OREI Project Details

Award Year 2009

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19. Building on Success: a Research and Extension Initiative to Increase the Prosperity of Organic Grain and Vegetable Farms Grant No: 2009-51300-05586

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21. Plant Breeding and Agronomic Research for Organic Hop Production Systems Grant No: 2009-51300-05598

22. Mental Models and Participatory Research to Redesign Extension Programming for Organic Weed Management Grant No: 2009-51300-05653

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26. Northern Vegetable Improvement Collaborative (novic) Grant No: 2009-51300-05585

Training Conference to Develop Certification Inspectors to Enable Organic Agriculture on Guam and the American Affiliated Pacific

Accession No.	0218749
Subfile	CRIS
Project No.	GUAN-2009-01346
Agency	NIFA GUAN
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05534
Proposal No.	2009-01346
Start Date	01 AUG 2009
Term Date	31 JUL 2011
Grant Amount	$41,616
Grant Year	2009
Investigator(s)	Barber, L. R.; Marutani, M.; McConnell, J.
Performing Institution	Cooperative Extension, UNIVERSITY OF GUAM COOPERATIVE EXTENSION, 303 UNIVERSITY DRIVE, UOG STATION

NON-TECHNICAL SUMMARY

The proposed project will offer conference and pre-conference workshops on organic-based agriculture for stakeholders critically needing to know about the organic agriculture certification program in Guam and American affiliated Pacific island nations. During the pre-conference workshops (2nd-7th month of the project), participants will review basic agricultural subjects including horticulture, soil management, animal production, aquaculture, pest management, marketing and agricultural business with an emphasis on using organic agriculture practices. A one-week Organic Agriculture Certification Conference during the 8th month of the project will be held by certified trainers from the Independent Organic Inspectors Association (IOIA) to train participants and to conduct the Organic Agriculture Certification Exam at the end of the conference. A short-term goal of the proposed conference project will be production of local certified personnel in Guam. Mid-term and long-term goals of the project will be initiation of commercial organic farms, and development and implementation of a sustainable organic agriculture certification program in this region.

OBJECTIVES

Our long-term goal is to develop and implement an organic agriculture certification program in Guam and neighboring American affiliated Pacific island nations. The cost of bringing in organic certification inspectors who are distant from Guam currently makes the cost of organic certification prohibitive, especially for small producers or those newly entering their niche market. Bringing inspectors to Guam is a major expense due to the high costs of travel. Certification costs can be reduced by training local inspectors from a variety of USDA accredited agencies. Training and certifying local inspectors is the first step, and primary goal of this project, toward the long-term goal of establishing a local certification program. The proposed project is a critical need. At the present, no USDA certified programs in organic agriculture production exist in the American Affiliated Western Pacific. There is a strong interest in organic production among local producers, retailers and agricultural professionals for the following reasons: Strong desire to use local renewable inputs, desire for alternatives to pesticides, and the marketing advantage conveyed by the USDA organic inspectors in the region. The proposed project will have

supporting outreach objectives to increase the number of local producers and agriculturists in the region who would have knowledge of USDA organic agriculture certification program and to increase the number of producers who would implement organic farming practices.

APPROACH

1. Description of activities: There will be three phases in the proposed project. Phase I. Preparation period (Months 1-7 of the project): Prior to the one-week Organic Agriculture Certification Conference, that will be conducted by certified trainers from the Independent Organic Inspectors Association (IOIA), personnel of University of Guam Cooperative Extension (Bob Barber) and Agricultural Experiment Station (Mari Marutani and James McConnell) will develop/revise educational materials, offer a workshop, seminar and field activities to teach the basic concepts of organic agriculture to staff members of Guam Department of Agriculture and other local and neighbor island stakeholders who wish to take Organic Agriculture Certification Exam. There will be four (4) steps in the preparation period. Step 1: Planning \-- PDs (Barber, Marutani & McConnell) will select topics and guest instructors to review the basic subjects: horticulture, soil management, animal production, aquaculture, pest management, marketing and agricultural business related to organic agriculture practices.. PDs will communicate with IOIA trainers to obtain major topics and emphases that Organic Agriculture Certification examinees should know about. Step 2: Selection of participants and assessment plan \-- The collaborator (P. Bassler) will identify participants from the Guam Department of Agriculture for this training project. PDs will contact others (agricultural professionals and other stakeholders) who would like to participate in the proposed project. We will accept 20 participants in the program. PDs and a part-time project assistant will prepare pre-test/post-test questions on general agriculture that will be covered during the preparation period. Step 3: Preparation of educational materials \-- PDs and a part-time project assistant will prepare handouts/study guide to be used by participants. Step 4: Pre-conference workshop - PDs and a part-time project assistant will coordinate and offer a workshop to participants. We will invite guest lecturers in the area of expertise, when available. A series of workshop, seminar and field activities will be offered to participants. One of the goals of participants will be to develop an organic farm implementation plan of their own. a. Meet with participants and conduct pre-test, assess knowledge levels b. Workshop, seminar, and field activities c. Participants to develop an organic farm implementation plan d. Conduct post-test Phase II. Organic Agriculture Certification Conference and Exam (Month 8 of the project): We fund two trainers from IOIA to offer a one-week conference. PD (Barber) will contact and coordinate with the IOIA trainers to offer the conference. A project assistant will prepare handouts regarding the schedule and other pertinent information about the conference, and contact with participants to the conference. Phase III. Post-conference review (Months of 9-12 of the project) a. Revision of Educational materials \-- The revised materials will be distributed to participants for their future reference and will be used as outreach educational materials at the Guam Cooperative Extension Service.

PROGRESS

2009/08 TO 2011/07 Target Audience: There were two target audiences for this project. The primary was the agricultural professional community on Guam and in the region interested in developing the expertise to become organic inspectors/advisors. The secondary audience consisted of farmers and gardners and other community members interested in learning about organic production. This audience attended workshops held by agricultural professionals as part of the ag. professionals service learning portion of the project. Changes/Problems: The project requested and received a one year no cost extension in order to conduct all the training activities. These were necessary to bring the agricultural professional team up to speed so they would receive maximum benefit from the two 1 week long training conferences. This also allowed for a much wider and involved effort to build interest in organic agriculture among community members through workshops. What opportunities for training and professional development has the project provided? 1) The best way to master a topic is to demonstrate and teach the material. Guam Ag. Professionals Developed Organic Workshop materials (powerpoints and hands on activities) and on campus demonstrations, then conducted workshops series for the public on many key organic topics for local gardeners and farmers over a two year period. Over 12 workshops (3-6 hours) were conducted. These were often based on ATTRA resources, these workshop topics included: Organic soil nutrient management, Sheet mulching, Composting, Organic Pest Control Principals, Organic Certification and Inspection Process, Soil Food Web, Organic vs Certified Naturally Grown Certification, Nitrogen fixing trees and green manures, Record Keeping for Organic production, Barrier plantings, filter strips, hedgerow and windbreaks, Seed and plant material sources for organic production These workshops both provided information to local producers and genereted interest in local orgainc production practices and brought a team of local agricultural professionals together to develop common shared materials and knowledge on organic production in preparation of the two week long training conferences on the organic inspection process. 2) One week long workshop on Organic

certification and inspections was conducted by Marty Mesh of Florida Organic Growers, for over 30 individuals interested in either becoming organic producers, trainers or inspectors. This was used to screen for selection of 15 participants to take part in a week long organic inspectors training six months later. 3) One week long Organic Inspectors Training was conducted by National Organic Inspectors Association (NOIA) for 15 participants from Guam, CNMI and FSM. Eleven of the participants Passed the NOIA training. Several now are seeking funds to travel to the mainland to be certified by various multi state certification bodies. How have the results been disseminated to communities of interest? All workshops and training conferences were announced in the local newspaper, and on radio. A multi-agency team of agriculture professionals developed workshop materials and extension flyers for this project. These team members regularly disseminate these materials to their clients and utilize in one on one trainings and workshops they conduct. Guam Department of Agricultura maintains a organic production demonstration site for tropical fruits and vegetables at their Mangilao farm that is used by many local agencies in trainings and field days. Guam Cooperative Extension Service\'s New Farmer program maintains a email and mailing list of gardeners, farmers and other community members who are interested in any workshops or educational opportunities in the area of organic production and sustainable agriculture practices. These community members are notified of any workshops. What do you plan to do during the next reporting period to accomplish the goals? This is the final report. Future needs in terms of developing an organic agricultural industry for Guam and the Western Pacific include: Establishment of a Multi-agency long term demonstration of first transistion to organic and then organic production under our tropical production environment for fruits, vegetables and herbs. Obtain funding to provide resources to take a few of the qualified inspectors from this project and bring them to mainland to undergo internship with one or more multistate certification bodies to be certified by these bodies, so they can conduct inspections in the Western Pacific. Explore as an intermediary step to USDA organic certification possibly bringing the \"Certified Naturally Grown\" program to Guam

IMPACT

2009/08 TO 2011/07 What was accomplished under these goals? Over 30 gardeners and farmers were identified who are interested in organic production practices on Guam. These individuals regularly attend workshops offered by UOG CES and partners on organic and sustainable agriculture topics. Several have their farms/gardens in transition to organic production. In the first year of the project a team of interested agricultural professionals on Guam was formed to start an organic production workshop series. Key topics relevant to Guams soil and climate conditions were identified and workshop materials prepared. This was to both build a producer support team around organic production and to develop the capacity of these team members in organic production issues. In the second year of the project more community workshops were held and two week long confereces. The first weeklong training we on pre-organic inspector training and was conducted by Marty Mesh of Flordia Organic Growers. The conference was five days long from 8 am to 5 pm and covered a whole range of topics related to organic production, record keeping, certification and the inspection process and role of the inspector. Thirty individuals participated and included agricultural professionals, farmers and gardeners. Six months later a core group of agricultural professionals from Guam, Rota, Pohnpei, Chuuk and Palau were brought together for a one week training conference co-sponsored by National Organic Inspectors Association (NOIA) and the University of Guam Cooperative Extension Service. Two NOIA trainers conducted the week long training and exams. Eleven of the 15 participants passed the NOIA exams. Since the project end this agricultural professional team on Guam has continued to conduct workshops for the public annually on many of these organic production topics. **PUBLICATIONS (not previously reported):** 2009/08 TO 2011/07 No publications reported this period.

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Hua Ka Hua - Restore Our Seed: a Symposium to Develop a Hawaii Public Seed Initiative

Accession No.	0219162
Subfile	CRIS
Project No.	HAWW-2009-01389
Agency	NIFA HAWW
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05745
Proposal No.	2009-01389
Start Date	01 SEP 2009
Term Date	31 AUG 2010
Grant Amount	$47,500
Grant Year	2009
Investigator(s)	Valenzuela, H.; Radovich, T.; Redfeather, N.
Performing Institution	THE KOHALA CENTER, PO BOX 437462, KAMUELA, HAWAII 96743

NON-TECHNICAL SUMMARY

Seed is the foundation of agriculture and is vital for the expansion of Hawaii\'s food production. Hawaii is the most isolated island chain on the planet and is now dependent upon long distance transport (2300 miles) for our food and fuel. Though as late as the 1940s Hawaii could feed itself, the state now imports 90% of its food and almost all of its agricultural inputs, including seed. Disruption of shipping through shortages, natural disasters, strikes, or rising costs, leaves the state with a 3-7 day food supply on grocery shelves according to the Food Security Briefing at last session\'s Hawai\'i State Legislature. Because Hawaii currently imports 90+% of our food, time is ripe for the development of a Public Seed Initiative. Hawaii\'s farmers and home gardeners are dependent upon mainland seed produced in temperate climates to provide the foundation for agriculture in the state. However Hawaii\'s climate is tropical and has diverse climatic zones as well as great variability in soil types and rainfall patterns. Open-pollinated seed nationwide is disappearing at an alarming rate and many of these OP and heirloom varieties, with their wide adaptation to climatic ranges, would be suitable for variety trials and seed development in and for Hawai\'i. The University of Hawaii had a seed breeding program at one time, but this program was discontinued. Although multinational corporations conduct research and development of genetically engineered seed varieties in Hawaii due to its geographic isolation, this seed is not suitable for Hawaii\'s organic market farmers or home gardeners. \"Hua Ka Hua - Restore Our Seed\" is a three-day statewide symposium to bring knowledgeable agricultural stakeholders, including farmers, researchers, and extension agents, to discuss Hawaii\'s needs and opportunities for a long-term public seed initiative in the State of Hawaii. This symposium is necessary to re-start an organized and scientific approach to organic seed breeding and selection in Hawaii. This research has not been a university or extension service priority for many years with resulting loss of heirloom varieties and plant biodiversity. We will assess Hawaii farmers\' knowledge and interest in organic seed production and solicit input on the development of a comprehensive plan for organic seed education and breeding programs specific to Hawaii and the Pacific Basin. This symposium will result in state-wide and local working groups that produce a plan and funding requests for island-by-island educational workshops, on-farm variety trials, selection and improvement of organic open-pollinated seed and germplasm (such as taro, and sweet potato) varieties suited for tropical environments, along with development of effective ways to share data in Hawaii and throughout the Pacific.

OBJECTIVES

The short-term objectives of the project are to bring together Hawaii farmers and gardeners and local and national experts to start a Hawaii Public Seed Initiative (HPSI), by examining diverse examples in other areas of the US, discussing Hawaii\'s critical need for action, and developing a work plan and funding strategy for initiative implementation. The symposium will facilitate sharing information among and between the diverse participants, including speakers from the University of Hawaii, the Organic Seed Alliance, the Hawaii Organic Farmers Association, and panels of local farmers, public policy experts, and agricultural economists. On the last day of the symposium a working session will create a roadmap for HPSI implementation that includes educational workshops given on all the islands to cover basic seed biology, genetics and research methods to identify and train for on-farm variety trials. Another working group will develop a communications system and a clearinghouse for organic seed storage and dissemination. In addition, the working group will begin to engage stakeholders in the Pacific Basin countries to facilitate the exchange of knowledge, seed and germplasm and lay plans for future seed development that might increase biodiversity across the region. The ultimate impact of the proposed symposium is the provision of fresh, vigorous organic open-pollinated varieties of food crops, medicinals, and culinary herbs for tropical and semi-tropical climates, increasing island food self-sufficiency in Hawaii. The immediate outcome of the symposium and planning meeting will be the development of a blueprint for to re-invigorating open pollinated seed production suited to Hawaii and Pacific growing conditions. An anticipated short-term outcome will be the development of new working relationships between members of the organic farming community, improvement of relationships between university researchers and farmers, and between farming and gardening associations, based on a spirit of collaborating for everyone\'s benefit. A second short-term outcome is the establishment of a Hawaii Public Seed Initiative to provide the educational, research and material support for the long-term restoration of seed and germplasm trials, selection, storage, and distribution by and for Hawaii and Pacific region farmers. The ability of farmers and gardeners to conduct trials in a variety of climatic zones, soil types, and seasons, and then analyze those research results will yield organic open-pollinated seed for the market farmers and the home gardeners across the state. This will be an important element in the restoration of increased food self-reliance for Hawaii and provide farmers with a value-added product for local and other tropical markets.

APPROACH

The short-term objectives of the project are to bring together Hawaii farmers and gardeners and local and national experts to start a Hawaii Public Seed Initiative (HPSI), by examining diverse examples in other areas of the US, discussing Hawaii\'s critical need for action, and developing a work plan and funding strategy for initiative implementation. The symposium will create a venue to share necessary background information with a diverse audience with speakers from the University of Hawaii, the Organic Seed Alliance, the Hawaii Organic Farmers Association, and panels of local farmers, public policy experts, and agricultural economists. On the last day of the symposium directors and key personnel, along with selected other key stakeholders, will meet in a working session to create a roadmap for HPSI implementation that includes educational workshops given on all the islands to cover basic seed biology, genetics and research methods to identify and train for on-farm variety trials. At the same time a state-wide seed initiative working group will develop plans for a communications system and a clearinghouse for organic seed storage and dissemination. In addition, the working group would identify and begin to engage stakeholders in the Pacific Basin countries to facilitate the exchange of knowledge, seed and germplasm and lay plans for future seed development that might increase biodiversity across the region.

PROGRESS

2009/09 TO 2013/08 Target Audience: *Farmers and producers in the Hawaiian and the Pacific Islands. *Extension agents on different Hawaiian and the Pacific Islands. *Land grant faculty, researchers, and agricultural professionals in the Hawaiian and the Pacific Islands. *Professionals at Universities, and community colleges. *University and high school students. Changes/Problems: We requested no cost extension for a year; the extension was required to complete outreach activities, publications, and economic analysis. There was a shift in the project toward including more locally produced and available composts to evaluate their effect on seedlings quality and reduce production cost/increase profitability. Nothing has changed in regard to the award terms and conditions. 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. 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 will continue to work with industry to facilitate adoption and evaluate impacts on certified organic farms and other operations. Expected impacts articulated in the proposal remain the same. Cost-benefit analysis has been roughly calculated and data were presented in public talks, but we are still working on a publication to be published in the near future. What opportunities for training and professional development has the project provided? Approximately 400 participants (local farmers and producers, extension agents, NRCS specialists, and other professionals) from different Hawaiian Islands and the American Samoa, were able to participate in workshops, field days/tours, and public talks were given by the project researchers, to spread out the project results among the community and benefit small farmers from its findings. Due to high/positive feedbacks we received from the participants, we are expecting high adoption of more sustainable practices by local farmers and producers on the Hawaiian Islands and the American Samoa. Adoption will continued to be monitored beyond scope of the project. Two international students were able to join us and participate in the project activities. They received training for the application of the sustainable and organic farming practices. The two students were from Ghana and Germany. Also, we are still presenting the project findings at different meeting (person-to-person, or public presentations) to increase awareness/adoption of local farmers to the new practices. How have the results been disseminated to communities of interest? 1-Field Days, 2-Workshops, 3-Public talks/presentations, 4-Extension bulletins, 5-Peer reviewed publications. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 OUTPUTS: * Five greenhouse experiments were conducted, at the University of Hawaii to produce seedlings for different vegetable crops using different new local media inputs (organic amendments were not evaluated earlier by this project). The preliminary results showing a promising results in reducing inputs cost while improving seedlings quality. * Two field experiments, and two aquaponics experiments have been conducted at the University of Hawaii (UH), to evaluate the new media on crop growth and yield after transplants. *Two recirculating aquaponic system (RAS) trials were conducted at Waimanalo research station, using seedlings produced with additional new organic amendments. *One field trials, using Eggplant seedlings, was conducted with the help of our International collaborator. The field trial was conducted with selected top performing media, from previous greenhouse trials during previous years of this project. The results showed no significant differences among the top performing media. The results are eyes opening which would allow to select from the lowest cost media, and increase profitability. *Two presentations at the annual meeting for the Hawaii Organic Farmers Association (HOFA) were given by the project PI. *One public presentation at the American Samoa Community College Land Grant was given by Ian Gurr, during a field day workshop event. *One public talk was given at the American Society for Horticultural Science (ASHS) annual meeting. PARTICIPANTS: CTAHR Collaborators: Dr. Brent Sipes- Nematology; Email: sipes@hawaii.edu; Dr. Janice Uchida- Mycology; Email: juchida@hawaii.edu; Dr. Robert Paull- Post harvest; Email: paull@hawaii.edu; Dr. Bradley K. Fox- Aquaponics; Email: bradleyf@hawaii.edu; Dr. Archana Pant-Organic farming program; Email: apant@hawaii.edu; Mr. Clyde Tamaru- Auquaponics; Email: ctamaru@hawaii.edu; Mr. Jensen Uyeda-Extension coordinator; Email: juyeda@hawaii.edu Multi State Collaborators: Ian Gurr, from American Samoa. International Collaboration: Wajid Farhad, PhD candidate from Pakistan. He joined our lab to gain experience in sustainable agriculture practices. On-Farm Collaborators: Olomana Garden, Poamoho Produce, Alex Karp- Island Harvest Organics; Gerry Ross- Kupaa Frams and others. * Local organic amendments producers, such as Island commodities company. TARGET AUDIENCES: *Local farmers and producers on Hawaiian and the Pacific Islands. * extension agents on different Hawaiian and the Pacific Islands. *Professionals at Universities, and community colleges. *University and high school students. PROJECT MODIFICATIONS: There is a shift in the project toward including more locally produced and available composts to evaluate their effect on seedlings quality, reduce production cost, and increase profitability.

2010/09/01 TO 2011/08/31 OUTPUTS: *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 presentations at the annual meeting for the Hawaii Organic Farmers Association (HOFA) were given by the project PI. *Two public talks were given at ASHS annual meeting. One public presentation at the University of Hawaii was given by Ian Gurr, during his master public defense. *Two field days were conducted to spread out project findings among local farmers and producers on the Island of Oahu and in American Samoa. PARTICIPANTS: *CTAHR collaborators: Dr. Brent Sipes- Nematology; Clyde Tamaru- Auquaponics; Dr. Janice Uchida- Mycology; Dr. Robert Paull- Post harvest; Dr. Bradley K. Fox-Aquaponics; Dr. Archana Pant-Organic farming program; Mr. Jensen Uyeda-Extension coordinator; and faculty at UH-Hilo. *Multi State Collaborators: Ian Gurr- graduate student, from American Samoa. *International Collaboration: Micahel Kermah, Coordinator and Research Associate from Ghana, and Master student from Germany (Luisa Malina). *On-Farm Collaborators: Olomana Garden, Poamoho Produce, Alex Karp- Island Harvest Organics; Gerry Ross- Kupaa Frams and others. TARGET AUDIENCES: *Local farmers and producers on Hawaiian and the Pacific Islands. *Local extension agents on different Hawaiian and the Pacific Islands. *Professionals at Universities, and community colleges. *University high school students. PROJECT MODIFICATIONS: *No cost extension for one year was requested by the project PI/Co-PI from the funding agency. The extension is required to complete outreach activities, publications, and economic analysis. *There is a shift in the project toward including more locally produced and available composts to evaluate their effect on seedlings quality and reduce production cost/increase profitability.

2009/09 TO 2010/08 OUTPUTS: Two preliminary trials were conducted to evaluate the response of sweet corn to several locally available organic compost amendments, and to determine residual nutrient availability from initial high amendment rate applications. For yield comparison purposes a field trial was conducted to evaluate the response of several new sweet corn varieties to conventional synthetic fertilizer applications. In fields that had been managed organically for over 10 years, three consecutive trials were conducted to evaluate the response of sweet corn to several organic amendment applications, and residual nutrient levels during each consecutive planting. Three parallel/concurrent field trials were conducted in the same organic production fields, to determine the effect of the same organic amendments, and modified tillage practices, on the water/moisture soil relations in sweet corn. Educational activities were conducted to share information about the technology behind the use of organic amendments, and ability to provide significant NPK nutrient inputs to cash crops with locally available amendments for either organic or conventional production systems. Educational activities included 10 production workshops, 6 field days, and 22 presentations, to community groups, gardeners, and farmers in Hawaii, and in the Pacific Region. PARTICIPANTS: Participants included the PI and one student assistant, who helped with clerical, paper work, and data management. Collaborators, not funded by the project included four field technicians that assisted with field management and data collection, and researchers from another department (a research professor, a post-doc, and a graduate assistant), that assisted with some aspects of the project. TARGET AUDIENCES: Targeted audiences included local commercial farmers in Hawaii, organic farmers, home-gardeners, and community members interested in local food production or in issues of food security and self-sufficiency. Some educational activities were targeted toward immigrant farmers in Hawaii. Farming communities were located in all islands of the state, including Hawaii (Puna and Hamakua), Molokai, Oahu, Maui, and Kauai. PROJECT MODIFICATIONS: We were not able to address one of the project objectives. Because funding for this grant was not made available for the second year, and because experimental land was also not made available until the second year of the project, we were not able to complete one of the objectives of the project. As a result of these changes we were not able to use a large portion of the funded monies, because of the inability to plan ahead- as funding after the first year became uncertain, and because of the inability to extend the duration of the project after its termination date on August 2008.

IMPACT

2009/09 TO 2013/08 What was accomplished under these goals? We have conducted ten greenhouse experiments, three greenhouse/pots trials were conducted, using tomatoes and eggplants varieties, three recirculating aquaponic system (RAS) trials were conducted at the Windward Community College, six greenhouse experiments and two field trials were conducted by our International Collaborators from Ghana and Germany, and Pakistan, through their fellowship programs, and 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. All the previous greenhouse, field, and aqauponic trials were covering the main first and second goals of this project. To meet the third objective, we gave two presentations at the annual meeting for the Hawaii Organic Farmers Association (HOFA), 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, two field days in Hawaii and Samoa are completed, andInitial farmer evaluation of

recommended media was completed as well. Training a master student (Ian Gurr), and three undergraduate students through SOFT organization at UH-Manoa were completed. Mr. Gurr has continued training farmers at American Samoa Land Grant Institutions. The use of local/relatively inexpensive materials, to produce vegetable seedlings, will increase farmers\' profitability due to reduce production cost and higher crops production/yield. **PUBLICATIONS (not previously reported):** 2009/09 TO 2013/08 Type: Journal Articles Status: Published Year Published: 2012 Citation: Radovich, T.J.K., Pant, A., Gurr, I., Hue, N.V., Sugano, J., Sipes, B., Arancon, N., Tamaru, C., Fox, B.K., Kobayashi, K.D., and Paull, R. 2012. Innovative use of locally produced inputs to improve plant growth, crop quality, and grower profitability in Hawaii. Horttechnology, 22(6): 738-742.

2011/09/01 TO 2012/08/31 *Approximately 200 participants (local farmers and producers, extension agents, and professionals) from different Hawaiian Islands, the American Samoa. were able to participate in workshops, field days/tours, and public talks were given by my program. We are expecting increase adoption of more sustainable practices by local farmers and producers. *Two undergraduate students from SOFT program were received support and training on the application of the project methodology in vegetable seedlings production. The two students were helping in conducting the greenhouse, aquaponic, and field experiments. The participation in SOFT program activities are increasing, especially among student from the College of Tropical Agriculture and Human Resources. *One international fellow joined our lab for a period of six months from Pakistan, the visitor fellow participated and trained on both greenhouse and field practices.

2010/09/01 TO 2011/08/31 *Approximately 400 participants (local farmers and producers, extension agents, and professionals) from different Hawaiian Islands, the American Samoa. were able to participate in workshops, field days/tours, and public talks were given by my program. We are expecting high adoption of more sustainable practices by local farmers and producers. *Three undergraduate students from SOFT program were received support and training on the application of the project methodology in vegetable seedlings production. The two students were helping in conducting the greenhouse, aquaponic, and field experiments. The participation in SOFT program activities are increasing, especially among student from the College of Tropical Agriculture and Human Resources. *Two international fellows received training on the application of this project, and they are working toward better sustainable agriculture in their home countries (Please see final report from Michael Kermah from Ghana) *High School students (Please see pictures in the Newsletter by Bradley et al., 2011): I have worked with two high schools (Kalani and Waipahu). Waipahu high school was received Science Fair presentation award: Best Practical Application Award at the state level in Spring 2011.

2009/09 TO 2010/08 A change in knowledge occurred among participants (farmers, gardeners, and community members) that participated in the seminars, field days, and workshops listed above. A greater awareness occurred about the importance of organic amendments to improve soil quality, and soil biota activity, and about the ability to provide a significant level of NPK nutrient inputs through the application of locally available resources (i.e. composted organic manures and amendments). A change in action occurred with participants at the several educational/outreach activities, with their decision to incorporate the use of organic amendments and composts into their production practices. This included the decision to incorporate the use of cover crops and organic amendments into their production programs. Surveys filled by participants after some of the organic workshops we offered indicated they would be willing to try some of the techniques they learned about in the workshops. Local conventional farmers also inquired about the use and availability of local organic amendments for use in their conventional farming operations. **PUBLICATIONS (not previously reported):** 2009/09 TO 2010/08 1. Abbas, F., A. Fares, and H.R. Valenzuela. 2009. Carbon Dioxide Emission from an Organically Amended and Differently Managed Tropical Soil. In Review. 2. Valenzuela, H. (Editor). 2006. Organic Farming Production Manual. UH-CTAHR Cooperative Extension Service. Educational Materials prepared as part of the Organic Farming Production Workshops held on Oahu, Maui, Hawaii, Molokai, and Kauai, Sept. 2006 to January 2007. 3. Valenzuela, H.R. 2007. Introduction to Organic Farming in Hawaii. In: H. Valenzuela, Editor. Proceedings of Organic Farming Workshops, Hawaii. CTAHR Organic Farming web site. 4. Valenzuela, H. 2009. Strategies to improve the ecological health of horticultural agroecosystems in the tropics. pp. 1-34. In: Proceedings of International Symposium of Tropical Agriculture on the Sustainable Utilization and Development. National Pingtung University of Science and Technology (NPUST), Taiwan, held May 15, 2009. 250 pp. 5. Valenzuela, H. 2009. Integrated Cultural Programs for the Production of Cash Crops in Organic Systems. Proceedings of Conference: Go Organic! 2009. International Conference on Organic Farming Held in Bangkok, Thailand held on August 19-21, 2009.

PUBLICATIONS

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Enhancing Farmers\` Capacity to Produce High Quality Organic Bread Wheat

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Performing Institution	Plant, Soil and Environmental Sciences, UNIVERSITY OF MAINE, ORONO, MAINE 04469

NON-TECHNICAL SUMMARY

Demand for local organic food has inspired new interest in growing bread-quality wheat in New England. Our region\'s farmers have long produced small grains for animal feed on dairy and crop farms, but lack local knowledge and research information regarding production for the organic bread market. We aim to build farmers\' capacity to produce high quality organic bread wheat. Our objectives are: 1. Actively partner with organic farmers, millers, and bakers to develop strategies for organic bread wheat production that satisfy multiple criteria: productivity, profitability, milling and baking quality, and flavor. On-farm and on-station trials will: - Test innovative weed management strategies from Europe that offer fundamentally new approaches for organic cereal production - Develop critically-needed organic fertility strategies for high grain protein - Identify cultivars suited to organic production in our region - Determine how cultivar performance and disease incidence are influenced by weed and fertility management 2. Develop information and tools for farmers to evaluate the economic and agronomic opportunities of diversifying their enterprises with bread wheat, including interactive enterprise budgets and a whole farm systems model. 3. Provide peer-learning opportunities within and beyond our region. Build connections with accomplished organic wheat farmers, millers, and researchers in Denmark and Quebec through farmer exchanges, video case studies (posted on eXtension), and on-line participation in workshops. A guide to \"Organic Wheat Production in New England\" will be developed from research data and farmer case studies collected over the project period. The guide will include information on the production, harvest, storage, processing, and economics of organic bread wheat, as well as farmer/baker profiles and perspectives on the challenges and benefits of growing and using local wheat. This will be available in print and online formats and posted on eOrganic. Research results will also be reported in at least three peer-reviewed journal manuscripts. The knowledge, products, and linkages developed in this project will contribute to vibrant and sustainable organic bread wheat production in our region and nationally.

OBJECTIVES

Demand for local organic food has inspired new interest in growing bread-quality wheat in New England. Our region\'s farmers have long produced small grains for animal feed on dairy and crop farms, but lack local knowledge and research information regarding production for the organic bread market. We aim to build farmers\' capacity to produce high quality organic bread wheat. Our objectives are: 1. Actively partner with organic farmers, millers, and bakers to develop strategies for organic bread wheat production that satisfy multiple criteria: productivity, profitability, milling and baking quality, and flavor. On-farm and on-station trials will: - Test innovative weed management strategies from Europe that offer fundamentally new approaches for organic cereal production - Develop critically-needed organic fertility strategies for high grain protein - Identify cultivars suited to organic production in our region - Determine how cultivar performance and disease incidence are influenced by weed and fertility management 2. Develop information and tools for farmers to evaluate the economic and agronomic opportunities of diversifying their enterprises with bread wheat, including interactive enterprise budgets and a whole farm systems model. 3. Provide peer-learning opportunities within and beyond our region. Build connections with accomplished organic wheat farmers, millers, and researchers in Denmark and Quebec through farmer exchanges, video case studies (posted on eXtension), and on-line participation in workshops. A guide to \"Organic Wheat Production in New England\" will be developed from research data and farmer case studies collected over the project period. The guide will include information on the production, harvest, storage, processing, and economics of organic bread wheat, as well as farmer/baker profiles and perspectives on the challenges and benefits of growing and using local wheat. This will be available in print and online formats and posted on eOrganic. Research results will also be reported in at least three peer-reviewed journal manuscripts. The knowledge, products, and linkages developed in this project will contribute to vibrant and sustainable organic bread wheat production in our region and nationally.

APPROACH

Methods for Objective 1: Our field research will involve two phases. In Phase 1, we will conduct extensive screening of spring and winter wheat cultivars and component studies of fertility and weed management practices for organic production in northern New England. In Phase 2 we will initiate more intensive characterization of regionally adapted genotypes, with an expanded range of grain quality and hedonic tests. Furthermore, recognizing the likelihood of important genetic by environment interactions, either to avoid or exploit, we will explicitly test top performing cultivars in a factorial combination of weed and fertility management treatments. Methods for Objective 2: To consider the performance of organic bread wheat in representative feed-based cropping systems, including silage corn, forages, and other feed grains, we will modify selected entries in the University of Maine\'s on-going Organic Dairy Cropping Systems Project (2005-51106-02390 \"Reducing Off-Farm Grain Inputs on Northeast Organic Dairy Farms.\"). We will evaluate various cropping system entry points for dairy farmers to incorporate spring and winter bread wheat into their rotations. These will be further broken down into four systems. Two of these will include corn silage and two will not, but will include other annuals such as soybeans, sorghum sudan grass (BMRSS) and cereals for forage and pasture. This cropping systems data set will provide the opportunity to use the Integrated Farm System Model (IFSM) (Rotz, 2007) to estimate variation in yield over time and a wide range of cropping scenarios and local weather conditions. Data from the replicated cropping systems (nutrient balance, yield, weed pressure, disease, and rotation effects) along with participatory farmer field data and production costs will be used to populate the IFSM model for Northern New England. In addition, we will develop enterprise budgets to assist producers evaluating the potential profitability (or loss) of a particular enterprise. We will use regional data from the field experiments and from the rejection frequency of organic grain from local mills to incorporate risk values. Methods for Objective 3: New England farmers and millers will have the opportunity to participate in tours/exchanges with accomplished organic bread wheat farmers, millers, and researchers in Quebec and Denmark. Locally, we will host several outreach events as an effort to continue to build and strengthen our regional network of growers, millers, bakers, research, and extension. Each year, will organize winter \"farmer to farmer\" conferences held in each state in alternating years. The outreach component will also include existing regional audiences, such as the Maine KNEADING conference, NOFA-VT and NY winter conferences, and New England Agricultural Service Provider Trainings. Lastly, on-farm field days in years 2-4 will be an effective part of our effort to promote particular production strategies that improve wheat yield and quality.

PROGRESS

2009/09 TO 2014/08 Target Audience: The primary target audience for this project was current and aspiring organic bread wheat farmers, millers, distributors, bakers, and chefs in Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, and northern New York. Farmers included cash grain, potato, mixed

vegetable, dairy, and other livestock farmers, and ranged in scale of grain production from less than one to hundreds of acres. Efforts to engage this audience included the numerous workshops and field days listed under "Accomplishments", Advisory Board meetings, peer-learning trips to Denmark and Quebec, the maintenance of a project website, informational factsheets, reports, videos, and individual farm visits. As well, co-PIs provided organizational support of the Northern Grain Growers Association and Maine Grain Alliance. The secondary target audience was agricultural service providers who consult with grain farmers, including professional crop advisors and staff from Extension, NRCS, and non-profits. Efforts to engage this audience included the above mentioned efforts and annual presentations at the New England In-service Training for Agricultural Service Providers and CCAs. As well, co-PIs conducted an intensive three-year professional development program, funded by USDA Northeast SARE, that increased the knowledge, skills, and activities of nine farmer educators in all aspects of local grain production, processing, and use. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? This project provided significant professional development opportunities for those involved in the project. Seven graduate students were trained as part of this project in the areas of organic soil fertility, weed and disease management, cropping systems analysis, food science, and intermedia arts. Ten project PIs, staff, and graduate students participated in one or both of the exchange trips to Quebec and Denmark. Seven PIs and graduate students presented at least once at national professional conferences; and all participated at least once in the events listed below under dissemination. The project also offered specific professional development opportunities for researchers and agricultural service providers not associated with the project. Project PIs led an intensive three-year train-the-trainer program in local grain production for nine agricultural service providers from Maine, Vermont, and New Hampshire as part of their state SARE professional development programs. Additionally, project PIs presented research results and industry trends annually at the New England In-service Training for Agricultural Service Providers and Certified Crop Advisors. How have the results been disseminated to communities of interest? We used a wide variety of outreach approaches to disseminate the information and research results generated from this project. Two winter grain conferences, three research station field days, and five farm tours held annually in Maine and Vermont attracted on average 115, 100, and 40 participants per event, respectively. Through our websites, the project reached over 2000 people in New England as indicated by unique visits. Project PIs authored 6 journal articles, 33 research reports, 7 Extension fact sheets, 9 videos, 5 popular press articles, and 21 newsletter articles. Please note that the 59 research reports and articles are not listed in this report but can be found on our websites at http://umaine.edu/localwheat/ and http://www.uvm.edu/extension/cropsoil/grains. In a 2013 survey of 31 Maine farmers, 83% said they had accessed two project resources, and 77% said they had accessed three or more resources. Workshops and conferences were the most commonly accessed. Project PIs gave over 100 presentations of project information and research results to farmer and agricultural service provider audiences, averaging per year 20 presentations within Maine and Vermont, 6 regional presentations, and 1 national presentation. Project PIs in Maine hosted five EPSCOR high school summer interns who worked in our research group and completed individual projects. Finally, our work to increase local production and consumption of a staple food, bread, has captured the interest of popular media and the public. Interviews with project PIs have appeared in well over 50 television, radio, newspaper, and blog features. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/09 TO 2013/08 Target Audience: The target audience for this project is current and aspiring organic bread wheat farmers, millers, bakers and chefs in Northern New England. Efforts to engage this audience have included the numerous workshops and field days, Advisory Board meetings, group trips to Denmark and Quebec, the development of a project website, informational factsheets, reports, and videos, and the organizational support of the Northern Grain Growers Association and Maine Grain Alliance. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? The project provided training for 5 graduate students during this reporting period. Two workshops and 5 field days provided professional development for farmers, millers, bakers, extension personnel and other agricultural service providers. How have the results been disseminated to communities of interest? Publications and prior project videos were made available at grower events, on our project website (www.extension.umaine.edu/localwheat) and the Northern Grain Growers Association website (www.northerngraingrowers.org). What do you plan to do during the next reporting period to accomplish the goals? During the last year of the project we will focus on completing the research trials, developing a regional organic bread wheat production guide, and reporting our trial results in journal papers.

2011/09/01 TO 2012/08/31 OUTPUTS: ACTIVITIES - During this reporting period we conducted five research projects in both Maine and Vermont to investigate key production issues with organic bread wheat. Variety trials of 18 winter and 22 spring bread wheat varieties were repeated for the third year at four sites to identify regionally-adapted varieties suited to organic production. A team of four artisan bakers developed a bake test

protocol and tested varieties that had shown promising agronomic and quality characteristics. In a separate set of trials, promising winter wheat varieties were evaluated for their tolerance to late planting. One fertility trial compared different organic preplant nitrogen sources for their effects on spring wheat grain yield and protein concentration. Another trial evaluated the use of in-season diagnostic tests to determine if and how much topdress N is cost effective. Lastly, a systems trial compared rotations for organic bread wheat on dairy farms with particular attention to nitrogen and weed dynamics, and grain yield and quality. Trial objectives, progress, and results were disseminated at 9 grower workshops and field days, 4 regional invited presentations, and 1 national meeting. EVENTS - Two winter conferences were held (Maine Grains Conference, February 17, 89 participants; Northern Grain Growers Association Conference, Vermont, March 15, 147 participants). Denmark. Topics included rotations for organic wheat, market opportunities, variety selection, post-harvest management, and creating a grain economy. The University of Vermont Grains Research Tour (June 29; 42 participants), the University of Maine Organic Wheat Research Field Day (July 10; 48 participants), and the University of Vermont Extension Crops and Soils 2012 Field Day (August 9; 256 participants) featured studies on varieties, preplant N source effects on protein, in-season N diagnostic testing, microbial inoculants, and fitting wheat in dairy rotations. Two on-farm field days were held: Nature\'s Circle Farm and Aurora Mills and Farm, Houlton ME, covered variety trials, wheat diseases, post-harvest handling, processing, and markets, July 3, 39 participants; Olivia\'s Croutons, New Haven VT, covered adding value to grain products, July 12, 35 participants. As a result of our project\'s tour of local wheat in Denmark in 2010, the Maine team organized a tour for 35 visiting Danish farmers of organic grain production, processing and use in Maine, Vermont and Quebec, July 2-6, and many local growers and advisors participated in the various stops. Project advisory board members met twice during the year in each Maine and Vermont to review project progress and guide future activities. PRODUCTS - A grower factsheet on wheat quality was produced in collaboration with a flour sales specialist, a local miller and a local baker. Reports were completed for variety and fertility trials, updated enterprise budgets, and bake test of locally-grown wheat. Publications and prior project videos were made available at grower events, on our project website (www.extension.umaine.edu/localwheat) and the Northern Grain Growers Association website. PARTICIPANTS: INDIVIDUALS - Ellen Mallory, project director and PI, administered project and oversaw all research outreach activities in Maine. Heather Darby, PI, oversaw all research and outreach activities in Vermont. Eric Gallandt, PI, oversaw weed management research, presented at workshop. Richard Kersbergen, PI, oversaw dairy systems trial. Mary Ellen Camire, PI, consulted on DON testing and grain quality measures. Sidney Bosworth, PI, agronomist, assisted with research project implementation and overisight of one graduate student. John Halloran, PI, consulted on enterprise budget development. Stewart Smith, PI, consulted on enterprise budget development. Ann Hazelrigg, PI, plant pathologist, worked throughout the first season to collect fusarium head blight data and with the team to develop mycotoxin protocols. David Lambert, PI, consulted on disease issues, presented at field day. Thomas Molloy, research technician, managed field and laboratory research and provided support for educational events in Maine, presented at workshop. Erica Cummings, research technician, assisted with research and outreach development and implementation in Vermont. Katie McPhee and Hannah Griffin, research technicians, provided support for field research and educational events. Susan Monahan, graduate student, conducted fertility research and presented at workshop. Lauren Kolb, graduate student, lead authored journal publication on weed management research. Aaron Englander and Erin Roche, graduate students, conducted fertility research and presented results. Chris Illingworth and Jessica Richards, student worker, and Anne de Ferron, French intern, helped with lab and field research. TARGET AUDIENCES: The target audience for this project is current and aspiring organic bread wheat farmers, millers, bakers and chefs in Northern New England. Efforts to engage this audience have included the numerous workshops and field days listed under Outputs, Advisory Board meetings, group trips to Denmark and Quebec, the development of a project website, informational factsheets, reports, and videos, and the organizational support of the Northern Grain Growers Association and Maine Grain Alliance. PROJECT MODIFICATIONS: None

2010/09/01 TO 2011/08/31 OUTPUTS: ACTIVITIES - We conducted the second year of five research trials in both Maine and Vermont to investigate key production issues with organic bread wheat in our region. Variety trials for both winter and spring bread wheat were repeated at four sites to identify regionally-adapted varieties suited to organic production. Over 16 commercially-available varieties of each type were evaluated for agronomic performance and grain quality. A fertility trial compared different topdress nitrogen sources and times of application for effects on winter wheat yield and grain protein. Two systems trials compared rotations for organic bread wheat on dairy farms with particular attention to nitrogen and weed dynamics and grain yield and quality. Trial objectives, progress, and preliminary results were disseminated at 9 workshops and field days, and 14 invited presentations. EVENTS - We organized and led a trip for 21 farmers, millers, and educators to Denmark (Oct 24-29). We visited 8 organic bread wheat farms and mills, 2 bakeries, and 2 research stations. We learned about production, milling techniques, marketing strategies, and heritage varieties, and returned home with a concrete example of a successful local grain economy in a climate similar to our own. Two winter conferences were held (Northern Grain Growers Association Conference, Vermont, March 9, 145 attendees; Maine Local

Bread Wheat Conference, January 11, 75 attendees). Denmark trip participants gave presentations, and in Vermont, Danish miller Marie-Louise Risgaard presented the keynote address. Other topics included wheat grain quality measures and associated production practices, alternative markets for organic wheat and other grains, techniques and equipment for small-scale production, and research updates. The University of Maine Organic Wheat Research Field Day (July 12; 39 attendees) and the University of Vermont Crops and Soils 2011 Field Day (August 9; 225 attendees) featured studies on varieties, weed control, nitrogen topdressing, microbial inoculants, and fitting wheat in dairy rotations. Five on-farm field days were held: Gleason Grains, Ben Gleason, topdress trial and modified mill based on Denmark & Quebec trips, June 9, 36 attendees; Aurora Farms, Tom Kenyon, topdressing, new varieties, interseeding project, June 21, 35 attendees; Nature\'s Circle Farm, Dick York and Aurora Mills and Farm, Matt Williams, variety trials, wheat diseases, post-harvest handling, processing, and markets, July 6, 18 participants; Sandy River Farm, Bussie York, winter wheat production, wheat quality standards and associated production practices, July 13, 15 attendees; Butterworks Farm, Jack Lazor, cleaning and processing equipment, September 20, 44 attendees. PRODUCTS - Four videos were produced that profile the farms and mills on our Denmark tour, and trip participants wrote a series of articles. Reports were completed for variety and fertility trials, updated enterprise budgets, and bake test of locally-grown wheat. Publications and videos were made available at grower events, on our project website (www.extension.umaine.edu/localwheat) and the Northern Grain Growers Association website. PARTICIPANTS: INDIVIDUALS - Ellen Mallory, project director and PI, administered project and oversaw all research outreach activities in Maine. Heather Darby, PI, oversaw all research and outreach activities in Vermont. Eric Gallandt, PI, oversaw weed management research, presented at workshop. Richard Kersbergen, PI, oversaw dairy systems trial. Mary Ellen Camire, PI, consulted on DON testing and grain quality measures. Sidney Bosworth, PI, agronomist, assisted with research project implementation and overisight of one graduate student. John Halloran, PI, consulted on enterprise budget development. Stewart Smith, PI, consulted on enterprise budget development. Ann Hazelrigg, PI, plant pathologist, worked throughout the first season to collect fusarium head blight data and with the team to develop mycotoxin protocols. David Lambert, PI, consulted on disease issues, presented at field day. Thomas Molloy, research technician, managed field and laboratory. research and provided support for educational events in Maine, presented at workshop. Erica Cummings, research technician, assisted with research and outreach development and implementation in Vermont. Katie McPhee, research technician, provided support for field research and educational events. Susan Monahan, graduate student, conducted fertility research and presented at workshop. Lauren Kolb, graduate student, conducted weed management research and lead authored journal publication. Daniel Kerry, graduate student, created enterprise budgets in year one. Aaron Englander, graduate student, conducted fertility research. John Zirkle, graduate student, implementing wheat research projects on weed and disease control strategies. Michael Correll, temporary worker, lab and field research. Hannah Griffin, student worker, lab and field research. Chris Illingworth, student worker, lab and field research. PARTNER ORGANIZATIONS - The Northern Grain Growers Association is a farmer driven organization that assisted with project outreach and also hosted research trials. Maine Organic Farmers and Gardeners Association assisted with publicity and outreach. COLLABORATORS - The project has advisory boards in Maine and Vermont that are each comprised of at least 7 organic bread wheat farmers, millers, and bakers. These groups met at least twice with project PIs during this reporting period to provide guidance on project implementation. TRAINING OR PROFESSIONAL DEVELOPMENT - The project provided training for 4 graduate students during this reporting period. A 5-day tour of the local bread wheat system in Denmark provided professional development for the 22 farmers, millers, bakers, and extension personnel who participated. Four workshops and 5 field days provided professional development for farmers, millers, bakers, extension personnel and other agricultural service providers. TARGET AUDIENCES: The target audience for this project is current or prospective organic bread wheat farmers, millers, bakers and chefs in Northern New England. Efforts to engage this audience have included the numerous workshops and field days listed under Outputs, Advisory Board meetings, the trips to Quebec and Denmark, the development of a project website, informational factsheets, reports, and videos, and the organizational support of the Northern Grain Growers Association. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Activities - During this reporting period, we established six research trials in both Maine and Vermont to investigate key production issues with organic bread wheat in our region. Variety trials for both winter and spring bread wheat were established at four sites each to identify regionally-adapted varieties suited to organic production. Over 24 commercially-available varieties of each type were evaluated for agronomic performance, grain quality, flour performance, and taste. A fertility trial at two sites compared different organic top-dress N sources and times of application for effects on winter wheat yield and grain protein. A weed management trial at two sites evaluated several innovative management systems in spring wheat for efficacy and economics, including narrow rows (for greater competitiveness with weeds) and wide rows (to allow inter-row cultivation). Finally, two systems trials compared alternative rotations and crop sequences for organic bread wheat on dairy farms with particular attention to nitrogen and weed dynamics and grain yield and quality. The

objectives, progress, and preliminary results of these trials were disseminated at 8 workshops and field days. Events - The project\'s kickoff event was a 2-day trip to Quebec for 26 farmers, millers, bakers and researchers to tour Quebec\'s highly successful local bread wheat system (Oct 26-27). We visited an organic farm, a mill that processes locally-grown organic wheat, and a large Montreal bakery that uses local flour. The tour and participants\' statements of what they learned and how it applies to our region were captured in a video. On February 3, 23, bakers, farmers, millers, and extension personnel from Maine and Vermont met at King Arthur Flour to foster networking and dialog around the topic of local flour production and quality. Topics discussed were; flour criteria, quality testing, bake test methodologies, milling, economic sustainability, and product marketing. Conferences, workshops and field-days held as part of the project included: Growing Grains in Maine Workshop held at the Maine Agricultural Trades Show (Jan 12); Producing Quality Grains in Maine: Part 1- Disease Management and Grain Cleaning, Drying & Storage (Feb 26) and Part 2 - Weed Management and Grain Seeding (April 14); Going the Whole Grain, NGGA Conference, Vermont (March 9); University of Maine Sustainable Agriculture 2010 Field Day (July 1) and University of Vermont NW Crops and Soils Team 2010 Field Day (August 5); as well as 4 field tours at collaborating farms. Products - Two videos were produced: \"Local Bread Wheat in Quebec\" and \"Weed Control in Organic Cereals.\" Both are posted on our newly created project website, http://sites.google.com/site/localbreadwheatproject/, as well as on the Northern Grain Growers Association website, which this project supports, http://northerngraingrowers.org/. An interactive enterprise budget was completed to allow farmers to evaluate the economics of adding a bread wheat enterprise to their operation. The budget was reviewed by our advisory board and posted on our website. Hard copies were distributed field days, workshops, and grower meetings. PARTICIPANTS: Individuals \-- Ellen Mallory, project director and PI, administered project and oversaw all research outreach activities in Maine. Heather Darby, PI, oversaw all research and outreach activities in Vermont. Eric Gallandt, PI, oversaw weed management research, presented at workshop. Richard Kersbergen, PI, oversaw dairy systems trial. Mary Ellen Camire, PI, consulted on DON testing and grain quality measures. Sid Bosworth, PI, oversaw DON field tests. John Halloran, PI, consulted on enterprise budget development. Stewart Smith, PI, consulted on enterprise budget development. Ann Hazelrigg, PI, oversaw DON testing. David Lambert, PI, consulted on disease issues, presented at field day Thomas Molloy, research technician, managed field and laboratory research and provided support for educational events in Maine, presented at workshop. Erica Cummings, research technician, managed field and laboratory research and provided support for educational events in Vermont. Katie McPhee, research technician, provided support for field research and educational events. Susan Monahan, graduate student, conducted fertility research and presented at workshop. Lauren Kolb, graduate student, conducted weed management research and presented at workshop and field day. Daniel Kerry, graduate student, created enterprise budgets. Lisa Weiss, graduate student, conducted fertility trial. John Zirkle, graduate student, conducted DON trial. Sabrina Correll, temporary worker, lab and field research. Hannah Griffin, student worker, lab and field research. Greta Landis, student worker, lab and field research. Partner Organizations \-- Northern Grain Growers Association, Maine Organic Farmers and Gardeners Association. Collaborators \-- The project has advisory boards in Maine and Vermont that are each comprised of at least 7 organic bread wheat farmers, millers, and bakers. These groups met at least twice with project PIs during this reporting period to provide guidance on project implementation. Training or professional development \-- The project provided training for 4 graduate students during this reporting period. A 2-day tour of the local bread wheat system in Quebec provided professional development for the 26 farmers, millers, bakers, and extension personnel who participated. Four workshops and 6 field days provided professional development for farmers, millers, bakers, extension personnel and other agricultural service providers. TARGET AUDIENCES: The target audience for this project is current or prospective organic bread wheat farmers, millers, bakers and chefs in Northern New England. Efforts to engage this audience have included the numerous workshops and field days listed under Outputs, the trip to Quebec, the development of a project website and resource materials, and the organizational support of the Northern Grain Growers Association. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/09 TO 2014/08 What was accomplished under these goals? IMPACT - Our project helped establish and expand New England's organic food grain sector by 1) developing critical research-based information and local expertise in organic bread wheat production, 2) building knowledge, skills, and capacity among farmers, extension, and agricultural service providers, and 3) fostering a vibrant network of farmers, millers, and bakers. Farmers now have access to region-specific information for organic bread wheat production, including the most suitable varieties for growing and baking, successful weed and fertility management strategies, and potential profitability and risk. A 2013 survey of 30 New England commercial grain farmers revealed that 83% had adopted at least one and, on average, three new management practices based on the project\'s research results,

including: using the project\'s reports to select adapted varieties (72%), increasing seeding rates (43%) and changing plant spacing (33%) to better suppress weeds, topdressing nitrogen to improve grain quality (29%), and changing a marketing practice (13%). As a result, farmers reported increases in grain yields (47%), grain quality and crop value (75%), buyers (40%), employment (33%), and wheat acreage (80%). The economic value these farmers placed on the benefits they gained from the project was an average of \$7,000 each. Bakers and distributors reported they increased their knowledge and skills related to local grain sourcing and use (93%), and, as a result, used more locally grown grains (71%), developed new products (36%), and contacted someone new (86%). They estimated an average of \$5,000 and up to \$20,000 in economic gain to their businesses from the project. Maine Grains at the Somerset Grist Mill provides a specific example of this project's broad impacts. The owner, who transformed an old jail into a new flour mill, says the tours of local wheat systems in Quebec and Denmark gave her confidence that her business model was appropriate, examples of successful locally-scaled mills to share with potential investors, and specific ideas that she implemented for handling and packaging flour. She relies on the project's personnel and resources to provide farmers with technical assistance, and noted a marked increase in farmers' knowledge and skills regarding bread wheat production as a result of the project. Her business now serves markets throughout New England, employs two full- and two part-time workers, and is the anchor for the Skowhegan food hub. Stakeholders credit this project with serving as the cornerstone for a new organic grain sector in New England by inspiring and enabling new markets for other food grains (e.g., spelt, barley, rye, oats), other end uses (e.g., malt and spirits), and organic or non-GMO feed. Our region now has at least 7 flour mills, 3 malt houses, 5 distilleries, and dozens of bakeries for whom using locally grown organic grains is central to their business model. Additionally, this project expanded scientific understanding of organic grain production through 6 journal articles and the training of five M.S. and two Ph.D. students. OBJECTIVE 1 - Actively partner with organic farmers, millers, and bakers to develop strategies for organic bread wheat production that satisfy multiple criteria: productivity, profitability, milling and baking quality, and flavor. Through on-station and on-farm research, we evaluated 39 spring and 30 winter hard red wheat varieties for agronomic characteristics over 16 site-years and worked with a team of bakers to develop and implement standard artisan bake test methods to identify those with superior baking qualities and flavor (Mallory et al. 2014a&b). We demonstrated that two innovative weed management strategies -- narrow row spacing and elevated seeding rates to improve the competitive ability of cereals and wide row spacing with inter-row hoeing to improve physical weed control -- both provided superior weed control, crop yield, and net returns in fields or years with heavy weed pressure, as compared with our farmers' typical sowing practice and tine harrowing (Kolb et al., 2012b). We evaluated various fertility practices and their influence on cultivar performance, weeds, and disease. Red clover, dairy manure, and poultry manures applied pre-plant produced equivalent yields and grain protein levels in winter and spring wheat although initial nitrogen (N) availability from clover and dairy manure was lower than from poultry manures (Englander, 2014). Applying organic N sources in early spring proved to be an effective strategy to increase grain protein in winter wheat (Mallory and Darby, 2013) and the use of in-season tests to determine when and how much N is needed showed promise (Roche, 2014). Red clover and white clover undersown in winter wheat both reduced weed pressure and had no impact on Fusarium head blight or deoxynivalenol (DON) levels, but red clover reduced yields whereas white clover did not (Zirkle, 2012). Delayed planting of winter wheat produced higher grain protein levels, but often reduced yields and increased weed biomass regardless of seeding rate (Darby et al., submitted). Some varieties were more tolerant of late planting than others. OBJECTIVE 2 - Develop information and tools for farmers to evaluate the economic and agronomic opportunities of diversifying their enterprises with bread wheat. Enterprise budgets were developed for winter and spring bread wheat production using local yields, costs, and prices (Kerry et al., 2011a&b). A field trial evaluated hard red wheat as a potential cash crop for dairy farms and means of re-establishing high-quality perennial forage stands. Rotating out of continuous perennial forage to produce winter wheat and re-establish perennial forage was equally profitability as continuous perennial forage even when wheat grain was valued as feed due to inadequate protein levels, and more profitable when management practices were used to optimize grain protein and the value of straw was included (Roche 2014). Sequences that included spring wheat were less profitable due to low yields caused by wet spring weather and poorly drained soils, typical of regional dairy farms. The Integrated Farming System Model (Rotz 2006) was used to evaluate the crop rotations from this field trial in a whole farm analysis using 25 years of weather data. In this analysis, there were no economic or environmental benefits associated with rotating from continuous grass-based production to annual crop sequences with wheat and back to perennial forage (Abreau 2014). OBJECTIVE 3 - Provide peer-learning opportunities within and beyond our region. We offered multiple educational and networking opportunities to build knowledge and connections among our stakeholder groups. Experienced farmers, millers, and bakers from within and outside our region were regular presenters at winter conferences, field days, and farm tours (see below for numbers of events), as well as co-authors on factsheets and articles (e.g., Gerritsen and Gerristen, 2011; Mallory et al. 2012b). Through our "peer learning across borders" tours, we built connections with accomplished organic wheat farmers, miller, and bakers in Quebec (2009) and Denmark (2010) that reaped many benefits. The 21 farmers and millers who participated in the Denmark exchange estimated they gained in sum over \$400,000 in economic value from what they learned.

