed portion of the cotton crop as it provides an excellent, high protein food source, and organic dairy and beef producers must try to find non-GM cotton seed for feed purposes in this important food chain, in an environment dominated by GM seed.

Project Director Jane Dever has been appointed to the National Genetic Resources Advisory Council and hopes to extend education efforts on seed security in a minority environment (non-GM seed in cotton production) to countries just beginning acceptance of GM cotton and to address issues in germplasm collections associated with GM seed (the gap in basic genetic improvements represented in the collections because new varieties containing biotechnology traits are not deposited).

Project Title: Development of non-antibiotic programs for fire blight control in organic apple and pear

Award number: USDA/NIFA Award Notification 2011-51300-30770

Period of funding: 09/01/2011 through 08/31/2014

Primary Institution: Oregon State University

Project Director Name and email: Kenneth B. Johnson johnsonk@science.oregonstate.edu

Project Director telephone: 541-737-5249

Co-Project Director Names and emails: Rachel Elkins <rbelkins@ucdavis.edu> Timothy Smith <smithtj@wsu.edu>

Website: working with eOrganic

The purpose of the project: Currently, National Organic Program standard organic pome fruits can be treated with antibiotics for fire blight, but recent actions by the standards board indicate these materials will likely be unavailable to organic growers after 2014. The project's goal is to develop, within the context of organic production practices, effective non-antibiotic programs for fire blight suppression in apple and pear.

Completed to date:

Significant progress:

Objective 2: In experimental orchard trials, evaluate integrated non-antibiotic programs for fire blight control, and the degree to which the effectiveness of these programs is influenced by frequency of treatment applications.

Objective 3: In apple, evaluate the degree to which the early bloom treatments of lime sulfur and fish oil contribute to fire blight control, and how to integrate additional non-antibiotic treatments with the fruit thinning protocol.

Summary of completed research: Apple and pear produced organically under the U.S. National Organic Program (NOP) standard can be treated with antibiotics for suppression of fire blight. Recent regulatory actions by the NOP, however, have lessened the likelihood of antibiotic use after the 2014 season. In response, western U.S. organic apple and pear stakeholders identified two immediate-need research objectives related to fire blight control: development of effective non-antibiotic control programs based on combinations of registered biological products; and in apple, integration of these products with lime sulfur, which is sprayed at early bloom to reduce fruit load. In orchard trials, increasing the frequency of treatment with biological products improved suppression of floral infection. In apple, fruit load thinning with 2% lime sulfur plus 2% fish oil (LS+FO) at 30 and 70% bloom significantly ($P \leq 0.05$) reduced the proportion of blighted flower clusters in 4 of 5 orchard trials. Moreover, lime sulfur significantly ($P \leq 0.05$) suppressed epiphytic populations of *Erwinia amylovora* after their establishment on apple flowers. Over four trials, treatment with *Aureobasidium pullulans* (Blossom Protect) after LS+FO reduced the incidence of fire blight by an average of 92% compared with water only; this level of control was similar to treatment with streptomycin. In three seasons, a spray of a *Pantoea agglomerans* product after the 70% bloom treatment of LS+FO established the antagonist on a significantly ($P \leq 0.05$) higher proportion of flowers compared to a spray of this bacterium before the thinning treatment. Consequently, in apple, biological treatments for fire blight control are not advised until after lime sulfur treatments for fruit load thinning are completed.

Extension and/or education activities completed or upcoming:

eOrganic Webinar:

“Fire Blight Control in Organic Pome Fruit Systems Under the Proposed Non-antibiotic Standard”, eOrganic webinar, national and international audience (247 on day of presentation), March, 2012.

Scientific presentation:

Temple, T., Elkins, R. and Smith, T. Systems approach to fire blight control in organic pear and apple without antibiotics. 2nd International Organic Fruit Research Symposium, Leavenworth, WA, June 2012

Extension Presentations:

"Fire blight Management in 2012". OSU Extension, Hood River Winter Horticulture Meeting, Pine Grove, OR, January, 2012.

“What’s new in conventional and organic fire blight control”, N. Central Washington Apple Day, Wenatchee, WA, January 2012.

"Managing fire blight in organic orchards", Yakima Valley Organic Grower’s Meeting, Prosser, WA, January, 2012.

Updates on current research efforts: “New Yeast Product to Control Fire Blight”, Western Orchard Pest and Disease Management Conference, Portland, January 2012.

“Life without antibiotics: Non-antibiotic systems approach to fire blight control”, Washington Hort Society Annual Conference, Wenatchee, WA, December, 2011.

“Organic Fire Blight Management”, Tilth Producers of Washington Research Symposium, Yakima, November 2011.

The significance of your findings to organic agriculture:

Our work is demonstrating that effective, non-antibiotic integrated programs for fire blight control in organic apple and pear can be developed from registered biological materials available for this purpose. Because the biological products are inherently less inhibitory (softer) to *E. amylovora* than are antibiotics, effective programs in commercial orchards will require more frequent treatment, which will result in a greater cost for the overall program. In apple, however, because fruit load thinning with lime sulfur is a common practice and because this practice provides partial fire blight control, effective non-antibiotic programs can be achieved with a relatively small increase of treatments compared to bloom thinning followed by an antibiotic.

Project Title: Improved Organic Milk Production through the Use of the Condensed Tannin-Containing Forage Legume Birdsfoot Trefoil

Award number: 2010-51300-21283

Period of funding: 9-1-2010 to 8-31-2014

Primary Institution: Utah State University (USU)

Project Director Name and email: Jennifer MacAdam, jennifer.macadam@usu.edu

Project Director telephone: 435-770-8019 (cell); 435-797-2364 (office); 435-753-0130 (home)

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Jennifer Reeve (sustainable & organic systems; soils, USU) jennifer.reeve@usu.edu

Glenn Shewmaker (forage extension, Univ. ID) gshew@uidaho.edu

Robert Ward (fatty acid biochemistry, USU) robert.ward@usu.edu

Allen Young (extension dairy specialist, Utah and Wyoming) allen.young@usu.edu

Website: (for the PD, not the project) <http://psc.usu.edu/htm/people/memberID=45>

The purpose of the project:

McBride and Greene (2009) demonstrated that organic dairy producers who make the most extensive use of pasture have feed costs 25% lower than organic producers who make the least use of pasture. However, grazing-intensive organic dairies have 30% lower milk production than dairies using high-concentrate diets. The purpose of this project is to increase production on pastures to narrow this gap between grazing-based production and concentrate-based production. The perennial forage legume birdsfoot trefoil has the potential to significantly increase pasture-based milk production compared with grass pasture, based on research published by scientists in New Zealand. The on-farm research and extension that will be carried out on this grant will compare milk production on grass and birdsfoot trefoil pastures, determine the costs and benefits of establishing and using birdsfoot trefoil pastures, compare the attributes of cheese made from the milk of cows on grass or birdsfoot trefoil pastures with cheese made from conventional cattle fed a total mixed ration, and evaluate nutrient utilization by grass- and birdsfoot trefoil-fed cattle to understand the reasons for improved milk production. The nitrogen mineralization of manure from cows on these treatments will also be compared because published research has demonstrated a reduced rate of both volatilization and mineralization of nitrogen compounds from the waste of cattle and sheep fed birdsfoot trefoil compared with grass or alfalfa. Results from this project will be shared with producers, and published as journal articles and Cooperative Extension bulletins, and extended through field days and Extension agent training.

Completed to date:

The award was received in September of 2010; ground was taken out of permanent grass pasture (in most cases) in 2011, and planted with birdsfoot trefoil in the late summer/early fall of 2011. In 2012 only two producers had stands that were sufficiently robust for grazing. Three producers replanted (two in Wyoming lost new but well-established stands to unusually dry, hot and windy spring weather), and one producer had a very weedy stand. We adapted to this varied establishment by collecting pasture and milk production data for 8 or 10 weeks on the two farms with good establishment, rather than on seven farms for four weeks, as planned. The seventh participant, Aurora Organic Dairy (AOD), had an excellent stand from which we have collected agronomic data, but because they are only willing to use it as one pasture in the rotation for their whole herd, it will not be possible to collect milk production data. Economic data

has been collected from all participants except AOD, two batches of cheese have been made (one in July and one in August), the total collection (cattle nutrient utilization) study is just being completed, and manure has been collected for the nutrient mineralization (soil incubation) study, which will be carried out this fall.

Extension and/or education activities completed or upcoming:

We expect to hold a field day in 2013 at which we can present 2012 (preliminary) results. We have also drafted three extension bulletins on the establishment and management of birdsfoot trefoil and the underlying differences in rumen bypass protein resulting from the low content and unique structure of the condensed tannins in birdsfoot trefoil.

Websites, patents, inventions, or other community resources created:

A video demonstrating the proper use of a rising plate meter for assessment of pasture dry matter has been shot and is in the process of being edited and completed. A web site for this project was established on eOrganic Dairy, but communication has been intense and one-on-one during the early phase of this project, so eXtension has not yet become the primary source of communication between the producers and the project staff.

The significance of your findings to organic agriculture:

Until data from two years of field research have been analyzed, we cannot quantify the potential impact of this work. However, based on New Zealand dairy cattle research, producers using birdsfoot trefoil pastures for grazing will have higher milk production due more efficient forage utilization than on grass pastures. Once the economics of establishment have been factored in, we will be able to predict the value for organic producers of incorporating birdsfoot trefoil pastures into their dairy production systems. The environmental benefits will only be quantified relative to nitrogen losses, but an enormous benefit of using a perennial legume is that it produces its own nitrogen, a plant nutrient that is challenging to supply to pastures and other agronomic crops in organic production systems. Furthermore, New Zealand research demonstrated reduced methane production from cows grazing birdsfoot trefoil compared with cows grazing perennial ryegrass-white clover pastures. Lastly, the potential benefits for consumers demonstrated one New Zealand study, such as higher CLA content or a higher omega-3 to omega-6 fatty acid ratio in cheese, will be quantified.

Project Title: Enhancing Farmers' Capacity to Produce High Quality Organic Bread Wheat

Award number: ME02009-01366

Period of funding: 09/01/2009 – 08/31/2013

Primary Institution: University of Maine

Project Director Name and email: Ellen Mallory, ellen.mallory@maine.edu

Project Director telephone: 207-581-2942

Co-Project Director Names, emails: Heather Darby, heather.darby@uvm.edu

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The purpose of the project:

Our project goal is to improve farmers' ability to produce high quality organic wheat to meet the increasing demand from local millers, bakers, and ultimately consumers.

Growing demand for local organic food has inspired new efforts to revive a staple element of the New England food system—*bread*. Millers and bakers cannot find enough locally grown organic wheat, and that which is available often does not meet the higher quality standards for bread production. Supplying the expanding market for organic bread wheat represents a significant economic opportunity for our region's farmers. While many of these farmers have long grown small grains for animal feed, they lack local knowledge and research information on how to produce high quality grains for bread end-use markets using organic methods.

Completed to date:

Listed below are the on-farm and on-station research trials conducted to date. See the following section for our Extension and Education activities.

Variety trials – to identify varieties that perform well in our region under organic production and possess desirable baking properties. Thirty-two spring and 30 winter bread wheat varieties have been evaluated at 4 sites over 3 years for disease tolerance, yield, and grain quality. Sixteen of each type have been identified for continued evaluation, and the first bake tests of a subset of this group have been completed. The annual reports that we publish from these trials have become a key resource for farmers and millers in our region.