Videos from these tours have had 4433 unique online views, many from other regions and abroad. And the exchanges continue: Maine and Vermont farmers and scientists hosted a group of Danish organic farmers in 2011, the Director of the International Centre for Research on Organic Food Systems in 2013, and a weed ecologist in 2014; Danish farmers, millers, and bakers have presented at conferences in Maine and Vermont, and visa versa; and a new miller from Maine returned to Denmark for additional training. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/08 1. Type: Journal Articles Status: Published Year Published: 2012 Citation: Kolb, L.N., and E.R. Gallandt. 2012a. Weed management in organic cereals: Advances and opportunities. Organic Agriculture 2:23-42. 2. Type: Journal Articles Status: Published Year Published: 2012 Citation: Kolb, L., E.R. Gallandt, and E.B. Mallory. 2012b. 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Soil fertility strategies for organic bread wheat (Triticum aestivum) production. Masters of Science, Plant, Soil and Environmental Sciences, University of Maine, Orono. 7. Type: Theses/Dissertations Status: Published Year Published: 2012 Citation: Giordano, W. 2012. Agriculture as Art. Masters of Fine Art, Intermedia, University of Maine, Orono. 8. Type: Conference Papers and Presentations Status: Published Year Published: 2009 Citation: Mallory, E. 2009. Reweaving our bread basket: New efforts in bread wheat production in New England. In Abstracts, Northeast Branch Agronomy Society of America, Crop Science Society of America, and Soil Science Society of America Meetings, Portland, Maine. 9. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Mallory, E.B. and H. Darby. 2011. Topdressing nitrogen effects on organic winter bread wheat yield and quality. In Abstracts. 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W. 2012 Interseeding wheat and clover: Implications for Fusarium head blight, deoxynivalenol concentration, grain yield, crude protein, and weeds management in organic Vermont production systems. Masters of Science. Plant and Soil Science, University of Vermont, Burlington. 14. Type: Conference Papers and Presentations Status: Published Year Published: 2010 Citation: Darby, H., R. Kersbergen, E. Mallory. 2010. Enhancing New England farmers\' capacity to produce high quality food grade grains. In Abstracts. ASA-CSSA-SSSA International Annual Meetings, November 1-4, 2014, Long Beach, California. 15. Type: Conference Papers and Presentations Status: Published Year Published: 2009 Citation: Kolb, L.N., E.R. Gallandt and T. Molloy. 2009. Combining enhanced competition and cultivation for improved weed control in organic cereals. 8th European Weed Research Society Workshop on Physical and Cultural Weed Control, March 9, 2009, Zaragoza, Spain. 16. 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Texas. 21. Type: Other Status: Published Year Published: 2010 Citation: Darby, H. 2010. Top Ten Factors to Consider Before Growing Grains. University of Vermont Extension Northwest Crops and Soils Program, St. Albans, VT. Available online at: http://umaine.edu/localwheat/resources/factsheets/ (accessed 28 Jan 2014). 22. Type: Other Status: Published Year Published: 2011 Citation: Kary, D., T. Molloy, A. Englander, and E. Mallory. 2011a. 2011 Maine organic spring wheat returns over variable costs budget. Available online at: http://umaine.edu/localwheat/resources/enterprise-budget/ (accessed 10 Dec 2014). 23. Type: Other Status: Published Year Published: 2011 Citation: Kary, D., T. Molloy, and E. Mallory. 2011b. 2011 Maine organic winter wheat returns over variable costs budget. Available online at: http://umaine.edu/localwheat/resources/enterprise-budget/ (accessed 10 Dec 2014). 24. Type: Other Status: Published Year Published: 2012 Citation: Mallory, E., T. Bramble, M. Williams, and J. Amaral. 2012b. Understanding wheat quality: What bakers and millers need and what farmers can do. Bulletin 1019. University of Maine Cooperative Extension, Orono. Available online at: http://umaine.edu/publications/1019e/ (accessed 19 Sept 2014) Awarded a 2012 Certificate of Excellence in Extension Publications from the American Society of Agronomy. 25. Type: Other Status: Published Year Published: 2014 Citation: Mallory, E., H. Darby, T. Molloy, and E. Cummings. 2014a. 2010-2013 Maine and Vermont organic spring wheat variety trial results. Available at www.umaine.edu/localwheat. 26. Type: Other Status: Published Year Published: 2014 Citation: Mallory, E., H. Darby, T. Molloy, and E. Cummings. 2014b. 2010-2013 Maine and Vermont organic winter wheat variety trial results. Available at www.umaine.edu/localwheat. 27. Type: Other Status: Published Year Published: 2013 Citation: Mallory E. and R. Kersbergen. 2013. Growing organic barley in New England. Bulletin 1027. University of Maine Cooperative Extension, Orono. Available at http://umaine.edu/publications/2207e/ (accessed 19 Sept 2014). 28. Type: Other Status: Published Year Published: 2010 Citation: Kersbergen, R., E. Mallory and T. Molloy. 2010. Growing organic cereal grains in New England. Bulletin 2207. University of Maine Cooperative Extension, Orono. Available online at: http://umaine.edu/publications/2207e/ (accessed 19 Sept 2014) 29. Type: Other Status: Published Year Published: 2013 Citation: Mallory, E. 2013. Topdressing organic hard winter wheat to enhance protein. eXtension. Available at http://www.extension.org/pages/68227/ (accessed 19 Sept 2014). 30. Type: Websites Status: Published Year Published: 2009 Citation: Northern New England Local Bread Wheat Project Website - http://umaine.edu/localwheat Extensive website with resources for farmers, millers, bakers and researchers, including videos, bulletins, research reports, and enterprise budgets. Awarded a 2012 Certificate of Excellence in Extension Websites from the American Society of Agronomy. 31. Type: Websites Status: Published Year Published: 2009 Citation: Northern Grain Grower Association?s Website ? http://northerngraingrowers.org Extensive website with resources for farmers, millers, bakers and researchers, including videos, bulletins, and research reports. 32. Type: Other Status: Published Year Published: 2012 Citation: Darby, H. and E. Cummings. 2012. It?s time to Plant Spring Grains! Agriview: Volume 76, Number 6. 33. Type: Other Status: Published Year Published: 2011 Citation: Gerritsen, J. and M. Gerritsen. 2011. New England farmers visit Viskinge Farm and Mejnerts Mill in Denmark. The Maine Organic Farmer and Gardener, Spring 2011. Print and online. 34. Type: Other Status: Published Year Published: 2014 Citation: Mallory, E.B. 2014. Review of The Organic Grain Grower: Small-scale, Holistic Grain Production for the Home and Market Producer by Jack Lazor. The Maine Organic Farmer and Gardener, Spring 2014. Print and online. 35. Type: Other Status: Published Year Published: 2011 Citation: Mallory, E., T. Gleason, B. Gleason, J. Gerritsen and M. Gerritsen. 2011. Lessons from Denmark: Local organic wheat production, milling and use. Online at http://umaine.edu/localwheat/denmark-trip/articles-by-the-travelers/ 36. Type: Other Status: Published Year Published: 2010 Citation: Rasmussen, I.A. and E.B. Mallory. 2010. Organic bread wheat in New England, USA. ICROFS (International Centre for Research in Organic Food Systems) News 4/2010.

2012/09 TO 2013/08 What was accomplished under these goals? Our project is helping to create local, organic food grain economies in our region. TRAINING, OUTREACH AND NETWORKING efforts have built capacity among farmers and educators in organic wheat production, and fostered strong state and regional networks of farmers, millers, bakers, and advisors. The project has reached over 1200 people in Maine and Vermont through its website, as indicated by unique visits, and 748 people in the rest of New England; and on average 230 people per year through the annual winter grain conferences held in Maine and Vermont. All of the 31 farmers and millers who responded to a recent survey reported having increased their knowledge as a result of the project. Two-thirds said they contacted someone new as a result of the project and that they shared their new knowledge with others. Eighty-three percent of respondents said they had accessed multiple project resources and events (i.e., project website, factsheets/reports, videos, educational events, and direct contacts). Workshops and conferences were the most commonly accessed. FIELD RESEARCH PROJECTS have provided new information that was implemented directly by farmers in our region. Twenty-five of the 30 (83%) northern New England commercial grain farmers who completed a recent survey reported they had adopted at least one and on average three new management practices based on the project's research results. These included selecting adapted varieties based on the project's variety trial reports (72%); increasing seeding rates (43%) and spatial density (33%) to better suppress weeds; topdressing nitrogen on winter grains (29%) to improve grain quality; and

changed a marketing practice (13%). PROJECT IMPACTS reported by FARMERS AND MILLERS on their grain businesses include: increased yields (47%); improved grain quality and crop value (75%); new buyer contacts (40%); increased or maintained employment (33%), and increased wheat acreage (80%). The economic value farmer respondents placed on the benefits they gained from the project was on average \$7,000 each. For farmer/millers and millers, this value was over \$35,000 each. GRAIN BUYERS ALSO HAVE BENEFITTED. Thirteen of 14 bakers and distributors who responded to the recent survey reported that the project increased their knowledge and skills related to local grain production, marketing, sourcing, and use. As a result, they increased their use of locally grown grains (71%), developed new products (36%), and contacted someone new (86%). Eight estimated an economic value of the project for their business, which ranged from \$500 to \$20,000, and averaged over \$5,000 each. ORGANIC WHEAT ACREAGE has increased from 300 acres in 2008 to just under 1,700 acres in 2013 (MOFGA Certification Services, LLC and Vermont Organic Farmers, L.L.C.) and they are well-positioned to meet further increases in demand New markets for other food grains (e.g., spelt, barley, rye) and other uses (e.g., malt and spirits) have developed as a result of the increases in production and infrastructure for bread wheat. SPECIFIC ACTIVITIES RELATED TO PROJECT OBJECTIVES Objective 1 - Develop strategies for organic bread wheat production through on-farm and on-station trials. During this reporting period we conducted five research projects in both Maine and Vermont to investigate key production issues with organic bread wheat. Variety trials of 18 winter and 22 spring bread wheat varieties were repeated for the fourth year at four sites to identify regionally adapted varieties suited to organic production. A team of four artisan bakers conducted bake tests of select spring varieties using a sourdough methodology that they developed. In a separate set of trials, promising winter wheat varieties were evaluated for their tolerance to late planting. Two fertility trials compared different organic preplant nitrogen sources for their effects on spring and winter wheat grain yield and protein concentration. Another trial evaluated the use of in-season diagnostic tests to determine if and how much topdress N is cost effective. Lastly, a systems trial compared rotations for organic bread wheat on dairy farms with particular attention to nitrogen and weed dynamics, and grain yield and quality. Objective 2 - Develop information resources and tools for farmers to evaluate the economic and agronomic opportunities of diversifying their enterprises with bread wheat. Research trial results were summarized in reports and disseminated at 7 grower workshops, conferences and field days, 5 regional invited presentations, and 1 national meeting. Enterprise budgets were updated for spring and winter bread wheat. Work is ongoing to use the Integrated Farming Systems Model in conjunction with field results from the organic dairy cropping systems trial to evaluate the profitability and risk associated with growing bread wheat for dairy farmers. Objective 3. Provide peer-learning opportunities within and beyond our region During this reporting period two winter conferences were held that featured expert speakers from within and outside our region (Maine Grains Conference, March 1, 77 participants, and Northern Grain Growers Association Conference, Vermont, March 14, 175 participants). Topics included rotations for organic wheat, fertility and disease management, market opportunities, variety selection, post-harvest management, and seed production and certification. Four summer field days featured studies on varieties, preplant N source effects on protein, in-season N diagnostic testing, microbial inoculants, and fitting wheat in dairy rotations (University of Vermont Grains Research Tour, June 24, 68 participants; University of Maine Small Grain and Forage Field Day, June 26, 42 participants; University of Maine Aroostook Farm Organic Grain Field Day, July 9, 50 participants; and University of Vermont Extension Crops and Soils 2013 Field Day, August 1, 225 participants). One on-farm field day was held in Randolph, VT with 72 participants. Project advisory board members met twice during the year in each Maine and Vermont to review project progress and guide future activities. **PUBLICATIONS (not previously reported):** 2012/09 TO 2013/08 1. Type: Theses/Dissertations Status: Accepted Year Published: 2012 Citation: Giordano, W. 2012. Agriculture as Art. Masters thesis, University of Maine, Orono. 2. Type: Theses/Dissertations Status: Accepted Year Published: 2012 Citation: Zirkle, Jonathon W. 2012 Interseeding wheat and clover: Implications for Fusarium head blight, deoxynivalenol concentration, grain yield, crude protein, and weeds management in organic Vermont production systems. Masters of Science. Plant and Soil Science, University of Vermont, Burlington. 3. Type: Journal Articles Status: Published Year Published: 2013 Citation: Mallory, E.B. and H. Darby. 2013. In-season nitrogen effects on organic hard red winter wheat yield and quality. Agronomy Journal 105:1167-1175. 4. Type: Other Status: Published Year Published: 2013 Citation: Mallory, E. 2013. Topdressing organic hard winter wheat to enhance protein. eXtension. Available at http://www.extension.org/pages/68227/. 5. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Mallory, E.B. and H. Darby. 2013. Evaluating in-season tests to guide topdressing rates for organic winter bread wheat. In Abstracts. ASA-CSSA-SSSA International Annual Meetings, November 3-6, 2013, Tampa, Florida. Oral Presentation. 6. Type: Other Status: Published Year Published: 2013 Citation: Darby and Cummings. 2013. Impacts of Fusarium Head Blight on Grain Quality. Northern Grain Growers Newsletter. Dec., 2013. 7. Type: Other Status: Published Year Published: 2012 Citation: Mallory, E., H. Darby, T. Molloy, E. Cummings and K. McPhee. 2012. 2012 Maine and Vermont organic winter wheat variety trial results. Available at http://umaine.edu/localwheat/research/variety-trials/. 8. Type: Other Status: Published Year Published: 2013 Citation: Mallory, E., H. Darby, T. Molloy, E. Cummings and K. McPhee. 2013. 2012 Maine and Vermont organic spring wheat variety trial results. Available at

http://umaine.edu/localwheat/research/variety-trials/. 9. Type: Websites Status: Published Year Published: 2013 Citation: Mallory, E. Northern New England Local Bread Wheat Project website. University of Maine Cooperative Extension. http://umaine.edu/localwheat

2011/09/01 TO 2012/08/31 Our project is helping create local, organic food grain economies in our region. FIELD RESEARCH PROJECTS provided new information that was implemented directly by farmers in our region. Three years of variety trials have identified 4 to 5 new varieties each of spring and winter wheat that show promise in our region for organic production. Bakers identified certain varieties (e.g., Redeemer) that have superior baking quality. As a result, at least 8 farmers in ME, 7 in VT, 3 in Quebec, 1 in NH, and 4 in NY have chosen new varieties based on this information. In trials, topdressing OMRI-approved nitrogen sources increased grain protein levels. In four site-years, both Chilean nitrate and dehydrated chicken manure significantly increased grain protein when applied to winter wheat in spring at an estimated 20 lbs of available N. Later applications were more effective than earlier ones, with protein levels increasing on average by 5, 7, and 12% for applications at tillering, flag leaf, and boot stages, respectively. Chilean nitrate was more effective than chicken manure. When applied at the boot stage, protein increased on average by 14% with Chilean nitrate and by 9% with chicken manure. To date, this trial has led two farmers to topdress winter wheat in 2011. TRAINING, OUTREACH AND NETWORKING efforts have built capacity among farmers and educators in organic wheat production, and fostered strong state and regional networks of farmers, millers, bakers, and advisors. Since our project began, farmers in our region have increased production of organic wheat from 300 acres in 2008 to just under 1,700 acres in 2012 (MOFGA Certification Services, LLC and Vermont Organic Farmers, L.L.C.) and they are well-positioned to meet further increases in demand. Farmers in Vermont who have attended Northern Grain Growers Association events reported in a 2012 survey that they had gained new knowledge (71%), increased their network with other grain growers (68%), increased grain production acres (29%), and improved grain yields and quality (20%), markets (29%), processing infrastructure (29%), weed management (27%), and the economics of their farm (27%). Farmers in Maine reported in a 2012 survey that as a result of this 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, farmers and millers who participated in a 2010 \"peer learning across borders\" trip to Denmark estimated they will gain in sum more than \$400,000 in economic value from what they learned. The relationships made with Danish farmers, millers and bakers on that trip continue to develop - in 2012 we hosted a tour group of 35 Danish farmers and advisors and a Vermont Master Baker was invited to teach a workshop on baking with locally grown grains at a baking festival in Denmark.

2010/09/01 TO 2011/08/31 TRIPS to tour farms, mills and bakeries in Denmark (fall 2010) and in Quebec (fall 2009) resulted in substantial changes in knowledge and action for participating farmers, millers, and educators. All participants rated the Denmark trip extremely or very valuable, and noted that it increased their knowledge of how to grow (92%), process (100%) and market (67%) local grains, and provided them with new contacts (83%) and information sources (75%). Major themes were producing a quality product through proper harvest, post-harvest handling, and processing; and distinguishing that product through marketing a story, package design, consumer education, and collaborations with chefs, bakers, and grocery chains. As a result of the trips, farmers reported harvesting crops earlier and improving grain handling systems to protect grain quality. A VT farmer expanded and redesigned his on-farm mill and built a meeting room to receive farm visitors. A new ME miller used what she learned in the setup of her high capacity mill (e.g., using mechanical vs. pneumatic flour transport system to protect flour quality). She shared the Danish example with economic developers to give credibility to her project. Two farmer-millers expanded their product line to include retail-sized packages, and one formulated different wheat blends for various baking purposes. Three participants estimated they will gain more than \$50,000 in economic value over the next 10 years from changes they have made as a result of this trip. Three others estimated an average value of \$10,000 from changes; and six participants estimated an average value of \$25,000 for changes they intend to make. All participants reported sharing what they learned via one-on-one discussions (reaching 270 people), 16 presentations (500 people), and articles (\>15,000 people). Contacts from the trip resulted in a Danish miller sourcing organic grain from the US and a group of Danish organic farmers planning a similar grain tour in ME and VT in 2012. FIELD RESEARCH PROJECTS provided new information that was implemented directly by farmers in our region. Two years of variety trials identified 4 to 5 new varieties of each spring and winter wheat that show promise in our region for organic production. Bakers identified certain varieties (e.g., Redeemer) that have superior quality. As a result, at least 8 farmers in ME, 7 in VT, 3 in Quebec, 1 in NH, and 4 in NY have chosen new varieties based on this information. In trials, topdressing OMRI-approved nitrogen sources increased grain protein levels. In four site-years, both Chilean nitrate and dehydrated chicken

manure significantly increased grain protein when applied to winter wheat in spring at an estimated 20 lbs of available N. Later applications were more effective than earlier ones, with protein levels increasing on average by 5, 7, and 12% for applications at tillering, flag leaf, and boot stages, respectively. Chilean nitrate was more effective than chicken manure. When applied at the boot stage, protein increased on average by 14% with Chilean nitrate and by 9% with chicken manure. To date, this trial led two farmers to topdress winter wheat in 2011.

2009/09/01 TO 2010/08/31 As a result of the farmer/miller exchange to Quebec, a Vermont producer who had been contemplating expansion of his on-farm flour mill used information he gleaned from Quebec miller Robert Beauchemin to construct a mill design appropriate for his small scale operation and to locate the needed equipment for sifting flour. As well, half of the farmers on the trip have started to harvest at higher grain moisture content to protect grain quality, while others have tried frost seeding spring wheat. The winter wheat variety trial identified 4-6 new varieties that show promise in our region for organic production. As a result, several farmers planted one new variety based on the yield and quality data that was made available to them in late August. The new variety had exceptional yield and quality; bake tests performed by local bakers confirmed field and lab results. A weed management trial conducted in 2009 and 2010 showed that elevating seeding rates (600 plants m-2 in either standard 17.7 cm or narrow 11.4 cm rows) or wide-row sowing with inter-row cultivation (22.8 cm, 200 plants m-2) reduced weed density and weed biomass at harvest and increased yields as compared to the regional standard practice (17.7 cm rows, 400 plants m-2). A forth treatment, in which 400 plants m-2 were drilled and 200 plants m-2 were broadcast to achieve more uniform spacing, also reduced weed density and biomass relative to the standard practice, but had equivalent yields. In a separate trial in 2010, inter-row cultivation in wide-row plots reduced quackgrass node development relative to standard row spacing with no cultivation, although no effects on yield were observed. Repeating inter-row cultivation did not reduce quackgrass node development more than the one cultivation treatment.

PUBLICATIONS

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Integrated Organic Dairy Research and Extension Planning

Accession No.	0218633
Subfile	CRIS
Project No.	MIN-02-E01
Agency	NIFA MIN
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-19828
Proposal No.	2009-01330
Start Date	01 AUG 2009
Term Date	31 JUL 2011
Fiscal Year	2009
Grant Amount	$38,466
Grant Year	2009
Investigator(s)	Heins, B.; Endres, M. I.; Raeth-Knight, M.
Performing Institution	West Central Research & Outreach Center, UNIV OF MINNESOTA, ST PAUL, MINNESOTA 55108

NON-TECHNICAL SUMMARY

The University of Minnesota has committed nearly 500 acres of pasture and cropland to be certified organac and 180 dairy cows plus replacement animals to be divided into a certified organic herd and a control herd. Potential colloberation with neighboring ARS soil, water and climate scientists is a powerful asset. A faculty position (60% research,40% Extension) supported by a research assistant will be recruited to lead an integrated research and extension program. The objective of this research and extension planning project is to create a multidisciplinary team that will design an excellent organic dairy research and extension program and prepare a highly competitive integrated organic dairy research and extension proposal for submission in 2010. The team will utilize focus groups comprised of stakeholders, study visits to current and emerging organic programs at other public research facilities, a series of seminars and consultations with organic experts, and intensive team meetings to explore and share share diverse ideas and review progress. Particular attention will be given to identifying and assessing effect methods for utilizing assets commited to organic research and extension that leads to effective strains of cattle, appropriate plant and animal nutrition, best management practices for herd health, pest management, profitability for organic farmers, impacts on wild animal and plants and environmental and conservation outcomes thrrough research and extension.

Two recent peanut butter recalls that caused economic hardship on peanut processors and growers resulted from post-processing contamination by Salmonella. Minimally processed peanut butters, often organic products, have an even greater risk of microbial contamination in the finished product. The proposed research will demonstrate for peanut butter the efficacy of HPP, an acceptable process per current organic guidelines, on Salmonella elimination and impact on product quality and shelf life. This research will facilitate the continued development of a processing technology that will benefit organic agriculture, as well as peanut processing and HPP technology stakeholders, and can be applied to other organic products. The expected outcome is the determination of the parameters needed for the elimination of Salmonella in peanut butter using high pressure processing. The benefit is increased food safety and prevention of future outbreaks in peanut butter and related products.

OBJECTIVES

Introduction Objectives: To gather information and create a team that will develop effective short and long range plans for use of University of Minnesota cattle and lands and a highly competitive integrated organic dairy research and extension proposal for submission in 2010. Goal of Focus Groups = We will identify key issues in organic dairy production. Three focus groups will include organic dairy producers and 1 focus group will contain scientists with expertise in areas relevant to organic farming. Goal of Organic Research Site Visits = Planning team members will participate in site visits where organic dairy research is being conducted in order to achieve coordination and seek collaboration. Goal of Seminar Series= Five seminars for team education and public outreach, followed by an open forum discussion, will be presented at the St. Paul Campus of the University of Minnesota. Goal of Planning Team Meetings = Four meetings will be held during the year starting with an organizational meeting and designation of individuals to sub-committees and establishment of sub-committee responsibilities. A critical role of planning team activities is to identify needs of the organic dairy sector in the Midwest. Clear needs from the outset are best management practices for organic dairy, improved strains of cattle for high forage organic farms, and increased forage quality and quantity from pastures.

High pressure processing (HPP), a viable method for increasing food safety and shelf life of certain food products that experience no or minimal processing, should be considered as a potential technology for peanut butter and minimally processed organic foods. This proposed research will demonstrate for peanut butter the efficacy of HPP on eliminating Salmonella and improving shelf life without decreasing quality. Reductions in Salmonella in inoculated, HPP treated peanut butter samples will be measured by enumeration on both selective and recovery media. HPP is an acceptable process under current organic guidelines, and therefore is suitable for this investigation. Pyrosequencing technology will also be utilized on samples spiked with fecal organisms to simulate real-world conditions and to investigate the survival of species of ecological significance in peanut butter. Industrial scale units, using process optima identified at the pilot scale, will be used to prepare samples for sensory and shelf life studies.

APPROACH

Methodology to achieve Objective: 1. Focus Groups 2. Organic Research Farm Visits 3. Seminar Series 4. Planning Team Meetings Focus Groups = The objective is to identify key issues in organic dairy production. Three focus groups will contain organic dairy producers and 1 focus group will contain scientists with expertise in areas relevant to organic farming. Each focus group will meet once and at least 2 members of the planning team will be present at each focus group meeting. The scientific focus group will meet at the St. Paul Campus at the University of Minnesota and the dairy producer focus groups will be located in 3 different areas in the state of MN that are centrally located for each focus group. Organic Research Site Visits = Planning team members will participate in site visits where organic dairy research is being conducted. Proposed sites include: a. University of New Hampshire (Kevin Brussel) b. California State University at Chico (Cindy Daley) c. North Carolina State University - if they move to establish a program Seminar Series= Five seminars, followed by an open forum discussion, will be presented at the St. Paul Campus of the University of Minnesota. The seminars will be held in the Animal Science Department and are open to public. Proposed topics areas include 1) Organic Dairy Farming Ins and Outs, 2) Organic Crop Production Systems, 3) Environmental Benefits and Challenges of Organic Dairy Farming, 4) Cow Health and Welfare, and 5) Consumer Market Trends and Economics of Organic Dairy Farming. Following each seminar and open forum discussion, a working session for planning team members will be held. Planning Team Meetings = Four meetings will be held during the year. Suggested itinerary for meetings include: organization, designation of individuals to sub-committees and establishment of sub-committee responsibilities; subcommitee working meetings to develop contributions to an integrated organic farming approach; finalization of integrated organic dairy research and extension proposal.

A Stansted ISO Food Lab System will be used for conducting lethality studies on minimally processed peanut butter. The vessel pressure and temperature will be monitored during each run using the data acquisition system that reads the pressure transducer and thermocouples in the pressure vessel while tracking the time during the HPP cycle (compression, dwell and decompression). The processing fluid (liquid in contact with sample packaging) will be maintained at 25 C using the temperature control equipment consisting of a chiller, heat exchangers and thermocouples. A 5-strain cocktail of Salmonella strains will be inoculated into peanut butter samples. The samples will be subjected to different pressures and the D values (decimal reduction time)will be

determined for each pressure selected. A shelf life study of organic peanut butter using pyrosequencing technology will be conducted to determine the significant populations of microorganisms surviving over time. Sensory and organoleptic properties of HPP treated minimally processed peanut butter will also be determined during the shelf life study.

PROGRESS

2009/09 TO 2011/08 OUTPUTS: Events: We have organized stakeholder focus groups, a seminar series, visits to organic dairy research programs throughout the US, and planning team meetings. Planning team members participated in site visits were organic dairy research is being conducted. In September 2010, 2 team members visited with Dr. Cindy Daley at the organic dairy at California State University, Chico in Chico, California. In May 2011, 4 team members visited with Dr. Andre Brito and colleagues from the University of New Hampshire in Durham, New Hampshire, and in August 2011, 4 team members visited with Dr. Steve Washburn at the North Carolina State University in Raleigh, North Carolina. A seminar series was conducted during 2011 at various locations around Minnesota and was planned to facilitate planning team education and public outreach. The first seminar, \"Requirements for Organic Dairy and Livestock in the United States\", was presented in January 2011 by Mr. Jim Riddle, University of Minnesota\'s Organic outreach coordinator on the University of Minnesota-St. Paul campus and 45 people attended. In March 2011, Dr. Hue Karreman, an internationally recognized organic dairy veterinarian from Pennsylvania, presented a seminar, \"Organic Dairy Cattle Health and Well Being\" in Rochester, MN, where 65 people attended. Dr. Stacey Hamilton, University of Missouri Extension Dairy Specialist, presented a seminar in May 2011 at the West Central Research and Outreach Center in Morris, MN entitled \"Measure, Monitor, and Manage: The 3 M\'s of Pasture Management, and 20 people attended. In July and August 2011, the last two seminars were presented on the University of Minnesota, St. Paul campus. Dr. Kathleen Delate, Organic Crops Specialist at Iowa State University, presented \"The Integration of Livestock Components in Organic Systems\" Regulatory Necessity and System Essential\", and Dr. Bob Parsons, Extension Economist at the University of Vermont, presented \"The Economics of Organic Dairy Farming\". For both seminars, over 30 people attended these events. Short planning team meetings were also convened after the seminars to discuss the needs of the organic dairy sector in the Midwest. Activities: Dairy producer focus groups were conducted around the state during 2011. Over 40 organic dairy producers from Minnesota attended these focus groups. The focus group purpose was to identify key issues in organic dairy production. Focus groups were organized in conjunction with two seminar series presentations. During the focus group interviews, we were able to identify numerous key issues affecting organic dairy producers. Products: Data from dairy producer focus groups was gathered that will help strengthen the organic dairy research and extension program at the University of Minnesota. Collaborative relationships with other organic dairy research institutions were established through the organic dairy site visits. Dissemination: Results of the organic dairy site visits and dairy producer focus group meetings will be shared with the Minnesota Department of Agriculture, the Minnesota Organic Advisory Task Force, and organic dairy producers in Minnesota. PARTICIPANTS: Brad Heins organized the organic dairy site visits, dairy producer focus groups, seminars, and traveled to all sites with the project planning team. Roger Moon and James Paulson also traveled to the organic dairy research sites to visit with researchers at other universities. The project directors (Brad Heins and Marcia Endres) organized and facilitated the dairy producer focus groups. Members of the planning team that traveled to the focus group meetings include Brad Heins, Marcia Endres, Mary Raeth-Knight, Roger Moon, Meg Moynihan, James Paulson, Amy Rager, and Sharon Weyers. Organic Valley provided mailings to producers to inform them of the date and time of the focus group meetings. Through organic dairy site visits, contacts were made with Dr. Cindy Daley (CSU-Chico), Dr. Andre Brito (UNH), and Dr. Steve Washburn (NCSU). Graduate students in the University of Minnesota\'s Department of Animal Science participated in dairy producer focus groups and attended the organic dairy seminars. Organic dairy producers in Minnesota provided information on key issues related to organic dairy production that will be used to further develop an integrated research and extension proposal. TARGET AUDIENCES: The main target audience for the project was organic dairy producers in Minnesota and the Midwest. Organic dairy personnel and veterinarians, as well as the general public, are target audiences for the project. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/08 TO 2011/07 OUTPUTS: There were four activities related to the project: 1) The main activity was to determine the otimal conditions for maximum log reductions of Salmonella by high pressure processing (HPP) in organic, minimally processed peanut butter, 2) sensory testing to compare untreated controls with HPP treated samples for the purpose of consumer acceptability , 3) shelf-life stability testing of HPP processed peanut butter samples as compared HPP treated samples to see if they are more microbiologically stable over time, and 4) analysis of peanut and peanut butter samples by high-throughput DNA sequencing to indicate what populations

of natural microflora resides on peanuts and peanut butter. The results of the high pressure processing work was disseminated through a presentation at the annual International Association of Food Protection meeting in 2010. The poster is on display in the Food Science Department and will be available for download from The Food Processing Center website. Two manuscripts are in preparation as a result of this work. PARTICIPANTS: Tara Stiles was an M.S. student who received her degree in Food Science and Techonology in August 2010 for her Thesis on this project, which greatly contributed to her professional development. Jayne Stratton, the PI on the project, was Tara\'s advisor. Tara was Dr. Stratton\'s first graduate student and greatly contributed to her professional development as a faculty member and mentor to future students. Steve Stephens (Process Engineer) and Dr. Durwood Smith, (Associate Professor and Co-PI), were involved in planning the resesarch project and a co-authored the poster with Ms. Stiles and Dr. Stratton that was presented at the International Association of Food Protection in 2010. Once Again Nut Butter company collaborated by providing the organic peanut butter for the high pressure, sensory, and shelf life studies. American Pasteurization Company (APC) collaborated by processing samples in their pilot-scale, food-grade facility for the sensory and shelf life studies. APC also provided input on processing conditions used in the study. Dr. Susan Cuppett, professor in the Food Science and Technology Department and Julie Reiling, product developer in The Food Processing Center, conducted the sensory analysis on the peanut butter samples. Dr. Vicki Schlegel in the Food Science Department has assisted by testing for rancidity during the shelf life study. Dr. Dave Rickert, a Co-PI, left The Food Processing Center for a new position before the project was able to start. Food Processing staff Robin Krokstrom (laboratory technician) and Bismarck Martinez (M.S. graduate student) completed the laboratory testing for the shelf life study and assisted in data analysis. Samantha Carter was an undergraduate student that assisted in compiling papers and conducting a literature review in preparation of the manuscript for publication. TARGET AUDIENCES: Target audiences for this work includes food processors, ingredient suppliers, government agencies, and the scientific community. The use of high pressure processing on a food system as challenging as peanut butter (high fat, low moisture) could lead to new applications in food safety on products that have not been previously studied. An effort to reach this audience was made by presenting a poster at the International Association of Food Protection Annual Meeting in August 2010. The poster from this meeting is displayed outside the The Food Science and Technology Department High Pressure Processing facility and will be used to inform students, faculty, and visitors of the potential food safety applications of high pressure processing. It will also be available for download from the Food Processing Center website. Two manuscripts are in preparation: one for the high pressure processing and another for the pyrosequencing. This will reach a wider audience that will include the international scientific community. PROJECT MODIFICATIONS: The initial project was designed to study the effect of high pressure processing on organic, minimally-processed peanut butter. However, early trials showed that high pressure was unable to reduce the level of Salmonella in plain, unaltered peanut butter even at high pressures and long holding times (600 MPa, 30 minutes). It was concluded that the high-fat, low moisture content was having a protective effect and raising the water activity of the peanut butter was necessary to allow for the reduction of Salmonella. Therefore, peanut butter was formulated with minimal ingredients into a palatable sauce that raised the water activity to levels that would allow high pressure processing to be effective in reducing Salmonella. This change did result in greater than 5-log reductions using certain HPP parameters. Therefore, it is possible that the results of this work can be transferred to new, innovative products that use peanut butter as an ingredient, thus increasing not only the safety of the product, but the sensory attributes as well. Also, a delay in receiving the award by several months (October instead of July) caused a delay in starting the project, and pushed back the start date of the shelf life study. In more recent stages of the project, the pyrosequencing facility was down for a month due to faulty kits which caused a delay in receiving the data from this part of the study. However, the facility was able to process all of the samples a few months later and send the finalized data set for analysis.

2009/08/01 TO 2010/07/31 OUTPUTS: There are four activities related to the project. Two primary activities were completed and two more are in the process of completion. First, the high pressure processing (HPP) studies on reducing Salmonella in organic, minimally processed peanut butter have been completed. This involved running several replications of inoculated samples under varying HPP conditions of time and pressure, and the otimal conditions for maximum log reductions were determined. Second, independent samples were processed by the recommended parameters found in the first study in a food-grade, pilot scale HPP system. Some of these samples were then used to run and complete a sensory panel comparing untreated controls with HPP treated samples. Third, a group of samples produced in the food-grade facility were subjected to a shelf-life study. The shelf life study of HPP processed peanut butter samples is two months into a six month long study, and will show if HPP treated samples are more microbiologically stable over time. Fourth, high-throughput DNA sequencing on peanut and peanut butter samples was just completed by the University of Nebraska-Lincoln Core for Applied Genomics and Ecology (UNL-CAGE), and data analysis is pending. This analysis will indicate what populations of natural microflora resides on on peanuts and peanut butter. Dissemination of the results of the HPP study from the first activity were presented in a poster at the International Association of Food Protection meeting in August

2010. PARTICIPANTS: Tara Stiles was a master\'s student who received her M.S. degree in Food Science and Techonology in August 2010 for her Thesis on this project, which greatly contributed to her professional development. Jayne Stratton, a co-PI on the project, was Tara\'s advisor. Tara was Dr. Stratton\'s first graduate student and greatly contributed to her professional development as a faculty member and mentor to future students. Steve Stephens (Process Engineer) and Dr. Durwood Smith, (Associate Professor and Co-PI), were involved in planning the resesarch project and a co-authored the poster with Ms. Stiles and Dr. Stratton that was presented at the International Association of Food Protection in 2010. Once Again Nut Butter company collaborated by providing the organic peanut butter for the high pressure, sensory, and shelf life studies. American Pasteurization Company (APC) collaborated by processing samples in their pilot-scale, food-grade facility for the sensory and shelf life studies. APC also provided input on processing conditions used in the study. Dr. Susan Cuppett of the Food Science and Technology Department conducted the sensory analysis on the peanut butter samples with the help of Julie Reiling, a product developer in The Food Processing Center. Dr. Vicki Schlegel in the Food Science Department has assisted by testing for rancidity during the shelf life study. Dr. Dave Rickert, a Co-PI, left The Food Processing Center for a new position before the project was able to start. TARGET AUDIENCES: Target audiences for this work includes food processors, ingredient suppliers, government agencies, and the scientific community. The use of high pressure processing on a food system as challenging as peanut butter (high fat, low moisture) could lead to new applications in food safety on products that have not been previously studied. An effort to reach this audience was made by presenting a poster at the International Association of Food Protection Annual Meeting in August 2010. The poster from this meeting is displayed in The Food Science and Technology Department and will be used to inform students, faculty, and visitors of the potential food safety applications of high pressure processing. PROJECT MODIFICATIONS: The initial project was designed to study the effect of high pressure processing on organic, minimally-processed peanut butter. However, early trials showed that high pressure was unable to reduce the level of Salmonella in plain, unaltered peanut butter even at high pressures and long holding times (600 MPa, 30 minutes). It was concluded that the high-fat, low moisture content was having a protective effect and raising the water activity of the peanut butter was necessary to allow for the reduction of Salmonella. Therefore, peanut butter was formulated with minimal ingredients into a palatable sauce that raised the water activity to levels that would allow high pressure processing to be effective in reducing Salmonella. This change did result in greater than 5-log reductions using certain HPP parameters. Also, a delay in receiving the award by several months (October instead of July) caused a delay in starting the project, and pushed back the start date of the shelf life study. In more recent stages of the project, the pyrosequencing facility was down for a month due to faulty kits which caused a delay in receiving the data from this part of the study.

IMPACT

2009/09 TO 2011/08 The objective of the planning grant was to identify the needs of the organic dairy sector and to develop a research and extension proposal for future submission to the Organic Research and Extension Initiative competitive grant program. The organic dairy site visits succeeded in establishing relationships, collaborations, and coordination with other University research institutions involved in organic dairy research. We conducted seminars that would provide for a range of activities (i.e. organic dairy cropping systems, cow health, and economics) that relate to organic dairy production systems. The seminar series provided an opportunity for the public, as well as researchers, to learn about the key issues related to organic dairy production. Over 150 people attended the five seminars organized by the planning team. The focus groups provided an opportunity for dairy producers to discuss current challenges and opportunities for organic dairy production in the Minnesota and the Midwest. Dairy producer\'s identified animal health, mastitis, improving forage quantity and quality from pastures, and profitability of organic dairy farming as the most important issues for organic dairy systems. Furthermore, planning team meetings assisted in identifying the needs of the organic dairy sector in the Midwest. The results gathered from the site visits, seminar series, focus group meetings, and planning meetings with translate into the development of an integrated research and extension proposal that will be submitted to NIFA. Scientists and stakeholders will continue to work together to identify organic producer challenges and concerns and this dialogue will provide the foundation for creating proposals that address these concerns and provide information needed to establish system-based organic best management practices. Producer focus group meetings will continue. The planning team will continue to have organizational meetings to identify the needs of the organic dairy sector in the future. **PUBLICATIONS (not previously reported):** 2009/09 TO 2011/08 No publications reported this period **CCESSION NO:** 0218820 **SUBFILE:** CRIS **PROJ NO:** NEB-31-125 **AGENCY:** NIFA NEB **PROJ TYPE:** OTHER GRANTS **PROJ STATUS:** TERMINATED **CONTRACT/GRANT/AGREEMENT NO:** 2009-51300-05541 **PROPOSAL NO:** 2009-01422 **START:** 01 AUG 2009 **TERM:** 31 JUL 2011 **FY:** 2009 **GRANT AMT:** \$69,806 **GRANT YR:** 2009

INVESTIGATOR: Stratton, J.; Rickert, D.; Smith, D. **PERFORMING INSTITUTION:** Food Science & Technology UNIVERSITY OF NEBRASKA LINCOLN, NEBRASKA 68583 ***HIGH PRESSURE PROCESSING OF NATURAL, ORGANIC, AND MINIMALLY-PROCESSED PEANUT BUTTER***

2009/08 TO 2011/07 In study 1, a pressure of 600 MPa with a hold time of 7 minutes was found to be the optimal condition to achieve a five log reduction of Salmonella in a 33% peanut butter sauce that was tested using a Stansted ISO Food Lab System. Although the hold time was longer than desirable, it is within the parameters used by industry. Parameters were also provided for products containing different percentages of peanut butter. As the percentage of peanut butter in the samples decreased, higher log reductions were achieved, indicating that the peanut butter had a protective effect on the organism. For example, a 15% peanut butter sauce required 1 minute at 600 MPa while a 20% peanut butter product required a hold time of 5 minutes to eliminate Salmonella. The results from the high pressure studies indicated that raising the water activity of peanut butter supports the use of the HPP process as an intervention to reduce the risk of Salmonella. This has the potential impact of increasing the safety of many different products that use peanut butter as an ingredient, such as sauces, confections, and Asian style marinades and dressings. This research was presented at the 2010 International Association for Food Protection Annual meeting. In study 2, industry collaborators at the American Pasteurization Company processed food grade samples for the sensory panels, and Once Again Nut Butter company provided the organic peanut butter. The results from the sensory panels indicated that the HPP processed samples had a more desirable color and texture than the control samples, thus signifying that the process would actually enhance the desirability of final product to the consumer. In study 3 the HPP processed samples performed much better in the shelf life than the untreated control samples. The control samples had over 1 million cfu/g Aerobic Plate Count by month 4 while the treated samples had less than 500 cfu/g. In study 4, the community and population of bacteria associated with peanut butter were evaluated using pyrosequencing of 16S rRNA gene amplicons. A diverse community was detected with several phyla and genera represented. The total number of reads per sample ranged from approximately 6,500 to 40,700. The classified sequences from the samples were assigned to 14 different phyla with the largest number of reads belonging to Proteobacteria and Firmicutes. Within the Proteobacteria, sequences belonging to the class gammaproteobacteria - particularly the genus Acinetobacter, Pseudomonas, and Citrobacter were the most numerous. The highest number of sequences within the class alphaproteobacteria belonged to the genus Sphingomonas. Within the Firmicutes, the class Bacilli was the most represented, with the predominant organisms from the genus Leuconostoc, Weissella, and Lactococcus. Pyrosequencing allowed a broader description of the bacterial composition and diversity of the peanut butter samples than possible using traditional culture-based detection and will be a powerful tool to help ensure the future safety and quality of both organic and non-organic peanut butter. **PUBLICATIONS (not previously reported):** 2009/08 TO 2011/07 No publications reported this period

2009/08/01 TO 2010/07/31 In the first study, a pressure of 600 MPa with a hold time of 7 minutes was found to be the best conditions for the reduction of Salmonella in the product that was tested using a Stansted ISO Food Lab System, and were within the parameters used by industry. The results from the high pressure studies indicated that raising the water activity of peanut butter supports the use of the HPP process as an intervention to reduce the risk of Salmonella, but is not effective on peanut butter alone. This has the potential impact of increasing the safety of many different products that use peanut butter as an ingredient. Equipment and laboratory resources, such as the HPP Processing Facility in the Food Science and Technology Department (FDST) and the BL-II microbiology lab at The Food Processing Center allowed for the evaluation of this project with minimal costs or waiting time. In the second study, outside collaborators at the American Pasteurization Company provided pilot scale processing of samples for the sensory panels, and Once Again Nut Butter company provided the peanut butter for all the studies. Working with these companies allowed project managers to directly interact with manufacturers, therefore real-world applications and impacts were considered. Internal collaboration with the FDST Sensory Laboratory found that HPP does not adversly affect the sensory characteristics of peanut butter, including taste, color, and oil separation. In the third study, observations at two months indicate that the HPP treated samples are more microbiologically stable than the controls, which are already showing microbial degradation. In the fourth study, the UNL pyrosequencing facility\'s data will enable researchers to observe the total population of microorganims that reside on peanuts and peanut butter and could lead to a new understanding of the naturally-occuring flora. It is important to know what potential spoilage or pathogenic organisms may be present in a low-moisture food product that may not always undergo a kill step.

PUBLICATIONS

2009/08/01 TO 2010/07/31 No publications reported this period

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Improving Organic Farming Systems and Assessing Their Environmental Impacts Across Agroecoregions

Accession No.	0218824
Subfile	CRIS
Project No.	NEB-41-038
Agency	NIFA NEB
Project Type	OTHER GRANTS
Project Status	EXTENDED
Contract / Grant No.	2009-51300-05603
Proposal No.	2009-01371
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Performing Institution	Northeast Res & Extension Center, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA 68583

NON-TECHNICAL SUMMARY

Research and extension professionals at the University of Nebraska-Lincoln (UNL Organic Working Group) in response to the growing demand for information on alternative production systems and input from our organic farmer advisory groups will continue to develop organic farming systems and recommendations adapted to the diverse agroecoregions of the Great Plains. The team will utilize four certified organic research sites across Nebraska and a network of private organic farms established through the previous grant to focus research and outreach on four farming system issues that have been identified as crucial by stakeholders: 1) nutrient and weed management, 2) biodiversity conservation and quantifying impact on natural resources, 3) antioxidant production in organic grains and seeds, and 4) on-farm research capability. Using standard research protocols it is anticipated that the nutrient and weed management research will provide specific recommendations to organic farmers concerning nutrient flows on their farms and the optimum use of non-mechanical (flaming) weed management practices. The impact of management on biodiversity will be quantified, and using the nutrient and weed management results made available to growers through the development of a structured decision support system being developed as the Healthy Farm Index (HFI). Management impacts on antioxidant production in grains will be determined and the results incorporated into the HFI. Three organic farmer research groups will be organized to encourage improved organic production.