Weed management trial – to evaluate innovative weed management strategies for organic wheat. Two strategies, 1) improving efficacy of physical weed control through use of wide rows and interrow cultivation and 2) increasing crop competitive ability through elevated seeding rates and narrow rows, were compared with regional standard practice. Increased seeding rate and narrow rows reduced weed density 30% and lowered grain protein 5% compared to the standard practice. Wide rows with interrow cultivation reduced weed density 62% and increased yield 16%, grain protein 5%, and net returns 19% compared to the standard organic practice. The high input cost of organic seed made the increased seeding rate treatment less economical than both interrow cultivation and farmers' standard practice.

Nitrogen fertility trial – to evaluate nitrogen top-dressing as a strategy to increase wheat grain protein levels. The high-value bread wheat market generally requires 12% grain protein. Three spring topdress timings (tillering, flag leaf, and boot stages of development) and two OMR approved

N sources were compared over four site-years. Topdressing significantly increased

grain protein. Later applications were more effective than earlier ones, and Chilean nitrate was more effective than chicken manure. When applied at an estimated 20 lbs of available N at the boot stage, protein increased by 15%, from 9.2 to 10.5%, from Chilean nitrate and by 9% with chicken manure. A new study has been initiated to develop in-season diagnostic testing to help farmers decide when topdressing is economical.

Dairy rotation study – to determine how best to integrate bread wheat into dairy crop rotations to minimize risk, optimize wheat yield and quality, and maximize whole farm returns. Nitrogen dynamics, weed pressure, yields, crop and forage quality, and total returns are being evaluated for 3-year crop sequences following forage that vary in the timing of wheat establishment (after forage or row crops and in the fall or spring) and method of re-establishing the forage crop (undersowing or relay cropping). One full sequence has been completed to date.

Fusarium spore sources study – to help farmers develop management strategies for *Fusarium* head blight, we determined the relative contribution of disease inoculum from naturally overwintered

corn debris versus airborne spores. Microplot cages were set out prior to stem elongation in two wheat fields in a containing either no debris or natural corn debris. At grain maturity, all spikes above the cages were harvested, dried, and analyzed for the *Fusarium* mycotoxin deoxynivalenol (DON). Elevated DON levels were detected from corn stubble microplots suggesting that crop rotation will play an important role in head blight management. All plots had measurable DON concentrations indicating infection via airborne spores as well.

Extension and/or education activities completed or upcoming:

Peer Learning Across Borders – Farmers, millers, bakers, and Extension educators from Maine and Vermont travelled to Quebec in 2009 (2 days, 27 participants) and Denmark in 2010 (5 days, 21 participants) to learn about local organic bread wheat production, milling, marketing, and use from our more experienced counterparts. We returned home with concrete examples of successful local grain economies in climates similar to our own. The information we gained was extended to others through a series of 6 videos, 6 articles, and over 15 presentations.

Participants reported a variety of individual impacts from the trips, from improving crop and product quality by changing production and processing practices, to expanding markets by adding retail-sized packages and new flour blends, to gaining support for a new grist mill by sharing the Danish example with economic developers. After one year, four participants reported having or expecting to gain in sum over \$400,000 in economic value over the next 10 years from changes they have already made or intend to make as a result of this trip. As well, the trip established permanent avenues of exchange among our regions from which we continue to benefit – a Quebecois agronomist and a Danish miller participated in grain conferences in Vermont and Maine, a Vermont baker taught a course on baking with local grains in Denmark, and the Maine team organized and hosted a tour of farms, mills, and research trials in Maine, Vermont, and Quebec for 36 Danish organic farmers and educators in July 2012.

Conferences, Workshops, and Field days – Each year, we offer winter conferences in Maine and Vermont and several hands-on workshops for farmers, millers, end users, and agricultural service providers. Attendance has ranged from 40-70 participants for the workshops and 90-200 for the conferences. During the field season, each state offers an on-station field day to highlight our wheat research and several on-farm field days to foster peer-learning and networking.

Strengthening State and Regional Networks – We've helped build the capacity of local grains groups by participating in their regular meetings and collaborating on activities. These include Northern Grain Growers Association, Maine Organic Farmers and Gardeners Association, and

the newly formed Maine Grain Alliance. As well, we meet at least two times per year with our project advisory board comprised of farmers, millers, and bakers to guide the project, identify emerging issues, and strategize solutions for local grains,

Train-the-Trainer program – We leveraged this project with funding from the SARE Professional Development program to conduct a 3-year training project for agricultural service providers that increased their capacity to advise on local grain production and developed a regional “community of expertise”.

Websites, patents, inventions, or other community resources created:

The Northern New England Bread Wheat Project website provides a variety of informational resources for organic wheat farmers, millers, bakers, and researchers. The site had >3,000 unique visits and >11,000 page views since Jan 2010. Most-visited pages include Variety Trial Results, Denmark videos, Production Info & Resources, and Who We Are. Located at <http://extension.umaine.edu/localwheat>

The significance of your findings to organic agriculture:

Our project is helping create local, organic food grain economies in our region by 1) developing research-based information and local expertise in organic production, 2) building capacity among extension and farmer educators, and 3) fostering a vibrant network of farmers, millers, and bakers. Since our project began, farmers in our region have increased production of organic wheat from 300 acres in 2008 to over 1,800 acres in 2012*, and they are well-positioned to meet further increases in demand. Farmers reported in a recent survey that as a result of our project they have made new contacts (80%) and changed at least one production or marketing practice (70%), which has helped them expand markets, improve crop/product quality, increase sales, increase yields, or reduce production costs. They estimated the economic value of these changes to be over \$10,000 each for those growing 10 or more acres of grain per year and over \$1,800 each for those growing less than 5 acres per year. Additionally, the farmers and millers who participated in the “peer learning across borders” trip to Denmark estimated they will gain in sum more than \$400,000 in economic value from what they learned.

* MOFGA Certification Services, LLC and Vermont Organic Farmers, L.L.C.

Other comments or recommendations for future work:

New question and areas of need have emerged since we began our project, including:

- Developing our production capacity for other food grains, such as spelt, barley, rye, oats, emmer and einkorn, and for other uses beyond bread, such as cereals, malting, and distilling
- Integrating food grain production with the increasing demand for organic feed
- Fine-tuning fertility strategies for optimal quality and returns
- Developing appropriate production practices for heirloom wheat and ancient grains
- Building farmers capacity to handle and store grains to maintain quality

Project Title: Vermicompost-based media to enhance organic vegetable seedling vigor, yield, crop quality and grower profitability

Award number: HAW01805-G 0219125

Period of funding:

Primary Institution: University of Hawaii at Manoa

Project Director Name and email: Theodore J.K. Radovich. Email: theodore@hawaii.edu

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Co-Project Director Names and emails:

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Website: <http://www.ctahr.hawaii.edu/RadovichT/lab-index.html>

The purpose of the project:

Vegetable production in Hawai'i relies heavily upon peat based media for seedling production. Peat is a non-renewable resource, and its mining disrupts an ecosystem vital for carbon sequestration. Peat has low nutrient levels, low pH values and moderate CEC, requiring amendment with nutrients and lime. The microbial diversity and populations found in peat are relatively low, as are the disease and pest suppressing effects, often resulting in the need for use of chemical pesticides. Peat replacement is not a new idea. In Hawaii, composts, coconut coir and sugarcane bagasse have been identified as potential peat substitutes, but efforts to-date have failed to significantly reduce organic grower reliance on peat and other imported products. The purpose of this project is to 1) develop a cost effective, NOP-compliant media made from 100% local materials that produces seedlings of comparable to superior quality relative to current farmer practice, and 2) facilitate adoption of this new media among certified organic growers and other producers.

Completed to date:

- Ten greenhouse experiments were conducted, at the University of Hawaii, to produce seedlings for different vegetable crops using different local media inputs.
- Three greenhouse/pots trials were conducted, using tomatoes and eggplants varieties, to test the effect of different level (0, 10, 25, 50 75 and 100%) of chicken-manure based vermicompost on seedling growth, and their resistance to nematode infection.
- Three recirculating aquaponic system (RAS) trials were conducted at the Windward Community College using liquid effluent rich in plant nutrients derived from fish manure, decomposing organic matter and metabolic byproducts from protein catabolism in fish, fertilizes hydroponic beds providing essential elements for plant growth.

- six greenhouse experiments and two field trials were conducted by our International Collaborators from Ghana and Germany, through their fellowship programs. They applied different media inputs to enhance vegetable seedlings growth and nutrient content. Also, they measured the continuous effect of the greenhouse media trials on vegetable yield in field experiments.
- Two field experiments were conducted, at Waimanalo research station of the University of Hawaii, to examine the effect of the media trials on vegetable seedlings growth and crops yield.

Extension and/or education activities completed or upcoming:

- Two presentations at the annual meeting for the Hawaii Organic Farmers Association (HOFA) were given by the project PI.
- Three public talks were given at ASHS annual (2011 and 2012) meetings. One public presentation at the University of Hawaii was given by Ian Gurr, during his master public defense.
- Farmer evaluation of recommended media and field days in Hawaii and Samoa are ongoing/upcoming

Websites, patents, inventions, or other community resources created:

none to report at this time

The significance of your findings to organic agriculture:

The short story is that we have used a science-based approach to develop a NOP compliant media made from 100% local materials that produces seedlings of comparable to superior quality relative to current farmer practice, and at less cost. We are currently working with industry to facilitate adoption and evaluate impacts on certified organic farms and other operations. Expected impacts articulated in the proposal remain the same.

Other comments or recommendations for future work:

Despite its value in promoting plant growth, the volume of vermicompost that can be feasibly employed in seedling production is low due to its cost. However the unique properties of the material can be leveraged to enhance the performance of other less-optimal, but less expensive local materials like green waste based composts. Continued biological, chemical and molecular characterization of vermicomposts and other local materials is needed to better understand the mechanisms behind their plant growth promoting effects.

Project Title: Carrot Improvement for Organic Agriculture With Added Grower and Consumer Value

Award number: 2011-51300-30903

Period of funding: September 1st, 2011 – August 31st, 2015

Primary Institution: Agricultural Research Service, USDA, University of Wisconsin, Madison

Project Director Name and email: Dr. Philipp Simon, Philipp.simon@ars.usda.gov

Project Director telephone: 608-262-1248

Co-Project Director Names and emails: John Navazio, john@seedalliance.org, Micaela Colley, Micaela@seedalliance.org, Lori Hoagland, lhoaglan@purdue.edu, Philip Roberts, Philip.roberts@ucr.edu.

Website: <http://eorganic.info/carrotimprovement>.

The purpose of the project:

This project addresses the critical needs of organic carrot producers by developing novel colored carrots with improved disease and nematode resistance, improved weed competitiveness, and improved nutritional value and flavor. Focus is placed on traits critical for crop production, but includes evaluation of storage quality important for both extending the market window of the crop and for successful seed production, as it often relies on postharvest storage to initiate flowering.

Addressing organic producer's needs for improved pest resistance in novel colored carrots

Organic production of carrots presents several significant challenges from pests (nematodes) and diseases (leaf blights). About 100,000 acres of carrots are grown annually in the U.S., primarily on loamy sand and sandy loam soils. The 2007 Census of Agriculture (USDA-NASS, 2008b), estimated 9% of this carrot production is in organic systems, vs. 3% for vegetable crops overall.