OBJECTIVES

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 will focus on four aspects of organic farming systems that were identified as crucial by our stakeholders: 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. This

multi-dimensional approach will allow the project team and cooperating farm operators to make progress toward developing organic farming systems that are adapted to the diverse agroecoregions of the Great Plains and in compliance with the NOP Standards. Project objectives, developed in collaboration with our Citizen Advisory group stakeholders, focus around the four certified farming systems. Objectives: Determine a) the effect of organic amendments on crop performance under organic production on organic farms, b) determine the interaction between general fertility levels and integrated weed control, c) assess nutrient balance on farms, d) use extension outreach to raise knowledge within the organic community on exported nutrients. Evaluate an integrated organic approach for weed control based on mechanical cultivation and/or flaming in corn and sunflower. Determine the effects of organic farming practices on antioxidant levels of at least two cultivars of organically grown crops compared to conventionally-grown check varieties in four Nebraska agroecoregions. Quantify the effect of organic management on breeding success of regional farm bird populations and institute long-term ecological monitoring on organic farms. Incorporate outputs of objectives 1-4 into the Healthy Farm Index. Advance and deliver the Healthy Farm Index to organic farmers as a model for farm assessment and structured decision making in organic farm management. Establish and provide the guidance, encouragement, and technical support required for the sustainability of three organic farmer research groups in Nebraska

APPROACH

Research will take place on 3 university farms, 16 cooperating organic farms and 9 additional farms (on-farm research groups) across Nebraska. Nutrient studies will focus on the impact of manure on the nitrogen and phosphorus on crop productivity with the goal of defining the nutrient flow of N and P. Manure, soil, crop and weeds will be sampled. Interaction with weed populations will be determined. Weed levels will be managed with inter-row cultivation and flaming with and without manure applications. Newly designed hoods for the flamers will be assessed with visual ratings of weed populations. Antioxidants levels and bioactivity of grains produced with all treatments will assessed with standard procedures. Avian biodiversity of the16 cooperating farms will be assessed, breeding bird success will be determined and related land-use and land cover patters at the field, farm and landscape scales. Long term monitoring of avian diversity on 8 of the 16 farms will be initiated using remote recorders managed by cooperating farmers. Results from the nutrient, weed management and biodiversity studies will be incorporated into the Healthy Farm Index. Three, on-farm research groups will be established to enable farmers to conduct independent research of interest to them. Each group will be mentored by experienced Extension educators. The goal is to move to self-sustaining groups assisted by local Extension educators.

PROGRESS

2009/09 TO 2014/08 Target Audience: The annual Western Sustainable Ag Conference was held in December, 2013 and reached farmers from Wyoming, Kansas and Nebraska. The annual NSAS conference in February reached farmers in eastern Nebraska. Various OCIA (Organic Crop Improvement Association) chapter meetings were also part of this reporting period. Over the length of the project we have reached farmers, government agencies, state agencies, non-governmental organizatons in Nebraska and at national conferences of sustainable agriculture groups as well as American Society of Agronomy and the MOSES conferences. Changes/Problems: As mentioned the turn-over of organic technicians was a major problem for continuity and use of resources. Organic farming requires knowledge of many aspects of production and a keen observational sense. This is developed overtime, and we had to be continually retraining. In addition, not having a base of hard funding for some aspects of the grant made it difficult to integrate fully with the rest of the institution. What opportunities for training and professional development has the project provided? In order to provide training we need to have land to conduct research for organic farmers. Certification was maintained at all four sites; three additional acres were added to be certified to accommodate increased research activity at the Haskell Ag Lab (HAL) site. The weed/nutrient management project was initiated at the HAL. A field day in June demonstrated the flamer, roller/crimper, and other organic research. One on-farm experiment was initiated in the spring to quantify weed/nutrient yields, and two in the fall (2010). A study was begun at South Central Ag Lab (SCAL-Clay Center) to evaluate the impact of animal manures on soil fertility and crop yield. Avian abundance, nesting success, and associated land use parameters were sampled at seven organic farms. Acoustic recorders were deployed at two participating farms. A three session in-depth training session on weed and nutrient management, economics, and ecosystem analysis was conducted and educated producers on these issues related to organic farming. We had five organizational meetings around Nebraska to identify organic farmers interested in cooperating in on- farm research projects that would help them to investigating production practices, inputs and share their findings with other organic farmers. Twelve farmers volunteered to participate in the project. Nine Extension Educators cooperated to help lay-out the experimental design and with data collection. At HAL (Concord) and High Plains Ag Lab (HPAL-Sidney), we evaluated the use of flaming and cultivation as weed control methods in sunflower

production. During 2011, OCIA certified organic fields at: ARDC, HAL, HPAL and SCAL. Stahinja Stepanovic, MS student, conducted weed management trials at several sites, each study had treatments including control, cultivation, flaming and cultivation, and flaming at two stages; HAL had a fertility component, with weed control treatments on manured and non- manured plots. Variety and environment effects on grain antioxidants was tested on 4 commodities grown at 3 sites, all were analyzed for phenols, flavonoids, and antioxidant content. Healthy Farm Index: Data were presented at the NSAS meeting and organic farm tours. Recorded bird songs were shared with farmers and others interested on CD and online. Recordings were also shared with NE Game and Parks. On-Farm Research: Three late winter meetings (2011) summarized 2010 results and planned 2011 farmer initiated research. Topics were identified, protocols developed, and roles defined, A factorial of weed control and fertility experiment at 10 organic farms. Two additional graduate students associated with the project are paid from other funds: Katja Koehler-Cole (Ph.D) and Jianru Shi(MS). During the 2012 growing season, the organic fields were maintained according to certification requirements at four research farm sites: ARDC (Mead), HAL (Concord, HPAL (Sidney) and SCAL (Clay Center). The infrastructure is established on these four research farms across three ecoregions to study organic farming systems. Two additional graduate students associated with the project are paid from other funds: Katja Koehler-Cole (Ph.D.) is in the 3rd year of her study on nitrogen balance in organic systems; Jianru Shi (MS) started in Aug 2011 to study the rate of nitrogen availability from cover crops in our standard corn/soybean/wheat rotation. 2013 Development of on-farm research to help farmers learn about research and the topics they find of interest: We had 12 on-farm organic research projects on-going. Farmers are interested in soil health, improving quality of their pasture with milk, how to use a crimper to crimp cover crops for row crop and vegetable production, integrated organic fly management on livestock and a Nebraska Indian College student, instructor and extension educator have developed organic gardening and open-pollinated corn projects. The difficult part was getting farmers to realize the benefits of on-farm research. We now realize we have to have more involvement with setting up and collecting data. Overall, we have reached a community of farmers that in the past did not communicate with each other. Now they are sharing ideas and working together. Organic farming community had no way to communicate with each other and the on-farm research projects were a way to bring them together. Farmers learned they needed to conduct the project at least two years -- use random, replicated farm sized strips. Researchers learned that the farmers need more help in setting up field designs and collecting the data and analyzing it. In order to facilitate sharing experiences with organic farmer research, a listserv was initiated to share research projects as they are occurring in the field. This is to encourage farmers to take pictures of what they are trying and to post them. Organic farmers are spread throughout the state and would like to attend field tours in the spring but cannot take the time to leave their farms because they are too busy in the field. Posting pictures on this listserv is a way to encourage them to share problems, ask for advice, and see what other farmers are experiencing with weather and soil conditions. We also had several graduate students share what they the research they are conducting on organic farms. PD Opportunity exists to train Extension Educators and researchers how to work with organic farmers\' cropping systems in various bioregions. Having a participatory research approach to studying organic cropping systems is a win-win situation for the farmers and the researchers/educators. Training the farmer how to conduct on-farm research experiments helps farmers save money and develop better cultural practices. Organic farmers are continually trying to develop no-till systems and experimenting with equipment or approved NOP inputs. Researcher will benefit by working within an established organic cropping system and a specific bioregion as the farmer will have the knowledge and equipment to conduct the experiments and will work on weekends and holidays when crucial field operations may need to be done. In order to work with organic farmers, researchers that work primarily with conventional growers need training on the various accepted cultural practices, equipment and labor constraints that exist on each farm. 2014 The project coordinator has trained and kept trained the organic technicians at each research site. Turn-over of organic research technicians is a continual problem with grant funded technical positions since the trained technicians take permanent funded positions when they become available. Producers have had many opportunities to learn about the specifics of nutrient, weed, biological diversity, and organic farming at field days and workshops. There have been two annual meetings in the east and west of the state that focused on sustainable agricultural production. Field days at the on-farm research sites were conducted as appropriate. Our project coordinator spoke at the Grain Place summer field days during the projects length. As the last year of the second year extension, activities were severely curtailed with the retirement (due to funding restraints) of the Extension Organic Educator. How have the results been disseminated to communities of interest? 2013 In addition to the meetings, conferences and communications efforts already reported the following are more examples of dissemination of results. Presented findings and talked about the benefits of on-farm research for organic farmers at two organic annual meetings and two sustainable Ag conferences reaching over 250 farmers. Presented at Nebraska Agribusiness Association research update to 80 crop consultants and agronomists. August farm tour which 35 organic farmers attended to view the on-farm research projects, talked about equipment built for projects, and how the projects were set-up for field research. On farm Research: Project coordinator worked with four organic farmers in Eastern Nebraska to develop cultural practices to use a flamer for weed control in corn. Organic Extension Educator consulted two

row crop organic farmers and one organic market gardener that demonstrated using a crimper on rainfed, irrigated ground; consulted with five farmers that were transitioning to organics or needing better information on nutrient management. With the information learned from on-farm and university driven experiments, farmers were able to make changes and improved their use of soil testing. Developed on organic farmer research listserv to share research projects as they are occurring in the field. This is to encourage farmers to take pictures of what they are trying and to post them. Organic teaching: A course in organic agriculture is offered in spring semester at UNL, and continues to attract 15-20 students each year. The agroecology course that includes a large number of organic farming examples and uses data from the long-term trial is now the largest capstone course in our department, attracting 80 students and taught in two sections. Bird conservation opportunities on-farm tour hosted at participating farm. 10+ participants including consumers and producers. 2014 Each annual report gives listed details of venues that we have presented results to. In addition, the propane flaming information has been presented worldwide at many conferences in Europe and other North Central states. Results are presented in press releases, workshops, invited speakers, and in management guides. A Nebraska Organic Farming NebGuide series is continuing with four NebGuides released to date, and more in the process. Videos on YouTube are also used to document various techniques, mostly in field preparation and weed control. Publications listed elsewhere are also important. The teaching component of this grant was consistent over time and several courses are on-going that teach about organic farming and the environmental issues related to agroecology. We cooperated with others in the University who were interested in cover crops, although they were not necessarily organic. The goal was to document the impact of cover crop use. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/09 TO 2013/08 Target Audience: In additon to previously mentioned groups: Consultative Group of Biological Diversity Nebraska Agribusiness Association Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Development of on-farm research: We now have 12 on-farm organic research projects on-going. Farmers are interested in soil health, improving quality of their pasture with milk, how to use a crimper to crimp cover crops for row crop and vegetable production, integrated organic fly management on livestock and a Nebraska Indian College student, instructor and extension educator have developed organic gardening and open-pollinated corn projects. The difficult part was getting farmers to realize the benefits of on-farm research. We now realize we have to have more involvement with setting up and collecting data. Overall, we have reached a community of farmers that in the past did not communicate with each other. Now they are sharing ideas and working together. Organic farming community had no way to communicate with each other and the on-farm research projects were a way to bring them together. At first the farmers were not sure what they wanted to research or do. This process is on-going and will take longer than this grant, but the seeds have been planted for them to share information and to experiment using on-farm research techniques. Farmers learned they needed to conduct the project at least two years -- use random, replicated farm sized strips. Researchers learned that the farmers need more help in setting up field designs and collecting the data and analyzing it. In order to facilitate sharing experiences with organic farmer research, a listserv was initiated to share research projects as they are occurring in the field. This is to encourage farmers to take pictures of what they are trying and to post them. Organic farmers are spread throughout the state and would like to attend field tours in the spring but cannot take the time to leave their farms because they are too busy in the field. Posting pictures on this listserv is a way to encourage them to share problems, ask for advice, and see what other farmers are experiencing with weather and soil conditions. We also had several graduate students share what they the research they are conducting on organic farms. PD Opportunity exists to train Extension Educators and researchers how to work with organic farmers' cropping systems in various bioregions. Having a participatory research approach to studying organic cropping systems is a win-win situation for the farmers and the researchers/educators. Training the farmer how to conduct on-farm research experiments helps farmers save money and develop better cultural practices. Organic farmers are continually trying to develop no-till systems and experimenting with equipment or approved NOP inputs. Researcher will benefit by working within an established organic cropping system and a specific bioregion as the farmer will have the knowledge and equipment to conduct the experiments and will work on weekends and holidays when crucial field operations may need to be done. In order to work with organic farmers, researchers that work primarily with conventional growers need training on the various accepted cultural practices, equipment and labor constraints that exist on each farm. How have the results been disseminated to communities of interest? 1. Presented findings and talked about the benefits of on-farm research for organic farmers at two organic annual meetings and two sustainable Ag conferences reaching over 250 farmers. Presented at Nebraska Agribusiness Association research update to 80 crop consultants and agronomists. 2. August farm tour which 35 organic farmers attended to view the on-farm research projects, talked about equipment built for projects, and how the projects were set-up for field research. 3. On farm Research: Project coordinator worked with four organic farmers in Eastern Nebraska to develop cultural practices to use a flamer for weed control in corn. 4. Organic Extension Educator consulted two row crop organic farmers and one organic market gardener that demonstrated using a crimper on rainfed, irrigated ground;

consulted with five farmers that were transitioning to organics or needing better information on nutrient management. With the information learned from on-farm and university driven experiments, farmers were able to make changes and improved their use of soil testing. 5. Developed on organic farmer research listserv to share research projects as they are occurring in the field. This is to encourage farmers to take pictures of what they are trying and to post them. 6. Organic teaching: A course in organic agriculture is offered in spring semester at UNL, and continues to attract 15-20 students each year. The agroecology course that includes a large number of organic farming examples and uses data from the long-term trial is now the largest capstone course in our department, attracting 80 students and taught in two sections. 7. Bird conservation opportunities on-farm tour hosted at participating farm. 10+ participants including consumers and producers. What do you plan to do during the next reporting period to accomplish the goals? Between now and the end of the grant period we will report to the public on the results of our research. We will finish two NebGuides for producers on fertility aspects and on the Healthy Farm Index.

2011/09/01 TO 2012/08/31 OUTPUTS: During the 2012 growing season, the organic fields were maintained according to certification requirements at four research farm sites: ARDC (Mead), HAL (Concord, HPAL (Sidney) and SCAL (Clay Center). The infrastructure is established on these four research farms across three ecoregions to study organic farming systems. Integrated Weed Control: trials using a combination of cultivation and flamer on corn at HAL, sunflower at HAL & HPAL; each study 12 treatments including control, cultivation, flaming and cultivation, flaming at V3-V4, V6-V7, weed species composition, visual ratings of control, crop yields. HAL added a fertility component, with weed control treatments on manured and non-manured plots. Variety & Environment Effects on Grain Antioxidants: Samples representing 3 commodities and grown at 3 locations, under various stress conditions, were collected: HAL (20 lines of wheat); HAL (2 fertility treatments and two weed pressures with blue and yellow corn; HPAL (2 sunflower varieties at 2 soil nitrogen levels); ARDC (2 soybean varieties at 2 nutrient levels). All were analyzed for total phenols, flavonoids, and antioxidant content. 20+ varieties of corn, soybeans, and sunflowers were pre-screened to determine which cultivars had most potential for elevated antioxidant levels. Tests in progress for proximates on all samples, and anthocyanins/proanthocyanins on corn. Cover Crop Study ARDC: Winter wheat was planted on 16 acres on Nov 10, 2010; on March 2011 red clover and white clover were over seeded into the winter wheat fields in a replicated design to determine if legume intercrops add nitrogen in the growing wheat crop and increase grain protein; effect on following corn crop will be measured. To determine N release from clovers, biomass samples were collected October 2011, dried and prepared for burial in sample bags. Residue samples will be buried in late November 2011. Samples will be recovered periodically over the next year and the rate of decomposition and nitrogen content determined. In October, 2011 a second year of the winter wheat/clover study was planted; the clovers will be sown in March 2012. Fertility at SCAL: 20 acres of sprinkler irrigated land, crop rotation of field corn, 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, a new rotation was initiated to provide higher levels of nitrogen nutrition to wheat to promote higher protein levels. Crop rotations were changed to study the effects of hairy vetch, radish and cocktail cover crop mixes. Two additional graduate students associated with the project are paid from other funds: Katja Koehler-Cole (Ph.D.) is in the 3rd year of her study on nitrogen balance in organic systems; Jianru Shi (MS) started in Aug 2011 to study the rate of nitrogen availability from cover crops in our standard corn/soybean/wheat rotation. PARTICIPANTS: Same as before. TARGET AUDIENCES: Same as before: Organic farmers, conventional farmers, Certified Crop Advisors, government agencies, NGOs, general public PROJECT MODIFICATIONS: We asked for and received a one-year extension.

2011/09/01 TO 2012/08/31 OUTPUTS: During the 2012 growing season, the organic fields were maintained according to certification requirements at four research farm sites: ARDC (Mead), HAL (Concord, HPAL (Sidney) and SCAL (Clay Center). The infrastructure is established on these four research farms across three ecoregions to study organic farming systems. Integrated Weed Control: trials using a combination of cultivation and flamer on corn at HAL, sunflower at HAL & HPAL; each study 12 treatments including control, cultivation, flaming and cultivation, flaming at V3-V4, V6-V7, weed species composition, visual ratings of control, crop yields. HAL added a fertility component, with weed control treatments on manured and non-manured plots. Variety & Environment Effects on Grain Antioxidants: Samples representing 3 commodities and grown at 3 locations, under various stress conditions, were collected: HAL (20 lines of wheat); HAL (2 fertility treatments and two weed pressures with blue and yellow corn; HPAL (2 sunflower varieties at 2 soil nitrogen levels); ARDC (2 soybean varieties at 2 nutrient levels). All were analyzed for total phenols, flavonoids, and antioxidant content. 20+ varieties of corn, soybeans, and sunflowers were pre-screened to determine which cultivars had most potential for elevated antioxidant levels. Tests in progress for proximates on all samples, and anthocyanins/proanthocyanins on corn. Cover Crop Study ARDC: Winter wheat was planted on 16 acres on Nov 10, 2010; on March 2011 red clover and white clover were over seeded into the winter wheat fields in a replicated design to determine if legume intercrops

add nitrogen in the growing wheat crop and increase grain protein; effect on following corn crop will be measured. To determine N release from clovers, biomass samples were collected October 2011, dried and prepared for burial in sample bags. Residue samples will be buried in late November 2011. Samples will be recovered periodically over the next year and the rate of decomposition and nitrogen content determined. In October, 2011 a second year of the winter wheat/clover study was planted; the clovers will be sown in March 2012. Fertility at SCAL: 20 acres of sprinkler irrigated land, crop rotation of field corn, 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, a new rotation was initiated to provide higher levels of nitrogen nutrition to wheat to promote higher protein levels. Crop rotations were changed to study the effects of hairy vetch, radish and cocktail cover crop mixes. Two additional graduate students associated with the project are paid from other funds: Katja Koehler-Cole (Ph.D.) is in the 3rd year of her study on nitrogen balance in organic systems; Jianru Shi (MS) started in Aug 2011 to study the rate of nitrogen availability from cover crops in our standard corn/soybean/wheat rotation. PARTICIPANTS: Same as before. TARGET AUDIENCES: Same as before: Organic farmers, conventional farmers, Certified Crop Advisors, government agencies, NGOs, general public PROJECT MODIFICATIONS: We asked for and received a one-year extension.

2010/09/01 TO 2011/08/31 OUTPUTS: During 2011, OCIA certified organic fields at: ARDC, HAL, HPAL and SCAL. Stahinja Stepanovic, MS student, conducted weed management trials at several sites, each study had treatments including control, cultivation, flaming and cultivation, and flaming at two stages; HAL had a fertility component, with weed control treatments on manured and non-manured plots. Variety and environment effects on grain antioxidants was tested on 4 commodities grown at 3 sites, all were analyzed for phenols, flavonoids, and antioxidant content. A cover crop study at ARDC on winter wheat was planted 11/10/2010; March 2011 red and white clovers were over seeded to determine effect on yield and grain protein. In October, 2011 a second year of the winter wheat/clover study was planted; At SCAL, a sprinkler irrigated site, had sheep manure was applied to two strips across all fields,in 2010, in 2011 manure did not increase yields. Healthy Farm Index: Data were presented at the NSAS meeting and organic farm tours. Recorded bird songs were shared with farmers and others interested on CD and online. Recordings were also shared with NE Game and Parks.On-Farm Research: Three late winter meetings (2011) summarized 2010 results and planned 2011 farmer initiated research. Topics were identified, protocols developed, and roles defined, with these results: 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. 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. Bio-char as a soil amendment on silt loam was applied in spring, 2010; in 2010 biochar did not affect yield. 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. Inoculation of soybean in long term rotations with Rhizobia was evaluated, but due to old Rhizobia there was no effect on yield.Seed treatment with Vitazyme trial was planted, but was badly damaged by hail with no yield results obtained. Intercropping hulless barley and flax was evaluated. The farmer mixed things up at harvest. The trial was repeated in 2011. A cheese dairy tested whey application on pasture in 2011. Grass yield was 18% more without whey applied, and not affected with the second grazing period; Raw milk and fish slurry were evaluated as a starter fertilizer for corn in 2011. Yield was not affected.Two farmers sowed radish with winter wheat in 2011. Another farmer compared cover crops following winter wheat harvest. Three farmers worked to develop cultural practices on timing and methods to use a flamer in corn. A factorial of weed control and fertility experiment at 10 organic farms. Two additional graduate students associated with the project are paid from other funds: Katja Koehler-Cole (Ph.D) and Jianru Shi(MS). PARTICIPANTS: Same as 2010 Report. TARGET AUDIENCES: Same as 2010 Report. PROJECT MODIFICATIONS: On farm nutrient management sites number reduced to 10/year due to difficulty in finding cooperators in western part of the state. More extension educators are expected to help in 2012.

2009/09/01 TO 2010/08/31 OUTPUTS: Certification was maintained at all four sites; three additional acres were added to be certified to accommodate increased research activity at the Haskell Ag Lab (HAL) site. The weed/nutrient management project was initiated at the HAL. A field day in June demonstrated the flamer, roller/crimper, and other organic research. One on-farm experiment was initiated in the spring to quantify weed/nutrient yields, and two in the fall (2010). A graduate student was recruited to research nutrient issues related to organic farming. A study was begun at South Central Ag Lab (SCAL-Clay Center) to evaluate the impact of animal manures on soil fertility and crop yield. Avian abundance, nesting success, and associated land use parameters were sampled at seven organic farms. Acoustic recorders were deployed at two participating farms. Preparation began for an instructional film to assist farmers in use of acoustic recorders. A three session

in-depth training session on weed and nutrient management, economics, and ecosystem analysis was conducted and educated producers on these issues related to organic farming. We had five organizational meetings around Nebraska to identify organic farmers interested in cooperating in on-farm research projects that would help them to investigating production practices, inputs and share their findings with other organic farmers. Twelve farmers volunteered to participate in the project. Nine Extension Educators cooperated to help lay-out the experimental design and with data collection. At HAL (Concord) and High Plains Ag Lab (HPAL-Sidney), we evaluated the use of flaming and cultivation as weed control methods in sunflower production. Our results showed that a combination of flaming and cultivation (at the same time) conducted at cotyledon and V12 (twelve leaf) stages provided up to 85% weed control with no reduction in sunflower yield. Our results from this year suggested that if wheat is used as a cover crop, the flaming treatments conducted at boot stage can reduce the seed production of wheat presenting an alternative way for organic farmers to control wheat after it finishes its function as a cover crop. Additionally, our results in sunflower suggested that a combination of flaming and cultivation conducted at the proper timing could provide acceptable weed control with no reduction in yield. No-till soybean yield following crimping of a winter rye cover crop was more with drilling compared with planting in 30 inch rows. Soybean yield was increased with application of 5 ton per acre of biochar. Studies at Clay Center suggest that hairy vetch planted as a winter cover crop and cultivated in before corn planting reduced weed pressure in corn. Comparison with the phenol levels and overall bioactivity between location and within variety are currently under evaluation. This data will be compared based on location and farming practices as more samples are evaluated. As an outcome, we expect that the impact of various organic based farming practices on the health promoting component present in multiple crops will be forthcoming. PARTICIPANTS: OCIA Nebraska Chapter #1,Lincoln, NE; OCIA Nebraska Chapter #2, Dalton, NE; OCIA, Lincoln, NE; Nebraska Indian Community College, Macy, NE; NRCS,NE; Nebraska Sustainable Agriculture Society; UNL collaborators: Dr. Bruce Anderson,Agronomy & Horticulture (AGHO); Dr. Timothy J. Arkebauer,AGHO; Dr. Stephen Baenziger,Small Grains Breeding, AGHO; Mr. Aaron Berger, Extension Educator; Dr. Erin Blankenship,Statistics; Mr. Paul Burgener,Ag Economics, Panhandle Rsch & Ext Cente; Dr. Avishek Datta, Post Doc Rsch Assoc,HAL; Ms. Karen DeBoer, Extension Educator, Panhandle Rsch & Ext Center, (HPAL); Mr. Terry A. Devries, Research Analyst, South Central Ag Research Lab, SCAL; Dr. Richard Ferguson,Soil Fertility,AGHO; Dr. Loren Giesler, Assoc. Professor, Plant Pathology Specialist; Dr. George Gogos,Mechanical Engineering; Dr. Robert Harveson, Plant Pathology, Panhandle Rsch & Ext Center; Dr. Gary Hergert,Soil Science, HPAL; Dr. Thomas Hunt, Entomology,HAL; Mr. James A. Kalisch, Extension Associate, Entomology; Dr. James M. Krall, Adjunct Faculty-Crops Specialist, Agronomy & Horticulture (Director of Research, SAREC and Professor of Plant Sciences, University of Wyoming); Dr. Gary Lesoing, Asst. Extension Educator, Southeast Rsch & Ext Center; Mr. Richard Little, Small Grains Breeding Specialist & Coordinator, Agronomy & Horticulture; Dr. Alexander Pavlista, Professor-Potato Specialist & Physiologist, Panhandle Rsch & Ext Center, HPAL; Dr. Paul Read, Professor-Grape Specialist, Agronomy & Horticulture; Dr. Teshome Regassa, Crops Performance/State Variety Trial Testing, Biological Systems Engineering; Dr. Dipak Santra, Asst. Professor, Alternative Crops Breeding, Panhandle Rsch & Ext Ctr.; Ms. Erin Taylor, Research Associate, Dept. of Crop and Soil Science, Michigan State University; Dr. Jerry Volesky, Professor-Forage Specialist, West Central Rsch. & Ext Ctr.; Dr. Stephen Wegulo, Asst. Professor, Plant Pathology; Dr. Roger Wilson, Ag Economist, West Central Rsch. & Ext. Ctr.; Ms. Kat Shiffler, School of Natural Resources Cooperators, Organic Community: Organic producers:Ken Brauer,Dennis Demmel,Ken Disney, Rick Gubbels, Todd Halle, Mike Heimes, Mike Herman, ;Paul Huenfeld,Mark Jones, Martin Kleinschmit,Doug Lockwood, Organic Grain Processing;Rich Mazour, Terry Mosel,Tim Nissen,Joe Roberts, Paul Rohrbaugh, Larry Stanislav, Joel Starr,Paul Swanson, Mike Tiensvold, Organic Producer;Henry Miller, Natural Resource Director,Nebraska Indian Community College, Niobrara; Angie Tunink, Executive Director, OCIA; David Vetter, Organic Grain Processing, The Grain Place; Partner Organizations: Blue River Hybrids Organic Seed;Jim Bender,Organic Producer;Mike Ostry,Organic Producer,Tami Highstreet, Administrator, OCIA Chapter #1 ;Marva Holt, Organic Producer and Administrator, OCIA Chapter #2 TARGET AUDIENCES: Organic farmers, Conventional farmers, NRCS, Consumers, Organic grain industry, Extension, NRDs, Community college faculty, State College faculty, Farmers markets, Conservation biologists, Nebraska Game and Parks Commission PROJECT MODIFICATIONS: We are requesting the following modification to our research protocol in the weed management section: for sunflower, we are adding 4 more treatments to HPAL site, and 2 more to HAL, the result will be a more balanced study with a total of 14 to each site: 1. Inter-row cultivation once (at VC); 2. Inter-row cultivation twice (at VC and V10);3. Inter-row-cultivation once (at V4-V6); 4. Inter-row-cultivation twice (at V4-V6 and V10-12); 5. Inter-row cultivation with hooded flaming once (at VC); 6. Inter-row cultivation with hooded flaming twice (at VC and V10); 7. Inter-row cultivation with intra-row hooded flaming once (at V4-V6); 8. Inter-row cultivation with intra-row hooded flaming twice (at V4-V6 and V10-V12); 9. Hooded flaming of both intra- and inter-row space once (at VC); 10. Hooded flaming of both intra- and inter-row space twice (at VC and V10-V12); 11. Hooded flaming of both intra- and inter-row space once (at V4-V6); 12. Hooded flaming of both intra- and inter-row space twice (at V4-V6 and V10-V12); 13. Weed-free control (hand weeding); 14.Weedy control (season long). For corn, the following will be added: New treatment 4, Inter-row cultivation alone (at V2-V3) followed by

cultivation-banded flaming (V5-V7); and new treatment 5, Inter-row cultivation alone (at V2-V3) followed by hooded flaming (V5-V7). Therefore, corn will have a total of 9 trts: 1. Weed free control (hand weeding-hoeing); 2. Inter-row-cultivation once (at V3-V4); 3. Inter-row-cultivation twice (at V3-V4 and V6-V7). 4. Inter-row cultivation alone (at V2-V3) followed by cultivation-banded flaming (V5-V7); 5. Inter-row cultivation alone (at V2-V3) followed by hooded flaming (V5-V7); 6. Inter-row cultivation with intra-row hooded flaming conducted once (V3-V4); 7. Inter-row cultivation with intra-row hooded flaming conducted twice (V3-V4 & V6-V7); 8. Intra-row and inter-row hooded flaming conducted once (V3-V4); 9. Intra-row and inter-row hooded flaming conducted twice (V3-V4 and V6-V7).

IMPACT

2009/09 TO 2014/08 What was accomplished under these goals? 2010 At HAL (Concord) and High Plains Ag Lab (HPAL-Sidney), we evaluated the use of flaming and cultivation as weed control methods in sunflower production. Our results showed that a combination of flaming and cultivation (at the same time) conducted at cotyledon and V12 (twelve leaf) stages provided up to 85% weed control with no reduction in sunflower yield. Additionally, our results in sunflower suggested that a combination of flaming and cultivation conducted at the proper timing could provide acceptable weed control with no reduction in yield. No-till soybean yield following crimping of a winter rye cover crop was more with drilling compared with planting in 30 inch rows. Studies at Clay Center suggest that hairy vetch planted as a winter cover crop and cultivated in before corn planting reduced weed pressure in corn. Comparison with the phenol levels and overall bioactivity between location and within variety are currently under evaluation. 2011 As examples of our outreach we report the following: SCAL organic wheat project tour, June 15. Rich Little showed conventional soft winter wheat variety plots sponsored by Hesco, Inc., plus studies using hairy vetch as weed control before popcorn (15 people). The organic project was discussed during a tour for the Research Center Administrators Society on August 17(40 people). UNL Rural Advantage/NSAS Healthy Farms Conference; five workshops, Managing Weeds with Crop Rotations, Managing Canada Thistle in Organic Systems, Integrated Approaches to Pest Management for Organic Vegetable and Fruit Production, Weed Control with Flaming. OCIA Annual Meeting, Richard Little, Wheat Breeding in the Northern Plains. Prairie Restoration Workshop/Organic Farm Tours, Larry Stanislav, organic farmer, discussed flamer practices for weed control, and cover crops experiments by Sam Wortman, UNL Ph.D. student and David Glett, UNL MS student, summarized the UNL Nutrient Management on-farm project. Mike Ostry of Wagon Wheel Farm shared results with UNL flamer for controlling weeds in corn. Antioxidant Evaluation of varieties exhibiting highest levels showed significant effects by variety (corn and soybeans) rather than treatment conditions. Flaming weeds in corn: at HAL in 2011 showed 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. Highest yields were obtained in the weed-free control (10.0 t/ha) and the flamed/cultivated treatment (9.4 t/ha). 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 flamed twice (1.6 t/ha). In 2011, banded flaming plus cultivation twice resulted in with 90% weed control and 10% crop injury. Satisfactory weed control can be achieved in sunflower when flamed twice, at the VC and V12 stages. At HAL a workshop on Flame Weeding 8/22/2011 had 30 participants. At HPAL when water was not limiting green manure fallow before winter wheat yielded same as black fallow. Supplemental N at jointing did not consistently add protein. John Quinn found and monitored 332 nests from 19 species. Nest success differed between years, 28% in 2010 and 14% in 2011, likely because of a cold wet spring across the region. In the previous year, there were 130 visits to the new bird song website and 409 visits to the Healthy Farm Index home page. 2012 Efforts to educate and extend organic knowledge has been accomplished through the following activities: Conducted Diversified Organic Farm Tours where cooperators discussed the University of Nebraska on-farm research studies: Nutrient Management Study, crop rotations, flaming for weed management, and moisture conservation on corn. The 2012 The Healthy Farm Index (HFI) program presented several programs: Birding on the Farm tours at Grain Place Foods, Common Good, and Sunset Farms. Met with organic farmers from Nebraska and Kansas on how to use the Healthy Farm Index to evaluate their farm\'s biodiversity. The 2012 Grain Place, Marquette, Nebraska annual farm tour in July featured the HFI research and on-farm research projects. Farmers transitioning to organic farming interacted with long-time organic farmers to learn about cultural practices. At the UNL Rural Advantage NSAS Healthy Farms Conference four workshops on crop sequencing and integrated systems and an update on UNL research using propane to control weeds were given. There were 12 On-Farm Research Projects included nutrient management on multiple sites with grain yields, test weights, crop moisture, crop and weed biomass production, weediness ratings, plant population, applied manure nutrients, rainfall, chlorophyll readings, and aerial photography (visible and near-IR). Antioxidant Evaluation of Varieties exhibiting highest levels showed significant effects by variety (corn and soybeans) rather than treatment

conditions. At the HPAL three studies were concluded these were: flaming for weed control in sunflower, winter wheat variety testing and measurement of greenhouse gasses comparing organic farming to reduced tillage. At the ARDC incorporating clover cover crops into a corn/soybean/wheat rotation has potential to increase yields and quality of all three crops and aid in weed control, but there may be soil moisture depletion in dry years. Overseeding clovers into wheat in early spring provides better germination and early clover growth and avoids establishment problems. 2013 Under the nutrient and weed management goal: field work for this component was completed in 2012, one graduate student finished his thesis in the fall 2013. Antioxidant production in organic grains and seeds; the antioxidants (flavonoid, phenols, and anti-oxidative capacity) were measured on various organically grown cultivars of winter wheat grown at the ARDC site were completed. Analysis of the results between cultivars and cross years are in progress. Biodiversity conservation and farm assessment field work component was completed in 2012. Several on-farm research projects continue. Soil samples were taken at the on-farm nutrient management sites and analysis will occur over 2014. A poster summarizing the results was presented in November, 2013. 2014 Nutrient and weed management: Nutrient management though on-station research, on-farm research, and farmer led research found mostly adequate nutrients available on organic farms; nitrogen and phosphorus management are both important and need to be monitored to avoid over or under availability. The survey of cooperating on-farm research sites and other organic farmers found median levels of pH, EC, SOM, P, and K of 7.0, 0.34 (dSm-1), 3.0(%), 54 (ppm), and 536 (ppm). These values represent a wide range, none are deficient, and in P and K, they are higher than statewide averages reported elsewhere. On-going at this time is fine tuning of the use of the roller crimper. Extension outreach has engaged the organic producers in the state in guiding the research through citizen advisory groups and our attendance at their meetings, as well as many one-on-one consults that have increased their capacity to conduct research on their own and improve their \'trial and error\' research. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/08 No publications reported this period.

2012/09 TO 2013/08 What was accomplished under these goals? 1) nutrient and weed management: The field work for this component was completed in 2012, one graduate student finished his thesis in the fall 2013. 2) antioxidant production in organic grains and seeds, The antioxidants (flavonoid, phenols, and anti-oxidative capacity) were measured on various organically grown cultivars of winter wheat grown at the ARDC site were completed. Analysis of the results between cultivars and cross years are in progress. 3) biodiversity conservation and farm assessment, The field work for this component was completed in 2012. 4) on-farm research capability. Soil samples were taken at the on-farm nutrient management sites and analysis of the results will be reported in next year's report. A poster summarizing the results was presented in November, 2013 and will be in the final report. **PUBLICATIONS (not previously reported):** 2012/09 TO 2013/08 1. Type: Journal Articles Status: Published Year Published: 2013 Citation: Wortman, S.E., Francis, C.A., Bernards, M.A., Blankenship, E.E., Lindquist, J.L., 2013. Mechanical Termination of Diverse Cover Crop Mixtures for Improved Weed Suppression in Organic Cropping Systems. Weed Sci. 61, 162?170. 2. Type: Journal Articles Status: Published Year Published: 2013 Citation: Wortman, S., C. Francis, T. Galusha, C. Hoagland, J. Van Wart, S. Baenziger, T. Hoegemeyer, and M. Johnson. 2013. Breeding Cultivars for Organic Farming: Maize, Soybean, and Wheat Genotype by System Interactions in Eastern Nebraska. Agroecol. Sustain. Food Sys. 37(8): 915-932. 3. Type: Book Chapters Status: Published Year Published: 2013 Citation: Francis, C.A. 2013. Organic farming. In: Reference Module in Earth Systems and Environmental Sciences, S.A. Elias, editor. Editor. Elsevier Publ. Co., Waltham, Massachusetts, USA. Doi: 10.1016/B978-0-12-409548-9.05237-4 4. Type: Book Chapters Status: Published Year Published: 2013 Citation: Francis, C.A. 2013. Crop rotations. In: Reference Module in Earth Systems and Environmental Sciences, S. A. Elias, Editor. Elsevier Publ. Co., Waltham, Massachusetts, USA. p. 318-322 5. Type: Journal Articles Status: Published Year Published: 2013 Citation: Quinn, J.E., A. Oden, J. Brandle. 2013. The influence of different cover types on American Robin nest success in organic agroecosystems. Sustainability. 5:3502-3512. 6. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Quinn, J.E, Giese, J., Oden, A., Brandle, J. 2013. Conservation of Bell?s Vireo in Managed Ecosystems. Poster presented at Nebraska Natural Legacy Conference. 7. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Quinn, J.E. 2013. Identifying conservation opportunities for species of conservation concern in managed ecosystems. Poster presented at 2013 Annual meeting of the Ecological Society of America. 8. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Quinn, J.E., A. Oden, and J.R. Brandle, 2013. Occupancy estimation on winter grounds: Integrating process-observation occupancy models with automated acoustic sampling. Paper presented at the 2013 British Ornithological Union spring meeting, University of Leicester, UK. 9. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Quinn, J.E. 2013. Conservation of Bell?s Vireo in agroecosystems. Poster presented at 2013 Wilson Ornithological Society annual meeting, Williamsburg, VA. 10. Type: Journal Articles Status: Published Year Published: 2013 Citation: Francis, C., A. Lawseth, A. English, P. Hesje, A. McCann, J. Jamieson, W. Wallen, G. Lieblein, and T.A. Breland. 2013. Adding values through experiential education in agroecology: experiences of Canadian MSc students. International Journal of

Agriculture and Food Research \Canada\. 2(2):7?17. 11. Type: Journal Articles Status: Published Year Published: 2013 Citation: Miller, M.M., M. Anderson, C.A. Francis, C. Kruger, C. Barford, J. Park, and B. McCown. 2013. Critical research needs for successful adaptation of food systems to climate change. J. Agric. Food Sci. Commun. Devel. J. Agric. Food Sci. Commun. Devel. \published online JAFSCD Aug 16, 2013: http://dx.doi.org/10.5304/jafscd.2013.034.016\ 12. Type: Theses/Dissertations Status: Accepted Year Published: 2013 Citation: Shi,Jianru. 2013. Decomposition rates and nutrient release of different cover crops in organic farm systems. MS Thesis. University of Nebraska. 13. Type: Other Status: Published Year Published: 2013 Citation: Little R.S., T. Regassa, E. Sarno, D. Santra, S. Wegulo, P. S. Baenziger. 2013. Selecting Winter Wheat Cultivars for Organic Production, NebGuide 2206, University of Nebraska Extension. Available online at http://www.ianrpubs.unl.edu/epublic/pages/publicationD.jsp?publicationId=1568

2011/09/01 TO 2012/08/31 Comprehensive evaluation of the project to date has not been conducted. Efforts to educate and extend organic knowledge has been accomplished through the following activities:Conducted Diversified Organic Farm Tours where cooperators discussed the University of Nebraska on-farm research studies: Nutrient Management Study, crop rotations, flaming for weed management, and moisture conservation on corn.The 2012 The Healthy Farm Index (HFI) program presented several programs: Birding on the Farm tours at Grain Place Foods, Common Good, and Sunset Farms. Met with organic farmers from Nebraska and Kansas on how to use the Healthy Farm Index to evaluate their farm\'s biodiversity. The 2012 Grain Place, Marquette, Nebraska annual farm tour in July featured our work with the HFI research and on-farm research projects. The 2012 Organic Wheat Plot Tour at the four research farms showed winter wheat varieties and other trials: for yield and quality, killing hairy vetch with roto-tiller following popcorn cash crop. ARDC cover crop demos, winter wheat plots and cover crops to increase protein; HAL winter wheat plots, nutrient management, cover crops, flaming; HPAL winter wheat plots, winter legume, flaming sunflowers. The organic project was discussed at the Research Center Administrators Society field day. At the Organic Crop Improvement Association NE Chapter 1 Annual Meeting Managing Weeds with Crop Rotations on a weed management was presented. Farmers transitioning to organic farming had opportunity to interact with long-time organic farmers to learn about cultural practices. At the UNL Rural Advantage NSAS Healthy Farms Conference four workshops on crop sequencing and integrated systems and an update on UNL research using propane to control weeds were given. At the OCIA Annual Meeting presented these workshops Plan for Your Market and Wheat Breeding in the Northern Plains. Prairie Restoration Workshop Organic Farm Tours were conducted using a prairie walk to identify native plants, discuss control of invasive species, restore, and manage native prairie and biodiversity. There were 12 On-Farm Research Projects included nutrient management on multiple sites with grain yields, test weights, crop moisture, crop and weed biomass production, weediness ratings, plant population, applied manure nutrients, rainfall, chlorophyll readings, and aerial photography (visible and near-IR). Antioxidant Evaluation of varieties exhibiting highest levels showed significant effects by variety (corn and soybeans) rather than treatment conditions. At the HPAL three studies were concluded these were: flaming for weed control in sunflower, winter wheat variety testing and measurement of greenhouse gasses comparing organic farming to reduced-tillage. At the ARDC incorporating clover cover crops into a corn/soybean/wheat rotation has potential to increase yields and quality of all three crops and aid in weed control, but there may be soil moisture depletion in dry years. Overseeding clovers into wheat in early spring provides better germination and early clover growth and avoids establishment problems.

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component present in multiple crops will be forthcoming. Comparison of estimated avian occupancy and nesting patterns suggests lack of nest initiation by many native shrubland species occupying organic farms in the region. Preliminary analysis of nest site selection by observed nesting species suggests that Mimids are selecting based on perceived site quality. Comparison of estimated avian occupancy and nesting patterns suggests lack of nest initiation by many native shrubland species occupying organic farms in the region. Preliminary analysis of nest site selection by observed nesting species suggests that Mimids are selecting based on perceived site quality.

PUBLICATIONS

2011/09/01 TO 2012/08/31 1. Shapiro C., E. Sarno, C. Francis, T. Hansen. 2012. UNL Organic Farming Research, NebGuide 2120, University of Nebraska Extension. 2. Drew J. Lyon and Gary W. Hergert. 2012. Nitrogen fertility in semiarid dryland wheat production is challenging for beginning organic farmers. Renewable Agriculture and Food Systems, Available on CJO 2012 doi:10.1017/S1742170512000324. 3. Quinn, J.E., J. Brandle, and R. Johnson. 2012. A farm-scale biodiversity and ecosystem services assessment tool: The Healthy Farm Index. International Journal of Agricultural Sustainability. 4. Quinn, J.E., J. Brandle, and R. Johnson. 2012. The effects of land sparing and wildlife-friendly practices on grassland bird abundance within organic farmlands. Agriculture Ecosystems, & Environment. 161:10-16. 5. Quinn, J.E. 2012. Sharing a vision for biodiversity conservation and agriculture. Renewable Agriculture and Food Systems. 6. Quinn, J.E., J.R. Brandle, R.J. Johnson and T. Awada. 2012. Conservation targets in managed ecosystems: consideration of tradeoffs and scale. Ecological Society of America 2012 Emerging Issues Conference. 7. Quinn, J.E. and J.R. Brandle. 2011. Determinates of avian nesting success in organic agroecosystems. Poster presented at Midwest Fish and Wildlife Conference. Des Moines, IA. 8. Sarno E., G. Lesoing, C. Francis, T. Hansen. 2012. Transitioning to Organic Farming, NebGuide 2145, University of Nebraska Extension. 9. Sarno E., C. Francis, T. Hansen. 2012. Developing an Individual Farm Organic System Plan, NebGuide 2146, University of Nebraska Extension. 10. Sarno E., C. Francis, T. Hansen. 2012. Certification Process for Organic Production, NebGuide 2163, University of Nebraska Extension.

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Eorganic: the National Online Information, Training, and Networking System for Organic Agriculture

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NON-TECHNICAL SUMMARY

Extension has traditionally been a source of reliable, science-based agricultural information for farmers and agricultural professionals. Until recently, Extension personnel typically have had little direct experience or training in organic agriculture, and there has been little published Extension information on organic agricultural practices. The growth in organic market opportunities has increased the demand on Extension personnel across the country to supply this clientele with information on all aspects of organic production. eOrganic, the eXtension Organic Agriculture Community of Practice and Resource Area at eXtension.org, was initiated in 2006 to fill this information gap. eOrganic publishes science-, experience- and regulation-based articles, FAQs, and videos authored by researchers, educators, farmers, certifiers and others with expertise in organic agriculture (at eXtension.org). eOrganic also answers organic agriculture questions through eXtension\'s Ask-an-Expert system. eOrganic members author and review eXtension content in its collaborative workspace (at eOrganic.info). This workspace is also developing as a web community supporting research/outreach project management and researcher/educator/practitioner networking and learning. In the long term, eOrganic\'s farming systems, discipline, and RO groups will efficiently deliver critical, high quality, research-, experience- and regulation-based information, through articles, videos, webinars, and short courses, to farmers, extension and other agricultural professionals, researchers, and certifiers in every state in the nation, resulting in enhanced sustainability of organic farms. eOrganic\'s active and engaged online research-outreach community will foster networking and collaboration amongst researchers, educators, agricultural professionals, and farmers engaged in understanding and improving organic farming systems. This community and its activities should increase the rate of learning about and the depth of understanding of these systems, as well as increase the rate of translation of organic farming systems research results into eOrganic content. These changes in understanding and translation will significantly increase the impact of OREI and other federal research dollars.

OBJECTIVES

Goal 1: Further develop eOrganic, the Organic Agriculture Resource Area at eXtension.org, as a resource for farmers, agricultural professionals, certifiers, researchers and educators seeking information on best organic agricultural practices, research results, farmer experiences, and certification. Goal 2: Train organic farmers, extension personnel, and other agricultural professionals in organic agricultural principles and practices. Goal 3: Facilitate researcher/educator networking, collaboration, and research and outreach project management through the eorganic.info workspace and web community. This project will publish at least 60 articles, 10 videos, and 45 FAQs at eXtension.org/YouTube in 09-10. eOrganic will continue to improve its drupal collaborative workspace to facilitate content development, review and publication; group management; and community networking. The 2 farming systems and 7 discipline groups will coordinate at least 11 webinars for farmers and agricultural professionals and 9 virtual seminars for researchers, ag professionals and farmers. Research/outreach groups will deliver at least 6 virtual project or farm tours for researchers, educators and farmers. This project will also publish at least one peer-reviewed journal article on the eOrganic workspace and public content.

APPROACH

The 2 farming system (dairy and vegetable production) and 7 discipline groups will focus this year on group and content development. Core members of each group will convene in a work retreat. By the end of the work intensive each participant will work collaboratively in the workspace and complete one final article draft; each group will describe its content goals, outline, and deliverables (# and titles of articles/FAQs/video/webinars) for the year. On average, each group will publish 9 articles, 1 video, and 5 FAQs. Quality and utility of articles, FAQs and videos will be evaluated through the use of surveys and focus groups with farmers, extension professionals and other content user groups. eOrganic will reach out to farmers, ag professionals, researchers and other stakeholders through our public content, webinars, and the eOrganic.info web community, as well as through outreach activities at organic and other farming conferences and agriculture professional society meetings.

PROGRESS

2011/09 TO 2012/08 OUTPUTS: From October 1, 2011 through September 30, 2012, eOrganic published 20 new articles, 7 new videos, 24 new webinars, 7 live conference broadcasts, 6 abstracts and conference presentations, 6 newsletters, and an annual report. eOrganic broadcast live presentations from the NOFA Organic Dairy and Field Crop Conference in New York, the Dryland Organic Grains Conference, The Organic Seed Grower\'s Conference, the 2nd International Organic Fruit Symposium in Washington state, the Carolina Organic Commodities and Livestock Conference in North Carolina, the Illinois Specialty Crops and Agritourism Conference, and a fly management workshop at the University of New Hampshire. Approximately 179 Ask An Expert Questions were answered within the past year In January-March, 2012, eOrganic conducted an online Introduction to Video Production course on the eXtension Moodle campus. There were 12 participants, who were university and Extension researchers from funded NIFA OREI and ORG projects that included funding for eOrganic. The instructors taught the basics of video planning, making storyboards, filming, and creating production plans so that they can create videos about their research for publication on eXtension.org. Materials from the course are now publicly available on the Moodle campus site. Representatives from eOrganic attended three major organic farming conferences in early 2012: The Ecological Farming Conference (Eco-Farm) in California, the MOSES Organic Farming Conference in Wisconsin, and the PASA conference in Pennsylvania. eOrganic had booths at these conferences and ads in the conference programs. eOrganic was also represented at both the Tennesee and Oregon Small Farms Conferences, and the NOFA Vermont Conference. Presentations about eOrganic were given at the American Society of Agronomy Meeting, the American Society of Horticultural Science meeting, the NOFA Organic Research Symposium, and at the University of Minnesota, the University of Arkansas, and the island of Dominica. In addition, CoP members presented a workshop on eXtension Learn on eOrganic\'s evaluation efforts attended by members of other eXtension communities. Articles about eOrganic were submitted and accepted to the HortTechnology journal (Stone, et al. 2012), as well as the Washington Tilth Producers magazine. eOrganic advertised in the monthly periodical Growing for Market. This publication serves market gardeners and small farms. It has an estimated circulation of 5,000. eOrganic publishes a bi-monthly newsletter (3500+ subscribers) that features newly published articles, upcoming and archived webinars, important organic news, and more. eOrganic maintains an active presence on social media sites such as Facebook, Twitter, and YouTube, which have been experiencing steady growth. Our YouTube channel has over 880,000 views and over 1100 subscribers, and we have 1423 Twitter followers and 1097 Facebook likes over the lifetime of the accounts. PARTICIPANTS: eOrganic has approximately 1000 members, including researchers, Extension and government agency personnel, organic certifiers, inspectors, farmers, and agriculture professionals. More than 200 members have actively contributed to eOrganic by authoring or reviewing articles and FAQs, producing or reviewing videos, answering Ask an Expert questions, presenting webinars or by

delivering other contributions. eOrganic Leadership Team: The eOrganic Community of Practice is led by the eOrganic Leadership Team (LT), comprised of leaders of content groups and the Project Leader and Senior Coordinator. LT members included Jim Riddle, U of MN (leader, certification group); Heather Darby, U of VT and Cindy Daley, Chico State (leaders, dairy farming systems group); Danielle Treadwell, U of FL (leader, cover crops group); Alex Stone, Oregon State (Project Leader); John McQueen, Oregon State (Senior Coordinator). The LT met by webconference 6 times per year. Project Leader: Alex Stone led the eOrganic CoP and Leadership Team, facilitated long term planning and short term management, supervised staff, raised funds, and served as eXtension and public liaison. eOrganic salaried staff Workspace Developer Roger Leigh provided required functionality by creating custom code when not publicly available, and maintained the workspace. Senior Coordinator, Web 2.0 Coordinator, and Workspace Manager John McQueen administered the workspace, YouTube, Facebook, Twitter and eXtension websites; trained staff and members; assisted Leigh with workspace development. Communications Coordinator Alic e Formiga, Oregon State coordinated the webinar series, authored user guides, published eOrganic News and conducted evaluation. Content coordinators: Deb Heleba coordinated the dairy group, as well as peer review and eOrganic.info membership for the first two years; Ed Zaborski coordinated the soils, insect, weed, and cover crops groups, and acted as Senior Editor; following the departure of Ed Zaborski, Cindy Salter conducted copy editing. Alice Formiga coordinated the vegetable and disease groups. NOP Compliance Reviewer and Certification Coordinator Jim Riddle reviewed all content for NOP compliance, authored certification content, and presented webinars. Lane Selman, Oregon State conducted a video training class attended by 12 participants from NIFA OREI project groups. TARGET AUDIENCES: eOrganic considers its primary Community of Interest (stakeholders of its public content) to be organic farmers and other farmers interested in certified organic agricultural information, as well as the Extension and other agricultural professionals who support them. eOrganic\'s stakeholders also include its more than 1000 eOrganic.info community members, comprised of researchers, educators, extension professionals, farmers, and other organic agriculture practitioners and service providers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: Activities: eOrganic\'s leadership team, content groups, and administrative groups meet regularly to plan, coordinate and develop eOrganic. The publication and staff groups coordinate the publication of eOrganic\'s articles, FAQs, videos, webinar series, Ask an Expert, newsletters, and other public content. The evaluation group coordinates evaluation of articles and webinars. Staff train members in use of the workspace and group tools including publication to eXtension. Products: eOrganic developed its public site at http://www.extension.org/ organic production (articles, FAQs, videos, webinars, Ask an Expert, newsletters) and its community and publication workspace at http://eorganic.info (group workspaces and tools, community networking, personal pages, help and training, publication to http://www.extension.org/organic production). eOrganic initiated and continues to develop a Facebook site (http://www.facebook.com/eorganic), a Twitter presence (http://twitter.com/eOrganic CP), and a Youtube site (http://www.youtube.com/eorganic) Services: eOrganic provides information, answers, and training to farmers, service providers, and others interested in organic agriculture. eOrganic coordinates peer and NOP compliance review, evaluation, marketing, and outreach for its public content for the eOrganic community. eOrganic supports members and project groups in group management and communication and publication to eXtension. eOrganic trains members in video, webconferencing, and other Web 2.0 tools and strategies. Dissemination: eOrganic members distribute outreach materials, staff booths, and give presentations at major and smaller events around the country, including small farms and dairy conferences and short courses. eOrganic has had a significant presence at 1) EcoFarm, CA (west), 2) PASA, PA and NOFA-VT (northeast), and 3) the Organic Farming Conference, WI (midwest). eOrganic distributes fact sheets describing the public content and site, eOrganic bookmarks with the url for the public site, and trifold brochures targeted to prospective eOrganic.info members. eOrganic has had a presence at more than 80 conferences, meetings, and workshops and communicated directly with more than 18000 individuals. eOrganic reaches out to eOrganic.info members and public stakeholders through its two bi-monthly newsletters as well as its webinar series and its Facebook, Twitter, and Youtube presences. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Activities: eOrganic\'s leadership team, content groups, and administrative groups meet regularly to plan, coordinate and develop eOrganic. The publication and staff groups coordinate the publication of eOrganic\'s articles, FAQs, videos, webinar series, Ask an Expert, newsletters, and other public content. The evaluation group coordinates evaluation of articles and webinars. Staff train members in use of the workspace and group tools including publication to eXtension. Leaders and staff coordinated events including the eOrganic visioning meeting and workshops at the National SARE, NCERA-59, and National Association of County Ag Agents conferences. Products: eOrganic developed its public site at

http://www.extension.org/ organic production (articles, FAQs, videos, webinars, Ask an Expert, newsletters) and its community and publication workspace at http://eorganic.info (group workspaces and tools, community networking, personal pages, help and training, publication to http://www.extension.org/organic production). eOrganic, in partnership with eXtension, developed a feed from eOrganic.info to eXtension.org so content developed at eOrganic.info could be published to eXtension. eOrganic initiated and continues to develop a Facebook site (http://www.facebook.com/eorganic), a Twitter presence (http://twitter.com/eOrganic CP), and a Youtube site (http://www.youtube.com/eorganic) Services: eOrganic provides information, answers, and training to farmers, service providers, and others interested in organic agriculture. eOrganic coordinates peer and NOP compliance review, evaluation, marketing, and outreach for its public content for the eOrganic community. eOrganic supports members and project groups in group management and communication and publication to eXtension. eOrganic trains members in video, webconferencing, and other Web 2.0 tools and strategies. Dissemination: eOrganic members distribute outreach materials, staff booths, and give presentations at major and smaller events around the country, including small farms and dairy conferences and short courses. eOrganic has had a significant presence at 1) EcoFarm, CA (west), 2) Southern SAWG Conference, TN (south); 3) PASA, PA and NOFA-VT (northeast), and 4) the Organic Farming Conference, WI (midwest). eOrganic distributes fact sheets describing the public content and site, eOrganic bookmarks with the url for the public site, and trifold brochures targeted to prospective eOrganic.info members. eOrganic has had a presence at more than 80 conferences, meetings, and workshops and communicated directly with more than 18000 individuals. eOrganic reaches out to eOrganic.info members and public stakeholders through its two bi-monthly newsletters (most recent at http://www.extension.org/article/29037), as well as its webinar series and its Facebook, Twitter, and Youtube presences. In addition, eOrganic reaches out to diversified vegetable farmers through its ads in http://www.growingformarket.com/. PARTICIPANTS: eOrganic Leadership Team: The eOrganic Community of Practice is led by the eOrganic Leadership Team (LT), comprised of leaders of content groups and the Project Leader and Senior Coordinator. LT members included Mary Barbercheck, Penn State (leader, insect management group); Michelle Wander, U of IL (leader, soils group); Jim Riddle, U of MN (leader, certification group); Heather Darby, U of VT and Cindy Daley, Chico State (leaders, dairy farming systems group); Danielle Treadwell, U of FL (leader, cover crops group); Tim Coolong, U of KY (leader, diversified vegetable cropping systems group); Corinne Alexander, Purdue (leader, economics group); Eric Gallandt, Univ. of ME (leader, weed management group); Alex Stone, Oregon State (Project Leader); John McQueen, Oregon State (Senior Coordinator). The LT met by webconference 6 times per year. Project Leader: Alex Stone led the eOrganic CoP and Leadership Team, facilitated long term planning and short term management, supervised staff, oversaw evaluation, supervised editorial management of content, raised funds, and served as eXtension and public liaison. eOrganic salaried staff Workspace Developer Roger Leigh provided eOrganic with insight into emerging web technologies; developed the eOrganic.info workspace and feed to eXtension in cooperation with John McQueen; identified, tested and installed suitable open source software for the project (built around a core Drupal content management system), provided required functionality by creating custom code when not publicly available, and maintained the workspace. Senior Coordinator, Web 2.0 Coordinator, and Workspace Manager. John McQueen provided eOrganic with insight on how best to adopt and adapt Web 2.0; administered the workspace, YouTube, Facebook, Twitter and eXtension websites; trained staff and members; assisted Leigh with workspace development; provided workspace support, identified usability and workflow issues; led testing on all enhancements and updates; provided technical support for webinars and short course software; and acted as technical liaison to eXtension. Communications Coordinator Alice Formiga coordinated the webinar series, authored user guides, and published eOrganic News. Content coordinators: Deb Heleba coordinated the dairy group, as well as peer review and eOrganic.info membership for the first two years; Ed Zaborski coordinated the soils, insect, weed, and cover crops groups, and acted as Senior Editor; Alice Formiga coordinated the vegetable and disease groups. eOrganic Core Contractors. NOP Compliance Reviewer and Certification Coordinator Jim Riddle reviewed all content for NOP compliance, authored certification content, and presented webinars. Evaluator. Michael Coe of Cedar Lake Research Group coordinated evaluation of eOrganic\'s articles and webinars. Thirty-nine eOrganic members presented webinars and 69 authored articles (see publication section); in addition, 108 members answered Ask-an-Expert questions. TARGET AUDIENCES: eOrganic considers its primary Community of Interest (stakeholders of its public content) to be organic farmers and other farmers interested in organic agricultural information, as well as the Extension and other agricultural professionals who support them. During eOrganic\'s first 3 years, the primary stakeholder groups were organic dairy farmers, diversified fresh market vegetable farmers, and the service providers who support them. eOrganic\'s stakeholders also include its more than 700 eOrganic.info community members, comprised of researchers, educators, extension professionals, farmers, and other organic agriculture practitioners and service providers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2011/09 TO 2012/08 Evaluation of eOrganic webinars: eOrganic evaluation reports can be found at http://eorganic.info/evaluation. Since December, 2010, participants in eOrganic webinars and conference broadcasts have received an online feedback survey. Across all survey respondents, 75% said the webinar improved their understanding of the topic and 78% said they would apply the knowledge gained; 83% said they would recommend the webinar to others. Only 4% of respondents said they had difficulty accessing the webinar or broadcast. Respondents were also asked how helpful they found eOrganic resources on eXtension such as articles, videos, other live and recorded webinars, and Ask-an-Expert; these were rated higher in 2011-12 than in the previous season. eOrganic sent an impact evaluation survey to all participants of 16 webinars 6-18 months after the webinars were broadcast. Out of 691 total respondents, 69% (almost equally divided between farmers and agricultural professionals) responded that they had changed practices or provided others with information, or were better able to communicate with farmers about the topic as a result of the webinar. Specific changes made by farmers and farm advisors are listed in the report. Self-evaluation of eOrganic by active Community of Practice members: With support from the Institute for Conservation Leadership, eOrganic surveyed 189 active members (members who had contributed to eOrganic as leaders, authors, reviewers, Ask-an-Expert responders, webinar presenters) in fall 2011. Fifty-five members (29%) responded. Fifty four percent of respondents ranked two eOrganic activities as Essential or Very Important: connecting a national community of organic professionals (farmers, certifiers, researchers, extension, etc.) at eOrganic.info, and facilitating engagement among farmers and organic professionals through webinars. Collaborative development of peer-reviewed articles for eXtension was ranked Important or greater by 69% of respondents, followed by video production (65%). Participation in the Ask-an-Expert feature of eXtension was ranked Important or greater by the majority of respondents, but to a lesser degree than other activities. Members viewed eOrganic as important because it is the only organic agriculture national resource with direct ties to university research. Members felt that the information on the site was credible and that eOrganic\'s relationship with eXtension provides eOrganic with credibility and visibility. They felt that the technology services eOrganic provides to research and outreach groups are valuable, and that it was a strength that eOrganic offered multiple functions and services under one umbrella. **PUBLICATIONS (not previously reported):** 2011/09 TO 2012/08 1. 2nd International Organic Fruit Research Symposium. (2012). eOrganic webinars. 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2010/09/01 TO 2011/08/31 eOrganic is a significant national organic agriculture web resource and one of eXtension\'s most-accessed resource areas. eOrganic has published more than 225 articles, 90 FAQs, 200 videos, and 40 webinars to eXtension.org/organic production and www.youtube.com/eOrganic. eOrganic\'s pages at eXtension.org have received more than 700,000 page views since October 2009 and its Youtube videos have been viewed 500,000 times. More than 3500 people attended eOrganic\'s first 40 webinars. eOrganic\'s community has answered more than 750 Ask-an-Expert questions. eOrganic communicates bi-monthly with its more than 2700 newsletter subscribers and keeps in frequent touch with its 500 Facebook fans, 500 Twitter followers, and 280 Youtube subscribers. eOrganic also reaches out to more than 8000 farmers and agricultural professionals through booths and other activities at 3 or 4 major (and many more minor) organic farming conferences across the US each winter. eOrganic is now in the process of surveying its users to evaluate the quality and impact of its resources and activities. In addition, eOrganic.info (eOrganic\'s community and publication workspace) was developed; this site currently has more than 700 members (researchers, educators, extension professionals, farmers, certifiers, and service providers). More than 25 NIFA proposals have included eOrganic in their plans of work. A survey was sent to participants in 8 eOrganic webinars 6-12 months after the webinars took place, in order to evaluate the impact of the webinars on the participant\'s knowledge, intentions or practices. 57 to 89% answered that the webinar \"moderately\" or \"significantly\" improved their understanding of the topic. 55 to 82% answered that they had applied the knowledge gained \"somewhat\" or \"a lot.\" 53 to 93% affirmed that their webinar experience had contributed to changes in their farming practices. 35 farmer participants in the Blueberry Production webinar stated that they changed practices as a result of attending the webinar. 5 (14%) planted blueberries in raised beds. 8 (23%) used weed mat in blueberry beds. 5 (14%) increased irrigation levels if using raised beds or weed mat. 11 (31%) changed irrigation practices. 4 (11%) used less fertilizer on young plants. 11 (31%) used fish emulsion as fertilizer. 6 (17%) decided against using vinegar or flaming as the sole means of controlling weeds. 10 (29%) other. 22 respondents stated that they provided the following information to farmers. 11(50%) planting blueberries in raised beds. 5 (23%) using weed mats in blueberry beds. 4 (18% increasing irrigation levels if using raised beds or weed mat. 8 (36%) changing irrigation practices. 8 (36%) using less fertilizer on young plants. 7 (32%) using fish emulsion as fertilizer. 5 (23%) deciding against using vinegar or flaming as the sole means of controlling weeds. 5 (23%) other topics (not stated).

2009/09/01 TO 2010/08/31 eOrganic is a significant national organic agriculture web resource and one of eXtension\'s most-accessed resource areas. eOrganic has published more than 180 articles, 90 FAQs, 200 videos, and 25 webinars to eXtension.org/organic production and www.youtube.com/eOrganic. eOrganic\'s pages at eXtension.org have received more than 270,000 page views since October 2009 and its Youtube videos have been viewed 250,000 times. eOrganic\'s community has answered more than 600 Ask-an-Expert questions. Two thousand people from all over the country attended the first 23 webinars hosted by eOrganic in winter and spring 2010. eOrganic communicates bi-monthly with its more than 2700 newsletter subscribers and keeps in frequent touch with its 500 Facebook fans, 500 Twitter followers, and 280 Youtube subscribers. eOrganic also reaches out to more than 8000 farmers and agricultural professionals through booths and other activities at 3 or 4 major (and many more minor) organic farming conferences across the US each winter. eOrganic is now in the process of surveying its users to evaluate the quality and impact of its resources and activities. In addition, eOrganic.info (eOrganic\'s community and publication workspace) was developed; this site currently has more than 700 members (researchers, educators, extension professionals, farmers, certifiers, and service providers). More than 10 NIFA proposals have included eOrganic in their plans of work. Reviewers of eOrganic articles indicate that articles have high relevance, quality, and utility. Of the reviewers, 29 percent described themselves as farmers, 38 percent researchers, and 33 percent extension personnel. On average, the reviewers (from Florida, Idaho, Indiana, Kentucky, Maine, North Carolina, Oregon, Pennsylvania, Virginia, and Washington) have been involved in agriculture and organic agriculture for 18.1 and 10.0 years, respectively. They considered the information to be accurate (100 percent strongly/moderately agreed); very relevant to important farming problems or issues (93 percent strongly/moderately agreed); useful and practical and could be applied in real farming practice (90 percent strongly/moderately agreed). Feedback from the first 215 webinar participants (49% farmers, 21% agricultural professionals, 12% extension personnel, 7% researchers, 7% non-profit staff, 4% master gardeners) has been collected. 30% from northeast, 26% central US, 33% west, and 11 % south. Eighty-eight percent said

the webinar improved their understanding significantly/moderately. 86 percent said they would apply the knowledge in their work a lot/somewhat. 94 percent would recommend the webinar to others. eOrganic will evaluate the impact of past webinars on participant knowledge and practices in winter 2010-11.

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Organic Stone-fruit Production: Optimizing Water Use, Fertility, Pest Management, Fruit Quality and Econmics

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NON-TECHNICAL SUMMARY

Fruit production in Utah and throughout the Intermountain West has come under increasing pressure in recent years due to: rising input costs, diminishing water supplies, and urban encroachment. Growers are seeking new management and marketing opportunities to withstand these pressures. While Utah has several regions historically noted for high quality fruit production, there are currently no organic stone-fruit growers in the state. Pressures from pests such as western cherry fruit fly and weeds kept growers in the area skeptical about transitioning to organic management. With conventional growers successfully implementing attract-and-kill and reduced-risk insecticides such as spinosyns, interest in organic management has grown. Managing weeds and fertility now appear to be the greatest challenges to organic production. As irrigation water is already a limiting factor, sustainable orchard floor management will need to optimize water use. We are proposing to carry out a long-term on-farm replicated trial of organic peach management systems, along with several companion orchard floor trials, and evaluate these for weeds, insects, fertility, water use, fruit quality, and economic potential. The goal is to compare management systems for suitability to arid climates with cold winters and shallow alkaline soils, to quantify the benefits and/or tradeoffs of these systems, to demonstrate these strategies to growers, and to train crop consultants, extension professionals and students in regionally appropriate organic practices. Results from these research and outreach efforts will enable local experts to better advise growers on organic fruit management strategies and lead to adoption of organic stone-fruit production in the region.

OBJECTIVES

The goals of this project are to: 1) develop a long-term on-farm research site devoted to testing and showcasing organic stone-fruit management strategies for increased water use efficiency, soil quality, pest management, fruit quality and economic stability in climates characterized by arid summers and cold winters; 2) develop a county Extension personnel trained in organic production methods; 3) work with Extension Agents, growers, fruit industry personnel, and national park officials to improve quality of life of rural populations by enhancing access to environmentally friendly, locally produced and nutritious foods while maintaining productive farmland through increased farm profitability and reduction of pesticide use. We will work towards these goals through the following

specific objectives: A. Characterize potential tradeoffs in water use efficiency and tree growth with living and non-living mulches, internal and external fertility inputs, and soil quality. B. Characterize weed and arthropod response to organic management practices. C. Select orchard floor cover crops for optimizing weed suppression, arthropod dynamics, water use, and early season N release for cold winters, arid summers and shallow alkaline soils. D. Select orchard floor management for maximum fruit quality, environmental benefit and economic return. F. Increase adoption of stone-fruit organic production through education and outreach.

APPROACH

Two orchards were established in April of 2008 at the USU Horticulture Research Station in Kaysville UT. The organic site was planted in a randomized complete block design with 4 blocks and 6 treatments. The six treatments are 1) straw mulch with a grass alleyway 2) straw mulch and a legume alleyway 3) living mulch (low-growing shallow rooted allysum) with grass alleyway 4) living mulch and legume alleyway 5) woven plastic mulch with a grass alleyway 6) tillage and high compost with grass alleyway. The conventional orchard is located next to the certified organic orchard on the same soil type and planted as described above. Three treatments include: 1) conventional herbicide + NPK as an industry standard, 2) conventional herbicide + NPK to be converted to organic after tree establishment and, 3) organic from planting, compost + spray on paper mulch. Tree leaf N and nutritional status will be assessed every year and these results used to determine fertilization rates. Percent increase in tree cross sectional area will be measured yearly. Soil nitrogen status will be determined at monthly intervals from May through August. Macro and micro elements will be measured yearly. Each experimental plot is equipped with an individually controlled micro sprinkler irrigation system. Flow meters in the system also allow for precisely determining water inputs. In order to assess soil quality differences between treatments, soil will be sampled in May during the course of the study. Each plot will be visually surveyed and all weed species in the plots recorded regardless of the number of plants present. Weed response to mulch and alleyway treatments will be evaluated by measuring weed densities within each treatment. Each type of arthropod sample will be collected to correspond to key tree phenology stages: 1) bloom (late April - early May), 2) shuck-split (early June), 3) pit-hardening (late June - early July), 4) rapid fruit enlargement (late July - early August), 5) harvest (late August - early September), and 6) post-harvest (late September).Novel cover crops will be assessed for suitability in orchards under Utah conditions in a separate trial. Establishment, weeds and arthropods will be monitored as described above. Fruit quality will be measured in year three and four of the study on the second and third expected crop. Sensory evaluation at the USU Food Science sensory evaluation laboratory will be conducted with 15 trained panelists1 All input costs will be tracked for each treatment. A sample of fruit from each treatment will be freeze dried for fruit chemistry analysis using HPLC. Cost benefits analysis will be conducted for each management scenario in the orchard trials using partial budgets. Capital budgeting techniques will be used to allow multiple years of the growing cycle to be taken into account. Each of the participating growers will test one, two or three of the above management plans in their own orchards depending on interest and available trees for the experiment. They will select the plan most suited to their operation, available equipment, interests, and needs, and modify it as needed. **PROGRESS: 2009/09 TO 2014/08** Target Audience: Target Audience Tree fruit growers, industry personnel and extension agents as well as the regional and national research community. Changes/Problems: Changes/Problems Our major challenge was the loss of our peach crop in 2012 to a killing frost. So we extended the project one more year so as to have two years of fruit data (2013 and 2014). In 2013 we conducted consumer sensory evaluations of the peaches on both varieties of peaches included in the trial (Starfire and Coralstar). Several harvest dates were pooled to account for potential differences due to ripeness. After looking at the findings from 2013 it became clear that consumers were focusing on differences in ripeness between peaches harvested at different dates and we worried that this might have distracted them from noticing more subtle differences between treatments. As a result we decided to concentrate on Coralstar only in 2014 and instead conduct multiple sensory tests on individual harvest dates. As both the Starfire and Coralstar varieties are very closely related (peak harvest date being the principle difference), we don\'t anticipate this to cause problems with publishing the results. We were disappointed that only two conventional growers expanded and or started the organic transition process as a result of participation in this project. Although several more growers have introduced legume cover crops into their conventional orchards as a result of findings generated. Our assessment has been that growers very much respond to short-term economic realities on the farm and while interest in organic tree fruit was intense during the recession, as markets rebounded (aided by poor harvests due to climatic events in competing states) interest in certified organic production by the large-scale growers has waned. We expect that this is a short-term effect but it illustrates the necessity for building long-term extension efforts in organic agriculture in order to transition more acreage. As outreach efforts on the project proceeded we discovered a new audience that had been historically underserved by extension services in Utah, however, the urban and small farms community in and around the Salt Lake City area. We therefore substantially refocused and expanded our efforts to reach this community and have been very happy with the response we have received as a result. The Annual Diversified Agriculture Conference historically held in Utah has been retooled to focus

more heavily on urban and small farmers (now the Urban and Small Farms Conference). And the unprecedented interest generated for the organic workshops held in conjunction with this conference has resulted in Utah extension deciding to make organic workshops a regular part of this conference in the future. What opportunities for training and professional development has the project provided? Opportunities OBJECTIVE A PhD Student Mae Culumber and MS students Marc Rowley and Esther Thomsen were trained in soil moisture monitoring, data collection and processing, laboratory analysis and given opportunities in public speaking. The project also supported Mae and Marc as they wrote their dissertation and thesis chapters. In addition one technician (Kareem Adeleke), four hourly workers (Alicia Campbell, Leanna Reynolds, Mark Womack, Bill Burns, Erin Patrizzo) and six undergraduate students (Andrew Noorlander, Jeremy Crapo, Ashley Salisbury, Moire Lindstrom, Gaia Nafsziger, Kirsten Lindstrom,) were trained in orchard maintenance, soil moisture monitoring, field sampling and laboratory analysis. Findings from this project were presented to students attending PSC 2800 Fundamentals of Organic Agriculture over four semesters. Faculty and students gave three research presentations and five posters on the findings at the Second International Organic Fruit Symposium, the Soil Science Society of America, the American Society for Horticultural Sciences, and the Organic Farming Systems Research Conference. Three presentations were also given by students and faculty at the Plants Soils and Climate department seminar. Three growers (Wayne Hanks, Randy Ramsley, and Mark Rowley) have worked alongside USU researchers to design and carry out on-farm research projects on this project and a further a further five growers gained knowledge of the research process through participating on our grower advisory panel (Steve Ela, Ray Rowley, Curtis Rowley, Alan Riley and Kenyon Farley). OBJECTIVE B A PhD student (Andrew Tebeau) and fourteen undergraduate students (Trevor Ballard, Jessica Smith, Danielle Phillips, Lacey Johnson, William Dew, Tyler Shumway, Forest Young, Jessica Shaw, Cassandra Collard, Harlie Hutchison, Megan OLaughlan, Trevor Peterson, Taylor Swain and Elizabeth Winters) were trained in arthropod and weed biomass data collection and identification, data collection and analysis, and laboratory analysis and provided opportunities in public speaking. The project also supported Andrew as he wrote his dissertation. Faculty and students gave five research presentations on the findings at the Entomological Society of America, Entomological Society Pacific Branch meetings and the Utah State University Graduate Student Symposium. OBJECTIVE C Three PhD students, Mae Culumber, Andrew Tebeau and Wang Chanjun were trained in soil moisture monitoring, data collection and processing, laboratory analysis and arthropod, weed and cover crop identification under this objective and provided opportunities for the students in public speaking. Twelve undergraduate students (Andrew Noorlander, Jeremy Crapo, Ashley Salisbury, Moire Lindstrom, Gaia Nafsziger, Kirsten Lindstrom, Trevor Ballard, Jessica Smith, Danielle Phillips, Lacey Johnson, William Dew, Tyler Shumway, Forest Young and Jessica Shaw) were also trained in plant biomass collection and identification. A poster was presented at the Weed Science Society conference in 2011. OBJECTIVE D. The project provided training for two graduate (MS) students (Varun Koneru, Shruti Sawant, Xu Tao and Abdulla Khan) and several undergraduate students in the quantification of fruit quality, volatile compounds, and consumer sensory testing. How have the results been disseminated to communities of interest? Dissemination OBJECTIVE E In addition to the research paper and conferences presentations described under outputs and opportunities the findings of this project were also disseminated through a number of field days, workshops, and grower meetings, described below. Two small farms organic workshops was held in Moab and Hurricane, Utah in April 2014. Topics included soil fertility management in organic orchards, general principles of organic arthropod management, approaches for pest management in orchards, and results from our findings on consumer willingness to pay for certified organic peaches in Utah farmers markets. The production workshops were held in conjunction with workshops designed to better link growers with local restaurants and market outlets. Approximately 25 participants attended each workshop. Presentations on organic orchard soil fertility, arthropod pest and weed management in organic orchards, organic certification, and consumer willingness to pay for certified organic peaches in Utah farmers markets were also given at the Utah Small and Urban Farms Conference in Salt Lake City in March of 2013 and 2014. The workshops also included invited presentations from Utah, Colorado and Washington State growers and researchers. A full day track devoted to organic agriculture was included as a direct result of this project which attracted 100 and 60 participants in 2013 and 2014 respectively. The talks were recorded and made publicly available through USU Extension. The feedback was excellent and as a result USU Extension has decided to include an organic agriculture track in the small farms conference on an annual basis. Eleven presentations on various aspects of organic stone-fruit management have been given at the Utah Horticultural Association winter meeting between 2009 and 2014 including four from Washington, Oregon, and Colorado state growers and researchers. Typically around 80 growers, extension agents and industry representatives present at these meetings on an annual basis. A presentation on organic and integrated pest management was given to the Northern Utah Fruit Grower meeting in 2012 and 2013 to 95 participants. Three presentations on cover crops, organic orchard floor and pest management were given at the Colorado Orchard Grower Association winter meeting in Grand Junction in 2012 and 2013 to a total of 230 participants. An organic fruit and vegetable workshop was held in Kaysville in June of 2013 with 20 participants and a field day that featured the Kaysville organic stone-fruit research was held in 2014, 2012 and 2010. In addition, three Master Gardener courses in

organic and integrated pest management in fruits and vegetables were held in Salt Lake City, West Jordon, Kaysville and Ogden, Utah in 2014 to a total of 115 participants. And a presentation on IPM for small and diversified farms given to 15 participants at the 8th Annual Diversified Agriculture Conference in Richfield Utah in 2011. A presentation on sustainable and organic tree fruit production was given to the USU Extension Fruit Pest In-service Workshop in 2010. This project was also introduced to a wider audience at the Wallace Stegner Sustainability Symposium held in Salt Lake City in 2010. A stakeholder round table meeting was held in June 2014 to discuss findings to date and gather input on future directions of the project. The roundtable included growers, researchers and distributors from Utah, Colorado and Washington States. Two factsheets, one on organic orchard floor management http://extension.usu.edu/files/publications/publication/Horticulture Fruit 2012 -01pr.pdf and one on earwig lifecycles and management http://extension.usu.edu/files/publications/factsheet/earwig-orn.pdf have been published so far and several more (six) are currently being completed on organic orchard fertility management, soil health in orchards, cover crops and water use in orchards, tree growth, productivity and fruit quality in organic orchard systems, organic orchard weed management, and organic orchard arthropod management. A webpage was developed that describes the goals of the project and will be updated with final results once the findings have been published. https://extension.usu.edu/productionhort/htm/organic/organic-stone-fruit-produc tion Organic management options for pests and diseases are now being included in all updated pest and disease management factsheets and an organic gardening guide was published by USU extension as a result of the profile or organic agriculture being raised among extension specialists as a result of this project, Especially in Utah and Davis counties. This guide contains a chapter specifically on organic integrated pest management. Two extension newsletter articles have also been on findings coming out of this project. http://utahpests.usu.edu/files/uploads/UtahPests-Newsletter-winter13.pdf http://utahpests.usu.edu/files/uploads/UtahPests-Newsletter-summer11.pdf What do you plan to do during the next reporting period to accomplish the goals? Plan of Work While the funding for this project has ended, we will continue to work on tying up loose ends (completing fruit chemistry and economic analysis) and publishing the findings generated by this project. The goal is to publish a minimum of eleven peer reviewed research papers resulting from dissertation and thesis chapters generated on this project. In addition we are in the process writing two overview research papers, one that presents an overview of the establishment phase and a second that summarizes the findings as a whole. Six factsheets are also in the process of being completed. In addition we have been in contact with e-organic about putting on a series of presentations on organic stone-fruit management in the Intermountain west. **IMPACT: 2009/09 TO 2014/08** What was accomplished under these goals? Accomplishments OBJECTIVE A. A paper in Acta Hort describes orchard establishment. Three dissertation chapters (C.M. Culumber) describe water use, tree growth, root distribution and changes in soil physical, chemical and biological parameters in response to orchard floor management. Few differences in water use were found between grass or trefoil alleyways but trefoil may require more water in hot dry years. Water use under living-mulch and straw did not differ from tillage or weed fabric. Tree growth in industry standards and legume treatments matched the conventional orchard. Tree growth and tree roots were reduced over time with tillage. Trefoil biomass blown into orchard tree-rows contributed 0.21 kg nitrogen (N) tree-1 year-1. Higher density of tree roots in trefoil alleyways, greater total N and lower N15 enrichment in tree leaves suggests enhanced nutrient acquisition from trefoil alleyways. Soil organic C, total N, microbial biomass and activity, and monthly soil inorganic N levels were higher in tree-row soils with a trefoil alleyway. There was also increased microbial growth efficiency in soils with trefoil alleyways. This suggests soil organic matter accumulation and enhanced reserves and availability of soil nutrients in trefoil treatments. Tillage resulted in lower total C and N content than trefoil treatments. Tillage had the lowest levels of microbial biomass and activity, and lowest microbial growth efficiency compared to all other organic treatments. Significantly higher bulk density was observed in tilled compared to non-tilled living-mulch treatments at 10-15 cm depth. At Capitol Reef National Park, inter-seeding alfalfa into established grass successfully introduced alfalfa to the understory and protected the alfalfa from grazing marmots. OBJECTIVE B Three dissertation chapters (A. Tebeau) detail arthropod species composition and dynamics, earwig population dynamics and weed and cover crop biomass in response to treatment. Total arthropod abundance was lower in trefoil than grass alleyways. In treerows, arthropods were most abundant in living mulch, intermediate in straw, and least in landscape fabric and tillage plots. Beneficial insects in the grass included pollenating bees, parasitic chalcidoid wasps, and predatory syrphid flies. Pests included mites, grasshoppers, and stink bugs. Legume pests were dominated by Lygus bugs, leafhoppers, aphids, and thrips. Beneficial arthropods included predators such as damsel bugs and lacewings, as well as parasitoids such as ichneumonids and braconids. Earwigs damaged a considerable amount of fruit in 2013 (\>25%). Legumes are attractive to cat-facing insects, a concern to growers. However, cat-facing damage was low and there was no correlation between cat-facing insect presence and fruit damage. Earwig abundance responded positively to available refuge space, nutrients, and soil health. Weeds provided good refuge and the living mulch treatment had the greatest density. Trefoil treatments also promoted earwigs, presumably due to increased nitrogen. Tillage offered little refuge, and interrupted earwig nesting behavior. Weed density and cover differed among treatments. Weeds responded to treerow, but not alleyway vegetation. Treerows with living mulch

had the most vegetation (100 g/m2), followed by straw mulch (62 g/m2), and tillage and fabric (16 and 14 g/m2), respectively. Biomass in all treatments declined in July, but tillage reached its minimum in June. Tillage was strongly associated with purselane, and straw mulch with field bindweed. Quack grass was more abundant in the straw treerow plots with trefoil in the alleyway than grass. The straw-grass treatment was associated with wild oats and alfalfa. Species composition differed by alleyway in the living mulch treatments, but with overlap. Dominant species in the living mulch plots were prickly lettuce, dandelion, alyssum, and clover. Trefoil alleyways were associated with green foxtail and mallow. Trefoil tended to creep into the treerow. Alfalfa planted in orchards at Capitol Reef National Park increased thrips on peach leaves but this effect was not seen when alfalfa was inter-seeded with grass. OBJECTIVE C. Two papers in the Journal of the American Pomological Society and the International Journal of Fruit Science describe selection of cover crops and mulches for N contribution and weed suppression in orchards. Alfalfa provided greatest biomass and N contributions at two locations. Thyme (Thymus vulgarius), provided greatest weed control in the tree row (83 %) Black medic (Medicago lupulina) and Catnip were satisfactory (60 and 64% cover respectively). Soil fertility and soil moisture were monitored in 2013 and 2014 to provide data for a fourth dissertation chapter (W. Chanjun). OBJECTIVE D. A graduate student (S Sawant) evaluated peach quality for all treatments in 2013. A second graduate student (A Khan) evaluated fruit quality and volatile components in 2014. Consumer acceptance of the peaches was evaluated in both years. In general, peaches were well liked with average ratings above five on a nine point scale for all treatments and years. Consumers preferred peaches grown with a legume alleyway in both years. Consumer acceptance data are still being analyzed and will be correlated to fruit quality parameters such as pH, firmness, size, degree brix, acidity, and volatiles. All required economic data have been collected. Thesis for T Knudsen is in final stages of preparation. Overview of economic returns to the peach production treatments (partial budgeting) to be completed in early 2015. We expect the organic orchard system with a legume alleyway and living cover treerow to be most productive, have highest quality fruit, be most economical and provide the greatest ecosystem services in terms of soil carbon, soil health and biodiversity of plants and arthropods. This treatment may use more water in dry years and also has potential to increase cat facing insects and earwigs. **PUBLICATIONS** (not previously reported): 2009/09 TO 2014/08 Type: Conference Papers and Presentations Status: Other Year Published: 2014 Citation: Presentations Ransom, C., Organic Weed Control Short Course, \"Organic Weed Control Principles,\" USU Extension, Hurricane, Utah. (April 16, 2014

PROGRESS

2011/09 TO 2012/08 OUTPUTS: \"Objective A. Tree trunk diameter and tree root distribution under alleyways and treerows were assessed. Soil NO3- and NH4+ was analyzed monthly from May to August and available nutrients, dehydrogenase and phosphatase enzyme activities, soil respiration and microbial biomass measured in June. Soil bulk density was measured in October. Leaf tissue analysis revealed that trees were no longer deficient in trace elements. Foliar applications of trace elements were continued as a precaution. Compost applications were limited to meet P needs and additional N supplied with an OMRI approved organic 12-0-0 fertilizer, NatureSafe. Measurements of soil volumetric water content continued, and irrigation quantities adjusted accordingly. Monthly readings of tree stem water potential were made to determine that tree water requirements were met. An on-farm trial was established at Capitol Reef National Park to demonstrate use of alfalfa for within-orchard N fixation. A trial to test effects of grazing and irrigation on frost survival of blooms was established at Randy Ramsley\'s farm; however, he lost his fruit before the experiment commenced. Objective B. We monitored weeds, arthropods, and diseases in relation to orchard floor management and tree health from May through September. Arthropods were monitored with sweep net, pitfall and ground vegetation samples, and various attractant traps. Pheromone monitoring, mating disruption, and supplemental insecticides were utilized to prevent crop injury from key lepidopteran pests. Earwig, cat-facing insect, and aphid injury was monitored on leaves and fruits. Processing and analysis of 2011 and 2012 arthropod samples continues. European earwigs were monitored with traps, and in 2012, an earwig capture-mark-recapture experiment was initiated. Objective C: Monitoring of six legume and four non-legume combinations as potential orchard alleyway cover crops continued at sites with partial shade. Biomass, percent cover of cover crops and weeds (by species) was taken prior to each mowing. Arthropods were sampled prior to mowing. In-row cover crops were monitored for biomass, weeds, soil N and water-use. Objective D: Unfortunately we lost most of our 2012 peach crop to spring frost. For this reason we were unable to carry out full sensory evaluation and fruit chemistry objectives. A limited sensory panel and preliminary lab studies were conducted on selected treatments using the small number of fruit available. Information gathering is ongoing from traditional orchard operations in preparation for economic analysis. All experimental orchard operations are being recorded and timed, and all input costs tracked. Total and marketable yields are being recorded so that break-even points for each system can be calculated. Objective E: PIs presented four talks on the project at the Utah State Horticulture Association and Colorado Fruit Growers meetings. A field day was held on August 16th to showcase the project. PIs met with the advisory team in February and September 2012. Growers are very impressed with how the organic peach trees look. Arthropod

results were presented at two meetings of the Entomological Society of America.\" PARTICIPANTS: Jennifer R Reeve; Brent Black; Diane Alston; Corey Ransom; Ruby Ward; Silvana Martini; Waine Hanks; Randy Ramsley; Mark Rowley, Mae Culumber, Andrew Tebeau TARGET AUDIENCES: Tree fruit growers and extension agents in Utah and the Intermountain West Region. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: Objective A. Tree trunk diameter and canopy cross sectional area were measured. Soil NO3- and NH4+ was analyzed monthly from May to August and available nutrients, dehydrogenase and phosphatase enzyme activities, soil respiration and microbial biomass measured in June. Leaf tissue analysis revealed that trees were no longer deficient in trace elements. Foliar applications of trace elements were continued as a precaution. Due to P and K buildup in some treatments, compost applications were limited to meet P needs and additional N supplied with an OMRI approved organic 12-0-0 fertilizer NatureSafe. The irrigation system was reconfigured to reduce water application rate. During late 2010 there appeared to be some surface runoff due to application exceeding infiltration. Measurements of soil volumetric water content continued, with irrigation quantities adjusted according to these readings. Monthly readings of tree stem water potential were carried out to determine how well tree water requirements were being met. Objective B. We monitored weeds, arthropods, and diseases in relation to orchard floor management and tree health from May through September. Food grade, 20.0% acetic acid was employed as an organic herbicide in straw mulch treatments. Pitfall trapping for epigeal arthropods replaced Berlese samples. Monitoring, mating disruption, and supplemental insecticides were utilized to prevent lepidopteran pest outbreaks. Processing of 2010 and 2011 arthropod samples continues. Objective C: Monitoring of six legume and four non-legume combinations as potential orchard alleyway cover crops continued at both full and partial shade sites. Percent cover of cover crops and weeds (by species) was taken prior to each mowing. Biomass samples were collected prior to flowering of the respective cover crops. Samples were separated according to species and wet and dry mass determined. Arthropods were sampled prior to mowing. Six varieties of potential in-row cover crops were seeded in a young tart cherry orchard and volumetric water content sensors placed at 0-15 and 15-30cm depth. Difficulties with establishment were encountered and so plots will be reseeded. A parallel study to evaluate combinations of mulch and organic herbicides was conducted in the 2009 and 2010 seasons. Objective D: In preparation for economic analyses, information is being collected from traditional orchard operations. All experimental orchard operations are being recorded and timed, and all input costs tracked. Total and marketable yields are being recorded so that break-even points for each system can be calculated. Objective E: Tim Dahle, a large-scale tart cherry producer from The Dalles, Oregon presented two talks at the Utah State Horticulture Association meeting. Tim grows sweet cherries under both conventional and organic systems. PIs met with the project advisory committee two times during 2011. The PIs visited orchards and operators in Capitol Reef National Park and Caineville in central Utah who already are or are interested in transitioning to organic stone fruit production. We learned more about their orchard operations and discussed on-farm trials to begin in 2012. PARTICIPANTS: Jennifer R Reeve; Brent Black; Diane Alston; Corey Ransom; Ruby Ward; Silvana Martini; Waine Hanks; Randy Ramsley; Mark Rowley. TARGET AUDIENCES: Tree fruit growers and extension agents in Utah and the Intermountain West Region. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Objective A. Tree trunk diameter and canopy cross sectional area were measured per plot. Soil nitrate and ammonium was analyzed each month from May to August and available nutrients measured in June. Leaf tissue analysis was conducted in July and revealed that trees in all treatments, including the conventional check, were deficient in manganese, sulfur and calcium. The trees responded to a foliar application of trace elements plus manganese. Soil applied sulfur will be applied this winter. Volumetric water content was monitored in one tree row and alleyway per plot three times per week and irrigation requirements were calculated. Differential irrigation requirements were applied once per week by varying the length of the irrigation set. Mae Culumber, a PhD student in Soil Science/Ecology was recruited to the project in September 2010. Objective B. We monitored weeds, arthropods, and diseases in relation to orchard floor management and tree health beginning in May, 2010. To monitor the effect of vegetation changes we studied the effect of mowing the tree row, alley way on arthropod abundance and diversity in the ground cover and trees. Andrew Tebeau, PhD student was recruited in the fall of 2009 to work on arthropod dynamics and interactions with ground covers and weeds. Marc Rowley, MS student, conducted weed and cover crop data collection. Objective C: six legume and four non-legume combinations were selected for testing as orchard alley way cover crops. Locations were selected in a full shade orchard and a full sun orchard. Data on percent cover of cover crops and weeds (by species) was taken in the spring. Volumetric water content sensors were placed in the top 10 cm of the soil profile to monitor water use. Biomass samples were collected prior to the flowering of the respective cover crops. Samples were separated according to species and wet and dry mass determined. After

biomass collection, the plots were mowed. Arthropods were sampled in late summer. Objective D: In preparation for the economic analyses we collected information for traditional orchard operations that will be used to compare the costs and returns from the organic production methods developed in this project. All orchard management operations are being recorded and timed and all input costs tracked in preparation for economic analysis. Total and marketable yields are being recorded so that break even points for each system can be calculated. Objective E: David Granatstein was invited to make two presentations to the Utah Horticulture Society during their January 2010 meetings: 1) organic orchard floor management and 2) the status of the organic tree fruit industry. An introduction to the project was presented to the Northern Utah Extension meeting in February. The Kaysville research plots were featured in a 1 hour, 15 min session repeated three times during the summer field day on August 17th 2010. The session included a general introduction to the goals of the project, presentations on water, weed and arthropod management and sampling techniques and included ample time for growers to look at the plots and ask questions. A grower advisory meeting was held. PARTICIPANTS: Jennifer R Reeve; Brent Black; Diane Alston; Corey Ransom; Ruby Ward; Silvana Martini TARGET AUDIENCES: Tree fruit growers and extension agents in Utah and the Intermountain West Region. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2011/09 TO 2012/08 \"Objective A: Tree growth with legume alleyways, weed fabric and tillage was greater than in straw and living mulch with grass matching the conventional check. Available soil N was greater under legume and tillage, soil quality was best in legume treatments, while tree roots were more abundant in legume alleyways than grass. The straw mulch treatment with grass alleyway used the least water. Data analysis is ongoing. Progress is evaluated at weekly meetings with students and biweekly meetings with the whole team. Two posters were presented at ISHS and SSSA on nutrient cycling and soil quality in organic peach orchards. We held two meetings with our grower advisory team in 2012 to provide updates on project results and seek advice on orchard management. Growers were very impressed with how the trees look and the response of the trees to legumes in the alleyways. Ray Rowley successfully harvested his first certified organic tart cherry block and other Utah growers are planning to plant an organic apple orchard. Objective B: Trees grown with legumes are resistant to competition from weeds as evidenced from their growth. A talk on tree growth and a poster on pest dynamics were presented at the ISHS Organic Fruit Symposium and are accepted for publication in Acta Horticulturae. The talk is available to the public online. Earwigs continue to be a significant arthropod in the peach orchards. An earwig capture-mark-recapture experiment was conducted in Aug and Sep. Over 2,000 earwigs were marked and released. Approximate 1,100 recaptures were recorded. Preliminary results suggest that tree row and alley way treatments are affecting abundance and diversity of arthropods. Earwigs were affected by alleyway, treerow, and fertilizer treatments. Treatments that provided high levels of refuge space and nutrients increased earwig densities. Green peach aphids and lygus bugs were other arthropods of concern. Minor cat-facing injury was observed and appeared to be associated with legume alleyways. Data analysis is ongoing. There were no significant disease issues in 2012. Objective C: Two papers were published on legume use in orchards and organic weed control in the Journal of the American Pomological Society and the International Journal of Fruit Science. Five cover crops (thyme, black medic, buckwheat, catnip, alyssum) were established in a mid-shade tart cherry orchard for potential use in the tree-row. Thyme (Thymus vulgaris) produced the greatest cover (60% average) relative to weeds (37% average), and bare ground (3% average). Data analysis for soil N contributions and water use is ongoing. Objective D: Due to the loss of the 2012 fruit crop we were unable to complete the fruit quality analysis this season. Objective E: Approximately 80 growers and fruit industry representatives attended the winter meeting and 12 growers attended the Kaysville field day. Of particular interest were findings showing the impact of legumes grown in alleyways on tree growth, despite considerable weed pressure in the tree row. Trees roots were much more abundant in alleyways with legumes than grass effectively increasing the rooting area of the trees in these treatments.\" **PUBLICATIONS (not previously reported):** 2011/09 TO 2012/08 1. Reeve, J., Black, B. L., Ransom, C., & Alston, D. G. (2012) Developing organic stone-fruit production options for Utah and the Intermountain West: Acta Horticulturae. (Accepted). 2. Rowley, M., Black, B. L., Cardon, G. (2012). Alternative orchard floor management strategies. In USU Extension (Ed.), USU Cooperative Extension:. (Published).

2010/09/01 TO 2011/08/31 IMPACTS/OUTPUTS Objective A: Tree growth in rows with weed fabric and tillage treatments was significantly greater than in straw and living mulch treatments, and matched the conventional check. The legume alleyways significantly increased tree growth in living and straw mulch treatments relative to grass alleyways. The straw mulch treatment with grass alleyway used the least water. The alyssum cover with a legume alley increased water use by 19%. Data analysis is ongoing. Progress on the project is evaluated at

weekly meetings with students and biweekly meetings with the whole team. Our progress is in line with the goals stated in the proposal. We held two meetings with our grower advisory team in 2011 to provide updates on project results and seek advice on orchard management issues. The growers were happy with the growth of the trees in 2011, indicating the success of our increased applications of trace elements, sulfur and N. The growers were very impressed with the response of the trees to legumes in the alleyways. However, many expressed concern over the potential for attracting rodents into the orchards as a result. When asked if they would be interested in hosting additional on-farm trials of legumes, most refused, stating this reason. Objective B: Acetic acid herbicide applied to quackgrass in straw plots was moderately effective. Green peach aphid colonized 25% of leaves early in the spring and required management with insecticidal soaps. Earwigs damaged ripening fruit late in the season and three experimental management strategies were implemented: trunk exclusion, an insect growth regulator, and a bacterial insecticide. Earwig development models and economic injury models are being created. There were no significant disease issues in 2011. Data analysis is ongoing. Objective C: Results from the alley way cover crop trials indicated that a significant portion of total tree N requirements could be supplied by legume covers. However, the legumes required significant increases in irrigation water inputs compared to the grass control. Also, the alfalfa treatment did not persist in the heavy shade of the mature tart cherry orchard. Results from this study were summarized in a manuscript submitted to the Journal of the American Pomological Society. Results from two seasons and three locations of organic herbicide trials indicated that weed control with combinations of mulch and acetic acid approached that of conventional system herbicide treatments. Results for this study were recently accepted for publication in the International Journal of Fruit Science. Objective D: Despite the promising results from some of the organic herbicide mulch combinations in controlling weeds, economic analysis indicates cost may be prohibitive. Objective E: Approximately 80 growers and fruit industry representatives attended the winter meeting. Of particular interest was Tim\'s use of nesting boxes and houses to encourage birds of prey to reduce rodent pests in his orchards. Because of the interest Tim generated in this topic, a follow up presentation was given at the summer USHA farm tour in August.

2009/09/01 TO 2010/08/31 Objective A: While data analysis is still in progress, preliminary results indicate tree growth in rows with weed fabric and tillage treatments was significantly greater than in straw and living mulch treatments, and matched the conventional check. Visual inspection of the trees suggests that the legume alley ways increased tree growth during the 2010 growing season but quantitative data has not as yet been collected and analyzed. The straw mulch treatment with grass alleyway used least water. The alyssum cover with a legume alley required a 19% increase in water use. Progress on the project is evaluated at weekly meetings with students and biweekly meetings with the whole team. Our progress is in line with the goals stated in the proposal. We also held a meeting with our grower advisory team at the study site. The growers toured the orchards and provided their feedback and comments. We discussed which of the treatments would fit best on their own farms. In terms of feedback the team was concerned about the trace element deficiencies seen in all of the treatments including the conventional check and confirmed this was a challenge they had on their farms due to high soil pH. Visual observations and leaf tissue analysis confirm the problem was less severe in the organic tillage, row fabric and legume alley treatments. The problem was worse this year than in previous years and also worse than in other young peach orchards on the Kaysville site. While the trees did respond positively to foliar applications of trace elements, tree growth in some treatments was not as good as expected. Data on soil, water, leaf nutrients were collected from all the orchards across the research station and will be used to determine the cause of and potential solutions to the problem. A pre-project survey was mailed out to all Utah fruit growers in the USU Extension database after approval from the USU Institutional Review Board. We also evaluated attendees at the winter meeting and summer field day. Objective B: Data analysis is still in progress. Preliminary results indicate that mowing did increase arthropod movement into tree canopies. Several peach diseases were prevalent including coryneum blight. Objective C: Data analysis is still in process. Objective D: Data analysis is still in process. Objective E: Approximately 60 growers and fruit industry representatives attended the winter meeting and approximately 50 growers visited the plots during the summer field day. We also held a grower advisory meeting after the field day to gather input and advice on the progress of the project so far.

PUBLICATIONS

2010/09/01 TO 2011/08/31 No publications reported this period

2009/09/01 TO 2010/08/31 No publications reported this period

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Using New Alternatives to Enhance Adoption of Organic Apple Production Through Integrated Research and Extension

Accession No.	0218650
Subfile	CRIS
Project No.	VT-0056OG
Agency	NIFA VT.
Project Type	OTHER GRANTS
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Investigator(s)	Berkett, L. P.; Moran, R.; Garcia, M. E.; Darby, H.; Parsons, R.
Performing Institution	Plant & Soil Science, UNIVERSITY OF VERMONT, BURLINGTON, VERMONT 05405

NON-TECHNICAL SUMMARY

Apples are an important component of New England\'s diversified agriculture. Although there is significant interest in organic production, there are very few organic apple orchards in New England, in part, because of the challenges associated with the traditional apple cultivar grown (McIntosh). However, because of recent shifts in consumer preference for newer cultivars, growers are planting different apple cultivars. Growers want to know what the potential is for sustainable and profitable organic production with the newer apple cultivars that are being planted in the region. This project holistically examines the opportunities and challenges of organic production within the 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. The long-term goal of this multi-state, multidisciplinary project is to enhance adoption of organic apple production in New England through research that advances the scientific knowledge base and provides practical information to stakeholders.