Over 80% of the U.S. carrot production land is infested with one or more of the common species of root-knot nematodes (*Meloidogyne*). In particular, *M. incognita* and *M. javanica* are especially problematic in California and other warm climate production areas of the US including Florida, Texas, and other southern states. Nematode damage to carrots is problematic because the marketable taproot is very sensitive to disfiguration (galling and forking) by nematode infection. Even very low soil population levels of root-knot nematode can cause economic loss to carrots. Standard pesticides used to control root-knot nematodes are unavailable to organic producers.

Alternaria leaf blight and other foliar diseases are major carrot pests in virtually all production areas of the world, but especially non-desert regions. They injure leaf tissue to reduce photosynthetic area. This reduced photosynthesis consequently reduces root yield and complicates harvest since most of the carrot crop is harvested by pulling plants from the soil by their tops. As part of NOVIC, the NIFA-OREI funded organic breeding and variety trial project, organic farmers were surveyed to determine their most important crop challenges. Farmers surveyed by NOVIC listed alternaria leaf blight resistance as a top breeding priority for carrots.

It is vital to the future of the US organic vegetable industry that effective non-chemical methods of root-knot nematode and alternaria leaf blight control be developed as soon as possible. Pests and diseases threaten both economic crop production and postharvest storage of carrot. Nematode and alternaria resistant varieties offer a realistic long-term alternative means of

control, particularly if roots free of disease can be grown in infested sites. Germplasm exists with effective resistance to both pests; and resistance can be incorporated into carrot varieties.

Addressing organic producer's needs for improved weed competitiveness in colored carrots

Carrots are one of the slowest crops for growers to establish because of slow seedling growth rate. Once established, growth continues to be slower than most weeds, making weed control often the most expensive costs of organic carrot production. The NOVIC farmer survey found that carrot producers rated improved germination as a top breeding priority. A wide range of seedling growth rates and canopy sizes have been observed in diverse carrot germplasm including land races with novel purple, yellow, and red storage root color. Among these novel colored carrots are breeding stocks with some of the most vigorous growing seedlings and large tops. Commercializing these stocks requires a focused breeding, screening and evaluation effort.

Addressing organic industry needs for improved flavor and nutrition in novel colored carrots

The development of carrots improved for nutrition and flavor characteristics will address the needs of the expanding organic industry. OSA conducted a survey of over 1000 organic producers as part of the NIFA-OREI funded State of Organic Seed (SOS) project. Producers were asked to rank the most important crops and traits to breed for in organic systems. Flavor was deemed the most important trait to breed for in carrots. Nutrition was considered the most important product quality in organic food by consumers (Yiridoe et al. 2005)

The needs of organic producers will be addressed by this project throughout its life-cycle

Our advisory panel structure includes representation from the organic carrot industry, including both the production and seed systems components. The panel includes small and large-scale carrot growers that can benefit economically from colored carrots bred for organic systems. Their input will be used to refine project goals throughout the process.

In addition to the key priority traits (vigor, weed competition, nematode and disease resistance) there is a need to better understand the genetic by environment interaction in organic versus conventional systems in order to advance our knowledge of the desirable traits and production practices influencing optimum organic carrot production. Our advisory panel includes small and large-scale organic carrot growers that can benefit economically with carrots that resist diseases and pests, and better compete with weeds. The advisory panel will also assist in identifying additional important traits and participate in cultivar selection and evaluation.

Carrots are highly regarded by consumers as nutritious, but food choices are strongly influenced by flavor, thus as pest resistance and weed tolerance is developed for carrot growers, nutritional value and flavor must be included in the breeding and outreach effort. The development of carrots improved for growers that also include high nutrition and novel color and flavor characteristics will fit well into the expanding organic agricultural production sector.

Completed to date:

Research activities for year 1 of the CIOA project focused on developing trial protocols, identifying cooperators, sourcing appropriate trial germplasm, and conducting year 1 field trials. The trial protocols and field evaluation tools were developed by the project team to ensure consistent trial methods across sites that capture crucial crop traits identified as important for participating growers in diverse carrot growing regions across the country. Evaluation criteria include evaluation of top growth, root quality, pest and disease impacts, and yield. Yield data was collected as number of roots per plot and total weight of roots per plot. Top growth was evaluated as low, high and average top height and width by plot. Additional criteria will be added including, detailed root quality and flavor evaluations, seedling vigor and early plant

growth in subsequent years as breeding lines are further developed (Simon lab). Evaluation criteria also incorporate feedback from participating farmers and growers involved in the OREI-funded project, NOVIC (Northern Organic Vegetable Improvement Collaborative). Samples from each plot were shipped to WI for analysis of nutritional qualities including carotenoid and anthocyanin pigments and flavor. Soil samples were also collected from each trial site and sent to Dr. Hoagland for analysis. She is analyzing samples for soil nutrients and microflora.

Comparative trials were established on organic and conventional participating farms in WA, WI, IN, and CA, utilizing a complete randomized block design with three replications. The organic and conventional sites were selected within each region with a goal of minimizing differences in soil type and growing climate. Conventional and organic trials were planted on the same date in each state at seasonally appropriate planting times that coincide with regional production windows. The first trial harvest and evaluation was conducted in WA on August 20th and the second in WI in early September. Project pathologist, Dr. DuToit, participated in the WA harvest and evaluated disease incidence in both the organic and conventional trials. DuToit collected tissue samples and verified incidence of *Cercospora carotae* in the organic trial and Downy Mildew in the conventional trial. Trials in IN will be harvested later this fall and in CA next January, 2013. All trials were successfully established, however dry conditions in WI required two plantings to achieve a full stand.

To evaluate root knot nematode resistance, select material was additionally planted in a trial on known nematode infested ground by Dr. Roberts at UC South Coast Research & Extension Center in CA. This trial will be evaluated in November, 2012 following standard protocols for evaluation of incidence of nematode root infestation. *Alternaria* leaf blight resistance of select germplasm was evaluated in 2012 in a naturally infested trial location on the University of Wisconsin Hancock Experimental Station, using standard rating protocols.

Extension and/or education activities completed or upcoming:

Year 1 Extension activities included creating project promotion and educational materials, coordinating outreach and evaluation activities, and delivering educational events. The project communications team created standardized forms for delivering outreach events and tracking event participation and evaluation. Forms include an event sign up sheet to track participation, an event evaluation form to report on impacts and improve future events, and an online tool for coordinating and tracking outreach activities related to the project. A website and printed brochure were also created to educate the public about the project and related resources. Each project collaborator received print copies of the brochure to disseminate at outreach events.

As part of education activities, undergraduates, graduate students and postdoctorates are being trained in vegetable breeding, crop and seed production, disease protection and diagnosis, and soil science with a focus on organic systems as they participate in research projects critical to the COIA Project achieving its research goals.

Collaborators will host public farmer field days in conjunction with each trial. Field days will coincide with timing of trial evaluations. Participants will learn about the project goals and preliminary trial results. Farmer participants will also be invited to participate in the evaluations

and provide input on project direction. The project team is developing a standardized evaluation form for farmer participation in trial evaluations and seed production, and a survey for farmer feedback on the project. These tools will be utilized in participatory evaluations and outreach activities in year two. 2012-2013 field days are currently planned for IN, September 17, 2012, WI, September 2012, CA, January, 2013, and WA, September 2013.

In addition to field days collaborators are providing education on organic plant breeding, conducting organic on-farm variety trials, and organic carrot production at various educational events, both field based and at conferences. In addition the project team plans to report on results to the scientific community in later years of the project.

Educational events and conference presentations delivered to date include:

August 2nd, Specialty Crops Research Initiative workshop, at 2012 ASHS meetings, Miami
March 23rd, Breeding for Nutrition eOrganic Webinar, open to the public and archived on eOrganic as well as CIOA website

August 8th, Developing Participatory Systems for On-farm Plant Breeding workshop, presented for farmers in conjunction with the Student Organic Seed Symposium, Vermont

August 9th, Breeding Carrots workshop, presented at the Organic Seed School hosted by High Mowing Seeds, Vermont

August 16th, Organic Variety Selection and Seed Saving workshop, included carrot trial growers and was hosted at Purdue University, Indiana

Educational events planned for 2012-2013

Presentations on breeding for organic systems and general promotion of the CIOA project will be delivered at Organicology conference, Portland, OR, Feb 7-9th, Southern Sustainable Agriculture Working Group Conference, Arkansas, January 23rd, Midwestern Organic and Sustainable Education Service (MOSES) conference, Wisconsin, February 21st. The project team plans to hold an annual planning meeting in conjunction with the MOSES conference. The project team will also co-host and participate in the 36th International Carrot Conference in Madison, WI, August 15-16, 2013.

This project includes development of the eOrganic seed and breeding community of practice. Colley will participate in a four-day eOrganic strategy development meeting with other eOrganic collaborators November 4-7th. In year two of the project Colley will lead in coordinating the eOrganic community of practice, delivering outcomes from the strategy meeting, identifying goals for seed and breeding content development, inviting new members to the community, and developing working groups among members.

Websites, patents, inventions, or other community resources created:

A project logo and acronym for public communications was created. The project name for public communications is – Carrot Improvement for Organic Agriculture (CIOA). The project team created a workspace on eOrganic for project coordination and development of outreach materials including a webinar on plant breeding for human nutrition. Through eOrganic a public website was created for educational and project promotion purposes. The CIOA public website is:

<http://eorganic.info/carrotimprovement>.

The CIOA website includes information about the project, the project collaborators, resources related to carrot breeding and seed production, notifications of events, relevant news, and a link to the eOrganic variety trial database.

The significance of your findings to organic agriculture: (If Secretary Vilsack asks us what good has been achieved from the money that was spent on your project, what could we tell him or the public to whom he is reporting? Aim for 200 words or less.)

The anticipated project impacts for organic agriculture are three-fold 1) delivery of novel germplasm well suited to enhance organic production systems and markets, 2) development of organic produce with superior flavor and nutritional quality, and 3) Improved understanding of the genetic by environment interactions in organic versus conventional systems as they relate to cultivar performance and inform growers about cultivar and soil factors that impact economic returns and reduce environmental impacts. The project is currently in its first year and collaborators are just now collecting and analyzing data, but the model for identifying key traits for organic systems, and subsequently breeding for those traits has been established. In the first year we've reached approximately 60 farmers with education on organic breeding and variety trials with plans in place to reach an additional 100 growers by the end of year two. Organic growers require vegetable varieties that are adapted to organic growing conditions and hold market qualities demanded by the organic consumer including superior nutrition and exceptional flavor. However consolidations in the seed industry and a focus on restrictive intellectual property, coupled with a shift in public breeding programs toward fundamental research has resulted in marginalization of organic systems in breeding priorities. This project provides crucial support for public breeding programs to advance the development of organic agriculture. In addition to the important research impacts and new germplasm this project is creating a model for farmer-researcher participation in breeding, seed production and evaluation programs for organic systems.

Project Title: Greenhouse Gas Emissions in the Transition from Traditional to Organic Dairy Farming: An Education and Research Collaboration

Award number: 2010-51106-21834

Period of funding: 2010/09/01 to 2013/08/31

Primary Institution: University of New Hampshire

Project Director Name and email: Ruth Varner (ruth.varner@unh.edu)

Project Director telephone: 603-862-0853

Co-Project Director Names and emails: William Salas (wsalas@agsemail.com), Changsheng Li (changsheng.li@unh.edu)

The purpose of the project:

Human food production is the dominant global process generating reactive N, primarily as synthetic fertilizer. In the U.S., most crops are produced with the use of such fertilizers, and the majority of these crops are fed to livestock for the production of dairy, meat, fiber, and energy. Historically, livestock farmers used local crop and pasture land to dispose of livestock waste. As livestock operations have become more concentrated, the associated manure production has also become more concentrated, and a number of counties in the U.S. now generate more manure than can be effectively assimilated by their soils.

This low efficiency of N-cycling in agricultural production is a source of pollutants for water, air and climate nationwide—leading to surface water eutrophication, groundwater contamination, air pollution, and greenhouse gas emissions.

As livestock operations consider their options for nutrient and manure management, they would benefit from systems-level decision support tools that can quantitatively assess the full nutrient cycle of their operation and find ways to limit nitrogen leaching, regional air pollution, and greenhouse gas emissions and enhance soil carbon sequestration and long-term soil fertility.

Our goal is to develop a decision support tool to quantitatively evaluate the management practices of livestock systems in the northeastern U.S. This tool should help farmers, policy makers, and other stakeholders to make management decisions that support both site and regional ecosystem services. The tool will be constructed by integrating an existing process-based model, Manure-DNDC (DeNitrification-DeComposition), with a regional database of soils, climate, livestock, crop, and management parameters.

This project is taking place over a three-year period, and involves calibrating Manure-DNDC, linking the model to a web-based, GIS database that will act as a decision support tool, testing the decision tool at dairy farms throughout Northeast, and conducting outreach and training workshops with stakeholders such as farmers, extension agents, and state departments of agriculture.

Completed to date:

To date, project outputs have addressed the first three objectives of our study: 1) to collect farm-level observational data for testing and improving the process-based biogeochemical model, Manure-DNDC; 2) to quantify the impact of baseline and alternative management practices on ecosystem services with Manure-DNDC; and 3) to develop a Northeastern GIS database to support Manure-DNDC applications at a regional scale.

To meet our first objective, we initiated a systematic sampling and chemical analysis of pools and fluxes of carbon and nitrogen at two University of New Hampshire farms. We are using these farms as model systems to calibrate Manure-DNDC and include the UNH Burley-DeMerrit (organic) and Fairchild (conventional) dairies. In the spring and summer of 2011, plots were established in the cropping areas of each of the farms for measuring carbon and nitrogen pools in crop biomass and soils. We also used the plots for measuring soil greenhouse gas emissions of carbon (methane, carbon dioxide) and nitrogen (nitrous oxide). A spatially intensive soil sampling was completed at both farms during the 2011 and 2012 growing seasons, and soil profiles have been characterized for DNDC model inputs such as texture, pH, bulk density, carbon, and nitrogen. Soil greenhouse gas emissions began in July 2011 and consist of bi-monthly measurements of methane, carbon dioxide, and nitrous oxide. An automated system that continuously collects data on carbon dioxide emissions was deployed to the organic dairy in July 2011. This automated system allows us to observe fine scale responses to changes in temperature, moisture, and management that our bi-monthly observations may miss. We have also identified and measured “hotspots” and “hot moments” of greenhouse gas emissions on each of the farms. A “hotspot” is a relatively small area where large amounts of greenhouse gases are released, such as in manure and silage stockpiles. A “hot moment” is a short period of time where a pulse of greenhouse gases may be released to the atmosphere, such as when manure is applied to a field. We are currently quantifying greenhouse gas fluxes from manure, silage, bedding, and from the cows themselves (enteric emissions), and have experimentally manipulated the effects of manure and urine inputs, mowing, grazing, and precipitation on soil greenhouse gas fluxes. Results of this work will be presented by Mr. Christopher Dorich at the upcoming ASA, ASSA and CSSA International Annual Meeting, 21-24 October in Cincinnati, Ohio. He will also present this research at the annual Fall meeting of the American Geophysical Union Meeting 3-7 December in San Francisco, CA.

To address our second objective, we have compiled management data on all aspects of farm operations for both the organic and conventional dairies. We also conducted initial DNDC model runs examining the effects of grazing and manure applications on soil carbon sequestration and greenhouse gas emissions. These findings were presented at the 2012 meeting of the Ecological Society of America in Portland, OR. A more complete suite of Manure-DNDC runs for model calibration, validation, and simulation of management scenarios are currently underway.

For our third objective, we have compiled a GIS database that will enable regional modeling of dairy management throughout the Northeast. The database includes characteristics of soils (clay fraction, organic matter fraction, pH, and bulk density) managed for pasture in the Northeastern US. It contains spatially explicit estimates of dairy farm distribution, daily weather data, and nitrogen deposition. This GIS database will be combined with Manure-DNDC to produce the web-based decision support tool outlined in the project proposal.

Extension and/or education activities completed or upcoming:

We are currently collaborating with Stonyfield Farms and Organic Valley to identify farmers across the region willing to test the web-based decision support tool. We anticipate that we will pilot the tool with ten farmers, five of whom have recently transitioned from conventional to organic management practices. The goal of this piloting process is to evaluate the ease of use of the Manure-DNDC decisions support tool. Based on feedback from the end users we will modify the web interface of the tool accordingly.

Once we have piloted the tool, we will hold a series of workshops. The first will allow for refining the tool based on the feedback of regional stakeholders such as farmers, extension agents, and state agriculture departments. The second workshop will be held in collaboration with Organic Valley during the final year of the project. This workshop will focus on dissemination and training on how to use the Manure-DNDC tool for farm level assessments of nitrogen cycling and greenhouse gas emissions.

In addition to our outreach efforts to stakeholders, we are integrating our research program with educational outreach to local schools. In the fall of 2012, we are hosting a workshop for middle and high school educators focused on farms as agro-ecosystems. A graduate student, Mr. Christopher Dorich and PI Varner will hold a one-day workshop in greenhouse gas emission inventories and measurements in agroecosystems as part of a larger professional development program for chemistry and earth science teachers (<http://earth.unh.edu/bryce/Dreyfus/GEOChem.htm>). Mr Dorich will follow up with teachers in their classrooms to present his research as part of this project and help them develop research projects for their students.

Finally, our research has also supported one post-doc (part-time), one master's student (full-time), a senior undergraduate thesis, and several class projects as part of a UNH Soil Ecology course.

Websites, patents, inventions, or other community resources created:

The broader impact of this study will be to develop a web-based decision support tool for quantitatively evaluating the best management practices that enhance ecosystem services in livestock systems, both at individual farms and across the Northeast. We have built the foundation for this outcome with our intensive field data collection, model testing, and GIS database development. In the coming year, we will integrate this work with outreach to farmers and stakeholders for the development of the web-based decision support tool. We anticipate that the website will be available mid-late 2013.

The significance of your findings to organic agriculture:

Dairy farming remains the largest agricultural sector in the northeastern United States. However, the number of dairy farms in the region has decreased by over 80% in the past 50 years. Financial pressures on the industry have resulted in fewer, larger farms with more milking cows living in concentrated areas. These concentrated feedlots are often too expensive for small family farmers to operate, and can cause environmental problems such as water and air pollution. Organic dairy management, and particularly organic grazing management, has been promoted as an economically viable alternative to conventional dairy farming in concentrated feedlots.

Organic dairy farming also has the potential to provide key ecosystem services that enhance soil fertility, reduce water and air pollution, and mitigate climate change.

We currently lack a rigorous, scientific assessment of how organic and / or grazing intensive systems result in positive economic and environmental outcomes for dairy farms. Our research will develop this scientific understanding using a combination of field measurements and modeling. We will then translate our model into a web-based tool that farmers, policymakers, and other stakeholders can use in making management decisions that maximize both economic and environmental gains for Northeastern dairy farms.

Other comments or recommendations for future work:

We are interested in further exploring the role of intensive rotational grazing on soil carbon sequestration and greenhouse gas emissions in dairy farms of the Northeast. The practice of intensive rotational grazing in pasture-based dairy farms is believed to promote soil carbon sequestration. An unintended consequence of this increased carbon storage may be higher soil greenhouse gas emissions, particularly of nitrous oxide, which could offset any gains in climate change mitigation achieved with grazing management.

Previous research examining the effects of grazing on soil carbon sequestration and / or greenhouse gas emissions has been performed in the great plains of the US, or in the steppes of Eurasia. Most of this work has examined soil carbon pools and greenhouse fluxes separately, making it difficult to draw a direct, causal chain between them. To our knowledge, there is currently no research quantifying the effects of intensive rotational grazing on soil carbon sequestration in the Northeast, despite the fact that this management strategy is increasingly viewed as an economically viable alternative to more traditional dairy farming. The promotion of management intensive grazing as both an economic and an ecological improvement over traditional farming should be supported by quantitative measures of soil carbon accumulation and greenhouse emissions, and the links between the two.

Abstracts for Posters

Project Title: Finding the Right Mix: Multifunctional Cover Crop Cocktails for Organic Systems

Project Director Name and email: Mary Barbercheck, meb34@psu.edu

Primary Institution: The Pennsylvania State University

Co-PIs: Jason Kaye, jpk12@psu.edu

Period of funding: 10/2011 - 9/2015

Abstract: Organic farmers rely on cover crops for a multitude of functions, including: nutrient supply, nutrient retention, weed suppression, erosion control, maintenance of soil quality, and pest regulation. These functions ultimately affect crop yield and system sustainability. Cover crop species affect these functions differently, and mixtures of species, or “cocktails”, are being promoted as a balanced approach to providing the wide range of functions desired from cover crops. Choosing a cover crop mixture, however, requires evaluating trade-offs among these functions at different points in a crop rotation. The objectives of this project are to improve our understanding of these trade-offs along with farmer-identified constraints and management challenges, and build collaborative relationships among farmers, researchers, and extension educators. In 2012, we assembled a farmer advisory committee, and participating farmers established three on-farm research and demonstration trials of cover crop cocktails. We also hired several staff members and graduate students, and established a large plot-scale experiment at Penn State’s Russell E. Larson Research Center in Rock Springs, PA. This experiment will evaluate the effects of 3, 4, and 6 species cover crop mixtures and six different single-species cover crops on a suite of functions in the context of an organic wheat-corn-soy crop rotation.

The significance of your project to organic agriculture:

Cover crops are a central component of successful and sustainable organic farming. Organic farmers in the mid-Atlantic region are interested in using multi-species cover crop “cocktails” to maximize the various benefits of cover cropping. This project will develop and share practical knowledge about the costs and benefits of diversity in cover crops while strengthening the network of farmers, researchers, and extension educators. This will result in improved understanding of the functions of cover crops and greater capacity for evaluation of cover cropping practices. Ultimately, these accomplishments should lead to greater opportunities for financial success and environmental sustainability for organic feed grain producers, and greater availability and affordability of organic dairy and meat products for consumers.

Project Title: Using New Alternatives to Enhance Adoption of Organic Apple Production through Integrated Research and Extension

Poster title: The OrganicA Project -- Addressing Apple Growers' Priorities and Critical Challenges in Sustainable Organic Apple Production

Project Director Name and email: Lorraine P. Berkett, Ph.D.