OBJECTIVES

Apples are an important component of New England\'s diversified agriculture. Although there is significant interest in organic production, there are very few organic apple orchards in New England, in part, because of the challenges associated with the traditional apple cultivar grown (McIntosh). However, because of recent shifts in consumer preference for newer cultivars, growers are planting different apple cultivars. Growers want to know what the potential is for sustainable and profitable organic production with the newer apple cultivars that are being planted in the region. This project holistically examines the opportunities and challenges of organic production within the 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. The long-term goal of this multi-state, multidisciplinary project is to enhance adoption of organic apple production in New England through research that advances the scientific knowledge base and provides practical information to stakeholders. Through a closely integrated extension/outreach program that addresses stakeholder needs, the project will enable whole farm planning, improve competitiveness, and enhance the ability of growers to grow and market

high quality organic apples. Stakeholders have been an intricate part of the development of the project\'s goals and objectives and have guided the project throughout the past three years; extensive stakeholder involvement will continue throughout the next three years. The project directly relates to five of the OREI goals/priorities, two of which are designated as OREI\'s highest priorities. The project\'s objectives are: Research 1. Continue to evaluate new apple cultivars and incorporate research-generated knowledge of apple ecosystem dynamics into organic production systems to determine sustainability and profitability. 2. Field test commonly used organically-certified growth regulators (i.e., seaweed products) and evaluate their impacts on fruit yield, quality, tree nutrition and health including impact on disease and arthropod pests. 3. Evaluate the benefits of different ground cover strategies in promoting tree health, plant and soil water status, and yield and fruit quality. Extension 4. Continue to collaboratively develop and implement with stakeholders a multi-dimensional extension program that addresses their priorities and needs, enables whole farm planning, improves competitiveness, and enhances the ability of growers to grow and market high quality organic apples.

APPROACH

Objective 1. The research initiated in 2006 to determine the opportunities and challenges of organic apple production with the five cultivars planted in two orchard systems will continue in the two certified organic orchards at the UVM Horticultural Farm in South Burlington, VT. In essence, this is a feasibility/profitability study having the following questions: (i)What are the opportunities and challenges of organic apple production with the five cultivars planted in the two orchard systems (ii) Is organic apple production profitable and sustainable with the knowledge and tools we have and with these cultivars (iii) Will there be a long-term difference in profitability between the two organic orchard systems The following types of data will be collected: horticultural measurements of tree health and productivity, disease and insect incidence, soil health measurements, and economical parameters. Objective 2. The questions we seek to answer include: (i) Given adequate mineral nutrition and water availability, is there an effect on tree growth, fruit yield and quality, attributable to applications of commonly used seaweed products (ii) Does application of seaweed products increase tree health such that incidence of disease and arthropod damage is reduced on fruit and foliage (iii) Can the use of seaweed products improve tree health to a point where they can better resist attack from pests, thereby reducing the need for pesticide intervention in the orchards There will be three treatments in this study: a standard nutrient application applied to all trees and two seaweed treatments commonly used by organic apple growers. Data collection will include tree growth and productivity measurements, fruit quality, leaf nutrient analysis, and disease and arthropod damage assessment across the five cultivars. Objective 3. The demonstration orchard at the University of Maine will contain a research study on ground cover management for weed control. Ground cover management strategies of close mowing, mulching, and an organic herbicide will be compared on Honeycrisp trees on G.11 and M.26 as to their impact on weeds and tree health. Data will be collected on weed biomass, tree growth, and soil health and moisture. Objective 4. The extension/outreach program will: (i) Continue the development of the OrganicA website, http://www.uvm.edu/organica/ (ii) Expand the delivery of resource materials to eOrganic. (iii) Collaboratively organize tours of organic apple farms in the region where growers can learn from the experience and insights of the host organic farmer. (iv) Organize grower field days and/or at the two organic research orchard systems. (v) Organize and conduct a regional Workshop on Organic Apple Production in December, 2011. (vi) Develop a comprehensive Practical Guide to Organic Apple Production.

PROGRESS

2009/08 TO 2014/07 Target Audience: Organic apple production information and research summaries were distributed to various audiences including commercial apple growers, scientists, extension personnel, industry personnel, students, and the general public in the region and beyond. A significant number of people have received information; for example, the organic apple website for the project had over 16,800 visits during the past year and a total of approximately 67,452 visits since the beginning of the project. Changes/Problems: There were no major changes/problems. What opportunities for training and professional development has the project provided? A multi-faceted extension/outreach program was developed and provided numerous opportunities for obtaining information and education on organic apple production in each year of the project. Please see the "Output" section of this and previous reports for details. How have the results been disseminated to communities of interest? Please see the "Publication" and "Output" sections of this and previous reports for details. A multi-dimensional extension program, which included on-site visits, orchard tours, newsletter articles, websites, and grower meetings, was developed and provided stakeholders with organic apple information. Organic apple production information and research summaries were distributed to diverse audiences which included commercial apple growers, scientists, extension personnel, industry personnel, undergraduate and graduate students and the

general public in the region and beyond. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/08/01 TO 2013/07/31 Target Audience: Organic apple production information and research summaries were distributed to diverse audiences which included commercial apple growers, scientists, extension personnel, industry personnel, undergraduate and graduate students and the general public in the region. Changes/Problems: There are no major changes/problems to in approach. What opportunities for training and professional development has the project provided? Please see \"output\" section of this report for specific events. A multi-dimensional extension program continued to provide stakeholders with organic apple information that included on-site visits, orchard tours, newsletter articles, websites, and grower meetings. Ten issues of Organic Orchard Observations were each sent out during the reporting period via email to OrganicA listserve members and archived on the OrganicA website. Stakeholders visited the various webpages on the OrganicA website a total of approximately 20,995 times during the past year. Project personnel answered numerous stakeholder questions on organic apple production; organic apple production information and research summaries were distributed to diverse audiences which included commercial apple growers, scientists, extension personnel, industry personnel, undergraduate and graduate students and the general public in the region. How have the results been disseminated to communities of interest? Please see \"output\" section of this report for specific events. A multi-dimensional extension program continued to provide stakeholders with organic apple information that included on-site visits, orchard tours, newsletter articles, websites, and grower meetings. Ten issues of Organic Orchard Observations were each sent out during the reporting period via email to OrganicA listserve members and archived on the OrganicA website. Stakeholders visited the various webpages on the OrganicA website a total of approximately 20,995 times during the past year. Project personnel answered numerous stakeholder questions on organic apple production; organic apple production information and research summaries were distributed to diverse audiences which included commercial apple growers, scientists, extension personnel, industry personnel, undergraduate and graduate students and the general public in the region. What do you plan to do during the next reporting period to accomplish the goals? Final organic apple research results will be summarized and presented to various stakeholders including commercial apple growers, scientists, extension personnel, industry personnel, and the general public in the region.

2011/08/01 TO 2012/07/31 OUTPUTS: Apples are an important component of diversified agriculture in Vermont and the region. Although there is significant interest in organic production, there are very few organic apple orchards in New England, in part, because of the challenges associated with the traditional apple cultivar grown (McIntosh). However, because of recent shifts in consumer preference for newer cultivars, growers are planting different apple cultivars. Growers want to know what the potential is for sustainable and profitable organic production with the newer apple cultivars that are being planted in the region. This project holistically examines the opportunities and challenges of organic production within the 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. The long-term goal of this multi-state, interdisciplinary project is to enhance adoption of organic apple production in Vermont and New England through research that advances the scientific knowledge base and provides practical information to stakeholders. Outputs during this past year included continued research in two certified organic orchards in Vermont and ground cover management research in Maine; further development of the OrganicA website, including the publication of a Practical Guide to Organic Apple Production; organizing a New England Organic Apple Workshop attended by over 70 stakeholders; presentations at state apple grower and research/extension meetings, answering grower questions on organic apple production; and publishing 13 issues of the Organic Orchard Observations newsletter which contained time-sensitive organic information distributed to over 100 subscribers via email and archived on the OrganicA website where they were viewed over 500 times by stakeholders. PARTICIPANTS: The project investigators have a diverse background and represent the disciplines of horticulture, plant pathology, entomology, soil science, agronomy, and agricultural economics. They have expertise in integrated and organic research, in developing and implementing effective extension/outreach programs, in academic teaching and student advising, and in practical organic farming. The project investigators include: Lorraine Berkett, Heather Darby, and Robert Parsons from the University of Vermont; Elena Garcia from the University of Arkansas; and Renae Moran from the University of Maine. Growers throughout the region provide guidance and input to the project and participate in various aspects. Opportunities for training or professional development occur each year (i.e., workshop/tour) often in collaboration with other organizations such as the Vermont Tree Fruit Growers Association, the Northeast Organic Farming Association, and others. A regional Organic Apple Workshop was organized this past year and held at the largest gathering of farmers and agricultural stakeholders in New England. The Workshop was highly rated; 98% of evaluators stated that the workshop increased their awareness and knowledge of organic apple production and 89% said they will use the information in their orchards. In addition, the OrganicA Project website and newsletter provided

information and resources to current and prospective organic apple growers and project personnel were involved in one-on-one education of stakeholders who wanted to learn more about organic apple production. TARGET AUDIENCES: The primary target audience of this project is current, transitioning, and prospective organic apple growers. Additional target audiences include extension specialists, researchers, agricultural consultants, government agency representatives, and members of the general public interested in organic apple production. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/08/01 TO 2011/07/31 OUTPUTS: Apples are an important component of diversified agriculture in Vermont and New England. Although there is significant interest in organic production, there are very few organic apple orchards in New England, in part, because of the challenges associated with the traditional apple cultivar grown (McIntosh). However, because of recent shifts in consumer preference for newer cultivars, growers are planting different apple cultivars. Growers want to know what the potential is for sustainable and profitable organic production with the newer apple cultivars that are being planted in the region. This project holistically examines the opportunities and challenges of organic production within the 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. The long-term goal of this multi-state, transdisciplinary project is to enhance adoption of organic apple production in Vermont and New England through research that advances the scientific knowledge base and provides practical information to stakeholders. Outputs during this past year included continued research in two certified organic orchards in Vermont and ground cover management research in Maine; planting a new organic research orchard to address identified challenges; further development of the OrganicA website (http://www.uvm.edu/organica/); an Organic Orchard Tour; presentations at state/regional apple grower and research/extension meetings, answering grower questions on organic apple production; and publishing 12 issues of Orchard Observations which is a web log of orchard observations disseminated to over 100 subscribers via email and posted on the OrganicA website. PARTICIPANTS: The project investigators have a diverse background and represent the disciplines of horticulture, plant pathology, entomology, soil science, agronomy, and agricultural economics. They have expertise in integrated and organic research, in developing and implementing effective extension/outreach programs, in academic teaching and student advising, and in practical organic farming. The project investigators include: Lorraine Berkett, Heather Darby, and Robert Parsons from the University of Vermont; Elena Garcia from the University of Arkansas; and Renae Moran from the University of Maine. Growers throughout the region provide guidance and input to the project and participate in various aspects. Opportunities for training or professional development occur each year (i.e., workshop/tour) often in collaboration with other organizations such as the Vermont Tree Fruit Growers Association, the Northeast Organic Farming Association, and others. In addition, the OrganicA Project website provides information and resources for current and prospective organic apple growers for professional development. TARGET AUDIENCES: The primary target audience of this project is current, transitioning, and prospective organic apple growers. Additional target audiences include extension specialists, researchers, agricultural consultants, government agency representatives, and members of the general public interested in organic apple production. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/08/01 TO 2010/07/31 OUTPUTS: Apples are an important component of diversified agriculture in Vermont and New England. Although there is significant interest in organic production, there are very few organic apple orchards in New England, in part, because of the challenges associated with the traditional apple cultivar grown (McIntosh). However, because of recent shifts in consumer preference for newer cultivars, growers are planting different apple cultivars. Growers want to know what the potential is for sustainable and profitable organic production with the newer apple cultivars that are being planted in the region. This project holistically examines the opportunities and challenges of organic production within the 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. The long-term goal of this multi-state, transdisciplinary project is to enhance adoption of organic apple production in Vermont and New England through research that advances the scientific knowledge base and provides practical information to stakeholders. Through a closely integrated extension/outreach program that addresses stakeholder needs, the project will enable whole farm planning, improve competitiveness, and enhance the ability of growers to grow and market high quality organic apples. Outputs during this past year included further development of the OrganicA website (http://www.uvm.edu/organica/); an Organica Workshop/Tour; presentations at regional apple grower and/or research/extension meetings, answering grower questions on organic apple production; and publishing 12 issues of Orchard Observations which is a web log of orchard observations. PARTICIPANTS: The project investigators have a diverse background and represent the disciplines of horticulture, plant pathology, entomology, soil science, agronomy, and agricultural economics. They have expertise in integrated and organic research, in developing and implementing effective extension/outreach programs, in academic teaching and student advising, and in practical organic farming. The project investigators

include: Lorraine Berkett, Heather Darby, and Robert Parsons from the University of Vermont; Elena Garcia from the University of Arkansas; and Renae Moran from the University of Maine. Opportunities for training or professional development occur each year (i.e., workshop/tour)often in collaboration with other organizations. In addition, the OrganicA Project website provides information and resources for current and prospective organic apple growers for professional development. TARGET AUDIENCES: The primary target audience of this project is current, transitioning, and prospective organic apple growers. Additional target audiences include extension specialists, researchers, agricultural consultants, government agency representatives, and members of the general public interested in organic apple production. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/08 TO 2014/07 What was accomplished under these goals? Extensive organic apple research was conducted over multiple years with results presented to growers and researchers. Please see prior reports for lists of publications and presentations. Currently, a comprehensive assessment of sustainability and profitability of the two organic systems under investigation over the full course of the project is being written. A multi-dimensional extension program, which included on-site visits, orchard tours, newsletter articles, websites, and grower meetings, was developed and provided stakeholders with organic apple information. Organic apple production information and research summaries were distributed to diverse audiences which included commercial apple growers, scientists, extension personnel, industry personnel, undergraduate and graduate students and the general public in the region and beyond. Also, this research project served as the basis for obtaining additional funding to further organic apple research in an area deemed important by stakeholders. **PUBLICATIONS (not previously reported):** 2009/08 TO 2014/07 1. Type: Conference Papers and Presentations Status: Other Year Published: 2014 Citation: Bradshaw, T.L. 2014. Scab Resistant Apple Cultivars: Potential for Low Input, High-Quality Cider Apple Production. U.S. Association of Cider Makers Conference, Chicago, IL. 2/05/2014. Contacts: 50 people from across the USA 2. Type: Other Status: Published Year Published: 2013 Citation: Bradshaw, T.L. 2013. The Apple Season: UVM Research Supports Growers and Consumers. Across the Fence Television Segment, WCAX TV, Burlington, VT. 10/04/2013. Contacts: 25,000 viewership 3. Type: Websites Status: Published Year Published: 2013 Citation: Berkett, L.P. 2014. Organic Orchard Observations. University of Vermont. http://www.uvm.edu/organica/ListservesBlogs/listservesblogs.html Contacts: 203 viewers 4. Type: Websites Status: Published Year Published: 2014 Citation: Berkett, L., Moran, R., Garcia, E., Darby, H., Parsons, R., Bradshaw, T., and S. Kingsley-Richards. 2014. The OrganicA Project website. University of Vermont. http://www.uvm.edu/organica/ (Contacts: approximately 16,838 during past year; 67352 from beginning of project) 5. Type: Conference Papers and Presentations Status: Other Year Published: 2014 Citation: Bradshaw, T., Campbell, C., and Flynt, D. 2014. What?s Worked for Us: A Panel Discussion on Growing Cider Apples.U.S. Association of Cider Makers Conference, Chicago, IL. 2/05/2014. Contacts: 50 people from across USA 6. Type: Conference Papers and Presentations Status: Other Year Published: 2014 Citation: Peck, G., Bradshaw, T., Miles, C., and Stewart, A. 2014. Panel: What are Cider Producers Future Research Needs? U.S. Association of Cider Makers Conference, Chicago, IL. 2/05/2014. Contacts: 50 people from across USA 7. Type: Theses/Dissertations Status: Other Year Published: 2014 Citation: Bradshaw, T.L. Biologic and economic assessment of five apple cultivars under two organic management systems in Vermont. University of Vermont PhD Dissertation, in preparation. 8. Type: Other Status: Published Year Published: 2014 Citation: Bradshaw, T.L. 2014. Organic Tree Fruit Production in New England. IN New England Tree Fruit Production Guide. Coop. Extension Systems of New England. 9. Type: Theses/Dissertations Status: Other Year Published: 2015 Citation: Hazelrigg, A. Comparison of Three Organic Apple Orchard Management Systems on Disease and Arthropod Pests. University of Vermont PhD Dissertation, in preparation. 10. Type: Conference Papers and Presentations Status: Other Year Published: 2014 Citation: Bradshaw, T.L., Berkett, L.P., and Kingsley-Richards, S.L. 2014. University of Vermont Apple Research and Outreach Programs. 13 February, 2014. Vermont Tree Fruit Growers Association Annual Meeting. Middlebury, VT. Contacts: 65 attendees

2012/08/01 TO 2013/07/31 What was accomplished under these goals? Research 1. Continue to evaluate 'new' apple cultivars and incorporate research-generated knowledge of apple ecosystem dynamics into organic production systems to determine sustainability and profitability. Field data on tree growth, fruit yield and quality, and disease/pest incidence on fruit and foliage were collected on all cultivars in two OrganicA research orchards. These data were included into the overall dataset for the project to continue to assess cultivar performance under organic management. Cumulative, long-term yield, fruit quality, and pest incidence data will be used to determine overall profitability of the cultivars under the two systems used in the project. This information is important to regional apple growers and may affect adoption of organic practices in apple orchards. 2. Field test commonly

recommended organic foliar nutrient sources and evaluate their impacts on fruit yield, quality, tree nutrition and health including impact on disease and arthropod pests. Norwegian kelp extracts commonly used in organic production systems were assessed in an organic orchard during 2009 and 2010, and found to be of little benefit in the study orchard. In 2012, complete results from this study were presented locally to Vermont apple growers, and internationally, at the 2nd International Organic Fruit Symposium. 3. Evaluate the benefits of different ground cover strategies in promoting tree health, plant and soil water status, and yield and fruit quality. Research on organic ground cover strategies for apple trees was completed and an on-farm organic research project to improve zinc nutrition in apple trees was continued in Maine. Extension 4. Continue to collaboratively develop and implement with stakeholders a multi-dimensional extension program that addresses their priorities and needs, enables whole farm planning, improves competitiveness, and enhances the ability of growers to grow and market high quality organic apples. A multi-dimensional extension program continued to provide stakeholders with organic apple information that included on-site visits, orchard tours, newsletter articles, websites, and grower meetings. Ten issues of Organic Orchard Observations were each sent out during the reporting period via email to OrganicA listserve members and archived on the OrganicA website. Stakeholders visited the various webpages on the OrganicA website a total of approximately 20,995 times during the past year. Project personnel answered numerous stakeholder questions on organic apple production; organic apple production information and research summaries were distributed to diverse audiences which included commercial apple growers, scientists, extension personnel, industry personnel, undergraduate and graduate students and the general public in the region.

2011/08/01 TO 2012/07/31 This project holistically is examining the opportunities and challenges of organic apple production within the 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 2006. In multiple stakeholder surveys, 98% to 100% of participants have 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 has become a leading resource for organic apple information. In various surveys, 92% to 100% of participants said it was Very or Extremely important to continue the research and extension in the region.

2010/08/01 TO 2011/07/31 This project holistically is examining the opportunities and challenges of organic apple production within the 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. The project was initiated in 2006 and since then, all aspects of the OrganicA Project have received high praise. The project has increased knowledge of organic apple production and has created a change in action among program participants. All participants (100%) who responded to an evaluation of the tour of the research organic apple orchards this past year agreed that the event increased their awareness and knowledge of organic apple production and 94% rated the OrganicA Project as very/extremely important to increasing information and insights into organic apple production. Ninety-five percent (95%) of participants planned on using the information presented at the tour. In an on-line evaluation of the project, 100% of respondents said the OrganicA Project has increased their knowledge and understanding of organic apple production; 83% stated that they have used the information in decision-making. Research results and insights have been presented at state/regional workshops involving growers, scientists, extension personnel, and agricultural consultants and at national and international scientific conferences. The OrganicA Project has also become a leading resource for organic information on the world wide web. This past year there were over 10,000 visits to the OrganicA website by people seeking organic apple information.

2009/08/01 TO 2010/07/31 This project holistically is examining the opportunities and challenges of organic apple production within the 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. The project was initiated in 2006 and since then, all aspects of the OrganicA Project have received high praise. The project has increased knowledge of organic apple production and has created a change in action among program participants. The OrganicA Project has become a leading resource for organic information on the world wide web. Research results and insights have been presented at regional workshops involving growers, scientists, extension personnel, and agricultural consultants and at national and international scientific conferences. This long-term project was nationally ranked #1 by the USDA Organic Agriculture Research & Extension Program upon review for funding the second phase of this long-term project.

PUBLICATIONS

2012/08/01 TO 2013/07/31 1. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bradshaw, T.L. 2013. Tour of UVM Orchards and Vineyard. Friends of the Hort Farm Annual Bloomtime Festival. South Burlington, VT. 11 May, 2013. Attendance: 80. 2. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Maine State Pomological Society Summer Tour, in Maine, Summer, 2012, attended by 30 apple growers. Tour of on-farm organic apple research plot at Pie-Tree Orchard. 3. Type: Websites Status: Published Year Published: 2013 Citation: Berkett, L.P. 2013. Organic Orchard Observations. University of Vermont. 10 issues. 31 pp. http://www.uvm.edu/organica/ListservesBlogs/listservesblogs.html Contacts: 1,060 people via listserve) 4. Type: Websites Status: Published Year Published: 2013 Citation: Berkett, L., Moran, R., Garcia, E., Darby, H., Parsons, R., Bradshaw, T., and S. Kingsley-Richards. 2013. The OrganicA Project website. University of Vermont. http://www.uvm.edu/organica/ (Inquiries: approximately 20, 995) 5. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Bradshaw, T.L. 2012. Introduction to Orchard Management. UVM Farmer Training Program. University of Vermont Horticulture Research Center, South Burlington, VT. Field lecture on orchard management systems, including organic to 24 post-collegiate certificate program students. 24 August 2012. Students continued to interact with speaker during fall harvest 6. Type: Other Status: Published Year Published: 2012 Citation: Berkett, L.P., Bradshaw, T.L., Griffith, M.C., Kingsley-Richards, S.L., Darby, H.M., Parsons, R.L., Moran, R.E. and Garcia, M.E. 2012. Disease and Arthropod Evaluation of Five Apple Cultivars under Organic Management in Vermont, USA. 2nd International Organic Fruit Symposium, Leavenworth, WA. http://www.tfrec.wsu.edu/pdfs/P2535.pdf 7. 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Assessment of Kelp Extract Biostimulants on Disease Incidence and Damage in a Certified Organic Apple Orchard. Acta Hort. (ISHS) 1001:265-271 15. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: NC140 Annual Meeting orchard tour, in Maine at the Highmoor Farm agricultural experiment station where organic apple research is being conduced, Nov. 2012, attended by 20 tree fruit researchers. 16. Type: Theses/Dissertations Status: Other Year Published: 2014 Citation: Bradshaw, T.L. Biologic and economic assessment of five apple cultivars under two organic management systems in Vermont. University of Vermont PhD Dissertation, in preparation. 17. Type: Other Status: Published Year Published: 2013 Citation: Berkett, L. P., Griffith, M.C. and T. L. Bradshaw. 2013. Organic Tree Fruit Production in New England. New England Tree Fruit Production Guide. Coop. Extension Systems of New England. 18. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Moran, R., M. Garcia, L. Berkett, T. Bradshaw, S. Kingsley-Richards, M. Griffith, H. Darby and R. Parsons. 2012. Organic weed management strategies for apple trees. An oral presentation made at the American Society for Horticultural Science Annual Conference in Miami, FL 19.

Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bradshaw, T.L. Managing Scab-Resistant Apple Cultivars. University of Maine Summer Orchard Tour. Monmouth, ME. 31 July, 2013 20. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bradshaw, T.L., Berkett, L.P., and Kingsley-Richards, S.L. Present Research and Outreach Programs from the UVM Apple Team. 14 February, 2013. Vermont Tree Fruit Growers Association Annual Meeting. Middlebury, VT. 21. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Bradshaw, T.L. Turn Your Lawn Into Eden, Pest Management Considerations in Home Fruit Plantings. 12 August, 2012. NOFA-VT Summer Workshop, Elmore, VT. 22. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Bradshaw, T.L. The OrganicA Project: Assessing the Feasibility of Organic Apple Production in the Northeast. UVM Student Scholars Poster Competition, Finalist. 3 October, 2012. Burlington, VT.

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The Seed We Need ???working Group, Symposium, and Action Plan for the Advancement of Organic Seed Systems

Accession No.	0218608
Subfile	CRIS
Project No.	WNW-2009-01343
Agency	NIFA WN.W
Project Type	OTHER GRANTS
Project Status	EXTENDED
Contract / Grant No.	2009-51300-05511
Proposal No.	2009-01343
Start Date	01 AUG 2009
Term Date	15 SEP 2010
Fiscal Year	2009
Grant Amount	$46,281
Grant Year	2009
Investigator(s)	Dillon, M.
Performing Institution	ORGANIC SEED ALLIANCE, 210 POLK ST STE 1, PORT TOWNSEND, WASHINGTON 98368-6739

NON-TECHNICAL SUMMARY

Organic seed systems are a recognized area in need of improvement within organic systems, by OREI priorities, National Organic Standards Board, National Organic Action Plan, and at a grassroots level in national and regional organic farm publications, online journals, and at conferences. The projects overall goal is to increase success and minimize risks for organic producers by advancing the viability of organic seed systems, and removing obstacles in availability and appropriateness of organic seed. We have letters of participation from a diverse Organic Seed Working Group (16 members) made up of organic producers, processors, seed industry, NGOs, University representation and other stakeholders. This group will develop a draft State of Organic Seed Report and Action plan that describes current successes, articulates hurdles and outlines a framework to advance the viability of organic seed systems, and that will be refined through the solicitation of feedback on national level. This draft document will provide a template for a working symposium on organic seed to be held in conjunction with the 2010 Upper Midwest Organic Farming Conference. Stakeholder participants of the symposium will further refine the working document through breakout sessions covering specific categorical issues. The symposium will also be a venue for building long-term partnerships and task groups to continue the work of advancing organic seed systems. The final draft of the State of the Seed Report and Action Plan will be published in May of 2010 and distributed widely by Organic Seed Working Group partners. This project will serve university research and extension, seed industry, NGOs, certifying agencies, policy makers, and above all organic producers and processors whom these sectors serve.

OBJECTIVES

The overall goal is to increase success and minimize risks for organic producers by advancing the viability of organic seed systems, and removing obstacles in availability and appropriateness of organic seed. This is a critical need for organic producers, resulting in difficulty and anxiety in the development of an Organic System

Plan, and preventing the attainment of full agronomic and market potential. This gap in organic systems must be addressed not only through breeding and increased oversight, but also by convening producers and other stakeholders to create an action plan to advance the viability of organic seed systems. Long term goals in addition to the stated overall goal: 1) improve organic farmers and agricultural professionals (certifiers, seed industry, extension, researchers) understanding of concerns, obstacles and realistic potentials in organic seed systems; 2) enhance public-private partnerships and farmer collaboration in the development of organic seed systems that fit social, agronomic, market, and regulatory needs; and 3) improve organic producers\' abilities to meet NOP requirement for use of certified organic seed. Supporting outreach objectives are: a.Convene the Organic Seed Working Group, with representation by farmers, certifying agencies, seed sector, organic food sector, university researchers/extension, and NGOs. Representatives will work collaboratively and systematically to identify concerns, obstacles, and opportunities in the implementation and success of organic seed systems, formulating a draft report and action plan that: 1) refines and builds on the seed specific objectives of the 2009 National Organic Action Plan; 2) creates 5 year and 10 year timelines for long-term deliverables; and 3) outlines partnership and funding strategies for implementation of the work. b.Host an Organic Seed Symposium, organized by the Organic Seed Working Group to: 1) solicit broad stakeholder feedback and refine the initial draft of the State of Organic Seed Report and Action Plan; 2) create ongoing working groups that are issue specific; and 3) develop long term partnership and funding strategies. Those unable to attend the Symposium will be able to submit pre-conference written comments, via the OSA web site, to be included as part of the discussion in the Symposium working sessions. c.Publish and Disseminate the State of Organic Seed Report and Action Plan, developed by a broad and diverse body of stakeholders in the organic community. The report will provide an in-depth analysis of the current organic seed sector and articulate a clear action plan with metrics to make improvements and overcome challenges. It will include: 1) farmer-led seed initiatives; 2) strengths and success by region and crop type; 3) white papers on monitoring genetic contamination at the seed level; 4) recommendations for the seed industry on reporting contamination; 5) action plans for the realistic development of initiatives to further address crop and region specific needs; and 5) a guidance document for public and private sector plant breeders on the agronomic, market based, and social value needs of organic producers.

APPROACH

OSA and its Organic Seed Working Group members are developing a dynamic and participatory methodology and process. An inclusive and committed dialogue between the grassroots (producers) and grasstops (professionals) stakeholder groups is necessary for the success of this project and implementation of the action plan. These stakeholders must not only participate in the dialogue and symposium, they must endorse the action plan and remain engaged, investing in the action plan goals via continued discussion and working partnerships. Working within a relatively short time table, the working group will draft an outline of the process and the plan, and immediately solicit input from the broader community. The initial draft of the State of Organic Seed Report and Action Plan will be used as a guide in developing the symposium agenda and the breakout working sessions. Upon completion of this initial draft of the report/action plan, OSA will post it on their web site. Partners will link to this, and all members will solicit input from their mailing lists, list serves, and constituencies where appropriate. The OSA web site will allow individuals and organizations to provide input directly on the web site, and will be viewable by others. Stakeholder input will be incorporated into a new draft that will then be presented at the 2010 Organic Seed Symposium at the Upper Midwest Organic Farming Conference for refinement. The Symposium will be a mix of key presentations followed by working group breakout sessions. Organic Seed Working Group partners will deliver summaries of the process, and an overview of the draft report/action plan. Working sessions will divide into categories to be determined during planning of the symposium by the Organic Seed Working Group. It is necessary to first develop a more integrated picture of the issues before moving into this level of detail; this cannot occur until partners and stakeholders articulate all concerns. Regardless of the categories, the expected format for working sessions will be a facilitated discussion in order to refine the report/plan. Organic Seed Alliance will oversee a final draft of report/plan with review by partners prior to publishing. \See Outreach section below for dissemination plans.\ The report/plan will include SMART (Specific; Measurable; Actionable; Relevant; Timely) objectives with benchmarks and timelines. Organic Seed Alliance has a mission-based commitment to on-going and periodic evaluation of our collective progress on the plan beyond the life of the grant, as well as re-calibration of the plan at annual meetings at existing organic conferences. Organic Seed Working Group partners and symposium participants will be encouraged to maintain a working relationship with OSA to engage in ongoing assessments as to the incorporation of action items.

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Sustainable Dryland Organic Farming Systems in the Pacific Northwest

Accession No.	0218862
Subfile	CRIS
Project No.	WNP06277
Agency	NIFA WN.P
Project Type	OTHER GRANTS
Project Status	EXTENDED
Contract / Grant No.	2009-51300-05578
Proposal No.	2009-01416
Start Date	01 SEP 2009
Term Date	31 AUG 2014
Fiscal Year	2009
Grant Amount	$1,040,210
Grant Year	2009
Investigator(s)	Burke, I. C.; Fuerst, E. P.; Koenig, R. T.; Painter, K.; Roberts, D.; Huggins, D.; Fortuna, A. M.; Machado, S.; Baik, B. K.; Goldberger, J.; Johnson-Maynard, J.
Performing Institution	Crop & Soil Sciences, WASHINGTON STATE UNIVERSITY, PULLMAN, WASHINGTON 99164

NON-TECHNICAL SUMMARY

Dryland organic farming in Idaho, Washington, and Oregon has great potential for growth as well as improved economic and environmental sustainability. The long-term goal of this integrated research and extension project is to foster the development of economically viable and environmentally sustainable dryland organic grain and forage farming systems in the dryland production regions of the Pacific Northwest. To meet this goal, we have two main objectives. Extension Objective: Promote communication among producers, processors, marketers, researchers, and extension educators by building an interactive three-state communications network to enhance the economic viability and environmental sustainability of organic production systems. Extension efforts, guided by input from producers, will include producer-implemented on-farm trials, annual winter meetings, summer field tours, comprehensive producer surveys in the first and fourth years, marketing information, and crop budgets for different crops and climatic zones. Research Objective: Develop economically viable and environmentally sustainable grain and forage cropping and intercropping practices that successfully address three major barriers: weed pressure, lack of fertility, and soil erosion.

OBJECTIVES

EXTENSION OBJECTIVE: Promote communication among producers, processors, marketers, researchers, and extension educators by building an interactive three-state communications network to enhance the economic viability and environmental sustainability of organic production systems. EXTENSION EXPECTED OUTPUTS: (1) Improved accessibility of information on organic management practices, marketing, economics, and research information through: (A) a tri-state website for dryland organic agriculture, updated with project bulletins, research results, and project presentations, with access to additional organic production and marketing information, and (B) an interactive tri-state electronic network for improved communication among producers, processors,

marketers, researchers, and extension educators. (2) Five on-farm trials replicated in field design and across years in Washington, Oregon, and Idaho. Results will be published on the tri-state extension website. (3) Trip for PNW producers to regional Organic Association meeting, year 2; Two project winter workshops, years 3 and 4; Four summer farm tours and research field days. (4) Extension bulletins on dryland organic crop rotation options, economics, annual and perennial weed management, intercropping with legumes, and soil fertility. RESEARCH OBJECTIVE: Develop economically viable and environmentally sustainable grain and forage cropping and intercropping practices that successfully address three major barriers: weed pressure, lack of fertility, and soil erosion. RESEARCH EXPECTED OUTPUTS: (1) Development of alternative organic rotations and management practices, including improved management of annual and perennial weeds with minimum-tillage methods. (2) An enhanced understanding of the role of legumes, supplemental manure-based fertility, crop rotation, and intercropping on the weed seed bank, annual and perennial weed severity, soil quality, crop productivity and quality, and profitability of organic production systems. (3) Increased understanding of the roles of mycorrhizae and soil microorganism processes in N and P cycling and the roles of these organisms in soil quality and plant health/productivity. (4) Peer-reviewed journal articles from all three states in journals in the fields of organic agriculture, cropping systems research, weed science, agronomy, soil science, and cereal chemistry. (5) Presentations at meetings of this project, at field tours, and at national meetings by PIs from all three states and by graduate students from WSU and UI.

APPROACH

Our approach to research and extension is based on input from our advisory council and knowledge gained in the prior study. Our scope has broadened, including not only our cropping systems research, but also engaging our growers in on-farm trials, an annual organic farming meeting, field tours, and other outreach activities. Our advisory council, comprised of six organic farmers from WA, OR, and ID and one representative from Small Planet Foods, Inc., an organic food manufacturer, will continue to guide our research and extension efforts. Their major issues are clearly weed control with conservation tillage and fertility. The investigators in this proposal will also be engaged in graduate and undergraduate education. EVALUATION: To evaluate outputs and impacts, mail and web surveys of certified organic producers will be conducted in the first and fourth years to assess the overall impact of the project. In Year 1, we will survey all certified organic wheat, barley, and alfalfa producers, as well as a sample of other certified organic crop, livestock, and integrated crop-animal operations in WA, OR, and ID. In Year 4, we will resurvey the same producers to allow us to measure changes in production practices (e.g., crop rotations, fertility inputs, weed control methods, soil conservation, etc.); agronomic constraints; marketing strategies; economic profitability (e.g., organic price premiums) and risk, and research, outreach, and information needs. This panel survey design will allow us to assess the quality and impact of our project.

PROGRESS

2009/09 TO 2014/08 Target Audience: Outreach efforts, guided by input from our Advisory Council, targeted producers, Cooperative Extension personnel, and agricultural professionals who advise producers on organic practices through in-person events (on-farm trials, field tours, winter meetings), printed materials (Extension publications, analysis tools), and digital resources (webinars, webpages, and web-based videos). Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Multiple opportunities for training and professional development have been provided by the project. At the conclusion of the project, four graduate students will have received degrees, with a fifth in progress. Additionally, a post-doctoral associate and two research associates were employed on the project. Each student received significant training as part of the graduate education process that included courses and training to conduct research tailored to the individual needs of the student. Research associate and graduate student professional development emphasized communication of results at scientific and grower meetings. How have the results been disseminated to communities of interest? The results have been disseminated using multiple formats to the target community, which is growers interested in organic production techniques for small grains. The project held annual meetings that were open to the public. A website was created to allow access to research findings, reports, posters, and presentations created by project personnel. Case studies were created based on interviews with grower-collaborators, and those studies were posted on the project website and will ultimately be published. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/09 TO 2013/08 Target Audience: Farm Services and Natural Resource Conservation Service personnel; growers and land owners; regional and commodity specific extension specialists; weed scientists; and

agroecosystem managers. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? One of the primary emphases of this grant was to educate graduate students. To date, three graduate students have finished: Julia Piaskowski, Misha Manuchehri and Dr. Kristy Borrelli. Three additional graduate students are currently working on various aspects of the project: Anne Park, Nicole Tautges, and Kendall Kahl. Additional professional development occurred as Louise Laurent learned to conduct grower interviews and develop case studies associated with the on-farm trials funded by this grant. How have the results been disseminated to communities of interest? Results of research, both on-farm trials and research trials, have been disseminated through regional extension presentations and direct grower interactions. What do you plan to do during the next reporting period to accomplish the goals? The final year of the project will include considerable outreach efforts, and also emphasize material production. The newly developed website will be expanded by adding case studies summarizing on-farm experiment outcomes, and the final rotations completed on the Boyd Farm. At the end of the reporting period, we will have accomplished all the goals proposed.

2011/09/01 TO 2012/08/31 OUTPUTS: Research continued at the Boyd Farm in WA. Poultry manure improved in-season production of small grain crops, and legume cover crops or perennial forage improved soil inorganic N levels for subsequent cereal crops. Reduced tillage methods and cover crops effectively controlled weeds, but weeds continue to be difficult to manage. Experiments in OR and WA evaluated the ability of intercropped legumes to control pests and improve soil fertility for cereals. Compatible combinations of wheat and legumes are being examined in OR and preliminary findings suggest that wheat yield can increase by 4 to 12% if the right balance is achieved. Soil moisture and wheat yield were not reduced in WA when a pea intercrop was removed at maturity, and a reduced tillage inter-row implement was effective at removing intercropped cover crops and weeds. At a second location, an in-season pea intercrop did reduce soil moisture and wheat yield. No value for legume intercrops to provide N has been found. Relationships with local producers address constraints to adopting organic practices with on-farm research. In OR, spring wheat (variety Dark Northern and Soft White) produced higher yields than winter wheat and spring barley but \'Dark Northern\' protein percentages were lower than premium grade. Higher spring crop yields were attributed to less weed competition because an undercutter could be used, and low protein levels were attributed to lower N additions than conventional systems. Extension personnel assisted farmers to conduct on-farm experiments and share results at field tours and workshops. Locally available manure was affordable and increased available P and K, but commercial organic fertilizers were too expensive. When management practices increased crop residue inputs and plant available N, numbers and diversity of novel microorganisms that control N and C cycling increased at Palouse Conservation Field Station, WA. Earthworm density was similar in the alfalfa rotation at Boyd Farm, but results were variable. Earthworms are being identified to the species level and soil aggregate stability is being analyzed. Organic cropping systems effects on wheat grain properties, nutritional value, flour properties, and end-use quality are being compared with conventional systems. Samples from the Boyd Farm and a similar trial at Montana State University, demonstrated that organic wheat kernels were often larger than conventionally grown kernels. Mineral content was slightly lower in Montana organic hard red wheat but slightly higher in Pullman organic soft white wheat. Protein content was lower in organic wheat, but low protein is desirable in soft white wheat and cake volume was greater from grain produced in low N organic systems. Lower protein in organic hard red wheat reduced bread loaf volume, but protein and bread quality were still excellent. Economic analyses indicate that farmers can save money on fuel costs and synthetic agricultural chemicals by adopting conservation tillage methods and legume intercropping or rotation methods. Economic evaluations of N inputs provided by legumes are still being determined. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: Based on input from the advisory panel, five on-farm trials were conducted to date. Trials in Idaho (ID) compared different rates of compost applications. In the first year, a 10 T/A compost application doubled phosphorus mineralization compared to the control. Based on one year of data, it appears to be economical and effective to use dairy compost on dryland organic alfalfa to build soil residual P and K levels. Washington (WA) trials focused on a comparison of organic fertilizers in a wheat-fallow rotation. There was no agronomic advantage from the organic fertilizer applications. The high cost of fertilizer meant that net returns were the same or lower than the control. One Oregon (OR) trial addressed crop rotations, cover crops, tillage, and weed control using some of the same approaches identified as effective in the research plots near Pullman, WA. In two years, two spring wheat cultivars produced significantly higher yields than winter wheat and spring barley. Although N applications increased by 3.5 lbs N per acre from 2010 to 2011, the total applied each year was much lower than the 40 to 60 lbs N/A that is usually applied under conventional production. Weed pressure was reduced substantially in each rotation when spring crops were planted, and reduced yield in winter

wheat was largely attributed to high weed infestations. Higher spring wheat yields could be attributed to less weed competition. Planting in the spring provided the opportunity to kill weeds using an undercutter implement. The second Oregon trial focused on the demonstration of bindweed control using the mite, Aceria Malherbe. The objective was to determine the best time of year to collect and redistribute the mite to obtain the greatest probability of establishment for use on organic wheat farms. To date, establishment has not been effective, apparently due to the poor adaptability of the mite to the area of introduction. Differences in soil microbial community structure resulting from land-use management, carbon, and nitrogen inputs and climate have been identified using 454 pyrosequencing technology coupled with veioinformatics and qPCR. The effect of organic cropping systems on wheat grain properties, nutritional value, flour properties, and end-use quality are being compared with conventional systems. In addition to analyzing samples from our own trial in Pullman, we are analyzing samples from a similar type of trial from Montana State University. Results varied by year and location. However, a few general trends were observed. Organic wheat kernels tended to be slightly larger. Minerals content was slightly lower in Montana organic hard red wheat but slightly higher in Pullman organic soft white wheat compared to conventional controls. Protein content tended to be lower, though not always, in organic wheat. Long-term organic cropping systems research continued near Pullman, WA, to identify profitable and sustainable cropping systems for the region. Research evaluated crop rotations, fertility practices, and integrated strategies for conservation tillage weed management. Intercropping research is being conducted in both OR and WA. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: An advisory council comprised of growers from Washington, Idaho, and Oregon was formed and met with university personnel from all three states. Grower input was obtained in order to set priorities for research and extension efforts. Six of the advisory council members have on-farm trials, discussed below. Multi-year on-farm trials were established in Washington, Idaho, and Oregon, two trials in each state. Trials in Washington are evaluating commercial organic fertilizers; trials in Idaho are evaluating rates of manure application and crop responses; one trial in Oregon is evaluating crop rotations, cover crops, tillage, rotation, weeds, and nitrogen using two tillage systems; the other trial is a demonstration study on biological control of bindweed by the mite, Aceria malherbe. Other extension activities included a survey of organic agriculture in Idaho, multiple tours of the Pullman, Washington research site, and presentations at the meetings of the American Society of Agronomy and Pacific Northwest Direct Seed Association. Long-term organic cropping systems research is being conducted near Pullman, Washington to identify profitable and sustainable cropping systems for this region. Research is evaluating crop rotations, fertility practices, and integrated strategies for conservation tillage weed management. Intercropping research is being conducted in Pendleton, Oregon. PARTICIPANTS: Individuals: Project Director: Ian Burke (revised 9/2010). Investigators: E. Patrick Fuerst, Richard Koenig, Kathleen Painter, Diana Roberts, Ann-Marie Fortuna, Stephen Machado, Byung-Kee Baik, Jessica Goldberger, and Jodi Johnson-Maynard. Others involved in project: Cindy Kinder, Lauren Hunter, both U of Idaho extension; Dennis Pittmann and John Rumph, both WSU agricultural research technicians. Partner Organizations: Washington State University, University of Idaho, and Oregon State University. Collaborators and Contacts: Grower Advisory Council: Lou Anderson and Matt Mclam (Idaho), Eric Nelson, David Stelzer, Cliff Bracher, and Paul Bracher (Oregon); and Gregg Beckley, Eric Zakarison, Owen Jorgensen, David Ostheller, and Alec McErlich (Washington). Training and Professional Development: The following graduate students are working on this project: Misha Manuchehri (M.S.), Kristy Ott-Borrelli (Ph.D.), and Julia Piaskowski (Ph.D.). We employed the following undergraduate students on our project: Jason Parsley, Madeline Richardson, and Nick Boydston. TARGET AUDIENCES: Target Audiences: dryland organic farmers in Washington, Oregon, and Idaho. Efforts: Meeting with previously mentioned members of advisory council; several tours of our field research site; implementation of previously mentioned on-farm trials. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2009/09 TO 2014/08 What was accomplished under these goals? Relationships with local organic producers have addressed constraints for adoption of organic practices through on-farm research throughout the inland Pacific Northwest. Extension personnel assisted growers in WA, OR and ID in their own on-farm experiments and results have been incorporated into case studies. In OR, two major crop rotations continue to be examined. Spring wheat (\'Dark Northern\' and \'Louise\') produced significantly higher yields than winter wheat and spring barley but \'Dark Northern\' protein percentages were lower than premium grade. Higher spring crop yields were attributed to less weed competition because of an opportunity to kill weeds with an undercutter, while low protein levels were attributed to lower N additions than conventional systems. Experiments in OR and WA evaluated the

ability of intercropped legumes to control pests and improve soil fertility for cereal. Compatible combinations of wheat and legume cultivars are being examined in OR and findings suggest that wheat yield can increase by 4 to 12% if the right competition/facilitation balance is achieved. In WA, growers found that locally available composted manure was affordable and increased available P and K levels, but commercial organic fertilizers were too expensive. In ID, growers found that manure applied to organic barley fields increased yields. Cropping system research concluded at the primary research site, the Boyd Farm in eastern WA. Additions of poultry manure improved in-season production of small grain crops, while legume cover crops or perennial forage alfalfa improved soil inorganic N levels for subsequent cereal crops. Reduced tillage methods and cover crops were effective for weed control, but weeds continue to be difficult to manage, particularly perennial weeds. Soil properties and earthworm populations were measured in three cropping systems, the organic 3-year wheat-pea hay, conventional 3-year wheat-pea hay, and organic 5-year alfalfa-wheat. Earthworms and cocoons were collected by hand sieving and sorting to calculate population density, biomass and for species identification. Microbial biomass was measured for the top 10 cm of the soil profile, while saturated hydraulic conductivity, total organic carbon, total nitrogen, bulk density, and pH were measured to a depth of 150 cm. Greater (P=0.052) earthworm density was observed in the organic wheat-pea crop rotation compared to the conventional wheat-pea. Earthworm densities in the organic alfalfa-wheat rotation were similar to those measured in the organic wheat-pea rotation. Greater aggregate stability was observed in the organic wheat-pea compared to the conventional wheat-pea rotation; however, means were not different. Based on the Boyd Farm research trials, economic feasibility was assessed through a cost of production analysis for integrating 100 acres of ORT crop production into a 2,000 acre non-organic dryland farm. Enterprise budgets for dryland organic crops were developed and were also based on research rotations at the Boyd Farm. Test weight, kernel weight, and kernel diameter tended to be greater in both soft and hard organic wheat than in conventional wheat. Phenolic content and total antioxidant capacity tended to be lower in organic than in conventional wheat. Content of flour ash, P, and Mg content in whole wheat flour varied in parallel among cropping systems but levels were not consistently associated with either organic or conventional cropping systems. Higher fertility led to higher protein content regardless of whether the cropping system was organic or conventional. Soft wheat flour from a very low fertility organic cropping system had lower protein content and improved end-use quality properties for cakes and cookies. In the hard wheat studies, higher fertility in both organic and conventional cropping systems tended to increase protein and bread loaf volume. In conclusion, organic or conventional cropping systems were similar in mineral and antioxidant nutritional properties. End-use quality of wheat was strongly associated with fertility level but not with either organic or conventional cropping systems. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/08 1. Type: Journal Articles Status: Published Year Published: 2014 Citation: Borrelli, K., Koenig, R., Burke, I., Gallagher, R. S., Pittmann, D., Snyder, A., and Fuerst, E. P. 2014. Transition cropping system impacts on organic wheat yield and quality. Renewable Agriculture and Food Systems, 1-12. 2. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: K., R. Koenig, I. C. Burke, E. P. Fuerst, and R. Gallagher. 2011. Nitrogen Dynamics In Nine Rotation Systems From Transition to Certification of Organic Dryland Grain Production. ASA Annual Meeting. Available online: http://a-c-s.confex.com/crops/2011am/webprogram/Paper66429.html 3. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Manuchehri, M.R., K.A. Borrelli, E.P. Fuerst, D.L. Pittmann, R.T. Koenig, I.C. Burke. 2012. Fertility and cropping system effects on spring annual weeds in Eastern Washington dryland organic systems. \Online\. Available at http://www.wssa.net/Meetings/WSSAAnnual/2012/WSSA2012Program.pdf (Accessed 3, February 2012). 4. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Tautges, N., Burke, I.C., Fuerst, E.P, Borrelli, K., Pittmann, D., and Koenig, R.T. 2014. Use of a nitrogen balance to assess nitrogen dynamics in dryland organic and conventional cropping systems. Poster presented November 3, 2014 at the ASA-CSSA-SSSA International Annual Meeting. 5. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Tautges, N., Burke, I.C., Fuerst, E.P., Borrelli, K., Pittmann, D., and Koenig, R.T. 2014. Brown vs. green: effects of animal and green manures on crop competitiveness and yield in dryland organic systems. \Online\. Available at http://wssaabstracts.com/public/22/proceedings.html (accessed 15 December, 2014). 6. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Sullivan, T.S., Tautges, N., and Burke, I.C. 2014. Long-term dryland organic rotations impact soil health and soil microbial community in eastern Washington. Poster presented November 3, 2014 at the ASA-CSSA-SSSA International Annual Meeting. 7. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Park, E.Y., Baik, B.K., Miller, P.R., Burke, I.C., Wegner, E.A., Morris, C.F., and Fuerst, E.P. 2014. Functional and nutritional characteristics of wheat grown in organic and conventional cropping systems. Cereal Chemistry submitted. 8. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Lorent, L., Roberts, D, Burke, I.C., and Fuerst, E.P. 2014. Organic grain production in the Pacific Northwest - a collection of farmer case studies. Poster presented October 28, 2014 at the BIOAG Symposium Poster Session and November 7, 2014 at the T40-Tilth?s 40th Anniversary Conference. 9. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Kahl, K., Painter, K.M.,

and Johnson-Maynard, J.L. 2014. Economic feasibility of organic, reduced-till dryland cropping systems in the Palouse. Poster presented November 3, 2014 at the ASA-CSSA-SSSA International Annual Meeting. 10. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Kahl, K., Johnson-Maynard, J.L., Painter, K.M., and Burke, I.C. 2014. Soil health and economic potential of organic, reduced-till cropping systems in the Palouse. Presented on November 5, 2014, at the ASA-CSSA-SSSA International Annual Meeting. 11. Type: Theses/Dissertations Status: Published Year Published: 2014 Citation: Kahl, K., J.L. Johnson-Maynard, K.M. Painter, and R. Heinse. 2014. Organic conservation tillage production systems in the Palouse \masters thesis\. Moscow (ID): University of Idaho. 178p. 12. Type: Websites Status: Published Year Published: 2014 Citation: http://smallgrains.wsu.edu/organic-production/

2012/09 TO 2013/08 What was accomplished under these goals? Cropping system research continued at the Boyd Farm in WA. Additions of poultry manure improved in-season production of small grain crops, while legume cover crops or perennial forage alfalfa improved soil inorganic N levels for subsequent cereal crops. Reduced tillage methods and cover crops were effective for weed control, but weeds continue to be difficult to manage, particularly perennial weeds. Experiments in OR and WA evaluated the ability of intercropped legumes to control pests and improve soil fertility for cereal. Compatible combinations of wheat and legume cultivars are being examined in OR and preliminary findings suggest that wheat yield can increase by 4 to 12% if the right competition/facilitation balance is achieved. Relationships with local organic producers have continued to address constraints to adopting organic practices through on-farm research. In OR, two major crop rotations continue to be examined. Spring wheat ('Dark Northern' and 'Louise') produced significantly higher yields than winter wheat and spring barley but 'Dark Northern' protein percentages were lower than premium grade. Higher spring crop yields were attributed to less weed competition because of an opportunity to kill weeds with an undercutter, while low protein levels were attributed to lower N additions than conventional systems. Extension personnel assisted farmers in WA, OR and ID to conduct their own on-farm experiments and results are being incorporated into case studies. Farmers found that locally available composted manure was affordable and increased available P and K levels, but commercial organic fertilizers were too expensive. Soil properties and earthworm populations were measured in three cropping systems, the organic 3-year wheat-pea hay (IV-B), conventional 3-year wheat-pea hay (V-B), and organic 5-year alfalfa-wheat (I-C). Earthworms and cocoons were collected by hand sieving and sorting to calculate population density, biomass and for species identification. Aggregates stability was measured for .5 - 1 mm and 1 - 2 mm aggregates using a high energy moisture characteristic method. Microbial biomass was measured using a fumigation and extraction method for the top 10 cm of the soil profile. Total organic carbon, total nitrogen, bulk density, and pH were measured to a depth of 150 cm using soil cores extracted with a hydraulic giddings probe. Saturated hydraulic conductivity was measured using a constant head well permeameter (Guelph). Preliminary results showed a trend for greater (P=0.052) earthworm density in the organic wheat-pea crop rotation compared to the conventional wheat-pea. Earthworm densities in the organic alfalfa-wheat rotation were similar to those measured in the organic wheat-pea rotation. There was a trend towards greater aggregate stability in the organic wheat-pea compared to the conventional wheat-pea rotation, however means were not significantly different. Data are currently being analyzed and will form the basis of a MS student's thesis that will be completed in spring 2014. The effect of organic cropping systems on wheat grain properties, nutritional value, flour properties, and end-use quality are being compared with conventional systems. Samples were analyzed from the Boyd Farm and a similar trial at Montana State University. In general, organic wheat kernels tended to be slightly larger than conventionally grown kernels. Mineral content was slightly lower in Montana organic hard red wheat but slightly higher in Pullman organic soft white wheat. Protein content was often lower in organic wheat. Lower protein is desirable in soft white wheat and greater cake volume was observed from grain produced in low N organic systems. When protein was lower in organic hard red wheat, bread loaf volume was slightly reduced, but protein quality and bread quality was still excellent. Economic analyses indicate that farmers can save money on the cost of fuel and synthetic agricultural chemicals by adopting conservation tillage methods and legume intercropping or rotation methods. Economic evaluations of N inputs provided by legumes are still being determined. **PUBLICATIONS (not previously reported):** 2012/09 TO 2013/08 Type: Journal Articles Status: Submitted Year Published: 2014 Citation: Borrelli, K.A., R.T. Koenig, I.C. Burke, R.S. Gallagher, D. Pittmann, A. Snyder and E.P. Fuerst. In review. Wheat yield and quality following legume and cereal-based cropping systems during the transition to organic production in the dryland region of the inland Pacific Northwest. Sust. Ag. Food Syst.

2011/09/01 TO 2012/08/31 Impact has been limited. Farmers conducted individualized on-farm research trials to address common restraints facing dryland organic grain producers and shared outcomes with other farmers at field days and workshops. The primary impact of our research has been to enable our grower collaborators to improve their current production systems or experiment with non-standard practices where they would otherwise be able to.

2010/09/01 TO 2011/08/31 Minimally invasive surface tillage practices for weed management, developed in our research, have been adopted by a grower near Fairfield, WA. A precision weed management tool developed in our research was adopted by a grower near Pendleton, OR. There is an increase in dairy compost use on dryland organic alfalfa in southern Idaho. As a result of our annual investigator - advisory panel meeting, a dryland organic grain production conference was organized to facilitate networking and discussion among the growers and a wider audience at the annual Tilth Conference in Yakima, WA.

2009/09/01 TO 2010/08/31 Adoption of surface tillage practices for weed management, developed in our research, by a grower near Fairfield, WA. Adoption of a precision weed management tool developed in our research by a grower near Pendleton, OR.

PUBLICATIONS

2011/09/01 TO 2012/08/31 1. Borrelli, K. Ott. 2012. Rotational cropping systems for nitrogen management and weed control in dryland organic wheat production. Washington State University. ProQuest Dissertations and Theses, pps. 141. 2. Manuchehri, M. 2012. The relative competiveness of spring crops in a dryland organic system in eastern Washington. MS Thesis. 3. Borrelli, K., R. Koenig, R.S. Gallagher, D. Pittmann, A. Snyder, I. Burke, L. Hoagland, and E.P. Fuerst. 2012. Alternative strategies for transitioning to organic production in direct-seeded grain systems in eastern Washington II: Nitrogen fertility. J. Sust. Ag. 36:461-477. 4. Borrelli, K., R. Koenig, I. Burke, D. Pittmann, and E.P. Fuerst. 2012. Managing soil nitrogen and weeds using legume and cereal-intensive cropping systems during the transition to dryland organic wheat production in Eastern Washington State. Washington State University Field Day Abstracts. Department of Crop and Soil Science Technical Report 12-1. pps. 43-44. \Online\. 5. Manuchehri, M.R., K.A. Borrelli, E.P. Fuerst, D.L. Pittmann, R.T. Koenig, I.C. Burke. 2012. Fertility and cropping system effects on spring annual weeds in Eastern Washington dryland organic systems. \Online\.

2010/09/01 TO 2011/08/31 1. Ott-Borrelli, K., Koenig, R. T., Gallagher, R., Pittman, D., Snyder, A., Fuerst, E. P, Burke, I.C. and Hoagland, L. 2012. Alternative Strategies for Transitioning to Organic Production in Direct-Seeded Grain Systems, Eastern Washington II: Nitrogen Fertility. J. Sustain. Agr. (Accepted for publication). 2. Ott-Borrelli, K., Koenig, R. T., Burke, I, Gallagher, R. and Fuerst, E. P. 2010. Crop and soil nitrogen dynamics of nine rotation systems during the transition and certified organic phases of dryland grain production. ASA Annual Meeting. Available online: http://a-c-s.confex.com/crops/2010am/webprogram/Paper60821.html 3. Borrelli, K., Koenig, R. T., Burke, I., Fuerst, E. P. and Gallagher, R. 2011. Nitrogen Dynamics In Nine Rotation Systems From Transition to Certification of Organic Dryland Grain Production. ASA Annual Meeting. Available online: http://a-c-s.confex.com/crops/2011am/webprogram/Paper66429.html 4. Fuerst, E. P., Burke, I., Huggins, D., Gallagher, R. Borrelli, K. Pittmann, D. and Koenig. R. T.. 2010. Dryland organic weed management strategies in eastern Washington. ASA Annual Meeting. Available online: http://a-c-s.confex.com/crops/2010am/webprogram/Paper61908.html 5. Gallagher, R., Pittmann, D., Snyder, A. M., Koenig, R. T., Fuerst, E. P., Burke. I. and Hoagland, L. 2010. Alternative strategies for transitioning to organic production in direct-seeded grain systems in Eastern Washington I: Crop Agronomy. J. Sustain. Agr. 34:483-503. 6. Hunter, L.A. and Kinder, C. A. Building an Interactive Three-state Communication Network Between Producers, Researchers, and Extension Educators. University of Idaho Extension Annual Conference, Burley, April 13-15, 2010. (Oral presentation and submitted abstract discussing the grant/partnership existing between WA,ID, and OR). 7. Hunter, L.A., Falen, C.L., Kinder, C.A., and Moore, A. Phosphorous and Potassium Availability from Dairy Compost in Dryland Organic Crop Production. 10th Annual Western Region County Agriculture Agents Meeting, Kenewick, Washington, October 12-13, 2011. (Oral presentation with submitted abstract/proceedings). 8. Manuchehri, M. R., Fuerst, E. P., Burke, I. and Pittmann, D. 2011. Relative competitiveness of spring crops in Eastern Washington dryland organic systems. Proc. West. Soc. Weed Sci. 64:104.

2009/09/01 TO 2010/08/31 1. Fuerst, E.P., R.T. Koenig, J. Kugler, K. Painter, M. Stannard, and J. Goldberger. 2009. Organic Alfalfa Management Guide. Washington State University Extension Bulletin EB2039E. http://cru84.cahe.wsu.edu/cgi-bin/pubs/EB2039E.html 2. E. P. Fuerst, I.C. Burke, D. Pittmann, R.T. Koenig, D. Huggins, D. Collins, C. Cogger, A. Corbin, and C. Benedict. 2010. Organic Conservation Tillage Practices: Innovations and Implications for Grain, Vegetable, and Conventional Farming Systems. Poster at Pacific Northwest Direct Seed Association Annual Meeting, January, 2010. 3. E.P. Fuerst, I.C. Burke, D.R. Huggins, R.S.

Gallagher, K. Ott-Borrelli, D. Pittmann, and R. T. Koenig Dryland Organic Weed Management Strategies in Eastern Washington. Abstract, American Society of Agronomy Annual Meeting, November, 2010. 4. Goldberger, J.R. 2010. Certified Organic Production: The Experiences and Perspectives of Idaho Farmers. http://csanr.wsu.edu/publications/SPNW/SPNW-v8-n2.pdf; http://csanr.wsu.edu/publications/researchreports/idaho certified org anic survey 2010.pdf 5. Gallagher, R.S., A. Snyder, R.T. Koenig, I.C. Burke, and L. A. Hoagland. 2010. Alternative strategies for transitioning to organic production in direct-seeded grain systems in eastern Washington I: Crop agronomy. J. Sustainable Agric. 34:483-503.

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No-till Organic Vegetable Production in Western Washington: a Planning Proposal

Accession No.	0218863
Subfile	CRIS
Project No.	WNP07375
Agency	NIFA WN.P
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05584
Proposal No.	2009-01327
Start Date	15 AUG 2009
Term Date	14 AUG 2011
Grant Amount	$46,794
Grant Year	2009
Investigator(s)	Burrows,C
Performing Institution	Extension, WASHINGTON STATE UNIVERSITY, 240 FRENCH ADMINISTRATION BLDG

NON-TECHNICAL SUMMARY

Organic vegetable farms have grown in number and acreage over the past decade in Western Washington, with over 2,300 acres in vegetable production in 2007. Consumers in the region are looking for locally produced, organically grown food; they are also looking for local growers to take measures to reduce impacts on the environment, for example, by practicing no- or low-till soil management. Farmers are inherently interested in methods that can reduce the deleterious effects to soil quality, soil erosion, soil compaction, excess fuel consumption, and contribution to greenhouse gases that can be caused by extensive tilling. This is a Research and Extension Planning Proposal with a goal to bring no-till experts from other parts of the country to western Washington and conduct a symposium where local farmers, researchers, educators, and industry representatives can learn about no-till farming and how it can fit into organic vegetable production systems. Held in Snohomish County in October, 2009, the symposium will also focus on understanding needs for the organic vegetable industry in western Washington regarding no-till practices and developing a successful plan for an integrated project. This project will likely involve evaluating agronomic performance, pest and weed control, economic viability and soil health in a no-till system. The long-term goal of such a project is to increase farmer economic and environmental sustainability in western Washington through soil conservation systems. This planning project will work towards the development of a larger research and extension project relating to no-till production in vegetable crops in western Washington.

OBJECTIVES

This planning proposal will inform an integrated proposal with the potential to develop and evaluate tools for organic vegetable growers in western Washington to implement no-till techniques. This project will bring no-till specialists from other parts of the United States to western Washington to a two-day symposium. The first day will involve the specialists sharing information on how no-till could work in organic vegetable systems in western Washington. The second day will consist of facilitated discussions on how an integrated project on no-till in organic vegetable production could be implemented in western Washington. In order to develop an invitation list

for the symposium, we will consult with researchers, other extension professionals, Tilth Producers of Washington board members, and farmers known to be interested in no- or low-till systems. We will invite researchers involved in a wide range of agricultural specialties, including soil science, vegetable production, entomology, pathology, weed management, and agricultural economics. At least 10 seats will be reserved for farmer participants. Extension professionals involved with organic vegetable farms in their regions will also be invited. If space allows, the symposium will be opened up to interested farmers, extension professionals, and researchers on an application basis. This planning project will work towards the development of a larger research and extension project relating to no-till production in vegetable crops in western Washington.

APPROACH

A small research and demonstration project will be underway in the spring of 2009. The farm at 21 Acres, a WSU Biologically Intensive and Organic Agriculture (BIOAg) site in Woodinville, Washington, will have a plot demonstrating the use of a winter rye cover crop, rolled and crimped in the spring. Pumpkins will be transplanted into the crimped rye during the 2009 growing season. This will serve as a small demonstration to symposium participants on how no-till farming can work into an organic system. A symposium will be held in the fall of 2009 to bring together no-till experts and other interested parties to develop an integrated proposal with the potential to develop and evaluate tools for organic vegetable growers in western Washington to implement no-till techniques.

PROGRESS

2009/08 TO 2011/08 OUTPUTS: A 2-day symposium was held on October 28 and 29 in Everett, Washington that brought together organic farmers, researchers, extension educators, and industry professionals around the issue of reduced tillage in organic vegetable production. The first day brought 4 experts on no-till production to share experiences and research findings. Participants travelled to a local organic on-farm research project utilizing no-till practices to observe equipment, methods and results. Seventy five people attended, with 39 farmers present. The second day had a goal of discussing future plans for research and extension in Western Washington around reduced tillage. Participants broke into 5 groups to discuss potential research areas to be targeted and the group was brought back together to further discuss these elements. On this day, 35 people participated, with 13 farmers present. During the fall of 2009, a project committee team was formed to prepare a full research and extension proposal for the OREI program. This group met in person and via videoconference to refine the appropriate goals for the project and to develop research and outreach methods for a proposed project. This project was not selected for funding, but the PIs were encouraged to resubmit. In the fall of 2010, four members of the working team travelled to Oregon State University to meet with Mr. Nick Andrews, Dr. John Luna and Dr. Ed Peachey to discuss reduced tillage efforts in western Oregon and how they might be translated to western Washington. The group visited reduced-tillage efforts in place on vegetable farms and discussed various methods for incorporating reduced-tillage methods into organic farms. In November 2010, a presentation titled \"Developing a Tillage Reduction Research Proposal for Western Washington Organic Vegetable Farms\" was given at the Crop Science Society of America International Annual Meeting. This presentation discussed the process by which we have worked through to identify production methods that integrate reduced tillage technologies through research station and on-farm experimentation. In collaboration with WSU\'s Social and Economic Sciences Research Center, three focus groups were held to further understand factors involved in future adoption of reduced tillage methods on organic vegetable farms. Each of the three focus groups was held in different locations within western Washington with 15, 8, and 8 participants; a Spanish translator was provided at one of the locations. An OREI proposal was developed and submitted in the fall of 2010, which would include research on reduced-tillage practices in organic vegetable production in western Washington and western Oregon brought about as a result of the previous trip to Oregon. This project was not funded, but again, was recommended for resubmission. PARTICIPANTS: Individuals: Craig MacConnell (Project Director) Mr. MacConnell is responsible for the outcomes of the project and gives oversight and direction to the project. Mr. MacConnell retired in August, 2010; the project has continued with the PI of Colleen Burrows. Colleen Burrows (Co-Project Director) Ms. Burrows was the project manager. She co-organized the symposium, managed the budget, and organized team meetings. Andrew Corbin (Co-PD) Dr. Corbin participated as part of the planning committee, co-organized the symposium and team meetings. Douglas Collins (Co-PD) Dr. Collins participated as part of the planning committee and co-organized the symposium and team meetings. Chris Benedict (Team member) Mr. Benedict participated in the symposium and was a key member in developing focus groups. Symposium Participants: In day one and day two of the symposium, participants were from a variety of backgrounds and positions, including: Extension and research professionals from Washington State University, Oregon State University, Conservation Districts, USDA/NRCS Organic vegetable farmers from most counties of Western Washington growing on a diversity of scales (from less than one acre to hundreds of acres of cultivated land). Representatives of non-profit

organizations associated with agriculture in Western Washington. TARGET AUDIENCES: The target audience of this project is organic vegetable farmers in Western Washington looking to reduce tillage in their production methods. PROJECT MODIFICATIONS: Not relevant to this project.

2009/08/15 TO 2010/08/14 OUTPUTS: A 2-day symposium was held on October 28 and 29 in Everett, Washington that brought together organic farmers, researchers, extension educators, and industry professionals around the issue of no-till or reduced tillage in organic vegetable production. The first day of the symposium brought 4 experts on no-till production to share their experiences and research findings. Symposium participants travelled to a local on-farm research project utilizing no-till practices in organic vegetable production to observe equipment, methods and results from this small trial. There was much interest in this session. Seventy five people attended, with 39 farmers present. The second day of the symposium had a goal of discussing future plans for research and extension in Western Washington around reduced tillage in organic farms. Participants broke into 5 groups to discuss potential research areas to be targeted and the group was brought back together to further discuss these elements. On this day, 35 people participated, with 13 farmers present. During the fall of 2009, a project committee team was formed to prepare a full research and extension proposal for the OREI program. This group met in person and via videoconference to refine the appropriate goals for the project and to develop research and outreach methods for a proposed project. PARTICIPANTS: Individuals: Craig MacConnell (Project Director) Mr. MacConnell is responsible for the outcomes of the project and gives oversight and direction to the project. Colleen Burrows (Co-Project Director) Ms. Burrows was the project manager. She co-organized the symposium, managed the budget, and organized team meetings. Andrew Corbin (Co-PD) Mr. Corbin participated as part of the planning committee, co-organized the symposium and team meetings. Douglas Collins (Co-PD) Mr. Collins participated as part of the planning committee and co-organized the symposium and team meetings. Symposium Participants: In day one and day two of the symposium, participants were from a variety of backgrounds and positions, including: Extension and research professionals from Washington State University, Oregon State University, Conservation Districts, USDA/NRCS Organic vegetable farmers from most counties of Western Washington growing on a diversity of scales (from less than one acre to hundreds of acres of cultivated land). Representatives of non-profit organizations associated with agriculture in Western Washington. TARGET AUDIENCES: The target audience of this project is organic vegetable farmers in Western Washington looking to reduce tillage in their production methods. PROJECT MODIFICATIONS: A no-cost extension was granted; the following additional activities will be performed. Members of the working team to travel to Oregon State University to visit with researchers working on reduced tillage in organic vegetable production and observe their trials in order to determine the best way for collaboration between institutions and to further understand various practices that may be applicable to organic systems in Western Washington. One co-PI will present information from this project at the American Society of Agronomy conference. Three focus groups of organic farmers in Western Washington will be formed to further understand what potential adoption rates may be for reduced till systems in organic vegetable production as well as barriers to adopting these practices. This work will be done in collaboration with Washington State University\'s Social and Economic Sciences Research Center. Further meetings with the research and extension team will be held to plan for the future OREI proposal.

IMPACT

2009/08 TO 2011/08 Farmers and other participants attending the first and second days of the symposium had positive comments about the program. Most increased their knowledge of no-till strategies, impacts of tillage on soil, and cover cropping. Most farmers indicated that they plan to make changes in their cropping systems in the areas of soil fertility, cover cropping, and weed management. Many of the farmers had a basic understanding of reduced tillage systems, but were interested in how they could incorporate it into their own farms. They were very enthusiastic about the potential for research and extension activities around this topic to be done in Western Washington. The second day of the symposium brought insights into future research and extension activities that were used in developing a grant proposal for the OREI program. The newly formed project team for future activities developed and submitted a proposal to the OREI program for research and extension activities around reduced tillage practices on organic vegetable farms in Western Washington. During the visit to Oregon State University, working team members discussed methods of using various implements in organic vegetable systems common to western Washington. The WSU group further understood how these implements worked; in meeting with growers using these implements, they understood some of the benefits and limitations in their use. Collaborative relationships were made with researchers in Oregon, which developed into a joint proposal to OREI. Participants at three focus groups conducted in western Washington farmed acreages ranging from 1-1000 acres. They ranged from slightly to very familiar with reduced tillage practices; many of the growers have attempted to reduce tillage in one form or another on their farm, though they have not yet employed roller-

crimpers or other specialized tools designed for reduced tillage systems. Key findings gleaned from the focus groups include that: Participants appreciate how reduced tillage can increase soil quality. Several talked about how rich their soil had been when it was first tilled and how repeated tillage reduced organic matter and led to a hard pan. Participants voiced that specific practices and specialized equipment will need to be adapted to their situation, particularly in light of our wetter climate and soil. There were concerns about weeds and other pests in reduced tillage systems. There was interest in which cover crops work the best and when to plant cover crops. Before adopting new practices, growers want to know that they have been tried in real settings and under conditions similar to their own situations. Findings from these focus groups will assist the working group in developing outreach material for this project and others targeting organic farmers. **PUBLICATIONS (not previously reported):** 2009/08 TO 2011/08 Corbin, A.T., Collins, D.P., Benedict, C. and Colleen Burrows 2011. Exploring adoption of reduced tillage practices in organic vegetable production. Poster presentation at the WSU All Faculty Conference, 10/05/11 Pullman, WA and the Tilth Producers of Washington Conference, 11/11/11, Yakima, WA.

2009/08/15 TO 2010/08/14 Farmers and other participants attending the first and second days of the symposium had positive comments about the program. Most increased their knowledge of no-till strategies, impacts of tillage on soil, and cover cropping. Most farmers indicated that they plan to make changes in their cropping systems in the areas of soil fertility, cover cropping, and weed management. Many of the farmers had a basic understanding of reduced tillage systems, but were interested in how they could incorporate it into their own farms. They were very enthusiastic about the potential for research and extension activities around this topic to be done in Western Washington. The second day of the symposium brought insights into future research and extension activities that were used in developing a grant proposal for the OREI program. The newly formed project team for future activities developed and submitted a proposal to the OREI program for research and extension activities around reduced tillage practices on organic vegetable farms in Western Washington.

PUBLICATIONS

2009/08/15 TO 2010/08/14 No publications reported this period

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Vermicompost-based Media to Enhance Organic Vegetable Seedling Vigor, Yield, Crop Quality and Grower Profitability.

Accession No.	0219125
Subfile	CRIS
Project No.	HAW01805-G
Agency	NIFA HAW
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05620
Proposal No.	2009-01405
Start Date	01 SEP 2009
Term Date	31 AUG 2013
Grant Amount	$351,028
Grant Year	2009
Investigator(s)	Radovich, T.; Paull, R.; Sipes, B.; Uchida, J.; Arancon, N.
Performing Institution	Tropical Plant & Soil Science, UNIV OF HAWAII, 3190 MAILE WAY

NON-TECHNICAL SUMMARY

There is strong need for renewable, locally-sourced materials to replace peat-based media for sustainable production of organic vegetable seedlings, especially in the Tropics. Properly produced vermicompost has several advantages as a seedling medium: it is relatively high in nitrate, which can enhance seedling germination and stimulate seedling growth; it has high microbial activity that may protect against some pests; and it has little or no phytotoxicity. However, there is no on-farm research to evaluate the relationship of seedling quality with pest resistance, yield and post harvest crop quality under certified organic conditions. Also, vermicompost is relatively expensive to produce and there is strong need to evaluate economic benefits associated with the costs of partial or complete replacement of peat with vermicompost. The 3-year project proposed herein will engage farmers, researchers, and industry professionals to address these deficiencies through a series of on-farm trials and educational activities to achieve the following objectives: 1. Evaluate quality, field performance and post-harvest quality of produce from seedlings grown in vermicompost-based media in organic production systems. 2. Quantify the impact of vermicompost as an organic seedling medium on vegetable transplant health and pest tolerance. 3. Enhance the efficiency and profitability of Hawaii\'s approximately 150 organic growers through increased vegetable yield and plant health on their farms using vermicompost. Outcomes of this work will directly address OREI goals through innovative use of local resources to enhance production stability and profitability of organic growers, particularly in the Tropics.

OBJECTIVES

The overall goal of this project is to improve the economic, environmental, and social sustainability of certified organic systems. To reach this goal, we will engage farmers, researchers, and industry professionals through a series of on-farm trials and educational activities to achieve the following objectives: 1. Evaluate quality, field performance and post-harvest quality of produce from seedlings grown in vermicompost-based media in organic production systems. 2. Quantify the impact of vermicompost-based seedling media on vegetable transplant health and pest tolerance. 3. Enhance the efficiency and profitability of Hawaii\'s approximately 150 organic

growers through increased vegetable yield and plant health on their farms using vermicompost. Expected outputs include extension bulletins, refereed journal articles, a website and training workshops.

APPROACH

Locally produced vermicomposts will be obtained from commercial producers on the island on O\'ahu. Compost will evaluated for chemical, biological, and physical characteristics including pathogen load, total microbial biomass, mineral nutrient content, and water holding capacity. Locally adapted tomato and lettuce varieties will be greenhouse grown on two commercial organic farms and at the long-term organic plots at the University of Hawaii. The methodology for seedling production will be the same across location. Seedlings will be grown for 4-6 weeks in a peat-based media amended with locally produced vermicompost of known qualities at rates of 0, 25, 50, 75, and 100% (v/v) with no additional fertilizer amendments. Control treatments will include 100% organic peat-based mix (OMRI registered peat + perlite) with no supplemental fertilizer and 100% organic peat-based mix with organic liquid fertilizer applied weekly. Seedlings will be grown in standard seedling trays, and trays will be blocked for location within the greenhouse. When seedlings are ready for transplanting, a total of at least 100 seedlings (25 from each of 4 replications) will be evaluated for quality using height, weight, dry matter and mineral content as primary indices. The remainder of the seedlings at each site will be planted to the field. The six treatments (0, 25, 50, 75, 100% vermicompost without supplemental fertilizer, and 0% compost with supplemental fertilizer) will be arranged in a randomized complete block design (RCBD). Plots will be managed in compliance with the National Organic Program according to the standard practice of each farm. The crop will be harvested at market maturity. For tomato, physical measures to be taken include total weight, marketable yield, fruit number per plant, fruit size, and moisture content. Lettuce physical measures to be taken include total weight, marketable yield, leaf number per plant, plant size, and moisture content. Lettuce microbial load and tomato eating quality will be evaluated Pest and disease incidence in the field is unpredictable because of the complex set of interactions governing plant response to pest pressure. A series of trials will be conducted under controlled conditions by the co-PDs to accurately quantify any potential pest tolerance conferred to the seedlings from the use of vermicompost. The work will be conducted over the course of years 1 and 2 of the project. For all greenhouse and on-farm activities, comparisons will be made between standard on-farm practice and control treatments with regard to organic seedling media on marketable yield and cost of production. Economic analysis will include the calculation of gross production costs, total variable costs, gross margins and other key economic parameters. Net benefit of alternative analysis will include all potential economic impacts throughout the production chain including seedling production time, crop yield and post harvest quality.

PROGRESS

2009/09 TO 2013/08 Target Audience: *Farmers and producers in the Hawaiian and the Pacific Islands. *Extension agents on different Hawaiian and the Pacific Islands. *Land grant faculty, researchers, and agricultural professionals in the Hawaiian and the Pacific Islands. *Professionals at Universities, and community colleges. *University and high school students. Changes/Problems: We requested no cost extension for a year; the extension was required to complete outreach activities, publications, and economic analysis. There was a shift in the project toward including more locally produced and available composts to evaluate their effect on seedlings quality and reduce production cost/increase profitability. Nothing has changed in regard to the award terms and conditions. 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. 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 will continue to work with industry to facilitate adoption and evaluate impacts on certified organic farms and other operations. Expected impacts articulated in the proposal remain the same. Cost-benefit analysis has been roughly calculated and data were presented in public talks, but we are still working on a publication to be published in the near future. What opportunities for training and professional development has the project provided? Approximately 400 participants (local farmers and producers, extension agents, NRCS specialists, and other professionals) from different Hawaiian Islands and the American Samoa, were able to participate in workshops, field days/tours, and public talks were given by the project researchers, to spread out the project results among the community and benefit small farmers from its findings. Due to high/positive feedbacks we received from the participants, we are expecting high adoption of more sustainable practices by local farmers and producers on the Hawaiian Islands and the American Samoa. Adoption will continued to be

monitored beyond scope of the project. Two international students were able to join us and participate in the project activities. They received training for the application of the sustainable and organic farming practices. The two students were from Ghana and Germany. Also, we are still presenting the project findings at different meeting (person-to-person, or public presentations) to increase awareness/adoption of local farmers to the new practices. How have the results been disseminated to communities of interest? 1-Field Days, 2-Workshops, 3-Public talks/presentations, 4-Extension bulletins, 5-Peer reviewed publications. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 OUTPUTS: * Five greenhouse experiments were conducted, at the University of Hawaii to produce seedlings for different vegetable crops using different new local media inputs (organic amendments were not evaluated earlier by this project). The preliminary results showing a promising results in reducing inputs cost while improving seedlings quality. * Two field experiments, and two aquaponics experiments have been conducted at the University of Hawaii (UH), to evaluate the new media on crop growth and yield after transplants. *Two recirculating aquaponic system (RAS) trials were conducted at Waimanalo research station, using seedlings produced with additional new organic amendments. *One field trials, using Eggplant seedlings, was conducted with the help of our International collaborator. The field trial was conducted with selected top performing media, from previous greenhouse trials during previous years of this project. The results showed no significant differences among the top performing media. The results are eyes opening which would allow to select from the lowest cost media, and increase profitability. *Two presentations at the annual meeting for the Hawaii Organic Farmers Association (HOFA) were given by the project PI. *One public presentation at the American Samoa Community College Land Grant was given by Ian Gurr, during a field day workshop event. *One public talk was given at the American Society for Horticultural Science (ASHS) annual meeting. PARTICIPANTS: CTAHR Collaborators: Dr. Brent Sipes- Nematology; Email: sipes@hawaii.edu; Dr. Janice Uchida- Mycology; Email: juchida@hawaii.edu; Dr. Robert Paull- Post harvest; Email: paull@hawaii.edu; Dr. Bradley K. Fox-Aquaponics; Email: bradleyf@hawaii.edu; Dr. Archana Pant-Organic farming program; Email: apant@hawaii.edu; Mr. Clyde Tamaru- Auquaponics; Email: ctamaru@hawaii.edu; Mr. Jensen Uyeda-Extension coordinator; Email: juyeda@hawaii.edu Multi State Collaborators: Ian Gurr, from American Samoa. International Collaboration: Wajid Farhad, PhD candidate from Pakistan. He joined our lab to gain experience in sustainable agriculture practices. On-Farm Collaborators: Olomana Garden, Poamoho Produce, Alex Karp- Island Harvest Organics; Gerry Ross-Kupaa Frams and others. * Local organic amendments producers, such as Island commodities company. TARGET AUDIENCES: *Local farmers and producers on Hawaiian and the Pacific Islands. * extension agents on different Hawaiian and the Pacific Islands. *Professionals at Universities, and community colleges. *University and high school students. PROJECT MODIFICATIONS: There is a shift in the project toward including more locally produced and available composts to evaluate their effect on seedlings quality, reduce production cost, and increase profitability.

2010/09/01 TO 2011/08/31 OUTPUTS: *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 presentations at the annual meeting for the Hawaii Organic Farmers Association (HOFA) were given by the project PI. *Two public talks were given at ASHS annual meeting. One public presentation at the University of Hawaii was given by Ian Gurr, during his master public defense. *Two field days were conducted to spread out project findings among local farmers and producers on the Island of Oahu and in American Samoa. PARTICIPANTS: *CTAHR collaborators: Dr. Brent Sipes- Nematology; Clyde Tamaru- Auquaponics; Dr. Janice Uchida- Mycology; Dr. Robert Paull- Post harvest; Dr. Bradley K. Fox-Aquaponics; Dr. Archana Pant-Organic farming program; Mr. Jensen Uyeda-Extension coordinator; and faculty at UH-Hilo. *Multi State Collaborators: Ian Gurr- graduate student, from American Samoa. *International Collaboration: Micahel Kermah, Coordinator and Research Associate from Ghana, and Master student from Germany (Luisa Malina). *On-Farm Collaborators: Olomana Garden, Poamoho Produce, Alex Karp- Island Harvest Organics; Gerry Ross- Kupaa Frams and others. TARGET AUDIENCES: *Local farmers and producers on Hawaiian and the Pacific Islands. *Local extension agents on different Hawaiian and the Pacific Islands. *Professionals at Universities, and community colleges. *University high school students.

PROJECT MODIFICATIONS: *No cost extension for one year was requested by the project PI/Co-PI from the funding agency. The extension is required to complete outreach activities, publications, and economic analysis. *There is a shift in the project toward including more locally produced and available composts to evaluate their effect on seedlings quality and reduce production cost/increase profitability.

2009/09/01 TO 2010/08/31 OUTPUTS: Six greenhouse experiments , 1 field experiment and an aquaponics study has been conducted at the University of Hawaii (UH). Two on-farm trials with collaborators on Hawaii and Maui islands have been initiated. Growth of eggplant and asian cabbage (Brassica rapa Pekinensis group) were curvilinear in response to increased proportions of vermicopmost in the mix (0-100%). Costs associated with mixes comprised predominantly of vermicompost were high so additional treatments including local thermophillic composts in combination with vermicomposts have been added. Ideal vermicompost content of media has been tentatively identified as 25-75% depending on crop species and pest pressure. Some correlation between size and nutrient content of the seedlings and final yield was observed in the field trial. Inclusion of vermicompost in the mix of seedlings improved the yield of aquaponically grown Asian cabbage, and this yield increase is associated with improved iron nutrition in the plants. MSc. student Ian Gurr has initiated the devolpment of a manuscript based on the greehouse and field trial conducted at UH. PARTICIPANTS: Ian Gurr- graduate student Dr. Brent Sipes- Nematology Dr. Clyde Tamaru- Auquaponics Dr. Janice Uchida- Mycology Dr. Robert Paull- Post harvest Alex Karp- Island Harvest Organics Gerry Ross- Kupaa Frams TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/09 TO 2013/08 What was accomplished under these goals? We have conducted ten greenhouse experiments, three greenhouse/pots trials were conducted, using tomatoes and eggplants varieties, three recirculating aquaponic system (RAS) trials were conducted at the Windward Community College, six greenhouse experiments and two field trials were conducted by our International Collaborators from Ghana and Germany, and Pakistan, through their fellowship programs, and 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. All the previous greenhouse, field, and aqauponic trials were covering the main first and second goals of this project. To meet the third objective, we gave two presentations at the annual meeting for the Hawaii Organic Farmers Association (HOFA), 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, two field days in Hawaii and Samoa are completed, andInitial farmer evaluation of recommended media was completed as well. Training a master student (Ian Gurr), and three undergraduate students through SOFT organization at UH-Manoa were completed. Mr. Gurr has continued training farmers at American Samoa Land Grant Institutions. The use of local/relatively inexpensive materials, to produce vegetable seedlings, will increase farmers\' profitability due to reduce production cost and higher crops production/yield. **PUBLICATIONS (not previously reported):** 2009/09 TO 2013/08 Type: Journal Articles Status: Published Year Published: 2012 Citation: Radovich, T.J.K., Pant, A., Gurr, I., Hue, N.V., Sugano, J., Sipes, B., Arancon, N., Tamaru, C., Fox, B.K., Kobayashi, K.D., and Paull, R. 2012. Innovative use of locally produced inputs to improve plant growth, crop quality, and grower profitability in Hawaii. Horttechnology, 22(6): 738-742.

2011/09/01 TO 2012/08/31 *Approximately 200 participants (local farmers and producers, extension agents, and professionals) from different Hawaiian Islands, the American Samoa. were able to participate in workshops, field days/tours, and public talks were given by my program. We are expecting increase adoption of more sustainable practices by local farmers and producers. *Two undergraduate students from SOFT program were received support and training on the application of the project methodology in vegetable seedlings production. The two students were helping in conducting the greenhouse, aquaponic, and field experiments. The participation in SOFT program activities are increasing, especially among student from the College of Tropical Agriculture and Human Resources. *One international fellow joined our lab for a period of six months from Pakistan, the visitor fellow participated and trained on both greenhouse and field practices.

2010/09/01 TO 2011/08/31 *Approximately 400 participants (local farmers and producers, extension agents, and professionals) from different Hawaiian Islands, the American Samoa. were able to participate in workshops, field days/tours, and public talks were given by my program. We are expecting high adoption of more sustainable

practices by local farmers and producers. *Three undergraduate students from SOFT program were received support and training on the application of the project methodology in vegetable seedlings production. The two students were helping in conducting the greenhouse, aquaponic, and field experiments. The participation in SOFT program activities are increasing, especially among student from the College of Tropical Agriculture and Human Resources. *Two international fellows received training on the application of this project, and they are working toward better sustainable agriculture in their home countries (Please see final report from Michael Kermah from Ghana) *High School students (Please see pictures in the Newsletter by Bradley et al., 2011): I have worked with two high schools (Kalani and Waipahu). Waipahu high school was received Science Fair presentation award: Best Practical Application Award at the state level in Spring 2011.

2009/09/01 TO 2010/08/31 none to report for this period

PUBLICATIONS

2011/09/01 TO 2012/08/31 1. Gurr, I. 2011. New gardening ideas for the community in the American Samoa. http://208.109.238.104/viewstory.phpstoryid=30923. 2. Radovich, T.J.K., Hue, N.V., Pant, A., Gurr, I., Arancon, N., Tamaru, N., Fox, K., Sipes, B., Kobayasi, K., and Paull, R. 2011. Innovative use of local inputs to promote plant growth in Hawaii. Annual Meeting of the American Society for Horticultural Science, Waikoloa Hawaii, 24-29 September, 2011. 3. Gurr, I., Radovich, T.J.K., Kobayashi, K., Paull, R., and Ahmad, A. 2012. Using Hawaii\'s Locally Produced Organic Material to Improve Quality of Vegetable Seedlings. HortScience, 47(9): S150, ASHS Annual Conference, July 31 to Aug. 3. Miami, FL, USA. 4. Radovich, T.J.K., Pant, A., Gurr, I., Hue, N.V., Sugano, J., Sipes, B., Arancon, N., Tamaru, C., Fox, K., Kobayashi, K., and Paull, R. 2012. Innovative use of locally produced inputs to improve plant growth, crop quality, and grower profitability in Hawaii. HortTechnology (in press).

2010/09/01 TO 2011/08/31 1. Gurr, I. 2011. Evaluating Vermicompost and Rendered Meat Products as Local Media Components in Vegetable Seedling Production. MSc. Thesis. Univ. Hawaii, Manoa. 72p. 2. Pant A., Radovich, T.J.K., Hue, N.V., and Arancon, N.Q. 2011. Effects of Vermi-compost Tea (Aqueous Extract) on Pak-choi Yield, Quality, and on Soil Biological Properties. Compost Science & Utilization. Vol.19(4):279-292. 3. Pant, A., Radovich, T.J.K., Hue, N.V. 2010. Application of Vermicompost Extract On Pak-Choi: Effects On Yield, Quality, and Soil Biological Properties. Annual Meeting of the American Society for Horticultural Science, Desert Palms, CA. 4. Pant, A., Radovich, T.J.K., Hue, N.V., and Bingham, J.P. 2010. The Influence of Compost Origin On Chemical and Biological Properties of Compost Extracts and Pak Choi (Brassica rapa Chinensis Group) Yield. Annual Meeting of the American Society for Horticultural Science, Desert Palms, CA. 5. Fox, B.K., Tamaru, S.C.S., Radovich, T., Klinger-Bowen, R., McGovern-Hopkins, K., Bright, L., Pant, A., Gurr, I., Sugano, J., Sipes, B., and Lee, C.N. 2011. Beneficial Use of Vermicompost in Aquaponic Vegetable Production. Extension article. www.ctahr.hawaii.edu/sustainag/news/articles/V10-Fox-Verm-Aquaponics. pdf. 6. Uyeda, J., Cox, L.J., and Radovich, T.J.K. 2011. An Economic Comparison of Commercially Available Organic and Inorganic Fertilizers for Hydroponic Lettuce Production. College of Tropical Agriculture and Human Resources, University of Hawaii. SA-5. www.ctahr.hawaii.edu/oc/freepubs/pdf/SA-5.pdf 7. Kermah, M. 2011. Sustainable Agriculture and Climate Change Project 2010 Borlaug Fellowship Program / Global Research Alliance.

2009/09/01 TO 2010/08/31 No publications reported this period

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Sustainable Systems for Cucurbit Crops on Organic Farms

Accession No.	0218890
Subfile	CRIS
Project No.	IOWN-176003
Agency	NIFA IOWN
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05581
Proposal No.	2009-01322
Start Date	01 AUG 2009
Term Date	31 JUL 2013
Fiscal Year	2009
Grant Amount	$0
Grant Year	2009
Investigator(s)	Gleason, M. L.; Lewis, D. R.; Jesse, L. H.; Batzer, J. C.; Duffy, M. D.; Schulte Moore, L.; Delate, K.
Performing Institution	Plant Pathology, IOWA COOPERATIVE EXTENSION, AMES, IOWA 50011-2026

NON-TECHNICAL SUMMARY

The 3-year Integrated project will develop ecologically based, systems-level solutions to some of the most urgent problems of organic cucurbit growers in the eastern half of the U.S. In on-farm trials and experiments, we will demonstrate effective control of cucumber beetle/bacterial wilt complex, the squash bug/cucurbit yellow vine disease complex, and squash vine borer by integrating extended-duration row covers with compost amendments and plant growth-promoting rhizobacteria. By showing how farm surroundings affect activity of wild pollinators and how floral provisioning can increase these ecosystem services, we will help organic growers to safeguard and enhance cucurbit crop pollination. An economic analysis will measure profitability of the new practices against existing strategies. Our intensive outreach program links innovative approaches - webinars for growers and educators, plus an online decision-support tool to pinpoint insect pest emergence - with traditional face-to-face methods. The proposal was developed with extensive stakeholder input and the project will engage stakeholders continually through an Advisory Panel and an online community of practice. Extensive field trials and surveys in states (IA, KY, and PA) representing three geographic regions (Midwest, South, and Mid-Atlantic) will yield management recommendations that can customized to regional differences but are also sufficiently robust for adoption throughout the eastern half of the U.S.

OBJECTIVES

The goal of the 3-year, 3-state (Iowa, Kentucky, Pennsylvania) project is to develop ecologically based, systems-level solutions to major pest and pollination concerns of organic cucurbit growers in the eastern half of the U.S. Objective 1 will achieve effective control of cucumber beetle/bacterial wilt complex, the squash bug/cucurbit yellow vine disease complex, and squash vine borer by integrating extended-duration row covers with compost amendments and plant growth-promoting rhizobacteria. Objective 2 will determine how farm surroundings affect activity of wild pollinators of cucurbit crops and how floral provisioning can increase these ecosystem services. In Objective 3, an economic analysis will measure profitability of the new practices against existing strategies. Our intensive outreach program (Objective 4) will combine webinars for growers and educators and an online

decision-support tool to pinpoint insect pest emergence with traditional face-to-face extension methods. Project outputs will include grower-tested, cost-effective strategies for management of the target pests and diseases, grower guidelines for deploying floral provisioning plots to enhance cucurbit crop pollination, and durable online forums for grower communication and a degree-day-based advisory system to time row cover removal for optimal impact on pest protection.

APPROACH

Field experiments on muskmelon, cucumber, and butternut squash in each state will assess timing of row cover removal, levels of compost soil amendment, and use of a plant growth-promoting rhizobacteria seed treatment. Data will include pest and diseases injury, pest counts, soil and plant nutrient analysis, weed counts, and yield. A partial budget analysis (Objective 3) will compare cost effectiveness of treatments in Objective 1. In Objective 2, 8 cucurbit farms per state will be selected to map features that can provide habitat for wild pollinators based on Landsat images and GIS software. In Year 2, we will count pollinators in cucurbit flowers, then collect bees for identification. GIS data for farm surroundings will be obtained from aerial photographs. For floral provisioning, a mixture of perennial species attractive to wild bees will be surveyed weekly for bloom timing (Fiedler and Landis, 2007). In Years 2 and 3, a muskmelon and butternut squash subplot will be planted on either side of the floral provisioning plot. Project scouts will visit each farm weekly during crop bloom to assess pollinator activity rate and identify pollinator species in cucurbit subplots and floral provisioning plots. At harvest, fruit will be counted, weighed, and rated for marketability. Outreach programs include two annual on-farm trials per state. Project scouts will help monitor insect populations and assess damage. An online community of practice will enable growers to share issues via access to a social networking space. We will also post information created for this site on eOrganic. Online focus groups and surveys will assess value of the site, and a hit counter will track utilization. We will develop two extension bulletins in both print and online (Wiki) formats. Years 2 and 3 will include three webinars for extension educators, that will be evaluated with online assessment tools. A web-based decision support tool to predict timing of insect pest phenology will enable cucurbit growers to predict when to time management actions. Phenology models will be combined with data from on-farm scouting to obtain biofixes. Field days, trade journal articles, and meeting presentations will complete the outreach effort. Year 1 and Year 3 online surveys will be sent to 200 growers to gauge project impact on awareness and utilization of the new strategies. Written evaluations will also be collected after field days and meeting presentations.

PROGRESS

2009/08 TO 2013/07 Target Audience: Our project reached 2,500 commercial growers of cucurbit crops (melon, squash, cucumber, gourd) in Iowa, Missouri, Wisconsin, Illinois, Kansas, Nebraska, Kentucky, and Pennsylvania via presentations at state and regional grower conferences during 2009-2013, as well as, the project website. Of this audience, we estimate that approximately 150 were organic producers or in transition to organic production. Changes/Problems: We streamlined the project\'s major field experiment on muskmelon and butternut squash after Year 1, when it became evident that treatments involving several levels of compost application and the use of plant growth-promoting bacteria did not yield promising results. Instead, we narrowed the scope of the field experiments in Year 2 and 3 to focus primarily on optimizing the use of row covers in organic production of each crop. We also learned a key fact about using row covers that is critical for growers: different row cover strategies are optimal in different parts of the eastern U.S., and different cucurbit crops require different approaches. For muskmelon, what worked best in Iowa and Pennsylvania - delaying removal of row covers until 10 days after the crop started flowering - was not as effective in Kentucky, where an on-off-on strategy appears to make more sense for organic growers. The reason for these differences is that the level of cucumber beetle populations is lower in the northern areas, and the main risk period is early in the growing season. In contrast, cucumber beetle populations are much higher in Kentucky and stay high all season, so a full-season strategy is needed to fight them. For butternut squash, on the other hand, removing row covers at the start of flowering gave the best results in all three states. Another piece of knowledge that emerged from the project is that it\'s important for growers to look carefully at the flowers on cucurbit crops before they pull off row covers. The plants have 2 kinds of flowers: the male flowers appear first, and the female flowers come along several days to weeks later. For optimal timing of row cover removal, growers need to focus on the female flowers, since these are the ones that produce fruit. Luckily, with a few minutes of training, growers can easily tell the difference between the two types of flowers. Based on preliminary analysis of our field studies in Iowa, Kentucky, and Pennsylvania, placing a strip of flowering perennial plants near a muskmelon or butternut squash planting on a farm did not raise the yield of either crop. The bottom line is that most of the wild bee species that visit the perennial flowers did not visit the cucurbit-crop flowers. Floral provisioning is sometimes recommended as a way to enhance pollination, but on our farms there was enough bee diversity already present. We also compared bee species diversity with the diversity

of the landscapes surrounding24 small-scale vegetable farms in the three states, and came to a similar conclusion: landscape diversity did not affect bee diversity. We think that the reason for this lack of a clear relationship is that even the \"simple\" landscapes around our farms had enough habitat diversity to attract most species of wild bees, and more diverse habitats, therefore, didn\'t result in more bee species on the farms. The bottom line here is that our results suggest that cucurbit farmers in Iowa, Kentucky, and Pennsylvania may not need to take measures to increase diversity of habitat on or near their farms; instead, their farms are already doing a good job attracting wild bees. So preserving existing habitat is likely to be important, but farmers don\'t need to work on increasing habitat diversity in order to attract wild bees. What opportunities for training and professional development has the project provided? Nothing Reported How have the results been disseminated to communities of interest? The project\'s activities and findings have been reported to commercial cucurbit growers through the project\'s website (http://organiccucurbit.plp.iastate.edu/) for the past 2 years. The website incorporates a range of resources including summaries of project results, and a photo gallery of the project\'s field trials, cucurbit-crop insect pests, diseases, and wild bee species, and research and outreach products from the project, as well as, related extension material from other states in the eastern U.S. As reported under activities, project\'s personnel participated in several dozen field days in Iowa, Kentucky, and Pennsylvania, highlighting the project\'s experiments and on-farm demonstration trials, and the principal investigators presented project summaries in more than 20 PowerPoint presentations at winter conferences of local, statewide, and regional organizations of commercial vegetable growers in the Mid-Atlantic, Upper South, and Midwest regions. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/08/01 TO 2012/07/31 OUTPUTS: On muskmelon in 6 site-years with cucumber beetle pressure, delaying row cover removal by 10 days significantly suppressed bacterial wilt compared to the no-row-cover control and removal at anthesis. Results of the on-off-on row cover strategy varied widely; in Year 1 in KY, voles destroyed the melons before harvest. In PA, delaying row cover removal by 10 days improved marketable yield compared to row covers removal at anthesis or no covers. Compost did not impact yield compared to Fertrell, and Kodiak PGPR bio-inoculant did not influence either bacterial wilt or marketable yield. Bottom line: delaying row cover removal by 10 days, supplemented with Pyganic, can help Midwest and Mid-Atlantic growers control bacterial wilt with less insecticide. Compost mineralized faster under row covers, indicating that less is needed under covers, which should cut input costs. For butternut squash, delaying row cover removal by 10 days gave no consistent yield or pest management advantage, and removal at anthesis was the top yielder. On-off-on row cover treatment sometimes had 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. In IA in 2012, late-season squash bug outbreaks killed almost all unprotected plants, so only season-long row covers gave acceptable yield. Bottom line: Row cover removal at anthesis was generally the best option on butternut squash. Delaying row cover removal for longer periods - either for 10 more days, or then replacing it until harvest - had variable results. Compost and Kodiak results were similar to muskmelon. Overwintering cucumber beetles appeared on cucurbits at 140-160 degree-days (base 55 F) after January 1. This biofix can be used to alert growers to start protection measures. We also successfully modeled timing of in-field cucumber beetle generations using a Gompertz equation. 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 and late planting strategies. In Objective 2 (cucurbit pollinators), correlation of harvestable yield with distance from a floral provisioning strip, and with presence/absence of the strip, varied with site, year, and crop. In the landscape diversity study, 8 farms were selected per state, representing a continuum of landscape diversity from simple to complex. During the summer\'s of 2010 and 2011, each farm was visited twice. During each farm visit, bees in muskmelon and winter squash flowers were identified to morpho-species, then collected. In addition, bee bowls (water, detergent, salt and propylene glycol) were emptied once per week. Digital maps of the landscape surrounding each farm were downloaded from USGS. A 3-mile-diameter perimeter was drawn around each farm and the land cover type was ground-truthed. 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. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/08/01 TO 2011/07/31 OUTPUTS: In IA, KY, and PA, field experiments on muskmelon and butternut squash during 2011 1) compared row covers, compost, and/or plant growth-promoting rhizobacteria (PGPR) for suppressing bacterial wilt, cucumber beetles, squash bug, and squash vine borer, and 2) assessed impact of floral provisioning on pollinators and yield. In IA, insect pest pressure was low, and row cover treatments did not impact muskmelon marketable yield significantly. However, incidence of bacterial wilt was twice as high on non-covered plots as where row cover removal was delayed until 10 days after anthesis. On butternut squash, yields

were depressed by delaying row cover removal until 10 days after anthesis but were higher, and equivalent to the non-covered control, when row covers were removed for only a 2-week pollination period between transplant and harvest. Row covers had no impact on pesticide spray frequency on muskmelon, but reduced sprays of pyganic and copper on butternut squash. In KY, in a year with very low insect-pest populations, the standard organic management practice of removing row covers at anthesis, followed by insecticide applications, resulted in significantly higher yield of both crops than the non-covered control. Delaying row cover removal by 10 days had either no significant effect on marketable yield (muskmelon), or else reduced marketable yield (squash), compared to the standard-organic treatment. The addition of Kodiak, which contains PGPR, to media in flats with transplants did not significantly impact marketable yield or fruit sugar content. In PA in 2011, removal of row covers on melons 10 days after anthesis significantly suppressed bacterial wilt compared to non-covered control and row cover removal at anthesis, and resulted in higher yield. Kodiak seed treatment had no impact on either bacterial wilt incidence or yield. For experiment 2 (the floral provisioning study) in IA and KY, rows of butternut squash closest to a strip of 10 perennial flower species had substantially higher marketable yield than rows located further from the strip; in the control plots (grass strip instead of flowers), marketable yield was not impacted by distance from the strip. In PA, total yield showed no trend with distance from the flower strip in either crop. In another research objective, each state used flats of Hubbard squash and strips of melon and squash as trap plants to monitor appearance of striped cucumber beetles (SCB), squash bug (SB), and squash vine borer (SVB). In 2010, we assumed that spring activity by SCB and SB would be primarily predictable by degree days (based on temperature). In 2011, however, SCB were observed on the trap flats on or near the same calendar date in each state, whereas degree days did not result in consistent prediction of emergence date. Also in 2011, each state completed the second and final year of a survey of 5 to 8 farms per state that counted and identified cucurbit pollinators, and is relating these data to differences in farm landscapes within a 3-km radius of each farm, using a GIS-based analysis. The project\'s main website, a community of interest for cucurbit growers, has been released for public use. PARTICIPANTS: At University of Kentucky, M.S. candidate Logan Minter, who is funded by the project, was responsible for carrying out the organic practices experiment (row covers, fertilizers, and PGPR), phenology monitoring, and floral provisioning studies. At Iowa State University, PhD candidate Amy Alesch, who is funded by the project, leads the Iowa project team for the pollinator surveys on Iowa farms and the floral provisioning field experiment, and has project-wide leadership for the landscape analysis objective. Staff member Dr. Jean Batzer leads the row cover experiment and provides overall project coordination. Another ISU PhD candidate, Evrim Baran, worked on development of content and format for the project\'s online learning community. Staff members at ISU included Eva Tao, who did programming to implement the website for the online learning community. At Penn State University, PhD candidates Amanda Bachmann and Sheena Sidhu have responsibility for the entomology-related aspects of the project including the floral provisioning, pollination, and phenology modeling aspects of the work, and PhD candidate Ermita Hernandez has overseen the field experiment involving row covers, compost treatments, and PGPR. Staff members at Penn State that are working on development of the web-based decision tool include Steve Crawford and Susan Anderson of Penn State\'s Center for Environmental Informatics. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: The project will have a one-day meeting of PIs, staff, and graduate students from all 3 states in Indianapolis, IN on November 30, 2011. Plans for project modifications during 2012 will be discussed and agreed upon during that meeting. In addition, plans for development of research publication and extension products summarizing the project\'s findings will also be reviewed and assigned.