Lorraine.Berkett@uvm.edu

Primary Institution: University of Vermont

Period of funding: 2006-2009; 2009-2012

Abstract:

Apples are an important component in the agricultural diversity of New England and sustainable and profitable organic apple production has been a long-existing goal of organic farming in the region. However, only a small number of orchards are organically certified; the number is disproportionately low to the interest in and demand for locally produced organic apples. Many more apple growers are interested in producing organic apples; the small number reflects, in part, the arthropod and horticultural challenges of organic apple production and the disease challenges associated with the traditional cultivars grown in the region. Shifts in consumer preference for 'newer' cultivars has led to the planting of different apple cultivars in New England and growers want to know what the potential is for sustainable and profitable organic production with these apple cultivars. In 2006, after extensive input from growers, the multi-state, multi-disciplinary OrganicA Project was developed and proposed as a nine year project to holistically examine the opportunities and challenges of organic apple production within two major orchard systems growers are using to change to new cultivars and with five of the top apple cultivars that growers identified as important to the future of the industry in New England. The long-term research period was deemed necessary to complete the comprehensive economic profitability analysis of the apple cultivars within the two orchard systems given that the standard, earliest economic breakeven point for new apple orchards is at least 8-12 years. The project was initiated through a major grant in 2006 from the USDA Integrated Organic Program and was continued in 2009 through a grant from the USDA NIFA Organic Research and Extension Initiative (OREI). The long-term goal of this project has been to enhance adoption of organic apple production in New England through holistic research that advances the scientific knowledge base and provides practical information to stakeholders. Opportunities have been identified, however, challenges remain. Stakeholders in the region and beyond have highly praised the project and strongly support the further research that has been proposed to address the remaining critical challenges to sustainable and profitable organic apple production. We intend to complete the comprehensive economic profitability analysis of the two organic apple orchard systems which was initiated in 2006 after the 2013 growing season data have been collected and to seek additional research funding to develop solutions to the remaining critical challenges to sustainable and profitable organic apple production in New England and beyond.

The significance of your project to organic agriculture:

Apple growers in New England want to know what the potential is for sustainable and profitable organic production with the new apple cultivars now being planted in the region. Only a small number of orchards are organically certified in the region; it is disproportionately low to the interest in and demand for locally produced organic apples. Many more apple growers are interested in producing organic apples; the small number reflects challenges associated with the traditional cultivars grown in the region. The OrganicA Project was initiated to determine the opportunities and challenges of organic apple production within two major orchard systems growers are using to change to new cultivars and with five of the top apple cultivars that growers identified as important to the future of the industry. Stakeholders in the New England region and beyond have highly praised the project consistently since it was initiated. In multiple stakeholder surveys, 98% to 100% of participants reported that the project has increased their

knowledge of organic apple production and the majority have used the information provided by the project in their own orchards. The project has had an impact; the majority of participants in various surveys repeatedly have stated that the information generated by the OrganicA Project will enhance the potential to grow higher quality organic apples. The OrganicA Project website has become a leading resource for organic apple information. Project research has identified opportunities in organic apple production; however, critical challenges remain to achieving sustainable and profitable organic apple production in the region. When stakeholders were asked recently how they would rate the importance of continuing organic apple research and extension programs such as the OrganicA Project in the region, 92% to 100% of participants in various surveys said it was ‘Very’ or ‘Extremely’ important to continue the research and extension. Stakeholders in New England and beyond strongly support the further research that has been proposed to address the remaining critical challenges to sustainable and profitable organic apple production.

Project Title: Researcher and Farmer Innovation to Increase Nutrient Cycling on Organic Farms.

Poster title: Rapid changes in root gene expression in response to nitrogen availability: Linking molecular biology, plant physiology, and soil biogeochemical processes

Project Director Name and email: Louise Jackson, lejackson@ucdavis.edu

Primary Institution: UC Davis

Period of funding: 2010-2013

Abstract (of poster):

Plant root nitrogen (N) uptake and assimilation systems are highly responsive to external N availability. Expression patterns of genes involved in these systems may serve as a sensitive “plant’s eye view” of soil N availability, even in situations when N cycling is so rapid that plant/microbial N uptake and N mineralization are tightly coupled and inorganic N does not accumulate. This would allow better understanding of N mineralization-immobilization dynamics, and thus factors that lead to pulses of N excess and periods of N deficiency in agroecosystems. We explored the relationship between soil biogeochemical processes and dynamic plant nutrient uptake by using novel applications of molecular biology techniques coupled with conventional metrics of soil N availability at an organic farm in the Sacramento Valley, California. Following N treatments (6.5 and 65 $\mu\text{g-NH}_4^+\text{-N g}^{-1}$ soil) designed to simulate a nutrient patch, we measured changes in expression of tomato (*Solanum lycopersicum* L.) root genes involved in N uptake and assimilation as well labile soil N pools, bioassays for microbial N transformations, and root/shoot N concentration. Since organic agriculture relies on microbial transformations of soil organic matter to render N available for strong plant demand, it is an excellent system to test these interactions.

Tomato root genes responded rapidly to N additions and to the subsequent changes in soil inorganic N concentrations. The high N treatment significantly increased soil ammonium (NH_4^+) and nitrate (NO_3^-) pools after 48 hours and significantly increased expression of an NH_4^+ transporter, AMT2, and glutamine synthetases, GS and GTS1. These genes also trended toward higher expression levels under the low N treatment, in spite of the lack of a detectable increase in soil inorganic N for this treatment. Root N concentration was significantly higher in both the low and high N treatments relative to the control after 120 hours. Rapid depletion of soil NH_4^+ after 48 hours indicates high N demand and likely high nitrification rates, since soil NO_3^- levels remained elevated 120 hours following N treatments. No differences in gene expressions were observed 120 hours after the treatments. Soil microbial biomass carbon did not differ among the treatments, suggesting that N was not limiting to microbial abundance.

The high sensitivity of these N uptake and assimilation genes to soil N cycling makes them strong candidates for diagnostic indicators of plant N availability, which could facilitate adaptive nutrient management on organic farms.

The significance of your project to organic agriculture: (If Secretary Vilsack asks us what good has been achieved from the money that was spent on your project, what could we tell him or the public to whom he is reporting? Aim for 200 words or less)

Organically-farmed crops are susceptible to nutrient limitations, which reduce yields, and to pulses of nitrogen losses, which cause harm to the environment. Organic farmers need better tools to manage nitrogen and avoid these outcomes. Current soil nitrogen testing approaches were developed for conventional agriculture, which relies mainly on synthetic fertilizers rather than organic matter inputs.

More sophisticated tools are needed to indicate nitrogen availability, increase crop nitrogen uptake on organic farms, and provide other environmental benefits. This project investigates the potential of a novel application of molecular technology to obtain a “plant’s eye view” of complex nitrogen processes. Studies are now underway on 13 organic farmers’ fields and benefited from extensive stakeholder engagement throughout the process. Farmers expressed significant interest in new tools and better understanding of soil processes that could reduce the uncertainty of managing nitrogen. Our preliminary results suggest that these molecular tools show promise for uncovering otherwise hard-to-measure soil processes across a range of organic management practices and soil types. We are working to see how these measurements compare with more traditional tools that are already available in soil testing laboratories. Ongoing outreach consists of on-farm measurements with many organic farmers in the study area and broader discussions with a variety of stakeholders (e.g. farmers, extension personnel, local NGOs, and university researchers), which are being planned.

Project Title: Assisting Organic Dairy Producers to Meet the Demands of New and Emerging Milk Markets

Project Director Name and email: André F. Brito (andre.brito@unh.edu)

Primary Institution: University of New Hampshire

Period of funding: 09/01/2011 through 8/31/2015

Abstract: Our regional project is guided by the following objectives: 1) Develop practical strategies for northeastern organic dairy farmers to enhance the nutritional quality of milk and viability of farms by evaluating advanced pasture production techniques as well as fine-tuned supplementation regimes; 2) Implement on-farm research trials to evaluate the best advanced pasture management practices combined with flaxseed supplementation trials and their impacts on milk production, milk composition, and herd health in a whole-farm setting; and 3) Deliver best management practices for producing nutritionally superior organic milk through enhanced learning opportunities among producers, industry, researchers, educators, and students in the Northeast and beyond via workshops, field days, and eOrganic webinars. To accomplish these objectives the University of New Hampshire is collaborating with other regional universities (i.e., University of Vermont, University of Maine, and Cornell University), the USDA-ARS-Pasture Systems and Watershed Management Research Unit in PA, and 14 organic dairy farmers across NH, ME, VT, NY, and PA. Activities described below are part of objective 1. During the winter of 2011-12, we sourced perennial ryegrass seed for 13 perennial ryegrass cultivars (and 'Alice' white clover) differing in traits including winter hardiness, heading date, and ploidity. Site preparation for the multi-cultivar perennial ryegrass experiment and ancillary cultivar monoculture study occurred from mid-summer 2011 through August 2012 at 4 research sites (NH, ME, VT, and PA). In addition to the perennial ryegrass study, a summer annual variety trial was established at UVM (10 varieties of Sudangrass, sorghum x Sudangrass, and pearl millet); a manure N fertility trial was initiated at UVM and UMaine; a flaxseed variety trial with seven varieties was implemented at UVM and UMaine; and a cool season cereal grain trial was implemented at UVM to evaluate organic N sources and impacts on yield and quality of oats harvested in different vegetative stages. With regard to animal work, a winter feeding trial was conducted at the UNH Organic Dairy Research Farm in which 20 lactating dairy cows were used to investigate the effects of incremental levels of ground flaxseed (0, 5, 10, and 15% of diet dry matter) on milk production and composition, nutrient digestibility, ruminal metabolism, and methane emissions. Preliminary results from this work indicated linear decreases in milk production, 4% fat-corrected milk, energy-corrected milk and yields of milk components (fat, protein, and lactose) when dairy cows were fed incremental levels of ground flaxseed. An in vitro continuous culture fermentor study was conducted at the USDA-ARS to assess the effects of replacing herbage with increasing dietary levels of flaxseed (0, 5, 10, and 15%) on nutrient digestibility, microbial N synthesis, and methane output. Nutrient digestibility and methane emissions decreased linearly with increasing supplemental flaxseed. Decreased nutrient digestibility, at the cow level, could result in decreased dry matter intake, milk production, or both. For objective 2, we have recruited 14 organic dairy farms across the Northeast to participate in our on-farm research trial. All farms have become enrolled in dairy herd improvement (DHI) record-keeping, which will enable our team to collect information about each herd milk production and composition, animal management strategies, and reproductive health. Our team has been visiting these 14 farms twice a month since June to collect data

including pasture biomass, quality and intake. Feed concentrate samples and body condition scores are also collected monthly. For objective 3, our team has organized two pasture walks (ME and NY) and three workshops in VT to highlight the overall project goals and to present preliminary results. A webinar offering insight about fly control in organic dairy operations was also produced and posted on eOrganic. Lastly, our research and extension team has met on two occasions to discuss and organize project activities and future plans. We will convene our first project advisory board meeting this September during the Northeast Organic Dairy Producers Alliance Field Days to discuss our current and future initiatives.

The significance of your project to organic agriculture: Among the key concerns of organic dairy farmers in the Northeast are developing cost-effective measures to enhance the quality and duration of the pasture-grazing season for their cows, and optimizing the marketability of their milk. The current project begins to address the first concern by exploring new avenues of pasture production and growing season extension using forage cultivars that have diverse environmental adaptations. Once promising forage mixtures have been identified, these can then be used to improve the quality and quantity of pasture available for feeding animals. The second concern is less easily resolved, but we have taken the approach that improvement in milk quality [e.g., increasing the content of omega-3 and conjugated linoleic acids (CLA)] can lead to improvement in marketability. Our proposed work will lead to strategies that enable organic dairy farmers to not only extend the grazing season (which enhances omega-3 and CLA content in milk), but also to sustain the high-quality content of their milk throughout the year. It is anticipated these measures will provide cost-effective, profitable approaches to enhance the organic dairy industry in the Northeast.

Project Title: On-Farm Research and Extension to Support Sustainable Soil Fertility and Nutrient Management for Organic Grain Cropping Systems in the Mid-Atlantic

Project Director Name and email: Michel A. Cavigelli (Michel.Cavigelli@ARS.USDA.GOV)

Primary Institution: USDA-ARS-ANRI-SASL

Period of funding: 9/2009 to 9/2012 plus no-cost extension through 9/2013

Abstract:

Despite increasing interest in organic grain crop production, adequate information on soil fertility and nutrient management practices for organic systems is lacking in the Mid-Atlantic (Delaware, Maryland, Pennsylvania, Virginia and West Virginia). Organic grain production in the region provides unique challenges since most Piedmont and Coastal Plain soils have low inherent soil fertility. In addition, many farmers rely heavily on manure to provide nitrogen which can result in over application of phosphorus and significant water quality concerns for the Chesapeake Bay watershed.

The long-term goals of this project are to improve nutrient management on organic farms in the Mid-Atlantic and to synthesize and disseminate the most current research-based knowledge addressing organic grain production.

We have worked with our stakeholders to develop three objectives:

- 1) Develop integrated legume-manure management strategies to improve manure nitrogen use efficiency
- 2) Increase economic returns for organic grain farmers by incorporating improved nutrient management programs into their cropping systems
- 3) Disseminate knowledge gained from on-farm and on-station organic grain crop research using on-farm field days, regional workshops, and the eOrganic website.

Significance of project to organic agriculture:

A highly interactive organic farmer advisory network was formed to guide our research and outreach efforts. Farmers expressed real world, farming systems-based information needs which have guided this project and have sparked new research ideas and collaborative efforts for additional projects.

Organic farmers on the Eastern Shore of Maryland have worked closely with us to plan and coordinate logistical details of replicated on-farm trials which will maximize legume nitrogen inputs, optimize manure nitrogen use efficiency, and minimize manure phosphorus loading of organic and conventional cropping systems in the Chesapeake Bay watershed.

An Organic Grain Production Workshop has been held annually (2009-2012) in Queen Anne's County, jointly sponsored by Maryland Cooperative Extension, Maryland Department of Agriculture, and USDA-ARS-SASL (~300 attendees). The 2011 and 2012 Workshops were filmed by a local cable access channel. Tapes are available to all Maryland Cooperative Extension offices and for posting to the eOrganic YouTube channel.

Sustainable farming tours were held at two research sites in cooperation with participating farmers and USDA-ARS-SASL, Maryland Department of Agriculture, and University of Maryland Cooperative Extension (~200 attendees).

An Organic Grain Cropping Systems Community of Practice has been formed and is developing content for the eOrganic and eXtension websites. Advisory panel priorities, research results, and outreach information will be posted.

Project Title: Value-added grains for local and regional food systems

Project Director Name and email: Mark Sorrells, mes12@cornell.edu

Primary Institution: Cornell University

Period of funding: Sept. 2011 to Sept. 2015

Abstract: Small grains provide multiple benefits to organic farms, but are often underutilized because of their relatively low economic value compared to other organic crops such as fresh market vegetables. This project aims to add value in multiple ways to wheat and specialty grain crops to enhance the diversity and sustainability of organic farms. Our specific objectives are to:

- 1) evaluate heritage wheat and spelt varieties and landraces of emmer and einkorn for
 - a) adaptability to organic management
 - b) desirable grain and baking characteristics (including flavor and nutritional quality)
- 2) develop best management practices for heritage wheat, emmer, spelt, and einkorn
- 3) optimize grain quality through improved management
- 4) investigate a variety of approaches to grain dehulling and milling that will work for small and larger-scale growers/entrepreneurs
- 5) explore multiple strategies for accessing local and regional markets.

Data from the first year of field trials shows significant differences among varieties for yield and test weight. Lodging did not have a significant impact on trials despite the inclusion of standard height historic and landrace varieties. Promising varieties of emmer and einkorn were identified from winter screening nurseries and spring trials. A replicated on-farm trial assessed relative performance of spring wheat versus spring emmer at early (optimum) and late planting dates. Preliminary analysis shows that spring wheat exhibited a lower relative yield loss due to late planting (51%) than did spring emmer (68%). Spring wheat, emmer and einkorn trials in North Dakota yielded well, and data from all spring trials is currently being analyzed. Emmer and spelt performance in the Northeast was likely affected by poor stand establishment due to plugging of the planter by the hulled emmer seed, a problem reported by growers as well as breeders. A prototype small-scale grain dehuller was developed with a team of Cornell engineering students and is currently being tested before building a production-scale model that could be used for food-grade emmer, spelt and einkorn as well as prior to planting with small-scale equipment. A replicated on-farm trial on top-dressing hard red winter wheat with N fertilizers permissible under NOP standards showed that wheat top-dressed with either Chilean nitrate or blood meal at late boot stage had protein contents over 1% higher than wheat that was untreated. Field days at trial sites on the research station and on-farm allowed farmers to observe varieties in the field and to see demonstrations of small-scale equipment. A mobile grain-cleaning unit has been assembled and is being tested by farmers in NY. Winter workshops at organic farming conferences attracted many farmers and others interested in local grain production, processing and retail. Three consumer preference tastings focused on breads made with wheat (heritage and modern varieties) grown on the same farm in the same year.

The significance of your project to organic agriculture:

Through on-farm experiments and demonstrations, farmers and project participants have been documenting that high-quality wheat can be grown organically in the Northeast and the Dakotas. The organization of grain buying clubs has also allowed organic growers to access high-quality

modern hard red wheat varieties, spring emmer, and heritage varieties. In collaboration with growers, fact sheets have been developed on basic aspects of organic grain management that can be expanded and enriched by the project's ongoing findings. Informational requests from farmers interested in growing grains for value-added projects are increasing, and we are seeing strong growth in interest from millers, bakers, brewers and distillers that would like to use regional grains. Lessons learned from this project should benefit the development of other locally grown food grains including oats, barley, corn, buckwheat, and quinoa.

Project Title: Use of Natural Strategies to Alleviate Enteric Pathogens in Organic Poultry

Project Director Name and email: Annie Donoghue; annie.donoghue@ars.usda.gov

Primary Institution: Poultry Production and Product Safety Research Unit, ARS, USDA

Period of funding: Sept 1, 2011- Aug 31, 2014

Abstract:

The main objective of this project is to provide organic poultry producers with natural, effective, and safe control strategies that address some of the most important health problems in the birds, and reduce the incidence of foodborne pathogens in organic poultry products. We have developed a holistic approach to evaluate the production system, bird health and postharvest parameters, while promoting animal productivity and economic viability. Our project also focuses on the development and demonstration of education and information training systems for extension personnel and other agricultural professionals who advise producers regarding organic practices, as well as the organizations of organic poultry producers around the country. In a study to reduce the incidence of foodborne pathogens including *Salmonella enterica* (SE) in organic poultry production, we evaluated the effect of therapeutic supplementation of plant compounds, *trans*-cinnamaldehyde (TC) and eugenol (EG) on SE colonization in market-age broiler chickens. Eighty four day-old chicks were placed into 6 groups (n=14/group): a negative control (no SE, no TC or EG), EG control (no SE, 1% EG), TC control (no SE, 0.75% TC), a positive control (SE, no TC or EG), an EG challenge group (SE, 1% EG) and a TC challenge group (SE, 0.75% TC). Before the start of each experiment, the flock was screened for any inherent *Salmonella*. Birds were given *ad-libitum* access to *Salmonella*-free feed and water. On d 30, birds were challenged with a four-strain mixture of SE (8 log₁₀ CFU/bird). Two birds from each group were sacrificed after 24 h (d 31) to check for colonization of SE in the cecum. Birds were given feed supplemented with TC (0.75%) or EG (1%) for 5 days before slaughter on d 42 for determination of SE populations in cecum and cloaca. The experiment was repeated twice. *Trans*-cinnamaldehyde and EG consistently reduced SE in the samples in both experiments ($P<0.05$). Body weights and feed consumption did not differ among the groups. Histological analysis revealed no abnormal changes in the liver due to supplementation of plant compounds. The results suggest that TC and EG supplemented through feed could reduce SE colonization in market-age chickens and may provide a strategy for organic poultry producers. Studies are also ongoing on seasonal evaluation and comparison of organic pasture and housing systems and the effect of environmental enrichment on poultry ranging. We have developed a multi-faceted outreach plan for helping organic poultry farmers implement science-based management strategies to improve bird health and increase the microbiological safety of organic chicken products. During this period of the project we have participated at multiple meetings to present our project to producers and interested stakeholders, we have visited with organic poultry producers and have made significant progress in the development of educational materials for the online community (48 articles written and awaiting review on *eOrganic*, 145 articles written on *eXtension* with 47 linked to *eOrganic*), 282 poultry related FAQs in *eOrganic* and *eXtension*) and printed materials for producers without access to internet services.

The significance of your project to organic agriculture: (If Secretary Vilsack asks us what good has been achieved from the money that was spent on your project, what could we tell him or the public to whom he is reporting? Aim for 200 words or less)

Although certified organic poultry nearly tripled in the U.S. between 2005 and 2009, to over 32 million certified broilers, 2.4 million certified layer hens and over 140 thousand certified organic turkeys, supply still trails demand. Unfortunately, organic poultry producers can face numerous challenges. Even though outdoor access offers many benefits to the birds, it has been demonstrated that it can increase exposure of the birds to a wide variety of microorganisms that are commonly present in the environment. The main objective of this project is to provide organic poultry producers with natural, effective, and safe control strategies that address some of the most important health problems in the birds, while reducing the incidence of foodborne pathogens in organic poultry products. Our project takes a holistic approach evaluating the production system, bird environment/health and postharvest parameters. Enteric diseases such as necrotic enteritis and food safety hazards *Salmonella* and *Campylobacter* are high priority issues for organic poultry producers. Our research indicates that natural compounds such as fatty acids, essential plant extracts and lactose (a natural product derived from milk) have antimicrobial efficacy against poultry enteric pathogens and provide solutions to address food safety and disease concerns in organic production systems.

Project Title: eOrganic, the organic agriculture community of practice for eXtension

Project Director Name and email: Alexandra Stone, stonea@hort.oregonstate.edu

Primary Institution: Oregon State University

Period of funding: 2007- current, through a combination of grants solely funding eOrganic and subawards in integrated projects.

Abstract:

eOrganic is the Organic Agriculture Community of Practice (CoP) and Resource Area for eXtension. eOrganic's primary Community of Interest (CoI) is organic farmers and the agricultural professionals who support them. The 250 members of the eOrganic CoP include farmers, researchers, certifiers, and extension/other agricultural professionals. eOrganic's mission is to build a diverse national CoP and use web technologies to synthesize existing information, emerging science, and practical knowledge into information resources and training materials for organic farmers and the professionals who support them. eOrganic strategies to achieve that mission include collaborative publication, stakeholder engagement, community development, project management, evaluation, and fundraising. eOrganic's public site currently offers 240 articles, 250 videos, 80 webinars and broadcasts, and 100 Frequently Asked Questions (FAQs). eOrganic CoP members have answered more than 1000 Ask-an-Expert questions. eOrganic authors collaboratively develop articles at eOrganic.info, eOrganic's collaborative workspace, which undergo review by two anonymous reviewers and National Organic Program compliance review. eOrganic will offer online courses in 2012. eOrganic CoI members evaluated eOrganic articles and videos in 2010 and overall they stated that they were relevant, science-based, and useful. Three quarters of webinar and broadcast participants said the webinar improved their understanding of the topic and 97% said they would recommend the webinar to others. Sixty nine percent of webinar survey respondents stated that they changed practices or provided others with information as the result of the webinar. eOrganic surveyed active CoP members in 2011. Members view eOrganic as important because it is the only organic agriculture national resource with direct ties to university research and they considered all of eOrganic's core activities important.

eOrganic is supported by small grants from eXtension and subawards in 20+ integrated research/extension projects. To enhance its financial sustainability, eOrganic will work to solidify its partnership with NIFA programs and diversify its funding sources to include course fees and underwriters.