2009/08/01 TO 2013/07/31 Target Audience: Our project reached 2,500 commercial growers of cucurbit crops (melon, squash, cucumber, gourd) in Iowa, Missouri, Wisconsin, Illinois, Kansas, Nebraska, Kentucky, and Pennsylvania via presentations at state and regional grower conferences during 2009-2013, as well as, the project website. Of this audience, we estimate that approximately 150 were organic producers or in transition to organic production. Changes/Problems: We streamlined the project\'s major field experiment on muskmelon and butternut squash after Year 1, when it became evident that treatments involving several levels of compost application and the use of plant growth-promoting bacteria did not yield promising results. Instead, we narrowed the scope of the field experiments in Year 2 and 3 to focus primarily on optimizing the use of row covers in organic production of each crop. We also learned a key fact about using row covers that is critical for growers: different row cover strategies are optimal in different parts of the eastern U.S., anddifferent cucurbit crops require different approaches.For muskmelon, what worked best in Iowa and Pennsylvania - delaying removal of row covers until 10 days after the crop started flowering - was not as effective in Kentucky, where an on-off-on strategy appears to make more sense for organic growers. The reason for these differences is that the level of cucumber beetle populations is lower in the northern areas, and the main risk period is early in the growing season. In contrast, cucumber beetle populations are much higher in Kentucky and stay high all season, so a full-season strategy is needed to fight them. For butternut squash, on the other hand, removing row covers at the start of flowering gave the best results in all three states. Another piece of knowledge that emerged from the project is that it\'s important for growers to look carefully at the flowers on cucurbit crops before they pull off row

covers. The plants have 2 kinds of flowers: the male flowers appear first, and the female flowers come along several days to weeks later. For optimaltiming of row cover removal, growers need to focus on the female flowers, since these are the ones that produce fruit. Luckily, with a few minutes of training, growers can easily tell the differencebetween the two types of flowers. Based on preliminary analysis of our field studies in Iowa, Kentucky, and Pennsylvania, placing a strip of flowering perennial plants near a muskmelon or butternut squashplanting on a farm did not raise the yield of either crop. The bottom line is that most of the wild bee species that visit the perennial flowers did not visit the cucurbit-crop flowers. Floral provisioning is sometimes recommended as a way to enhance pollination, but on our farms there was enough bee diversity already present.We also compared bee species diversity with the diversity of the landscapes surrounding24 small-scale vegetable farms in the three states,and came to a similar conclusion: landscape diversity did not affect bee diversity. Wethink that the reason for this lack of a clear relationship is that even the\"simple\" landscapes around ourfarms had enough habitat diversity toattract most species of wild bees, and more diverse habitats,therefore, didn\'t result in more bee species on the farms. The bottom line here is that our resultssuggest that cucurbitfarmersin Iowa, Kentucky, and Pennsylvania may not need totake measures toincrease diversity of habitat on or near their farms; instead, their farms are already doing a good job attracting wild bees. So preserving existing habitat is likely to be important, but farmers don\'t need to work on increasing habitat diversity in order to attract wild bees. What opportunities for training and professional development has the project provided? Nothing Reported How have the results been disseminated to communities of interest? The project\'s activities and findings have been reported to commercial cucurbit growers through the project\'s website (http://organiccucurbit.plp.iastate.edu/) for the past 2 years. The website incorporates a range of resources including summaries of project results, and aphoto gallery of the project\'s field trials,cucurbit-crop insect pests, diseases,and wild bee species, and research and outreach products from the project, as well as, related extension material from other states in the eastern U.S. As reported under activities, project\'s personnel participated in several dozen field days in Iowa, Kentucky, and Pennsylvania, highlighting the project\'sexperiments and on-farm demonstration trials,and the principal investigators presented project summaries in more than 20 PowerPoint presentations atwinter conferences of local, statewide, andregionalorganizations of commercial vegetable growers in the Mid-Atlantic, Upper South, and Midwest regions. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2009/08/01 TO 2010/07/31 OUTPUTS: At university farms in IA, KY and PA, experiments on muskmelon and butternut squash: 1) compared row covers, compost, and plant growth-promoting rhizobacteria (PGPR) for suppressing bacterial wilt, cucumber beetles, squash bug, and squash vine borer; and 2) assessed impact of floral provisioning on pollinators and yield. In IA, insect pest pressure was minimal; row cover treatments enhanced muskmelon yield and had variable yield impact on squash. Row covers reduced fungicide use by protecting the plants against anthracnose, a fungal disease, and raised the sugar content of melons. In KY, row covers resulted in higher yield by protecting against high populations of cucumber beetles and bacterial wilt (melon) and squash bug (squash). Highest melon yields occurred when row covers were removed at anthesis (when female flowers began to appear). Removing row covers for 10 days at anthesis, then replacing them for the rest of the season, reduced yield because voles destroyed most of the melons. Fertrell organic fertilizer gave greater yield and higher sugar content than composted dairy manure, but there was no effect of fertilizer treatment on squash yield. Kodiak (PGPR) in transplant flats resulted in higher fruit number in both crops and higher sugar content in melons. In PA in 2009 and 2010, removal of row covers on melons 10 days after anthesis suppressed bacterial wilt by 31 and 38%, respectively, and increased yield. The low rate of compost combined with PGPR as seed treatment resulted in less bacterial wilt. In 2009, yield increases resulted from removing row covers at anthesis (18%) or 10 days later (37%). A high rate of compost resulted in 20 and 13% increase in fruit number and weight; effect of the lower amount of compost on yield was similar to that of Fertrell. In 2010, treating plants with PGPR as a seed treatment increased marketable fruit by 9%. In squash, time of row covering was inversely proportional to powdery mildew severity. In both years there was a significant increase of marketable fruits when row covers were removed at flowering (10% in 2009 and 17% in 2010), but yield was lower when row cover removal was delayed for 10 days or covers were left on all season. Kodiak had no significant impact on squash in either year. In the floral provisioning study, each state established 10 species of native flowers in a strip and planted melon and squash in adjacent rows, with a no-flower control plot located on the same farms; data analysis is ongoing. Each state also used flats of Hubbard squash and strips of melon and squash as trap plants to monitor appearance of cucumber beetles, squash bug, and squash vine borer; we are now developing models to predict their emergence. A survey of 21 cucurbit farms in the 3 states counted and identified cucurbit pollinators, and is relating these data to differences in farm landscapes. Penn State PIs are leading development of a web-based decision tool to help cucurbit growers anticipate when pest insect will arrive in their fields. The project\'s main website, a community of interest for cucurbit growers, is in an advanced stage of development at Iowa State. PARTICIPANTS: At University of Kentucky, PhD candidate Bob Caudle, who is funded by the project, was responsible for carrying out the organic practices experiment (row covers, fertilizers, and PGPR) at

University of Kentucky. At Iowa State University, PhD candidate Amy Alesch, whose stipend is funded by the project, has been the leader of the Iowa project team for the pollinator surveys on Iowa farms, the floral provisioning field experiment, and has taken project-wide leadership for the landscape analysis objective. Another ISU PhD candidate, Evrim Baran, has been working on development of content and format for the project\'s online learning community. Staff members at ISU include Eva Tao, who is doing programming to implement the website for the online learning community. At University of Kentucky, M.S. candidate Logan Minter has day-to-day responsibility for all entomology-related aspects of the field studies. At Penn State University, PhD candidate Amanda Bachmann has day-to-day responsibility for the entomology-related aspects of the project including the floral provisioning, pollination, and phenology modeling aspects of the work, and PhD candidate Ermita Hernandez oversees the field experiment involving row covers, compost treatments, and PGPR. Staff members at Penn State that are working on development of the web-based decision tool include Steve Crawford and Susan Anderson of Penn State\'s Center for Environmental Informatics. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Based on a recent in-depth review of results of field experiments (2009 and 2010 in PA, 2010 in KY and IA) at a December 6, 2010 PI meeting in Indianapolis, IN, the project team has planned a number of modifications for the upcoming field season. In the row cover, fertility, and PGPR experiment, each state has somewhat different plans for 2011 based on the results to date. Both the ISU and UKY teams will reconfigure the experiment to focus more intensively on pest management, with additional row cover treatments but fewer fertility and PGPR treatments. The Penn State team will continue to examine various fertility, as well as, pest management treatments, but will have fewer PGPR treatments. For the pollination survey, coordinators will work closely with grower-cooperators to insure that they are willing to participate in 2011, so that we will be able to survey 24 farms as indicated in the proposal (21 farms were surveyed in 2010). All states will continue to have the same methodology for the floral provisioning experiment (Objective 2b) and insect-pest phenology monitoring (Objective 4).

IMPACT

2009/08 TO 2013/07 What was accomplished under these goals? One challenge we addressed is a tough one for organic muskmelon and squash growers: how to deal with the threat of bacterial wilt, a disease that can wipe out whole fields. Cucumber beetles spread bacterial wilt, so stopping the beetles is the key to fighting off the disease. Unfortunately, the few organic insecticides on the market are very expensive and don\'t work well against cucumber beetles. This is where row covers come in. Row covers are breathable synthetic fabrics that are placed over rows of young plants in the springtime to protect against cold and windy weather and to keep out insect pests like cucumber beetles. Our project made a difference for organic growers by showing them how row covers can work best against bacterial wilt. We showed growers that they need to customize the way they use row covers depending on where they live and what crop they grow. On muskmelon in Pennsylvania and Iowa, for example, delaying the removal of row covers until 10 days after female flowers appeared cut down on bacterial wilt by 38%, increased marketable yield, and reduced the need for using insecticides. But the picture looked different for muskmelon growers in Kentucky, in the face of much higher numbers of cucumber beetles all season: the most effective row cover strategy was to remove them at the start of flowering, then rely on organic insecticide sprays for the rest of the season. For butternut squash, the optimal strategy was more consistent among the three states: removing row covers at the start of flowering resulted in the highest yield. However, this strategy was occasionally undermined by huge infestations of another insect pest, the squash bug. Another major success of the project was developing the first model to predict when cucumber beetles show up in a field. Penn State researchers used air temperature and beetle-trapping information from all three states to put together a model; it predicted with good accuracy that beetles would emerge150 degree-days (based on temperature), with a base temperature of 55o F, after January 1. The upshot is that growers can use daily temperature readings from their farm or locality to be ready for the start of the cucumber-beetle risk period each spring, and can time their beetle-control tactics more effectively as a result. We also made the first large-scale survey of the wild bee species that occur in and around muskmelon and squash crops in all three states. On-farm trapping of bees at 24 sites for two years revealed a vast diversity: more than75 species of bees were present, and several species were often found in flowers of these crops, so they are likely to be important as pollinators. Our survey showed that wild bees play a major role in muskmelon and squash pollination in these regions, and emphasized that we need to find ways to conserve the wild bees in order to protect crop yield. Finally, we launched the most comprehensive website ever developed for organic cucurbit growers. The site provides practical, up-to-date advice for managing pests, diseases, and pollinators in cucurbit crops, and summarizes the project\'s accomplishments in straightforward language. **PUBLICATIONS (not previously reported):** 2009/08 TO 2013/07 1. Type: Journal Articles Status: Published Year Published: 2013 Citation: Caudle, J.R., Coolong, T., Williams, M.A., Vincelli, P. and Bessin, R. 2013. Development of an organic muskmelon production system

against bacterial wilt disease. Acta Horticulturae 1001:249-254. 2. Type: Journal Articles Status: Published Year Published: 2013 Citation: Saalau Rojas, E., Dixon, P.M., Batzer, J.C., and Gleason, M.L. 2013. Genetic and virulence variability among Erwinia tracheiphila strains recovered from different cucurbit hosts. Phytopathology 103:900-905. 3. Type: Journal Articles Status: Accepted Year Published: 2013 Citation: Saalau Rojas, E., Jesse, L.H., and Gleason, M.L. 2013. Bees, beetles, and bacteria: the cucurbit bacterial wilt dilemma. Plant Health Instructor: Accepted. 4. Type: Journal Articles Status: Under Review Year Published: 2014 Citation: Alesch, A.S., Gleason, M.L., and Nonnecke, G.R. 2013. The case of the missing pollinators. HortTechnology: Accepted pending revision. 5. Type: Journal Articles Status: Submitted Year Published: 2013 Citation: Schmidt, J., Barney, S., Williams, M., Bessin, R., Coolong, T., and Harwood, J. Predator-prey trophic relationships in response to organic management practices. Submitted to Molecular Ecology on July 6th, 2013. 6. Type: Theses/Dissertations Status: Published Year Published: 2012 Citation: Bachmann, A. 2012. Using population structure and phenology to advance insect management in diversified vegetable agroecosystems. PhD Dissertation, Department of Entomology, Pennsylvania State University, University Park, PA. 180 pp. 7. Type: Theses/Dissertations Status: Published Year Published: 2012 Citation: Minter, L. 2012. Integrating sustainable pest management and pollinator conservation efforts in cucurbit production systems. PhD Dissertation, Department of Entomology, University of Kentucky, Lexington, KY. 175 pp. 8. Type: Theses/Dissertations Status: Published Year Published: 2013 Citation: Hernández, E. 2013. Integrating row covers, compost and rhizobacteria to manage nutrients and key pests in organic cucurbit production. PhD Dissertation, Department of Horticulture, Pennsylvania State University, State College, PA. 150 pp. 9. Type: Theses/Dissertations Status: Published Year Published: 2013 Citation: Shapiro, L. 2013. A to ZYMV guide to Erwinia tracheiphila infection: An ecological and molecular study. PhD Dissertation, Department of Entomology, Pennsylvania State University, College Park, PA. 159 pp. 10. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Batzer, J.C., and Gleason, M.L. 2012. On-farm cooperator trials 2012: effect of extended-duration row covers on muskmelon and winter squash on bacterial wilt and yield. Research Progress Reports, Iowa State University Horticulture Research Station. Report RFR-A1228. Pp. 32-33. http://www.ag.iastate.edu/farms/2012%20Farm%20Reports/Hort/OnFarmCooperatorTria 11. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Batzer, J.C., and Gleason, M.L. 2012. Organic practices for the production of muskmelon. Research Progress Reports, Iowa State University Horticulture Research Station. Report RFR-A1227. Report RFR-A1227. Pp. 18-20. http://www.ag.iastate.edu/farms/2012%20Farm%20Reports/Hort/OrganicPracticesMusk 12. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Batzer, J.C., and Gleason, M.L. 2012. Organic practices for the production of butternut squash. Research Progress Reports, Iowa State University Horticulture Research Station. Report RFR-A1226. Pp. 7-10. http://www.ag.iastate.edu/farms/2012%20Farm%20Reports/Hort/OrganicPracticesSqua 13. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Gleason, M.L., and Sanchez, E. 2013. Row covers and compost for managing cucumber beetles in organic muskmelon and squash & Perimeter trap cropping for conventional muskmelon. Pennsylvania Association for Sustainable Agriculture\'s farming for the Future Convention, State College, PA, February 8, 2013. 65 attendees. 14. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Sanchez, E., and Fleischer, S. 2013. Compost and Row Covers for Nutrient and Cucumber Beetle Management in Organic Cucurbits. Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA, January 29, 2013. 87 attendees. 15. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Sanchez, E. 2013. Compost and Row Covers for Nutrient and Cucumber Beetle Management in Organic Cucurbits. Mountain Top Fruit and Vegetable Conference, McHenry, MD, January 26, 2013. 35 attendees. 16. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Fleischer, S. 2013. Biology and Management of Cucumber Beetles. Endless Mountains Winter Commercial Vegetable Meeting, Towanda, PA, Feb. 12, 2013. 20 attendees. 17. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Gleason. M. 2013. Controlling and avoiding bacterial diseases of vegetable crops. Great Plants Fruit and Vegetable Conference, St. Joseph, MO, January 11, 2013. 75 attendees. 18. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Gleason, M. 2013. Fungal and bacterial diseases in vegetables. Iowa Fruit and Vegetable Growers Association Conference, Ankeny, IA, January 24, 2013. 25 attendees. 19. Type: Other Status: Published Year Published: 2012 Citation: Williams, M., Wilson, N., and Coolong, T. 2012. Organic production of cucurbit crops using row-covers. 2012 Fruit and Vegetable Research Report. University of KY Cooperative Extension Service Bulletin PR656. P. 36-39. http://www.ca.uky.edu/agc/pubs/PR/PR656/PR656.pdf 20. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Coolong, T. 2012. Sustainable vegetable production field day. The Giving Fields, Campbell County, KY, September 6, 2012. 85 attendees. 21. Type: Theses/Dissertations Status: Published Year Published: 2013 Citation: Caudle, R. 2013. Control of Erwinia tracheiphila in Cucumis melo. PhD Dissertation, Department of Horticulture, University of Kentucky, Lexington, KY. 125 pp. 22. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Coolong, T. 2012. Farm tour for youth farming programs (Menifee County). Lexington, KY, Sept.

27, 2012. 16 attendees. 23. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Coolong, T., 2012. Home vegetable production using sustainable practices. Hopkins County KY, Oct. 18, 2012. 22 attendees. 24. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Coolong, T. 2012. Sustainable Vegetable Production. Asbury College, KY. 18 students. 25. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Coolong, T. 2012. Home vegetable production using sustainable practices. Barren County KY, Nov 13, 2012. 26 attendees. 26. Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Coolong, T. 2012. Updates for vegetable production. Bath County Produce Auction, KY, Dec. 13, 2012. 65 attendees. 27. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Coolong, T. 2013. Minimizing Chemical inputs for pest control in Vegetables: A focus on Cucurbits. Great Plains Growers Conference, St. Joseph, MO, Jan 11, 2013. 35 attendees. 28. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Coolong, T. 2013. Strip tillage for vegetable production organic and conventional. Tennessee Horticulture Expo, Jan 26, 2013. 25 attendees. 29. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Coolong, T. 2013. Organic production of vegetables for small scale growers. Jessamine County, KY Feb 11, 2013. 65 attendees. 30. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Coolong, T. 2013. Diversified vegetable production. Clark County, KY Feb 12, 2013. 56 attendees. 31. Type: Websites Status: Published Year Published: 2013 Citation: Organic Cucurbit Growing Community (http://organiccucurbit.plp.iastate.edu) 32. Type: Theses/Dissertations Status: Published Year Published: 2013 Citation: Sidhu, C.S. 2013. Farmscape and landscape-level effects on cucurbit pollinators on small farms in a diversified ecosystem. PhD Dissertation, Department of Entomology, Pennsylvania State University, College Park, PA. 124 pp.

2011/08/01 TO 2012/07/31 The project website (Organic Cucurbit Growers Community) is the flagship 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 creative suggestions to improve the site\'s usefulness to growers. The suggested improvements were incorporated and additional resources, graphics and pictures added. The Project\'s interactive web-based decision tool 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.

2010/08/01 TO 2011/07/31 Commercial cucurbit growers learned about the project\'s strategies to suppress cucurbit pests and diseases, manage fertility, and enhance pollination through attendance at eight field days in 2010: 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). We have also shared findings with growers through publication of research summaries in handouts to growers at indoor meetings of grower groups in 2011 including Iowa Fruit and Vegetable Growers Association (January 29 in Des Moines) and the Mid-Atlantic Fruit and Vegetable Convention (January 31 in Hershey, PA). Six organic growers (three each in Iowa 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 2011. In addition, 12 organic cucurbit growers (4 from each of the participating states) on the project\'s Advisory Panel have gained current knowledge of the project\'s progress through three 90-minute teleconferences with project PIs during 2011. Finally, the scientific community learned about the project\'s progress through presentations by project PIs and graduate students during 13 national, regional, and local scientific society meetings throughout the U.S. during 2011.

2009/08/01 TO 2013/07/31 What was accomplished under these goals? One challenge we addressed is atough one for organic muskmelon and squash growers: how to deal with the threat ofbacterial wilt, a disease that can wipe out whole fields. Cucumber beetles spread bacterial wilt, so stopping the beetles is the key to fighting off the disease. Unfortunately, the few organic insecticides on the market are very expensive and don\'t workwell against cucumber beetles. This is where row covers come in. Row covers arebreathable syntheticfabrics that are placed overrows of young plants in the springtime to protect against coldand windy weather and to keep out insect pests like cucumber beetles.Our project made a difference for organic growers by showing them how row covers can

work best against bacterial wilt. We showed growersthat theyneed to customize the way they use row covers depending on where they live and what crop they grow. On muskmelon in Pennsylvania and Iowa, for example,delaying the removal of row covers until 10 days after female flowers appeared cut down on bacterial wilt by 38%, increased marketable yield, and reduced the need for using insecticides. But the picture looked different for muskmelon growers in Kentucky, in the face of much higher numbers ofcucumber beetles all season: the most effective row cover strategy was to remove them at the start of flowering, then rely on organic insecticide sprays for the rest of the season. For butternut squash, the optimal strategy was more consistent among the three states: removing row covers at the start of flowering resulted in the highest yield. However,this strategy was occasionally undermined by huge infestations of another insect pest, the squash bug. Another major success of the project was developing the first model topredict when cucumber beetlesshow upin a field. Penn State researchers used air temperature and beetle-trapping information from all three states to put together a model; it predicted with good accuracy that beetles would emerge150 degree-days (based on temperature), with a base temperature of 55o F, after January 1. The upshot is that growers can use daily temperature readings from their farm or locality to be ready for the start of the cucumber-beetle risk period each spring, and can time their beetle-control tactics more effectively as a result. We also made the first large-scale survey of the wild bee species that occur in and around muskmelon and squash crops in all three states. On-farm trapping of bees at 24 sites for two years revealed a vast diversity: more than75 species of bees were present, and several species were often found in flowers of these crops, so they are likely to be important as pollinators. Our survey showed that wild bees play a major role in muskmelon and squash pollination in these regions, and emphasized that we need to find ways to conserve the wild bees in order to protect crop yield. Finally, we launched the most comprehensive website ever developedfor organic cucurbit growers. The site provides practical, up-to-date advice for managing pests, diseases, and pollinators in cucurbit crops, and summarizes the project\'s accomplishments in straightforward language.

2009/08/01 TO 2010/07/31 Through attendance at 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) - cucurbit growers have learned about the project\'s strategies to suppress cucurbit pests and diseases, manage fertility, and enhance pollination in organic cucurbit production. We have also 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). 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. In addition, 12 organic cucurbit growers (4 each for the participating states) on the project\'s Advisory Panel have gained current knowledge of the project\'s progress through two 90-minute teleconferences with project PIs during 2010.

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Farmer Driven Breeding: Addressing the Needs of Southeastern Organic Field Crop Producers

Accession No.	0218754
Subfile	CRIS
Project No.	NC09790
Agency	NIFA NC.
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Investigator(s)	Reberg-Horton, S. C.; Carter, T.; Goodman, M.; Isleib, T.; Murphy, P.
Performing Institution	Crop Science, NORTH CAROLINA STATE UNIV, RALEIGH, NORTH CAROLINA 27695

NON-TECHNICAL SUMMARY

The long-term goal of this project is to increase the sustainability of organic agriculture by insuring continual improvement of the genetic base for organic field crops. The proposed project seeks to institutionalize a system for organic field crop breeding, organic on-farm testing, and annual meetings with organic producers and breeders to evaluate and update variety development efforts. The impetus for this project grew directly out of a series of farmer panel discussions hosted by North Carolina State\'s Organic Cropping Systems Program from 2006 to 2008. At these panel discussions , farmers voiced concern over increasing privatization of breeding, decreasing availability of GMO-free varieties, and lack of breeding under organic conditions. The short-term benefit for the breeding program will include: 1) establishing relationships between organic producers and breeders; 2) inclusion of organic testing in breeding protocols; 3) bolstered support for public breeding programs; 4) increased business investment confidence to Southeastern industries needing local organic grain supplies; and 5) improved methods for organic crop breeding. The long-term benefits will include: 1) increased organic acreage, improved yields and profit for organic producers (even a 10% yield grain will result in millions of dollars for regional organic producers and processors); 2) stable feed sources for organic animals; 3) reduced dependence on genetically modified crop varieties; 4) reduced dependence on high input agriculture; and 5) a more genetically diverse foundation for organic agriculture.

OBJECTIVES

Long-term Goal: The long-term goal of this project is to increase the sustainability of organic agriculture by insuring continual improvement of the genetic base for organic field crop production. Improvement of this organic genetic base depends on: (1) participation of public breeding programs to address the needs of organic field crop producers; (2) improved regional breeding networks for sharing and testing of advanced crop lines designed for organic field crop production; and (3) increased farmer involvement in the organic variety development process.

Objectives: To achieve this long-term goal, the following three main objectives are proposed: 1. Involve farmers in identification of traits advantageous in organic systems and screen lines for those traits for incorporation into breeding programs. 2. Institutionalize sharing and testing of regional advanced lines of major agronomic crops under organic conditions and utilize on-farm testing to integrate organic producers into the variety release process. 3. Create a mechanism for organic farmers to interact with public plant breeders and have their concerns addressed.

APPROACH

Soybeans. Screening of 500 diverse and previously untested soybean genotypes from Asia, the ancestral home of soybean, for weed competitiveness under organic conditions will be done at agricultural research stations in North Carolina. Plots will be over-seeded with pigweed seed immediately after planting for uniform weed pressures. Standard varieties will also be included as controls in testing. Non-destructive screening tactics will be carried out along with visual ratings of genotype performance. These screening tactics, which include overhead photography and image analysis, will be based on previous North Carolina State University research that identified soybean traits and canopy measurements most correlated with weed competitive ability. Newly-developed, advanced, non-GMO breeding lines will be yield tested on-farm under organic testing conditions. Corn. Population development will be initiated with three-way crosses using corn genotypes NC476 and NC320.NC368. Single crosses will also be conducted with NC476. Top-crossing will be carried out with new back cross progeny to appropriate testers. NC368 will be crossed to earlier inbred lines. Wheat. Approximately 50 advanced generation lines and released cultivars of diverse parentage will be evaluated for allelopathic activity at research stations in North Carolina. Experimental design will consist of a randomized complete block design with three replications. Plot sizes will be approximately 3 m by 1.5 m with 0.14 m row spacing. Plots will be over-seeded with annual ryegrass immediately after planting for uniform weed pressures. Peanuts. Approximately 150 peanut genotypes will undergo greenhouse screening for seedling disease resistance. Experimental design will be an incomplete block with 3 replications. Pots will be filled with potting soil artificially infested with a mixture of seedling disease fungi (Fusarium, Rhizoctonia, Pythium, and Aspergillus niger). Each pot will be planted with 10 untreated peanut seed. Temperature and moisture conditions conducive to the development of disease will be maintained. Genotypes will be evaluated based on percent survival, disease presence, and vigor ratings. Seed will be increased for lines showing resistance to seedling diseases. On-farm organic variety tests for all four crops will be operated in a similar manner. The breeder and postdoctoral researcher will plant the variety test plots in measured areas utilizing a cone planter designed specifically for research. The farmer will maintain the plots during the growing season using routine organic management. The breeder and postdoctoral researcher will harvest the variety test plots utilizing a research plot combine to obtain precise yield data for each variety. The research group and farmer will coordinate all activities and maintain communication throughout the season.

PROGRESS

2009/09 TO 2013/08 Target Audience: Organic field crop producers Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Nothing Reported How have the results been disseminated to communities of interest? Outreach for the project has occurred at multiple venues. We have an annual field day that has alternated between on-farm sites and research stations that host our organic variety trials. We also host a conference every winter where the previous years results are discussed and variety trial recommendations are handed out. We also regularly update our audience with the quarterly NC Organic Grain newsletter. Finally, the newest edition of the NC Organic Grain Production Guide was printed (2,000 copies) and is presented on our website, www.organicgrains.ncsu.edu What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 OUTPUTS: Maize 1. Provide double-cross hybrids that can readily be produced and that are competitive in performance with current, non-organic hybrids. 2. Develop Ga1 s hybrids that will provide isolation from GMO pollen from neighboring fields. 3. Determine if Tcb1 hybrids can be developed as an alternative to (2). The source of Tcb1 traces to work done by Jerry Kermicle at the University of Wisconsin, who isolated the gene from teosinte. 4. Develop lines and hybrids based on newly-discovered dominant gametophytic factors isolated from Mexican racial accessions. Much of the accession identification was done by Jesus Sanchez, now at the University of Guadalajara. We have also demonstrated that the double crosses can be produced by using bulk increases of the component single crosses, which may be a real advantage to organic seed corn production. We have produced and tested many single-cross and topcross Ga1 s hybrids, including a commercially available one from Blue River. Although we have numerous Ga1 s lines, they share too much

parentage to have adequate heterosis when crossed among themselves. So we are developing new lines using various combinations of our own lines, ex-PVP lines, some Ga1 s lines from Missouri (their 500-series lines), and two composites from Frank Kutka. Thus far, the most promising combinations appear to be NC and ex-PVP lines, but further testing is needed. Ultimately, Ga1 s hybrids will fail to be isolated from GMO pollen. We have ourselves released lines carrying Ga1-M, a promiscuous allele that, when present in either homozygous or heterozygous state, allows pollination from all sources, including Ga1 s. And we have shown that at least one ex-PVP line carries that allele. Sanchez at Guadalajara has shown that Ga1-M is at high frequency in Mexican landraces and hybrids, so it is likely to increase in frequency among US commercial breeding stocks over time (perhaps \> 20 years). And that will ultimately end isolation using Ga1 s. For those reasons, we are attempting to substitute Tcb1 for Ga1 s. Tcb1 has the advantage of being dominant, while Ga1 s - for practical purposes - is effectively recessive, although the degree of Ga1\'s dominance/recessive-ness varies among materials and among environments. We have run the only yield trial ever run using Tcb1 stocks, and it was not encouraging. It may be that the teosinte source of Tcb1 causes the low yields that we observed via linkage drag. We are doing more backcrossing to try to eliminate any such source effects, but that takes time. As an alternative to Tcb1, we are using some newly discovered Dominant Gametophytic Factors (DGaFs) from Mexican landraces of maize. We verified that they work as advertised, isolated some families that have plants that are heterozygous/homozygous for various DGaFs and have begun a backcrossing program to incorporate these DGaFs into our leading lines. We will also have a small-scale yield trial of DGaF topcrosses this summer. It remains to be seen if the various DGaFs are allelic to Tcb1 or Ga1. PARTICIPANTS: Carolina Organic Commodity and Livestock Conference. Rocky Mount, NC. January 12 and 13, 2012. 115 participants. Partners, Carolina Farm Stewardship Association and Rural Advancement Foundation International Organic Farm Advisory Board Meeting. March, 2012. 15 participants. Organic Grains Field Day, July 19, 2012. 75 participants. TARGET AUDIENCES: Not relevant to this project. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: The double-cross corn hybrid that we are currently using, NC476.DKHBA1 x NC320.NC368 is reasonably competitive with current commercial hybrids (which are not available for organic use), and is resistant to the disease pressure found in the Southeast. We are both testing existing lines that might improve its performance and developing new lines that might also. Existing lines that look promising for substituting on the NC476.DKHBA1 side include 2 NC296 dervatives and two other lines, PHN47 and NC412. On the NC320.NC368 side, 2309-1 (a NC320 derivative) and LH132 show promise. We have identified 4 possible gametophytic double-crosses that promise isolation from GMOs, reasonable productivity, and at least adequate disease resistance. Three of the four involve an NC492-derived line which we are temporarily calling E015. Three also involve Frank Kutka derivatives that we call KN and KS: NC338.NC302 x KN.E015 KN.NC460 x KS.E015 NC302.NC354 x NC464.KS NC520.NC464 x E015.NC354 Based on previous results we continued screening for another season on a selection of over 500 soybean genotypes from the over 18,000 genotypes in the USDA soybean germplasm collection. In this year\'s expanded wheat study we will use this new screening method to test the weed suppressive ability of the entire 2012 NC Official Variety Test and several hard winter wheat lines being developed for organic production systems. Laboratory studies have suggested that some wheat varieties gain a competitive edge against weeds through allelopathy, the release of chemicals through roots that suppress the growth of neighboring plants. We have conducted a laboratory bioassay to test the allelopathic ability of all of the varieties in the Official Variety Test. Organic Breeding: Official Variety Testing in Organic Conditions Official variety testing (OVT) for organic conditions was conducted at three organic locations in Salisbury, Kinston, and Herford, NC for the wheat testing and in Goldsboro, Kinston, and Herford NC for soybean and corn testing. PARTICIPANTS: Participant work on this project is described in the previous report section. TARGET AUDIENCES: All official variety test results from the project have been issued to interested producers through the North Carolina Organic Grains newsletter. PROJECT MODIFICATIONS: The organic corn test had very few entries from southeastern states. The number of corn varieties available to growers without seed treatment and with no transgenics was limited to 19 entries with the majority coming from the Midwest. Of course, this lack of adapted varieties for the Southeast is one of the impetuses for this project. We capitalized on an opportunity to participate with a group of public corn breeders and smaller seed companies in the Midwest conducting a multi-regional test of available corn varieties for organic producers. This United States Testing Network (USTN) is led by the Practical Farmers of Iowa.

2009/09/01 TO 2010/08/31 OUTPUTS: Organic Breeding for Peanuts Soil-borne damping-off diseases is one of the biggest obstacles facing organic peanut production in the Southeast. Conventional producers control these diseases by using seed treated with fungicides. But organic producers can\'t use seed treated with the usual products, and organic approved seed treatments have not proven to be highly effective. So we have embarked on finding sources of resistance to the various elements of the damping-off complex. We conducted assays this

year to measure lines\' reactions to CBR, Sclerotinia blight, and more recently white mold (southern stem rot, Sclerotium rolfsii). Each disease assay includes four reps of 49 genotypes from the peanut genotype core collection. Organic Breeding for Corn On the basis of very limited data, we identified the double cross hybrid DKHBA1.NC476 x NC320.NC368 as being potentially useful for organic corn farmers. NC320 x NC368 has consistently been a high yielding hybrid. NC476 is broad-leafed, reasonably high yielding and early. DKHBA1 is well-adapted, high yielding and early. We are making attempts to use Ga1-S as an isolating mechanism to alleviate the threat of GMO pollen in organic production fields. While we have an array of gametophytic inbreds available that yield well in hybrids (in contrast to most other groups attempting to utilize this concept), all of our own lines are rather closely related. We have obtained some unrelated Ga1-S stocks from Frank Kutka and will be testing them in crosses with each other and with the Ga1-S crosses next summer. Organic Breeding for Soybeans Based on previous results we selected over 500 genotypes from the over 18,000 genotypes in the USDA soybean germplasm collection. Each soybean genotype was screened for early growth vigor. This screening process involves taking equivalent overhead digital images of each soybean genotype and processing the images with imaging software that enables us to quantify the leaf to ground ratio for the soybean genotype. A higher leaf to ground ratio is indicative of a more weed competitive soybean genotype. Additionally we measured the soybean canopy width, height, and overall vigor rating to select competitive genotypes. Organic Breeding for Wheat In October 2010 we planted an experiment designed to find a simple and effective method of estimating weed suppressive ability in plots overseeded with Italian ryegrass. Plots were overseeded with ryegrass at rates of 0, 50, 150, and 300 plants per square meter. We intend to test three methods of investigating weed suppressive ability in these plots: 1) visual ratings, 2) aerial photographs of the plots evaluated with Sigma Scan image analysis software (SPSS), and 3) multiband spectral signature data collected with a Crop Circle ACS-210 multiband sensor. At the end of the growing season (Zadoks 92) we will cut a twelve square foot swath of each plot with a forage harvester, separate the wheat and ryegrass biomass by hand, and determine the ratio of weed to wheat biomass in each plot. Each of the proposed proxy methods will then be tested for correlation with the end of season biomass ratios. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/09 TO 2013/08 What was accomplished under these goals? Maize 1. Provide double-cross hybrids that can readily be produced and that are competitive in performance with current, non-organic hybrids. 2. Develop Ga1?s hybrids that will provide isolation from GMO pollen from neighboring fields. 3. Determine if Tcb1 hybrids can be developed as an alternative to (2). The source of Tcb1 traces to work done by Jerry Kermicle at the University of Wisconsin, who isolated the gene from teosinte. 4. Develop lines and hybrids based on newly-discovered dominant gametophytic factors isolated from Mexican racial accessions. Much of the accession identification was done by Jesus Sanchez, now at the University of Guadalajara. We have also demonstrated that the double crosses can be produced by using bulk increases of the component single crosses, which may be a real advantage to organic seed corn production. We have produced and tested many single-cross and topcross Ga1?s hybrids, including a commercially available one from Blue River. Although we have numerous Ga1?s lines, they share too much parentage to have adequate heterosis when crossed among themselves. So we are developing new lines using various combinations of our own lines, ex-PVP lines, some Ga1?s lines from Missouri (their 500-series lines), and two composites from Frank Kutka. Thus far, the most promising combinations appear to be NC and ex-PVP lines, but further testing is needed. Ultimately, Ga1?s hybrids will fail to be isolated from GMO pollen. We have ourselves released lines carrying Ga1-M, a promiscuous allele that, when present in either homozygous or heterozygous state, allows pollination from all sources, including Ga1?s. And we have shown that at least one ex-PVP line carries that allele. Sanchez at Guadalajara has shown that Ga1-M is at high frequency in Mexican landraces and hybrids, so it is likely to increase in frequency among US commercial breeding stocks over time (perhaps \> 20 years). And that will ultimately end isolation using Ga1?s. For those reasons, we have attempted to substitute Tcb1 for Ga1?s. Tcb1 has the advantage of being dominant, while Ga1?s - for practical purposes - is effectively recessive, although the degree of Ga1\'s dominance/recessive-ness varies among materials and among environments. We have run the only yield trial ever run using Tcb1 stocks, and it was not encouraging. It may be that the teosinte source of Tcb1 causes the low yields that we observed via linkage drag. We are doing more backcrossing to try to eliminate any such source effects, but that takes time. As an alternative to Tcb1, we are using some newly discovered Dominant Gametophytic Factors (DGaFs) from Mexican landraces of maize. We verified that they work as advertised, isolated some families that have plants that are heterozygous/homozygous for various DGaFs and have begun a backcrossing program to incorporate these DGaFs into our leading lines. We also have a small-scale yield trial of DGaF topcrosses. Wheat We have

conducted studies to identify effective screening methods for quantifying weed suppressive ability in field trials, test the allelopathic activity of locally adapted winter wheat lines from the North Carolina Official Variety Test (OVT) in controlled laboratory bioassays, determine the relative importance of allelopathy and competitive ability in determining weed suppressive in the field, and identified morphological traits and molecular markers associated with the competitive ability of winter wheat lines in North Carolina. In 2011 and 2012 we conducted a pilot study to identify efficient screening methods for quantifying weed suppressive ability in field trials. Measurements of Italian ryegrass seed head density during grain fill were strongly associated with the weed to crop biomass ratio, the generally accepted measure of weed suppressive ability. Visual ratings of weed biomass in the plots taken at all growth stages, especially during and after heading, were also strongly correlated with weed suppressive ability. Measurements from non-imaging spectrophotometers and overhead photographs taken from tillering to early dough development were unreliable estimates of end of season Italian ryegrass. A manuscript detailing our protocol development was recently published in Weed Science (Worthington et al. 2013) and a review of breeding methods for improving weed suppression through allelopathy and competitive ability was published in the Journal of Chemical Ecology (Worthington and Reberg-Horton 2013). We found significant variation in the allelopathic activity of winter wheat lines from the 2011 OVT in a controlled laboratory bioassay. However, allelopathic lines were not found to have superior weed suppressive ability to non-allelopathic lines of similar height in replicated field trials in 2012 and 2013. The role of morphological traits conferring competitive ability to wheat lines appears far more important than allelopathy in determining weed suppression outcomes in the field. Elite lines adapted to North Carolina growing conditions varied widely in their weed suppressive ability. We have identified commercially available cultivars with high yield potential in conventional and organic trials with promising weed suppressive ability. Morphological traits including erect growth habit and vigor during tillering, height throughout the growing season, and early heading date were generally associated with superior weed suppressive ability. Short vernalization alleles (vrn A1 and vrn B1) were also associated with enhanced weed suppression. Manuscripts describing these findings will be submitted to Crop Science this fall. A new study focused on identifying QTLs for weed suppressive ability in a biparental cross between weakly and strongly weed suppressive cultivars will be planted this fall. Soybean We tested multiple methods of measuring soybean canopies to predict their weed competitive ability. Directly measuring competitive ability is extremely expensive as it involves growing the crop in competition with weeds and then separating crop and weed biomass to assess the outcome. Fortunately, one of the techniques, overhead image analysis of the soybean canopy combined with pixel counting software, was sufficiently predictive to allow it to serve as an indirect measure of competitive ability (publication, Place et al 2011a). We utilized this approach to screen 45 entries chosen to represent as wide a range in growth patterns as possible (publications, Place et al. 2011b and Place et al. 2011c). Heritable variation in competitive ability is present in soybean and now the next step is to screen more genotypes from the national soybean germplasm collection. Our first screening of the national collection was conducted in 2012 and was repeated in 2013. The level of variation amongst 2012 entries was substantially higher than in our first trials suggested an even greater potential to improve this trait for organic production. Peanuts Seedling diseases continue to be the greatest barrier to organic production of large in-shell peanuts. Sixty to seventy percent of emerging seedlings die in the first two weeks. We have developed greenhouse screening protocols for the major disease organisms and are continuing to screen our collection for resistant lines. We created a genetically diverse cross population by bulking seed of our most disease resistant crosses, then growing the population for three generations without seed treatment, fungicides or insecticides. We have harvested these peanuts to serve as the seed for the next generation in a mass selection ("evolutionary breeding") program. Evolutionary breeding harnesses natural selection for crop improvement and is arguably best suited for low input environments like organic farms. After harvest each year, we screen the peanuts to insure that only ones with sufficient size and quality are used as seed the next year. **PUBLICATIONS (not previously reported):** 2009/09 TO 2013/08 1. Type: Journal Articles Status: Published Year Published: 2011 Citation: Place, G.T., S.C. Reberg-Horton, and T.E. Carter. 2011. Screening tactics for identifying competitive soybean genotypes. Communications in Soil Science and Plant Analysis 42:2654-2665. 2. Type: Journal Articles Status: Published Year Published: 2011 Citation: Place, G.T., S.C. Reberg-Horton, D.A. Dickey and T.E. Carter. 2011. Identifying soybean traits of interest for weed competition. Crop Science 51:2642-2654. 3. Type: Journal Articles Status: Published Year Published: 2011 Citation: Place, GT, SC Reberg-Horton, TE Carter, AN Smith. 2011. Effects of soybean seed size on weed competition. Agronomy Journal 103:175-181. 4. Type: Journal Articles Status: Published Year Published: 2011 Citation: 4. Sanchez, J., J.M. Padilla, L. De la Cruz, J. Ron, J.Holland, M. Krakowsky, and M. Goodman. 2011. Use of gametophytic isolating mechanisms for maize. Plant Breeding News 29:1.14. Available at http://www.fao.org/ag/agp/agpc/doc/services/pbn/pbn-230.htm#a114 5. Type: Journal Articles Status: Published Year Published: 2013 Citation: Worthington, M.L. and S.C. Reberg-Horton. 2013. Breeding cereal crops for enhanced weed suppression: optimizing allelopathy and competitive ability. Journal of Chemical Ecology 39:213-231. 6. Type: Journal Articles Status: Published Year Published: 2013 Citation: Worthington, M.L., S.C. Reberg-Horton, D. Jordan, and J.P. Murphy. 2013. A comparison of methods for evaluating the suppressive ability of winter wheat cultivars against Italian ryegrass (Lolium perenne). Weed Science 61:491-

4999. 7. Type: Websites Status: Published Year Published: 2009 Citation: http://rafiusa.org/bopscoalition/ 8. Type: Theses/Dissertations Status: Accepted Year Published: 2013 Citation: Worthington, M.L. Breeding Winter Wheat for Improved Powdery Mildew Resistance and Weed Suppressive Ability against Italian Ryegrass.

2011/09/01 TO 2012/08/31 Wheat We have conducted a study to identify effective screening methods for quantifying weed suppressive ability in field trials and tested the allelopathic activity of locally adapted winter wheat lines from the North Carolina Official Variety Test (OVT) in controlled laboratory bioassays. We are also conducting the second year of studies testing the relative importance of allelopathy and competitive ability in determining weed suppressive in the field and identifying morphological traits associated with the competitive ability of winter wheat lines in North Carolina. In 2011 and 2012 we conducted a pilot study to identify effective screening methods to quantify weed suppressive ability in field trials. Measurements of Italian ryegrass seed head density during grain fill were strongly associated with the weed to crop biomass ratio, the generally accepted measure of weed suppressive ability. Visual ratings of weed biomass in the plots taken at all growth stages, especially during and after heading, were also strongly correlated with weed suppressive ability. Measurements from non-imaging spectrophotometers and overhead photographs taken from tillering to early dough development were unreliable estimates of end of season Italian ryegrass. A manuscript describing this research is currently under review in Weed Science. Soybeans We tested multiple methods of measuring soybean canopies to predict their weed competitive ability (see publications). Directly measuring competitive ability is extremely expensive as it involves growing the crop in competition with weeds and then separating crop and weed biomass to assess the outcome. Fortunately, one of the techniques, overhead image analysis of the soybean canopy combined with pixel counting software, was sufficiently predictive to allow it to serve as an indirect measure of competitive ability. We utilized this approach to screen 45 entries chosen to represent as wide a range in growth patterns as possible. Heritable variation in competitive ability is present in soybean and now the next step is to screen more genotypes from the national soybean germplasm collection. Our first screening of the national collection was conducted in 2012 and will be repeated in 2013. The level of variation amongst 2012 entries was substantially higher than in our first trials. Peanuts Based on the germplasm screening using bioassays for seedling diseases, we have created a cross population of the accessions with the highest seedling disease resistance and of advanced lines from our peanut breeding program that are well adapted to the region. This population will be planted at two participating organic farms and one organic research site according to the production practices on each farm. We will harvest the peanuts from these farms to serve as the seed for the next generation in a mass selection (evolutionary breeding) program. Evolutionary breeding harnesses natural selection for crop improvement and is arguably best suited for low input environments like organic farms. After harvest each year, we will screen the peanuts to insure that only ones with sufficient size and quality are used as seed the next year.

2010/09/01 TO 2011/08/31 Project outputs of this manner are still pending as we are only in the second year of a long term breeding effort. However, one tangible effort from our corn breeding efforts includes the double cross hybrid NC476.DKHBA1 x NC320.NC368 which is reasonably competitive with current commercial hybrids (which are not available for organic use), and is resistant to the disease pressure found in the Southeast.

2009/09/01 TO 2010/08/31 Official Variety Testing in Organic Conditions Official variety testing (OVT) for organic conditions was conducted at three organic locations. We teamed up with the North Carolina OVT group to create similar testing conditions. We also hope that these efforts may result in an eventual inclusion of variety testing in organic conditions as part of the normal NC OVT process. The organic wheat test received 38 entries from private seed companies and public breeders throughout the Southeast. The organic corn test had very few entries from southeastern states. The number of corn varieties available to growers without seed treatment and with no transgenics was limited to 11 entries. Of course, this lack of adapted varieties for the Southeast is one of the impetuses for this project. We capitalized on an opportunity to participate with a group of public corn breeders and smaller seed companies in the Midwest conducting a multi-regional test of available corn varieties for organic producers. We included 18 corn entries in our organic OVT to provide a Southeastern regional test site. The organic soybean test had the largest number of entries (48) for organic and non treated, non GMO soybean cultivars . Farmer outreach with the Rural Advancement Foundation International (RAFI) The focus of our work has been to reach out to farmers in the southeast and develop a system for soliciting their input and participation in our breeding work. Our first goal was to develop visibility and clear messaging of the project - to make it recognizable and understandable to farmers. To accomplish this goal RAFI developed a logo and website for the BOPS project. Our second goal was to identify and develop a network of organic grain farmers across the southeast. We have developed a database of over 500 organic farms across the southeast, which we have sent multiple mailings and email updates to. We have also made phone calls to many of the farmers on this list. We have been able to interact with a core group of 65 farmers from 11 different states on multiple occasions. Our

third goal was to develop a system for soliciting input from farmers to influence the breeding work at NC State. To accomplish this goal this past year we developed an organic seed survey, which was mailed to our southeastern farmer network database. We also worked with NC State partners to host a webinar in January of 2010 to collect input from farmers and share what the breeders were working on. We have identified individual farmers who serve as opinion leaders in our area, and have begun to network with these farmers to identify their major concerns. We have made many visits to farmers in North Carolina and Virginia to learn about the challenges they face. We will create opportunities for discussion about the major issues identified by the farmer network, including: organic seed supply and distribution, traits needed to combat disease and pests, and concerns over GMO contamination. We will also work with NC State partners to host a session at the January 2011 Organic Grains Conference in North Carolina in which we bring together prominent members of the network, either in person or via webinar.

PUBLICATIONS

2011/09/01 TO 2012/08/31 1. Sanchez, J., J.M. Padilla, L. De la Cruz, J. Ron, J.Holland, M. Krakowsky, and M. Goodman. 2011. Use of gametophytic isolating mechanisms for maize. Plant Breeding News 29:1.14. Available at http://www.fao.org/ag/agp/agpc/doc/services/pbn/pbn-230.htm#a114 2. Worthington, M.L. and S.C. Reberg-Horton. 2013. Breeding cereal crops for enhanced weed suppression: optimizing allelopathy and competitive ability. Journal of Chemical Ecology. (Accepted) 3. Place, G.T., S.C. Reberg-Horton, D.L. Jordan, T. G. Isleib and G.G. Wilkerson. 2012. Influence of Virginia market type genotype on peanut response to weed interference. Peanut Science 39:22-29. 4. Place, G.T., S.C. Reberg-Horton, D.A. Dickey and T.E. Carter. 2011. Identifying soybean traits of interest for weed competition. Crop Science 51:2642-2654. 5. Place, G.T., S.C. Reberg-Horton, and T.E. Carter. 2011. Screening tactics for identifying competitive soybean genotypes. Communications in Soil Science and Plant Analysis 42:2654-2665. 6. Place, GT, SC Reberg-Horton, TE Carter, AN Smith. 2011. Effects of soybean seed size on weed competition. Agronomy Journal 103:175-181.