The significance of your project to organic agriculture: (If Secretary Vilsack asks us what good has been achieved from the money that was spent on your project, what could we tell him or the public to whom he is reporting? Aim for 200 words or less)

eOrganic published its first content more three years ago and is well on its way to becoming the national online source for science-based, practice-based, and NOP compliant organic information. eOrganic's online information is convenient and accessible to most farmers and agricultural support professionals.

Farmer testimonial:

"I just wanted to say that I really love your webinars. They are the perfect way to learn- I don't have to take time off the farm to travel, if the information is not applicable, I can leave, and the topics are pertinent. Today was perfect -- a cold, rainy day here -- and I got to come in for an hour and a half, have a cup of coffee, and watch the webinar. Right after the webinar on pastures, I was inspired to head back out and make some changes to my grazing system. Thanks for inspiring and informing me!"

Project Title: State of Organic Seed

Project Director Name and email: Kristina Hubbard, kristina@seedalliance.org

Primary Institution: Organic Seed Alliance

Period of funding: 2009 - 2010

Abstract:

State of Organic Seed (SOS) is an ongoing project facilitated by Organic Seed Alliance (OSA) to monitor the status of organic seed systems in the United States. The project aims to develop diverse stakeholder involvement in implementing policy, research, education, and market-driven activities that result in the improved quality, integrity, and use of organic seed. A planning team of farmers, non-government organizations, certifiers, and food industry and seed industry representatives directed project activities. To collect information from a broad and diverse group of stakeholders, OSA and its partners conducted a survey with farmers in addition to questionnaires with researchers, certifiers, food and seed industry representatives, and farm and food policy experts. In February 2010, OSA hosted a full-day SOS symposium to discuss preliminary data and prioritize next steps. Building on this data and feedback, OSA published its *State of Organic Seed* report in February 2011, the first comprehensive assessment of the challenges and opportunities in building the organic seed sector. The report includes results from the national organic farmer survey, an analysis of organic breeding initiatives, and an overview of challenges by crop type with recommendations for collaborative solutions. Our data shows that organic seed systems are developing. Farmers report increased attempts to source organic seed and more pressure from certifiers to do so. Public research in organic plant breeding has increased slightly, with investments from both the public and private sector. Still, challenges and needs loom large for expanding organic seed systems. An important outcome is a general agreement from stakeholders that the challenges and opportunities to building organic seed systems are interwoven and demand comprehensive, collaborative approaches. Few priorities can move forward independently. The project has clarified the need for feedback loops to increase this collaboration within the organic community. As such, ongoing working groups will carry out the action items outlined in this report. Regional listening sessions and other follow-up meetings will also move forward this discussion and work.

The significance of your project to organic agriculture:

Our State of Organic Seed (SOS) research continues to provide the only comprehensive analysis of the challenges and opportunities in building the organic seed sector. We continue to convene working groups to carry out recommendations identified in the report, including helping to launch a new organic seed database (Organic Seed Finder), developing a research agenda for organic plant breeding, and discussing appropriate policies and practices for protecting the genetic integrity of organic seed. We frequently use the data in public presentations and in conversations with media.

Project Title: Tools for Transition: Financial Data and Educational Resources for Farmers and Agricultural Professionals

Poster Title: Conversion to Organic Farm Management: A Dynamic Programming Approach

Project Director Name and email: Robert P. King (rking@umn.edu)

Primary Institution: University of Minnesota

Period of funding: 09/01/2010 to 08/31/2014

Abstract: Several recent studies have shown that organic crop production in the Midwest is as profitable as conventional production on a per-acre basis, yet only a small fraction of cropland currently is under organic management. This poster presents results from a dynamic programming analysis of transition to and away from organic production for a representative Minnesota crop farm with a two-year cornsoybean rotation under conventional management and a four-year corn-soybean-oat/alfalfa-alfalfa rotation under organic management. The model also evaluates the effects of conservation program payments for organic transition and production. The analysis is based on data from an 18-year experimental trial supplemented with empirical whole-farm cost data. Based on alternative assumptions about machinery sizes, three conventional farm sizes are considered: 320, 880, and 1,360 acres. The corresponding farm sizes under organic management are: 320, 560, and 800 acres. The transition decision is influenced by current gross returns, and the model permits conversion from organic to conventional management when gross returns for conventional management are high. With no conservation payments, a farm in the smallest size category transitions to organic management when conventional gross return is less than \$475/acre and transitions back to conventional production only when conventional gross returns approach \$800/acre. A farm in either of the other size categories transitions to organic management when conventional gross return is less than \$425/acre and transitions back to conventional production only when conventional gross returns exceed \$600/acre. Conservation payments for transition and for the use of organic practices both increase the likelihood of transition to organic and reduce the likelihood of conversion from organic to conventional management. Payment effects are greater for small farms than for large farms, and a payment for organic practices (comparable to current CSP payments) is more effective than a transition payment (comparable to current EQIP payments).

The significance of your project to organic agriculture: Summaries of farm records indicate that organic crop and dairy farms in Minnesota are few in number and generally are smaller than conventional farms. Informal conversations with farmers, organic certifiers and representatives of companies that buy organic crop and livestock products suggest that the rate at which new land is being transitioned to organic production has declined significantly. There also are reports of large organic crop farms switching back to conventional production. This research provides an explanation for these phenomena. The results show (i) that small conventional farms are much more likely to transition to organic production and (ii) that larger organic farms many revert to conventional production when conventional gross returns are high, as they are now. The results also show that payments for the use of organic practices (comparable to current CSP payments) are more effective in encouraging transition to organic production than are payments solely for the transition period (comparable to current EQIP payments).

Project Title: Improving the Safety and Post-harvest Quality of Field-grown Organic Leafy Greens: Assessment of Good Agricultural/Production Practices Along the Farm to Fork Continuum

Project Director Name and email: Sadhana Ravishankar, sadhravi@email.arizona.edu

Primary Institution: University of Arizona, Tucson, AZ

Period of funding: 09/01/2011-08/31/2012

Abstract: The potential for internalization and consequential phylloplane transfer of shiga-toxigenic *Escherichia coli* through hydroponically grown organic spinach roots (cultivars Waitiki and Space) was studied. *E. coli* O157:H7 internalized through root and reached the phylloplane. Internalization was dependent on bacterial population, not curli production. Hydrophobicity, curli production, and biofilm forming abilities of *Salmonella* Newport were tested in leafy greens wash water. *S. Newport* strains had varying hydrophobicities, were curli positive and produced biofilms in produce wash waters, indicating a possible new contamination niche. Hydrophobicity of wash water microflora varied depending on produce. Reused leafy green wash waters had increased turbidity and decreased pH. Survival of *S. Newport* and *E. coli* O157:H7 in 8 commercial organic composts and that of *S. Newport* in 6 compost teas was determined. There was no recovery of either pathogen in some composts by day 3. *S. Newport* reduction varied in compost teas. Field studies conducted in organic plots at the Yuma Agricultural Center showed that compost teas enhanced *E. coli* K12 attachment to lettuce leaves and improved their survival. Three coring tool designs were evaluated for risk of pathogen transfer and contamination during coring of lettuce. A modified tool with angled core end resulted in 56% of *E. coli* positive lettuces, compared to 100% from the current commercially used tool. Irrigation water and sediments were sampled from Maricopa and Yuma agricultural areas for presence of enteric pathogens. *Salmonella* and *E. coli* were detected in 8.7% and 8% water samples and 16.8% and 13.6% of sediment samples, respectively, from Yuma. From Maricopa, *Salmonella* and *E. coli* were detected in 18.8% and 25% water samples and 37.5% and 6.3% sediment samples, respectively. Plant extracts were tested against *E. coli* O157:H7 and *S. Newport* on various leafy greens, *Pediococcus damnosus* on baby spinach, and *Pseudomonas fluorescens* on iceberg lettuce. Carvacrol (CAR), oregano, cinnamon, and lemongrass essential oils reduced *E. coli* O157:H7 on baby spinach. On organic iceberg lettuce, CAR, citral, oregano, lemongrass and cinnamon oils reduced pathogen counts significantly at day 0. Hibiscus tea reduced *E. coli* O157:H7 by 2-4 logs on leafy greens. On day 0, olive extracts reduced *E. coli* O157:H7 populations by 2 logs in mature spinach and *P. damnosus* by up to 4 logs in baby spinach. *Salmonella* reduction by lemongrass oil directly correlated with exposure time and concentration. Oregano oil proved effective against *S. Newport* at all levels. Concentration dependent reductions were observed in *S. Newport* on leafy greens by hibiscus tea, grapeseed and green tea extracts. CAR at 0.5% showed no survivors of *Salmonella* by day 1 on organic leafy greens. Cinnamon oil reduced *P. fluorescens* below detection levels and lemongrass oil by 1 log at day 1 on iceberg. Dietary supplements, mushroom extracts and rice hull liquid smoke were tested against *S. enterica*. Rice hull liquid smoke had antibacterial activity *in vitro*. Mushroom extracts and rice hull liquid smoke improved recovery in mice from *Salmonella* infection. Antimicrobial activities of apple skin polyphenols against *Listeria monocytogenes*, *E. coli* O157:H7, and *S. enterica* and bactericidal activities of 10 nutraceuticals against *E. coli* O157:H7, *S. enterica*, *L. monocytogenes*, and *Staphylococcus aureus* were tested. Olive pomace, olive powder and oregano leaves were active against *E. coli* O157:H7, *S. enterica*, *L. monocytogenes*, and *S. aureus*. Plant extracts were tested *in vitro* against murine norovirus. CAR, cinnamon oil, cinnamaldehyde (CIN), olive extract were effective against murine norovirus showing up to 4 log reductions within 6 h. Three commercial organic sanitizers and calcium hypochlorite were tested on organic leafy greens inoculated with *S. Newport*. CHICO wash caused up to 2.5 log *Salmonella* reduction in 3 days in lettuces. Antibacterial activities of apple-based edible films containing apple polyphenols were evaluated and these films were highly effective against *L. monocytogenes*. Apple, carrot, and hibiscus-based edible films with CIN and CAR were tested for

physico-chemical properties and ability to inactivate *S. Newport* and *P. fluorescens* in organic leafy green salad bags. Edible films with carvacrol reduced *Salmonella* by 5 logs at day 0 and were also effective against *P. fluorescens* on organic leafy greens. The pH, color and thickness of the edible films varied. Target audiences for this project include: growers, producers, and processors of organic leafy greens; manufacturers of natural antimicrobials and organic sanitizers; and consumers of organic leafy greens. Leafy green producers and manufacturers of natural antimicrobials and organic sanitizers have been involved in this project by providing in-kind support to the project. Online and mobile application versions of Fresh Organic Produce Safety Training, aimed towards needs of commercial producers and direct marketers, are being created. The PIs have been regularly visiting Yuma and Maricopa to talk to and educate organic producers. As part of outreach, food safety workshops have been conducted in Yuma and Louisiana with a goal to increase the applied knowledge in specific areas within the production of safe organically grown leafy greens. Students at the high school, undergraduate, and graduate levels have been educated in safe produce handling practices.

The significance of your project to organic agriculture: This project has focused on finding practical solutions for improving profitability for organic leafy green producers. Over 300 fresh produce farmers, handlers and processors have been trained in Organic Fresh Produce Safety workshops conducted within Arizona. The organic food safety training program has been adopted from classroom based, USDA GHP/GAP Certification Training Program and in collaboration with the Arizona Department of Agriculture, Citrus, Fruits and Vegetable Program. The curriculum is tailored for small-scale producers, and is focused on all aspects of organic specialty crop production. This training also includes comprehensive overview of documents that organic farmers can use as templates to design their SOP's and organic food safety plan. A lettuce coring tool with a design that prevents bacterial attachment was developed by Yuma scientists and can be utilized by growers. We have shown that composts and compost teas have varying effects on foodborne pathogens, and those that inhibit growth could be better for field applications. The multidisciplinary groups of scientists from University of Arizona and USDA-ARS successfully demonstrated that bioactive plant-based edible compounds, extracts and edible films protect organic leafy greens against contamination by foodborne pathogens. Our discoveries have the potential to improve microbial food safety of organic produce.

Project Title: Strengthening public corn breeding to ensure that organic farmers have access to elite cultivars

Project Director Name and email: Paul Scott (paul.scott@ars.usda.gov)

Poster presented by: Rich Pratt (ricpratt@ad.nmsu.edu)

Primary Institution: USDA-ARS

Period of funding: 2011-2014

Abstract:

In the United States corn is used for animal feed, food products, ethanol production, and many other industrial applications. Corn is marketed as a commodity that is priced by volume so little attention is paid to product quality and production strategies often involve extensive use of genetically engineered varieties and high inputs of fertilizer, herbicides, pesticides and fungicides. Organic farmers use corn for different purposes, focusing on food and animal feed. These focused uses make it possible to capture the value of a high quality product because quality can be simply defined as nutritional value. Organic production practices are different from conventional practices as well, with limitations on the use of genetically engineered varieties, fertilizers, herbicides, pesticides and fungicides. The differences in product focus and production practices limit the utility to organic farmers of the majority of corn varieties on the market today. There is a great need for a new pipeline for production of corn varieties optimized for organic corn production systems.

Our project seeks to produce organic corn varieties that are specifically tailored to the needs of organic farmers. In the two years of our project so far, each of our cooperators has contributed to a set of about 40 breeding populations that will form the basis of one of our key deliverables: a catalog of publicly available breeding germplasm with good potential for development of organic varieties. We are completing our second year of cooperative evaluation of this germplasm. We are currently working to make this information available to the public using GRIN-Global, a database under development by the National Genetic Resources Program, and we tentatively plan to distribute seed through the National Genetic Resources Program as well.

Our approach involves unprecedented cooperation among the performing institutions. Our activities are coordinated by monthly conference calls and annual meetings at a different cooperator's site each year. Each cooperator carries out organic yield trials containing entries from the other cooperators. Thus, we have the potential to get data from New York, Illinois, Wisconsin, New Mexico and Iowa. This tremendous geographical variation will allow us to make valuable observations on adaptation of maize. In addition, we are testing the compatibility of each cooperator's best lines with those from each of the other cooperating breeding programs using a Design II mating scheme. This is a widely used experimental format in the scientific community because of its power to identify genetic effects that are highly relevant to hybrid production. We will evaluate traits of specific interest to organic seed producers and publish the results in a widely read scientific journal such as *Crop Science*. A fringe benefit of this activity is that we helped to establish the first (to our knowledge) certifiable organic winter corn breeding nursery. This nursery doubles our rate of gain through breeding by allowing us to grow two generations each year.

Improving grain quality is limited by the difficulties associated with measurement traits associated with nutritional quality. NIR spectroscopy has the potential resolve this limitation. To facilitate deployment of this technology, a package program, including calibration installation, instrument standardization and ongoing quality/control/validation will be developed. A set of written protocols and SOPs will accompany the program. A process of including new NIRS instruments not presently in the calibration

pool will be described. The goal is to make NIRS based quality analysis more accessible, less expensive and easier to use for the organic breeding community as a whole.

By making a connection between organic seed producers and public breeders, we have the opportunity to revitalize public breeding while providing a pipeline of new corn varieties for organic seed producers. Public breeding activity has been steadily decreasing in part due to the lack of an outlet for public varieties. Large seed producers tend to recycle their own successful varieties and report that it is difficult to incorporate public germplasm into their programs. Since organic seed producers would ideally have different varieties than conventional seed producers anyway, the public corn varieties produced by our project can meet these needs.

More information about our project can be found at: <http://tinyurl.com/OREI-Corn> .

The significance of your project to organic agriculture:

There are currently very few corn varieties that have been developed for organic corn production. Organic producers must therefore use the same varieties as conventional farmers but the increasing use of genetically engineered corn limits the number of varieties available to organic producers. The goal of this project is to develop varieties specifically tailored to meet the needs of organic producers. These varieties will not only be GMO-free, but will actively exclude GMO pollen and have high yield, superior nutritional value, improved weed suppression and natural insect and disease resistance. In addition to providing much-needed varieties to organic producers, our ultimate success will result in a re-vitalization of public corn breeding by providing an outlet for publicly-developed varieties through organic seed producers.

Project Title: Carrot Improvement for Organic Agriculture With Added Grower and Consumer Value

Project Director Name and email: Dr. Philipp Simon, Philipp.simon@ars.usda.gov

Primary Institution: Agricultural Research Service, USDA, University of Wisconsin, Madison

Award number: 2011-51300-30903

Period of funding: September 1st, 2011 – August 31st, 2015

Abstract

Carrot Improvement for Organic Agriculture (CIOA) is a long-term breeding project that addresses the critical needs of organic carrot farmers by developing orange and novel colored carrots with improved disease and nematode resistance, improved weed competitiveness, and improved nutritional value and flavor. This four-year project will also compare the relative performance of breeding material in organic versus conventional environments and investigate whether some carrot varieties perform better under organic soil conditions.

Organic growers require vegetable varieties that are adapted to organic growing conditions and hold market qualities demanded by the organic consumer including superior nutrition and exceptional flavor. In carrots, work has been done to identify and breed for nutritionally superior varieties across multiple color classes including orange, red, purple and yellow. These varieties are in high demand and in a high value crop, however much of this germplasm has not been improved for organic systems in general. Organic producers need varieties that germinate rapidly with good seedling vigor, compete with weeds, resist pests, are efficient at nutrient uptake and are broadly adapted to organic growing conditions.

Engaged organic farmer and industry stakeholders will participate in the breeding, variety trials, and planning aspects of the project. Project results will be disseminated widely through eOrganic, PD, Co-PD, and collaborator outreach programs, through agricultural publications, and at field days. The project will also train graduate and undergraduate students in plant breeding and vegetable trial development for organic systems, and soil quality assessment through research and field assistant positions.

The **Carrot Improvement for Organic Agriculture** project will deliver improved carrot varieties; improved understanding of the farming systems influence (organic vs. conventional) on variety performance; and develop a breeding model adaptable to other crops for organic systems.

While significant progress has been made in carrot breeding to improve nutritional value, flavor, and disease resistance for conventional production systems, the majority of the conventional U.S. crop is threatened due to loss of chemical fumigants and sprays to control nematodes and alternaria leaf blight, and organic production has no obvious means for economical carrot production when either of these pests threaten the crop.

Significance of project to organic agriculture:

The anticipated project impacts for organic agriculture are three-fold 1) delivery of novel germplasm well suited to enhance organic production systems and markets, 2) development of organic produce with superior flavor and nutritional quality, and 3) Improved understanding of the genetic by environment interactions in organic versus conventional systems as they relate to cultivar performance and inform growers about cultivar and soil factors that impact economic returns and reduce environmental impacts. The project is currently in its first year and collaborators are just now collecting and analyzing data, but the model for identifying key traits for organic systems, and subsequently breeding for those traits has been established. In the first year we've reached approximately 60 farmers with education on organic breeding and variety trials with plans in place to reach an additional 100 growers by the end of year two. Organic growers require vegetable varieties that are adapted to organic growing conditions and hold market qualities demanded by the organic consumer including superior nutrition and exceptional flavor. However consolidations in the seed industry and a focus on restrictive intellectual property, coupled with a shift in public breeding programs toward fundamental research has resulted in marginalization of organic systems in breeding priorities. This project provides crucial support for public breeding programs to advance the development of organic agriculture. In addition to the important research impacts and new germplasm this project is creating a model for farmer-researcher participation in breeding, seed production and evaluation programs for organic systems.

Website:

The CIOA website is: <http://eorganic.info/carrotimprovement>.

The CIOA website includes information about the project, the project collaborators, resources related to carrot breeding and seed production, notifications of events, relevant news, and a link to the eOrganic variety trial database.

Project Title: Greenhouse Gas Emissions in the Transition from Traditional to Organic Dairy Farming: An Education and Research Collaboration

Poster title: Soil Carbon Sequestration and Greenhouse Gas Emissions in the Transition from Traditional to Organic Dairy Farming: An Education and Research Collaboration

Project Director Name and email: Ruth Varner, ruth.varner@unh.edu

Primary Institution: University of New Hampshire

Period of funding: 2010/09/01 to 2013/08/31

Abstract:

In the northeastern US, organic dairy farming is often promoted as both an economically and an environmentally sustainable alternative to conventional dairy farming in concentrated feedlots. Farmers and livestock operators contemplating the switch to an organic management strategy would benefit from a rigorously tested, scientifically based tool that would help them assess their soil, crop, and livestock resources and make decisions that optimize the sustainable use of those resources.

The goal of this project is to develop such a decision support tool, which will help farmers, policy makers, and other stakeholders to make management decisions that support both farm-level and regional ecosystem services. The project is taking place over a three-year period, and involves calibrating the biogeochemical model Manure-DNDC (DeNitrification-DeCompostion), linking the model to a web-based, GIS database that will act as a decision support tool, testing the decision tool at dairy farms throughout Northeast, and conducting outreach and training workshops with stakeholders such as farmers, extension agents, and state departments of agriculture.

The project is currently in its second year. To date, project activities have included 1) collecting farm-level observational data for testing and improving the process-based biogeochemical model, Manure-DNDC; 2) quantifying the impact of baseline and alternative management practices on ecosystem services with Manure-DNDC; and 3) developing a Northeastern GIS database to support Manure-DNDC applications at a regional scale.

The significance of your project to organic agriculture:

Dairy farming remains the largest agricultural sector in the northeastern United States. However, the number of dairy farms in the region has decreased by over 80% in the past 50 years. Financial pressures on the industry have resulted in fewer, larger farms with more milking cows living in concentrated areas. These concentrated feedlots are often too expensive for small family farmers to operate, and can cause environmental problems such as water and air pollution. Organic dairy management, and particularly organic grazing management, has been promoted as an economically viable alternative to conventional dairy farming in concentrated feedlots. Organic dairy farming also has the potential to provide key ecosystem services that enhance soil fertility, reduce water and air pollution, and mitigate climate change.

We currently lack a rigorous, scientific assessment of how organic and / or grazing intensive systems result in positive economic and environmental outcomes for dairy farms. Our research will develop this scientific understanding using a combination of field measurements and modeling. We will then translate our model into a web-based tool that farmers, policymakers, and other stakeholders can use in making management decisions that maximize both economic and environmental gains for Northeastern dairy farms.