2010/09/01 TO 2011/08/31 No publications reported this period

2009/09/01 TO 2010/08/31 No publications reported this period

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Organic Certified Seed Potato Production in the Midwest

Accession No.	0218819
Subfile	CRIS
Project No.	WIS01416
Agency	NIFA WIS
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05582
Proposal No.	2009-05689
Start Date	01 SEP 2009
Term Date	31 AUG 2013
Fiscal Year	2009
Grant Amount	$0
Grant Year	2009
Investigator(s)	Charkowski, A.; Genger, R.; Groves, R.; Rouse, D.; Jansky, S.; Guenthner, J.
Performing Institution	Plant Pathology, UNIV OF WISCONSIN, 21 N PARK ST STE 6401

NON-TECHNICAL SUMMARY

Use of certified seed potatoes has proven benefits for potato production. Use of disease-free planting stock limits tuber-borne diseases in potato crops, improving yield and quality. The current situation, with limited organic production of certified seed potatoes in the Midwest, forces organic growers to import at least some of their planting stock from other regions, and increases the risk of accidental introduction and spread of potato diseases. This project will support organic production of certified seed potatoes in the Midwest through field-based and economic research. Organic potato growers are also in need of access to a greater diversity of varieties, and to varieties adapted to organic production system. Heirloom varieties are likely to perform well in low-input organic conditions, and there is increasing consumer interest in the flavor and nutritional qualities of specialty potatoes. Our research will provide growers with detailed agronomic, sensory and nutritional data on heirloom and specialty potato varieties. Heirloom potato varieties will be grown in on-farm trials and characterized for yield, quality, disease resistance, taste and nutritional quality. Heirloom potato varieties are difficult to obtain as seed potatoes. Our collaboration with Seed Savers Exchange to eliminate pathogens from their heirloom potato collection is crucial to increase the availability of these varieties. We will conduct on-farm trials to define best management practices for organic production of seed potatoes, testing strategies for control of aphid-transmitted viruses which are a major seed potato production problem. A microeconomic analysis will be conducted based on the results of on-farm trials, and will be complemented by a macroeconomic analysis of organic markets. A grower-oriented publication focusing on the feasibility of growing organic seed potatoes will include worksheets useful to growers as operating guidelines and as financial documents for loan applications. Extension materials on heirloom and specialty varieties, best management practices for seed potato production, and the economics of organic seed potato production will be provided to growers and extension professionals through industry meetings and publications, field days, and online. Increased regional access to high quality seed potatoes for varieties that perform well in organic production will benefit organic growers in the Midwest by reducing seed potato costs (including shipping costs), reducing crop loss due to disease, increasing profitability by use of varieties suited to organic production, and increasing growers\' ability to serve high value specialty potato markets. Economic risk to growers entering the seed potato industry will be reduced by providing them with analyses of the economic feasibility of organic seed potato production and markets for organic seed and tablestock potatoes. Increased economic stability of organic growers will benefit rural communities by providing employment opportunities and a

demand for services in rural areas. Improved disease management of potato crops by cultural methods will reduce pesticide use, improving ecosystem health.

OBJECTIVES

Our goals 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. Our objectives are: 1. Characterize heirloom and specialty potato varieties expected to perform well in organic production, and increase availability of these varieties; 2. Develop organic methods for production of seed potatoes that meet certification standards; 3. Conduct an economic analysis of organic certified seed potato production, using a whole-farm planning approach. Objective 1: We will collaborate with Seed Savers Exchange to treat their collection of tissue culture plants of heirloom varieties to eliminate pathogens. Depending on pathogen incidence in the collection, 20-70 heirloom varieties will be made available as pathogen-free tissue culture clones. On-farm trials of at least 12 heirloom and specialty varieties will generate detailed information on agronomic, disease resistance, tuber sensory and nutritional characteristics. Objective 2: We will test methods of tuber multiplication from tissue culture plants and greenhouse-produced minitubers that limit virus spread and maximize seedpiece production, comparing row covers and mineral oil sprays. In on-farm trials of field-scale certified seed potato production, we will test strategies to limit spread of aphid-borne potato viruses, including borders around seed potato plots, live mulch or straw mulch between potato rows, mineral oil sprays, and green-sprouting. We will determine the value of strategies to manage Potato Virus Y (PVY) spread, and formulate recommendations combining a set of best management practices based on new knowledge about the relationship between aphid alightment patterns and PVY incidence. We will determine the practicality of our \"best management\" recommendations on a small field scale. Objective 3: We will use data from field trials, together with wholesale and retail price data, to develop an econometric model to forecast organic potato prices. We will evaluate the management strategies in Objective 2 from an economic perspective by conducting a whole farm budgeting analysis of each strategy. Since the demand for organic seed potatoes is derived from the demand for organic potatoes for human consumption, both market segments will be modeled. The end result will be a publication and worksheet that displays typical costs for producing organic seed potatoes, the costs of different management strategies and a blank worksheet for users to calculate their costs. We will inform growers about characteristics and seed sources for specialty and heirloom potatoes, seed potato certification resources and pathogen testing procedures, and assist organic growers with integrating use of these resources into their management decisions. We will develop extension materials and distribute them at organic farming and sustainable agriculture meetings, training courses, field days, online, and through industry publications.

APPROACH

Objective 1. Tissue culture plants for 100 heirloom varieties from the Seed Savers Exchange (SSE) collection will be tested for potato spindle tuber viroid, Potato Virus A, M, S, X, Y and Potato Leafroll Virus, and Clavibacter michiganensis subsp. sepodonicus (Cms). Infected plants will be treated with antivirals, antibiotics and/or thermotherapy as needed. On-farm variety trials will evaluate performance of ten to twelve heirloom and specialty potato cultivars. Yield variables and defects due to common scab, silver scurf, soft rot, and black scurf will be recorded for harvested tubers. Varieties will be assessed for PVY, late blight and common scab resistance. The effects of variety, production site and year on yield and disease variables will be analyzed by ANOVA. Tubers from the on-farm variety trials will be used in taste panels and assessed for antioxidant and amylose assays. The effects of variety, production site, year, and storage time on flavor, antioxidant activity and amylose will be analyzed by ANOVA. Objective 2. We will test small- and field-scale methods of organic seed potato production. PVY-control tactics evaluated will include row covers, borders, live or straw mulch, mineral oil sprays, and green-sprouting. Aphid populations will be monitored using pan traps and visual inspection. To determine the spatial distribution of aphid alightment relative to the field border, and the contribution of aphid alightment to PVY incidence, we will collect alightment and PVY data along four transects into the field; alightment patterns will be analyzed by a permutation procedure. The effect of management tactics on aphid alightment and colonization will be analyzed by ANOVA. Weight, number, size distribution and quality of harvested tubers will be recorded. Harvested tubers will be tested for Cms and PVY. ANOVA will be used to detect significant differences in yield variables and disease incidence related to management tactics. Objective 3. The first phase of the economic analysis will consist of a deterministic model in which the values of key variables, such as yield, are assumed or taken as averages, providing profitability estimates under typical conditions. The second phase will build a stochastic model that includes risk and incorporates ranges and probabilities of yields, quality and prices, using data from the field trials as well as wholesale and retail prices. This will enable us to estimate best management

strategies in the real world of production and price risks. The end result will be a publication and worksheet that displays costs for producing organic seed potatoes and a blank worksheet for users to calculate their costs. Our outreach plan will inform growers about characteristics and seed sources for specialty and heirloom potato varieties, seed potato certification resources and pathogen testing procedures, and assist organic growers with integrating appropriate use of these resources into their management decisions. Data from field trials and economic analysis will be used to develop extension materials that will be distributed at industry meetings, training courses, field days, in industry publications and online.

PROGRESS

2009/09 TO 2013/08 Target Audience: 1. Researchers interested in participatory plant variety trialing. 2. Researchers interested in organic potatoes. 3. Farmers interested in growing seed potatoes or organic potatoes. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Numerous undergraduate students were trained in this project. Each year, we had a team of at least 4 undergraduates. Several of them have since found jobs in agriculture. For example, two participants found jobs in potato breeding or tissue culturelaboratories. How have the results been disseminated to communities of interest? We developed a website: http://labs.russell.wisc.edu/organic-seed-potato/to disseminate results to organic farmers. We have also regularly presented our results at the MOSES Organic Farming Conference in LaCrosse WI. In 2013, we presented a 1.5 hour workshop at this meeting. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 OUTPUTS: Activities included conducting experiments on (1) pest and disease control for major pathogens in organic potato production, including potato virus Y, leafhoppers, surface blemish diseases, and aphids; (2) analyzing yield potential and robustness of heirloom and specialty varieties on partner organic farms; (3) performing taste and nutrition experiments on harvested potatoes; (4) curing heirloom and specialty varieties of potatoes from viral potato pathogens so that they can be used by potato farmers; (5) training Seed Savers Exchange personnel in pathogen detection and tissue culture methods. We also taught our partner farmers some key aspects of seed potato production and mentored several young scientists during our activities. Events included yearly participation in the MOSES conference, including presentations and hosting discussions, participation in annual field days at UW agricultural research stations, and training staff from local organic farms on seed potato production methods. Products include peer-reviewed publications; extension information for organic potato farmers; entries about potato into Wikipedia and YouTube; and nearly 100 newly cleaned potato varieties that can now be used for organic potato production. One graduate student and numerous undergraduates participated in this project. PARTICIPANTS: In addition to the project co-PIs, the individuals who worked on this project included the following: Undergraduates: Ross Hackbarth, Kate McAbee, Samantha Sparrow, Grace Christensen, Anna Hubbart, Yong-Suk Chung, Phillip Smith, Neicole Heise; Visiting Scientists: Jeffry Dorgans (France), Jose Caram de Souza (Brazil). We also had numerous farmer partners, including, most notably, Erin Schneider, who also aided in post-harvest pathogen testing for this project. TARGET AUDIENCES: The target audiences of this project are organic potato farmers in the Midwest. We disseminated information from this project to them through bulletins, phone calls and visits, and at the annual MOSES meeting. We observed changes in potato variety choices, pathogen and pest control methods, and seed potato production methods through the course of this project. PROJECT MODIFICATIONS: A no-cost extension to extend the grant until March 2013 was submitted.

2010/09/01 TO 2011/08/31 OUTPUTS: The activities on this project in 2011 for objective one included characterizing over 40 heirloom and specialty potato varieties on 12 organic farms and two research stations. This characterization included experiments to compare yield, quality, disease and pest resistance, weed suppression, flavor and nutrition, and feasibility of production of early generation material for farmers in a hydroponic system. We also cured several additional heirloom varieties of viruses and are on track to reach our goal of 100 disease-free heirloom varieties in tissue culture. The activities for objective two included testing virus control methods for organic farms, including silver mulches, row covers, green sprouting, and early vine kill. Experiments were performed both on an organic farm and on a research station. For objective three, we completed an economic analysis of organic certified seed potato production, using a whole-farm planning approach. In our economic analysis, we found that the cost of producing organic seed potatoes was significantly higher than the cost of producing fresh potatoes. That is due to lower yields as well as higher per-acre costs of controlling pests. Under certified organic rules organic potato growers may use conventional seed potatoes if they can\'t find organic seed. In spite of a large difference in price many organic growers prefer to use organic seed potatoes. The events for this project included a project meeting at the MOSES conference in Feb, 2011, and training of staff at Seed Savers Exchange in pathogen detection and in curing viruses from tissue culture

plantlets. The products for this project include development of Wikipedia pages that provide variety information and extension materials for the growers that we work with. Several undergraduate students were trained through this project, including Kristi Severson, Michael Gehring, Adam Schraeber, and Anna Hubbart. Two graduate students joined this project, Chakradhar Mattupalli and Emily Haga. One organic farmer, Erin Schneider, participated in the laboratory portion of this work and 12 farmers-cooperators hosted on-farm experiments. PARTICIPANTS: The project co-PIs (Charkowski, Genger, Groves, Jansky, Rouse, and Guenthner) insured that project objectives were met. Graduates students who worked on this project include Chakradhar Mattupalli and Emily Haga. Staff people include Andy Hamernick and postdoc Emily Mueller. Undergraduate students include Kristi Severson, Michael Gehring, Adam Schraeber, and Anna Hubbart. An organic farmer, Erin Schneider, assisted with laboratory aspects of this project (tissue culture and pathogen testing) in the winter. We also have 12 farmer-collaborators. This project is labor intensive and involves multiple sites throughout Wisconsin. The staff and students involved in this project worked as a team at these locations to insure that experiment plots were planted and harvested and that data was collected. Partner organizations include our 12 farmer-collaborators and Seed Savers Exchange. Additional collaborations were formed with Paul Patterson, Univ. Idaho and Kate Painter, Univ. Idaho. The students trained in this project learned tissue culture, plant disease identification and pathogen detection assays, insect collection and identification, and field plot management and analysis. Seed Savers Exchange personnel were trained in tissue culture and pathogen detection methods. TARGET AUDIENCES: Our target audience is mainly organic farmers interested in potato production. We also include students in our target audience and have directly trained several graduate and undergraduate students through this project. An experimental graduate level course \"Organic and Urban Agriculture\" was offered by Charkowski in 2011, in part to share expertise gained through this project. Our target audience also includes those interested in germplasm maintenance, specifically Seed Savers Exchange. Finally, it includes researchers interested in organic farming and potato production. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: The activities on this project in 2011 for objective one included characterizing over 40 heirloom and specialty potato varieties on 12 organic farms and two research stations. This characterization included experiments to compare yield, quality, disease and pest resistance, weed suppression, flavor and nutrition, and feasibility of production of early generation material for farmers in a hydroponic system. We also cured several additional heirloom varieties of viruses and are on track to reach our goal of 100 disease-free heirloom varieties in tissue culture. The activities for objective two included testing virus control methods for organic farms, including silver mulches, row covers, green sprouting, and early vine kill. Experiments were performed both on an organic farm and on a research station. For objective three, we completed an economic analysis of organic certified seed potato production, using a whole-farm planning approach. In our economic analysis, we found that the cost of producing organic seed potatoes was significantly higher than the cost of producing fresh potatoes. That is due to lower yields as well as higher per-acre costs of controlling pests. Under certified organic rules organic potato growers may use conventional seed potatoes if they can\'t find organic seed. In spite of a large difference in price many organic growers prefer to use organic seed potatoes. The events for this project included a project meeting at the MOSES conference in Feb, 2011, and training of staff at Seed Savers Exchange in pathogen detection and in curing viruses from tissue culture plantlets. The products for this project include development of Wikipedia pages that provide variety information and extension materials for the growers that we work with. Several undergraduate students were trained through this project, including Kristi Severson, Michael Gehring, Adam Schraeber, and Anna Hubbart. Two graduate students joined this project, Chakradhar Mattupalli and Emily Haga. One organic farmer, Erin Schneider, participated in the laboratory portion of this work and 12 farmers-cooperators hosted on-farm experiments. PARTICIPANTS: The project co-PIs (Charkowski, Genger, Groves, Jansky, Rouse, and Guenthner) insured that project objectives were met. Graduates students who worked on this project include Chakradhar Mattupalli and Emily Haga. Staff people include Andy Hamernick and postdoc Emily Mueller. Undergraduate students include Kristi Severson, Michael Gehring, Adam Schraeber, and Anna Hubbart. An organic farmer, Erin Schneider, assisted with laboratory aspects of this project (tissue culture and pathogen testing) in the winter. We also have 12 farmer-collaborators. This project is labor intensive and involves multiple sites throughout Wisconsin. The staff and students involved in this project worked as a team at these locations to insure that experiment plots were planted and harvested and that data was collected. Partner organizations include our 12 farmer-collaborators and Seed Savers Exchange. Additional collaborations were formed with Paul Patterson, Univ. Idaho and Kate Painter, Univ. Idaho. The students trained in this project learned tissue culture, plant disease identification and pathogen detection assays, insect collection and identification, and field plot management and analysis. Seed Savers Exchange personnel were trained in tissue culture and pathogen detection methods. TARGET AUDIENCES: Our target audience is mainly organic farmers interested in potato production. We also include students in our target audience and have directly trained several graduate and undergraduate students through this project. An experimental graduate level course \"Organic and Urban Agriculture\" was offered by Charkowski in 2011, in part to share expertise gained through this project. Our target audience also includes those interested in germplasm

maintenance, specifically Seed Savers Exchange. Finally, it includes researchers interested in organic farming and potato production. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Fifty-three potato varieties were obtained from Seed Savers Exchange (SSE) as tissue culture plantlets, and tested for PSTVd, PVY, PVS and PLRV. No varieties tested positive for PSTVd and forty-five varieties were positive for one of the three viruses. These forty-five varieties were initiated into the virus elimination program. Thirty varieties were trialed in NFT production to generate seed potatoes for field trials. Trials of field scale production were conducted on organically certified land at Hancock Agricultural Research Station (HARS), to test the effect of pre-sprouting, live alfalfa mulch, and mineral oil sprays on PVY incidence, using foundation class Yukon Gold potatoes as planting material. Post-harvest tests of PVY incidence in harvested tubers are underway. Trials of small scale production from minitubers planted into silver reflective mulch were conducted at HARS and on a Wisconsin organic farm. Treatments included mulch-free plots, mineral oil sprays, row cover and planting density. Harvested tubers will be planted in spring to compare seed quality and determine PVY incidence. Variety trials were conducted at four Wisconsin organic farms to compare four russet, four yellow, four red and four fingerling potato varieties. Varieties differed in susceptibility to early blight with several fingerling varieties showing good levels of resistance. Harvested tubers were graded and are being assessed for surface defects including common scab, silver scurf and black scurf. PVY incidence will be determined for representative PVY-susceptible varieties. Aphid landing was monitored in organic potato fields in 5 locations in order to determine species preference for field edge or interior landing sites. Water pan traps containing soapy water were set out on along four transects into potato fields at four organic farms, and set out in a grid pattern at the fifth site at HARS. Traps were collected weekly between mid-June and mid-September. Trap contents are being sorted and aphids trapped are being identified to species. Varieties used in these trials were tested for resistance to important potato pests and pathogens, including PVY, late blight, and leaf hoppers. PARTICIPANTS: co-PIs: Amy Charkowski, Ruth Genger, Russ Groves, Shelley Jansky, and Doug Rouse. Farmer cooperators: Igl Farms, Vermont Valley Farm, Malek Farm, Dean Kincaid Inc, Meadowbrook Farm, Driftless Organic Farm. Industry cooperators: Jay-Mar Inc. Post-doc: Emily Mueller. Research Specialists: Andy Hamernik Undergraduates: David Cizewski, Matthew Manes, Maria Sabljak, Amy Wallner, Anna Hubbart, David Johnson, Kyle LaPlante, TARGET AUDIENCES: Target Audiences: Organic farmers and researchers interested in organic agriculture Field trials were completed on Igl Farms, Vermont Valley Farm, Malek Farm, Dean Kincaid Inc, Meadowbrook Farm, and Driftless Organic Farm to evaluate variety characteristics ranging from insect resistance to taste, and seed potato production practices. We are still evaluating the data from these trials. A poster was developed for the MOSES meeting, which is attended by many organic farmers. Additional extension materials were provided on seed potato production to interested growers and we participated in providing information about late blight control to our farmer cooperators. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2009/09 TO 2013/08 What was accomplished under these goals? Goal 1. Characterize heirloom and specialty potato varieties expected to perform well in organic production, and increase availability of these varieties Accomplishment: Over 90 heirloom and specialty lines were trialed on organic farms over the course of this project. Lines that performed well on organic farms were identified. Resistanceto potato leafhoppers, early blight, and early dying appeared to be important for production on organic farms in the Midwest. A farmer was trained in early generation seed potato production and has begun producing numerous specialty varieties in Wisconsin. Healthy plantlets of these specialty lines are now available for seed potato production. Goal 2. Develop organic methods for production of seed potatoes that meet certification standards. Accomplishment: Potato virus Y is the major seed potato disease in North America. We trialed PVY control methods on organic farms and found that organic farmers can produce suitable organic seed. However, we found that tuber blemish diseases were the major cause of loss on the organic farms that we worked on. Goal 3. Conduct an economic analysis of organic certified seed potato production, using a whole-farm planning approach. Accomplishments: We published two manuscripts on economic analysis, one on field production of organic seed potatoes and organic potatoes and the other on production of minitubers. **PUBLICATIONS (not previously reported):** 2009/09 TO 2013/08 1. Type: Journal Articles Status: Published Year Published: 2013 Citation: Mattupalli, C., R. K. Genger, and A. O. Charkowski. 2013. Evaluating incidence of Helminthosporium solani and Colletotrichum coccodes on asymptomatic organic potatoes and screening potato lines for resistance to silver scurf. Amer. J. Potato Res. 90:369-377. 2. Type: Journal Articles Status: Awaiting Publication Year Published: 2014 Citation: Guenthner, J. F., A. O. Charkowski, R. Genger, and G. Greenway. 2014. Varietal differences in minituber production costs. Amer. J. Potato Res. In press 3. Type: Conference Papers and Presentations Status: Other Year Published: 2013

Citation: Midwest Organic and Sustainable Education Service (MOSES) Organic Farming Conference, La Crosse, February 21-23, 2013 Genger, R. K., C. Malek, A O. Charkowski. Growing great potatoes! (Invited 1.5 hour workshop for farmers) 4. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: 2013 American Phytopathological Society Meeting, Austin, August 10-14 Charkowski, A. O, R. K. Genger, and D. Rouse. Organic potato variety and production trials. Phytopathology 103:S25. 5. Type: Websites Status: Other Year Published: 2013 Citation: http://labs.russell.wisc.edu/organic-seed-potato/

2011/09/01 TO 2012/08/31 Changes in knowledge included identification of the major constraints to seed potato production in the Midwest and economic analysis of some of these constraints; identification of potato varieties resistant to some of these pests and pathogens; development of pest and pathogen control methods for seed potato production; determination of the effects of different weed control methods for potato. Change in actions included adoption of new seed potato production methods and varieties by partner farmers and adoptions of aphid control methods by conventional farmers. Change in conditions includes development of a pipeline for cleaning potato varieties that is now being used in a USDA-SCRI project, identification of differences in potato variety taste and nutrition, development of a collaboration with Seed Savers Exchange (SSE) to further evaluate their potato collection, and development of a potato group that regularly participates in experimental work that consists of several Wisconsin potato farmers. It also included training SSE personnel in tissue culture and pathogen detection methods. Finally, some of our farmer partners have begun growing new varieties as a result of this project.

2010/09/01 TO 2011/08/31 Change in Knowledge: We now have extensive data on the performance of many heirloom and specialty varieties on organic farms and are preparing a publication based on this data. We also have gathered extensive information on aphid landing patterns in organic fields, which aids in development of recommendations for control of aphid-transmitted viruses. We also have data on the feasibility and effectiveness of other virus control measures, such as use of reflective mulches, intercrops, green-sprouting of tubers, and early vine killing. Change in Action: We have clearly demonstrated that the use of border crops for aphid control in organic potato grown in small fields is not effective. Reflective mulches did provide effective weed control and a yield increase and have been adopted by one of the farmers we work with. Change in conditions: We are on track to have increased our tissue culture clone bank by 100 disease-free specialty and heirloom varieties and have trained staff at Seed Savers Exchange in how to cure tissue culture plantlets. Thus, numerous varieties are available for production of healthy seed tubers that were not previously available.

2010/09/01 TO 2011/08/31 Change in Knowledge: We now have extensive data on the performance of many heirloom and specialty varieties on organic farms and are preparing a publication based on this data. We also have gathered extensive information on aphid landing patterns in organic fields, which aids in development of recommendations for control of aphid-transmitted viruses. We also have data on the feasibility and effectiveness of other virus control measures, such as use of reflective mulches, intercrops, green-sprouting of tubers, and early vine killing. Change in Action: We have clearly demonstrated that the use of border crops for aphid control in organic potato grown in small fields is not effective. Reflective mulches did provide effective weed control and a yield increase and have been adopted by one of the farmers we work with. Change in conditions: We are on track to have increased our tissue culture clone bank by 100 disease-free specialty and heirloom varieties and have trained staff at Seed Savers Exchange in how to cure tissue culture plantlets. Thus, numerous varieties are available for production of healthy seed tubers that were not previously available.

2009/09/01 TO 2010/08/31 The eight SSE potato varieties that tested negative for PVY, PVS and PLRV are likely to be resistant to these viruses based on the high incidence of viral pathogens in the SSE potato collection. Of the 30 varieties tested in NFT production, 16 varieties produced 30 or more tubers per square foot of greenhouse space. Field scale production trials continued to provide no data supporting the hypothesis than aphids land on field edges. Overall, aphid levels were low in 2010, which will make it difficult to make conclusions about methods targeting aphid control.

PUBLICATIONS

2011/09/01 TO 2012/08/31 1. Verchot-Lubicz, J., D. H. Halterman, and A. O. Charkowski. 2012. Potato, Viruses, and Seed Certification in the USA to Provide Healthy Propagated Tubers. Pest Technology. 6:1-14. 2. Fulladolsa, A. C., R. Kota, and A. O. Charkowski. 2013. Optimization of a chemiluminescent dot-blot immunoassay for

detection of potato viruses. Amer. J. Potato Res. (in revision) 3. Mattupalli, C., R. K. Genger, A. O. Charkowski. 2013. Detection of Helminthosporium solani and Colletotrichum coccodes in organically grown asymptomatic and symptomatic potatoes. Submitted to Amer. J. Potato Res. 4. Frost, K. E., R. L. Groves, and A. O. Charkowski. 2013. Integrated control of potato pathogens through seed potato certification and provision of clean seed potatoes. In revision for Plant Disease.

2010/09/01 TO 2011/08/31 1. Greenway, G, J Guenthner & R Genger. 2011. Cost of producing organic fresh potatoes and seed potatoes in the Midwest. University of Idaho AE Series 2011-04. 2. Genger, R., E. Mueller, R. Groves, S. Jansky, D. Rouse and A. Charkowski. Production of healthy seed potatoes on organic farms. Poster presentation at MOSES Organic Farming Conference, February 24-26, 2011 La Crosse WI. 3. Mueller, E., R. Genger, A. Charkowski, and R. Groves. The effect of mixed cropping systems on winged aphid dispersal and Potato virus Y spread in organic potato crops. Poster presentation at MOSES Organic Farming Conference, February 24-26, 2011. La Crosse WI. 4. Hernandez, N., R. Groves, E. Mueller, A. Charkowski. Seasonal flight dynamic of aphid species in occurrence with potato virus Y infection in commercial potato fields. Annual Meeting, Entomological Society of America, Nov 13-16, 2011. Reno NV. 5. Charkowski, A., R. Genger, R. Groves, E. Mueller, J. Guenthner. Production of healthy seed potatoes on organic farms. Phytopathology 101:S31. Annual Meeting, American Phytopathological Society, Aug 6-11, 2011. Honolulu HI.

2010/09/01 TO 2011/08/31 1. Greenway, G, J Guenthner & R Genger. 2011. Cost of producing organic fresh potatoes and seed potatoes in the Midwest. University of Idaho AE Series 2011-04. 2. Genger, R., E. Mueller, R. Groves, S. Jansky, D. Rouse and A. Charkowski. Production of healthy seed potatoes on organic farms. Poster presentation at MOSES Organic Farming Conference, February 24-26, 2011 La Crosse WI. 3. Mueller, E., R. Genger, A. Charkowski, and R. Groves. The effect of mixed cropping systems on winged aphid dispersal and Potato virus Y spread in organic potato crops. Poster presentation at MOSES Organic Farming Conference, February 24-26, 2011. La Crosse WI. 4. Hernandez, N., R. Groves, E. Mueller, A. Charkowski. Seasonal flight dynamic of aphid species in occurrence with potato virus Y infection in commercial potato fields. Annual Meeting, Entomological Society of America, Nov 13-16, 2011. Reno NV. 5. Charkowski, A., R. Genger, R. Groves, E. Mueller, J. Guenthner. Production of healthy seed potatoes on organic farms. Phytopathology 101:S31. Annual Meeting, American Phytopathological Society, Aug 6-11, 2011. Honolulu HI.

2009/09/01 TO 2010/08/31 1. Genger, R. K., R. Groves, D. I. Rouse, E. Mueller, and A. O. Charkowski. Production of organic and specialty seed potatoes in the Midwest (poster). 94th Annual Meeting of the Potato Association of America, August 15-19 2010, Corvallis OR. 2. Genger, R. K. R. Groves, D. I. Rouse, and A. O. Charkowski. Production of healthy seed potatoes on organic farms (poster). 21st Annual MOSES Organic Farming Conference, February 25-27 2010, La Crosse WI.

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Marketing Opportunities and Constraints Confronting Organic Farming Operations in the High Plains

Accession No.	0218707
Subfile	CRIS
Project No.	WYO-00607
Agency	NIFA WYO
Project Type	OTHER GRANTS
Project Status	TERMINATED
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Proposal No.	2009-01436
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Grant Year	2009
Investigator(s)	Norton, J. B.; Press, M. D.; Ritten, J. P.
Performing Institution	Ecosystem Science and Management, UNIVERSITY OF WYOMING, 1000 E UNIVERSITY AVE DEPARTMENT 3434

NON-TECHNICAL SUMMARY

This integrated project aims to assess the agronomic and economic viability and effectiveness of a variety of soil amendments for use on small and medium sized organic farms in the semiarid northern high plains and intermountain regions of Wyoming and Western Nebraska. Few previous studies have compared soil amendments within organic agriculture. An extension component ensures that information gleaned from this project is transferred to producers. This project addresses key priorities of the OREI program by focusing on both on-farm and experimental research that examines novel soil amendments. Soil productivity and fertility will be examined to assess the viability of each alternative. In addition, crop production, and economic and marketing opportunities and constraints up and down-stream from the farm will be assessed as part of the project. This three-year project assembles researchers in soil science, agricultural economics and marketing, educators, and producers to establish much-needed region-specific organic agricultural knowledge through research conducted in affiliation with the Sustainable Agriculture Research and Extension Center (SAREC), as well as on site, at organic farms in the semiarid northern high plains and intermountain regions. SAREC boasts state-of-the-art laboratory, education, and dormitory facilities. This project will piggy-back on a preexisting USDA-NRI Agricultural Prosperity for Small and Medium Sized Farms program grant, \"Economic and environmental sustainability of conventional, reduced-input, and organic approaches on western crop-range-livestock farms.\" This project will take advantage of existing plots in transition to certified organic production at SAREC, as well as information from organic farmers participating in the NRI grant.

OBJECTIVES

First, we propose to facilitate the development of organic agriculture production methods by conducting a feasibility study of soil amendments that address specific challenges to organic production in this region. Soil productivity and fertility will be examined to gain a whole picture of the viability of each alternative. Outputs will include clearer extension recommendations for viable amendments for use in the High Plains region. Second, we will evaluate the potential economic benefits to producers and processors who use organic methods. Our study

will account for different economic returns for different amendment within an organic setting. As most studies classify returns that include returns to labor, the increased returns associated with organic systems may not be as desirable when accounting for the additional labor these intensive systems require. Our study will account for different economic returns for different amendments evaluating specific differences in both labor and machinery needs. Third, we will identify some of the marketing and policy constraints on the expansion of organic agriculture. Primary and secondary data will be collected to assess and potentially resolve the following marketing and policy issues. a), some farmers may lack basic agronomic information about eco-zone appropriate production practices; b), some farmers may face high opportunity costs that limit their opportunities to create or look for new market opportunities; c), in this area of the country, farms are located far from major processing and consuming markets, which poses unique transportation and marketing challenges; and d), farmers may lack evaluative information, tools and technology for sensing input opportunities and demand signals in innovative or emerging organic and natural product markets, and thus have decreased ability to participate. And fourth, we will conduct advanced on-farm research and development that emphasizes observation of, experimentation with, and innovation for working organic farms, including research relating to production and marketing and to socioeconomic conditions.

APPROACH

First, we propose to field test the effects of organic-certified humate and P amendments in replicated plots embedded in an on-going agricultural systems experiment. Eight (or possibly more) treatments analyzing soil fertility renewal options will be replicated four times in 3 x 10 m plots in a complete randomized block design within the framework of a long-term agricultural systems project at SAREC. In addition, soil cores will be collected from 15 points and composited for each plot at three times during each growing season for analyses. The field test will provide data for evaluating economic parameters of using the amendments and for comparing their use to the economics of other organic, reduced-input, and conventional strategies. The results will inform decisions on improving availability of the products, possibly including development of humate sources related to eastern Wyoming\'s coal industry. Second, to compare alternative soil amendments, partial budget analysis will be employed. Partial budgeting is a technique used to evaluate changes in revenue and cost associated with a modification of a baseline farming system. Budgets analysis for this project will focus mainly on the availability, cost and labor/machinery requirements of each amendment within the given farming system. The analysis will compare economic returns for each of the amendments across years to account for variation in flows of revenue across time for the various farming systems approaches. This information will be useful for producers considering adoption of the soil amendments described above before drastic investment is made in machinery required to utilize a potentially unfeasible soil amendment. Third, we will investigate up- and downstream marketing issues and opportunities associated with organic farming in the High Plains region identified in the previous paragraphs. Upstream issues include information acquisition, feasibility of soil amendments, including viability, procurement storage, and application costs. Downstream issues and opportunities for organic producers include search costs for market outlets, learning new marketing procedures, and building channels relationships in a fairly new and small, but quickly-growing marketplace. These issues will be explored by collecting primary and secondary data. Secondary sources will include local USDA, CSREES CRIS Data Base, Wyoming Business Council, producer organizations, and other publications. Primary data will be collected by surveying an \"extensive\" sample of farmers about their market opportunities. Interviews will be recorded, transcribed, and analyzed using qualitative data analysis software employing recognized procedures to ensure trustworthiness and credibility. Little is known about the marketplace issues and opportunities organic producers in this area face. Learning about the market challenges, including supply chain challenges, that organic producers face in the High Plains region will benefit organic producers in the long-term. The information generated will be disseminated to local producers through direct engagement at field days, extension programs, and through extension bulletins.

PROGRESS

2009/08 TO 2014/07 Target Audience: Efforts that reached target audiences in the Aug 1, 2013, to July 31, 2014, reporting period include: an oral presentation at the USDA OREI PI meeting in Washington DC on January 13, 2014; the first annual Wyoming Organic farming conference, including presentations by PIs Norton, Arnould, and Press and by PhD candidate Renee King, along with many others; one MS thesis defense and one PhD dissertation defense, and publication of an MS thesis and a PhD dissertation. PhD candidate presented results of phosphorus amendment research at the American Society of Agronomy meetings in Tampa Bay, Fl, in October 2013, winning first runner up in the student oral presentation competition. These efforts reached researchers, students, farmers, educators, and the general public. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Training: two graduate students were trained

under the project, one Masters in business management, and one PhD in soil science. The project also provided partial funding for a project coordinator who received training on each aspect of the project, and for two postdoctoral researchers, who both received mentorship from senior project personnel, and provided it to students. Professional development: Information on soil phosphorus and other amendments for organic production was presented at University of Wyoming Ag Experiment Station field days each year of the project.These were attended byfarmers, agricultural educators, and consultants.Results of the work were featured as part of the \"first annual\" Wyoming Organic Farming Conference attended by 50 people in February, 2014. Professional development was supported for students to attend regional, national, and internationalmeetings, at which their presentations provided professional development for attendees, including researchers, consultants, educators, and students. How have the results been disseminated to communities of interest? Communities of interest include organicfarmers, agricultural educators, and researchers. Farmers and educators have been reached during Ag Experiment Station field day presentations, with a field day proceedings bulletin, and at the 2014 Wyoming Organic Farming conference. Researchers have been reached through seminars presented at the University of Wyoming, the annual OREI PI meeting, the Great Plains Soil Fertility Conference, the Western Nutrient Management Conference, and the Soil Science Society of America meetings (2013 best student oral paper award, runner up). Market research results were presented at several international conferences and via publication in peer-reviewed market research journals. Renee Gebault-King, the PhD student supported by this project, spent one year during her graduate program as an instructor in the NSF Science Posse. During this period she exposed elementary and secondary school students and teachers to her research, using it as a tool to teach fundamentals of soil science, scientific process, and organic farming. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/08/01 TO 2013/07/31 Target Audience: Efforts that reached target audiences in the Aug 1, 2012, to July 31, 2013, reporting period include: presentations at the Wyoming Agricultural Experiment Station\'s Sustainable Agriculture- and Laramie- Research & Extension Centers field days to farmers, researchers, ag educators, and others. Field Day bulletin article on the soil amendment component of theproject; educational materials based on soil amendment findings presented to Wyoming 5th to 12th grade students and teachers as part of NSF Science Posse; published report on organic marketing opportunities and constraints in August, 2012, targeting ag producers, consultants, millers, and USDA; an MA thesis and two papers on market issues targeting academic audience; presentations at professional meetings of the American Marketing Association conference and the European Operations Management Conference, as well as presentations at academic meetings in France, Belgium, Finland, Denmark, Ireland and England. Changes/Problems: Changes include that PIs Press and Arnould left the University of Wyoming. They continue to work toward completing their roles in the project, however, and will attend the Organic Farming Conference on February 22. PhD student Renee Gebault-King took a one-year position with the NSF Science Posse, which created salary savings on our OREI project and slowed her progress in analyzing and publishing data. For this reason we applied for and received the one-year unfunded extension and now Renee is on track to publish results and graduate in June. What opportunities for training and professional development has the project provided? Nothing Reported How have the results been disseminated to communities of interest? So far as research and extension presentations, researchpublications, a popular press article, and a field days proceedings bulletin. What do you plan to do during the next reporting period to accomplish the goals? We are planning an Organic Farming Conference for February 22, 2014, in Torrington Wyoming that is generating a great deal of interest. This comes near the end of this project but we intend to create an annual conference starting with this one.

2011/08/01 TO 2012/07/31 OUTPUTS: Renee King, PhD student in soil science at the University of Wyoming, continued trials of organic-approved phosphorus amendments, initiating the third year of cropping system trials in organically grown beans at the University of Wyoming Sustainable Agriculture Research and Extension Center. She also established a greenhouse study to examine effects of the amendments on alfalfa growth and nodulation and mycorrhizae activity. Ms. King also established an on-farm field trial of humic acid soil amendments. Graduate Student Ryan Owens collected and analyzed primary and secondary resource data. Primary research included telephone and in-person interviews with 20+ farmers, distributors, and millers of organic wheat. All interviews were recorded, transcribed, and summarized. Secondary research included collection and analysis of current production yields, acreage, and pricing data from USDA and other sources, and a comprehensive collection and review of current literature, including news articles, peer reviewed papers and articles, and academic research studies. In addition, Mr. Owens analyzed the gathered data and created documentation for extension bulletins, as well as summary findings and recommendations. Katie Strand, who received her MA from UW in 2010, has also taken the lead on a paper covering our findings, submitted to a peer reviewed journal for publication. Robin Wikoff, Ph.D. Candidate in the Systems Science Graduate Program at Portland State University, analyzed wheat data, comparing conventional, organic, food, and feed data, including current and

historical acreage planted, bushels harvested, and price trends for conventional and organic food and feed grade wheat. She also interviewed a feed marketer/distributor, a poultry feed miller, and a small scale food grade wheat producer/miler, surveyed organic certifiers for current wheat harvest data, explored export procedures and data, and investigated the poultry feed market. The team is currently preparing a number of extension bulletins for review by other members of the team. PARTICIPANTS: Portland State University was added as a partner organization when co-PIs Arnould and Press changed their academic affiliations from the University of Wyoming to Portland State. Ryan Owens was added to the project team in the spring of 2012. He is a recent graduate of the MBA program in the School of Business at Portland State University with a concentration in Sustainability. He holds a BA in English Literature from Lewis and Clark College. Robin Wikoff was added to the project team in the spring of 2012. She is a Ph.D. candidate in the Systems Science Graduate Program at Portland State University. She is currently working on her dissertation, a qualitative study of materialism and how increasing intrinsically satisfying activities can encourage sustainable lifestyles. She holds a Masters of Science in Systems Science from Portland State University. TARGET AUDIENCES: We targeted professional agronomists and researchers of the Great Plains region with a presentation at the 2012 Great Plains Soil Fertility Conference in Denver, Colorado, in March, 2012. Business academics and practitioners were targeted at two presentations at the Portland State University conference on sustainability. Since the date of the University of Wyoming research station field day changed from July in 2011 to August in 2012 it did not fall within this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/08/01 TO 2011/07/31 OUTPUTS: Twenty three farmers interviewed last year for the project have been reinterviewed this year. Only one participant has dropped out. At the Sustainable Agriculture Research and Extension Center (SAREC), last year\'s alfalfa crop has been plowed under and corn was planted in late April (this is the third year of a four-year crop rotation). Amendment to be applied in test plots are as follows: humic acids; compost tea, bone meal, rock phosphate; humic acids + bone meal; humic acids + rock phosphate; compost tea + bone meal; compost tea + rock phosphate. This year soil samples were collected shortly after planting and are currently being analyzed for various chemical, biological, and physical parameters. These results will be compared to last year\'s soil samples, which established the baseline character of the organic plots. This year an additional control plot has been added for analysis. This new control plot is under organic management but receives compost/manure applications; analysis of this plot will provide information on whether the amendments are having any impact on the soil fertility versus compost/manure. Significant upstream marketing constraints include lack of affordable organic seed; lack of affordable, agronomically proven soil amendments, and lack of proven, economical organic weed control technology. In addition, time and knowledge necessary to handle paperwork needed for organic certification hinders adoption of organic farming practices. Significant downstream marketing constraints include lack of available, affordable, segregated off-farm storage, lack of available, reliable segregated transport facilities, lack of market information, thin, volatile markets, and limited forward contracting arrangements. The NRCS EQIP program, which has begun to reimburse use of compost and Austrian peas, is an important stimulator for experimentation with soils improvement. In addition to marketing challenges the team has found that negative attitudes towards organic farming as an ideology and way of life and towards the Federal government, as well as negative social sanctions from others in the farming community, inhibit adoption of economically lucrative organic farming practices. PARTICIPANTS: Renee A. Gebault King is a Master\'s graduate student in soils science working on the test plots. Katherine A. Strand was a Master\'s student in anthropology who completed a Master\'s thesis based on data collected with participating farmers. Results were shared with Wyoming Organic Wheat association members. PIs Eric Arnould, Jay Norton, Melea Press, and John Ritten continue to work on the project. Producers associated with Wyoming Organic Wheat have collaborated with the project team. TARGET AUDIENCES: Organic producers in eastern Wyoming and western Nebraska. Would-be organic producers in eastern Wyoming and western Nebraska. Other stakeholders in the organic wheat marketing system in the high plains of eastern Wyoming and western Nebraska. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/08/01 TO 2014/07/31 Target Audience: Efforts that reached target audiences in the Aug 1, 2013, to July 31, 2014, reporting period include: an oral presentation at the USDA OREI PI meeting in Washington DC on January 13, 2014; the first annual Wyoming Organic farming conference, including presentations by PIs Norton, Arnould, and Press, along with many others; an MS thesis defense, and publication of an MS thesis. These efforts reached researchers, students, farmers, educators, and the general public. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Information on soil phosphorus and other amendments for organic production was presented at University of Wyoming Ag Experiment Station field days each year of the project. Results of the work were featured as part of the \"first annual\" Wyoming Organic Farming Conference attended by 50 people in February, 2014. The project provided training for one Phd student and one MS student, as well as partial support for two postdoctoral researchers. How

have the results been disseminated to communities of interest? Communities of interest include organicfarmers, agricultural educators, and researchers. Farmers and educators have been reached during ag experiment station field day presentations, with a field day proceedings bulletin, and at the 2014 Wyoming Organic Farming conference. Researchers have been reached through seminars presented at the University of Wyoming, the annual OREI PI meeting, the Great Plains Soil Fertility Conference, the Western Nutrient Management Conference, and the Soil Science Society of America meetings (2013 best student oral paper award, runner up). Market research results were presented at several international conferences. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2009/08/01 TO 2010/07/31 OUTPUTS: Objective 1: Hired PhD student Renee Gebault King. Start date: June, 2010. In consultation with producers and ag advisers, the team selected eight treatments that will be applied to plots at the SAREC farm, including 1) Biohumus (Ag Ventures); 2) SP-1 (Ag Ventures); 3) Bone meal; 4) Ida-Gro pelletized phosphate (Soda Springs Phosphate); 5) Biohumus + bone meal; 6) SP-1 + bone meal; 7) Biohumus + Ida-Gro pelletized colloidal phosphate; and 8) SP-1 + Ida-Gro pelletized colloidal phosphate Plots have been delineated within the existing organic cropping system experiment. Treatments will be replicated four times and an additional plot fertilized with composted manure, as the remainder of the larger cropping system plot will be included for analyses. These products have been ordered and will be applied after the first cutting of alfalfa. Objective 2: So far, on site we have identified and marked micro plots for organic fertilizer research and located, priced, and ordered all specialty organic fertilizer, but are still awaiting delivery of some inputs. Inputs have proven difficult to locate. As far as focus groups, as we did not locate enough irrigated cash-crop organic producers, we just conducted in-person interviews with local producers to help guide our research. We have collected economic and production data related to organic fertilizer available for this area, and have set up a database to collect production data from the micro-plot study. When we gather harvest data, we will begin to compare the cost and benefits of each of the fertilizers. Objective 3: Hired Katie Strand to assist in data collection and analysis; Start date: September 2009. 1. Secondary data collection began in October of 2009. This process includes a general internet and library search for any information concerning organic agriculture, soil amendments, no-till agriculture, green manure crops, cover crops, and market opportunities. These sources were included in an annotated bibliography that currently consists of 57 entries. 2. The establishment of contacts with organic, minimum till, and conventional producers started in November of 2009. Contact information was primarily found through the Wyoming Business Council\'s annual publication of the Wyoming Agribusiness Directory. Contact information for western Nebraska agricultural producers was primarily found on the Nebraska Department of Agriculture website http://www.agr.state.ne.us/pub/apd/organic.htm. 3. Fourteen interviews have been conducted and many more are planned. Interviews consist of questions from six categories including: farm characteristics, life on the farm/ranch, crop production, soil amendments, up-stream economic and market opportunities, and down-stream economic and market opportunities. No new knowledge has as yet been disseminated to communities of interest. PARTICIPANTS: Eric Arnould, distinguished professor, Department of Management and Marketing; Jay Norton, assistant professor, Department of Renewable Resources; Melea Press, assistant professor, Department of Management and Marketing; John Ritten, assistant professor, Department of Agricultural and Applied Economics; Renee Gebault King, PhD student; Katie Strand, student employee. TARGET AUDIENCES: Ag advisers and producers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/08 TO 2014/07 What was accomplished under these goals? The goals of this project address two major constraints to expansion of organic grain production in the northern High Plains region of eastern Wyoming and western Nebraska, as well as other regions: Phosphorus (P) deficiency and upstream/downstream market access. Phosphorus deficiency is a problem in regions like the High Plains with alkaline soils that fix P and that do not have abundant animal confinement facilities that provide composted manure. We evaluated the effects of P amendments available to High Plains organic producers on crop yields and the economic viability of each amendment specifically for organic production in the northern High Plains region. Results show that some commonly marketed inputs are not effective for these alkaline soils, and that some P amendments are made more available for plant uptake when combined with organic acid amendments. This information is helping farmers choose economically viable alternatives for P fertility. Access to markets for both organic inputs and products is difficult for High Plains producers who are relatively isolated and lack cooperative storage, transport, and buying/selling structures. We evaluated market constraints and opportunities in the region, creating a report and presentation that provided valuable information on grain storage, transport, emerging markets, grain quality, input availiability,and other constraints and opportunities. An important outcome of the project is initiation of the

annual Wyoming-Nebraska Organic Farming Conference, which has become a collaborative effort between the Universities of Wyoming and Nebraska. The 2nd annual conference is now being planned for February. For this reporting period we accomplished the following: Objectives 1 & 2:Field test the effects of organic-certified humate and P amendments in replicated plots and compare them via partial budget analysis: Research on NOP-approved soil amendments, including soil quality, yield, and cost-benefit analyses,was completed and a PhD dissertation published. The information has been presented to farmers at field days and in an Ag Experiment Station bulletin; to researchers at presentations at the University of Wyoming and the Soil Science Society of America meetings. A scientific paper and extension bulletin are in preparation based on the results. Also,postdoctoral research on weed and cover crop management in organic dry beanswas completed and a paper is in preparation; Objective 3: Investigate up- and downstream marketing issues and opportunities associated with organic farming in the High Plains region. Collection of primary and secondary data on market opportunities and constraints was completed, data were analyzed and presented at several conferences, and publications are in print or press. **PUBLICATIONS (not previously reported):** 2009/08 TO 2014/07 1. Type: Theses/Dissertations Status: Published Year Published: 2014 Citation: Gebault King, Ren?e A., Phosphorus Dynamics in Calcareous Soils of the High Plains Under Organic Management, Ph.D., Ecosystem Science and Management, August 2014. 2. Type: Journal Articles Status: Published Year Published: 2014 Citation: Strand, K., E.J. Arnould, M.E. Press. 2014. Tillage Practices and Identity Formation in High Plains Farming. Journal of Material Culture.DOI: 10.1177/1359183514552240. 3. Type: Journal Articles Status: Published Year Published: 2014 Citation: Strand, K., E.J. Arnould, M.E. Press. 2014. Ideological Challenges to Changing Market Orientation in Commodity Agriculture. Journal of Marketing. 4. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Gebault-King, R.A., and J.B. Norton. 2013. Economic viability of enhanced application rates of humic acid, compost tea, bone meal and rock phosphate on extractable phosphorus of calcareous soils in organic farming systems. Agronomy Abstracts, 2013. 5. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Gebault-King, R.A., and J.B. Norton. 2013. Influence of alternative amendments on soil phosphorus in organic farming systems. Agronomy Abstracts, 2013.

2012/08/01 TO 2013/07/31 What was accomplished under these goals? 1. Data collection on soil amendments completed; results presented at field days; publications in preparation; 2. Economic cost/benefit analysis of various soil amendments available to farmers was started by collecting cost information on products, application, transport, etc.; publication of this information is in preparation; 3. Collection of primary and secondary data on market opportunities and constraints was completed, data were analyzed and presented at several conferences, and publications are in review or have been accepted.

2011/08/01 TO 2012/07/31 Project is in its 3rd year and results of on-station trials are being analyzed. Further, we would say that 1) research reports are under review at scientific journals including Journal of Material Culture and Journal of Marketing; 2) discussions are under way to develop an \"organic extension day\" at the University of Wyoming research & extension center; 3) draft extension reports have been prepared for further review and dissemination; and 4) preliminary research results have been presented at the Great Plains Soil Fertility Conference, and twice at the Portland State University conference on sustainability. It is too soon to assess impacts on farmer practice at this time.

2010/08/01 TO 2011/07/31 Participating farmers were provided with a report summarizing the results of the first year marketing, agro economic, and soils analytic results. Results of first year soils trials were reported at the SAREC field days. Renee King presented in a poster session for Western Soil Science Society of America on 20 June entitled \"Novel soil amendments and their efficacy in organic farming in the intermountain west.\" The titles for the SAREC Field Days presentations she made (2010 and 2011) are \"Soil Fertility Challenges for Organic Farmers in the Intermountain West.\" Katherine Strand presented two papers: April 2010 Society for the Anthropology of North America Annual Meeting, Denver, CO, Paper Title: Organic Agriculture in the Cowboy State. October 2010 Rocky Mountain Landscape and Memory Symposium: Soundscapes, Places, and Pathways- Laramie, WY, Paper Title: Good Farmer, Bad Farmer, Wheat Farmer, Weed Farmer: Negotiations of Legitimacy in High Plains Farming Communities. Melea Press presented marketing findings to the marketing department at Lille University 2 in Lille, France in April 2011. Eric Arnould presented marekting findings to the 2010 Business and Sustainability Conference at Portland State University.

2009/08/01 TO 2014/07/31 What was accomplished under these goals? 1. Research on NOP-approved soil amendments, including soil quality, yield, and cost-benefit analyses,was completed and a PhD dissertation published. The information has been presented to farmers at field days and in an Ag experiment station bulletin;

to researchers at presentations at the University of Wyoming and the Soil Science Society of America meetings. A scientific paper and extension bulletin are in preparation based on the results; 2. Postdoctoral research on weed and cover crop management in organic dry beanswas completed and a paper is in preparation; 3. Collection of primary and secondary data on market opportunities and constraints was completed, data were analyzed and presented at several conferences, and publications are in print or press.

2009/08/01 TO 2010/07/31 Objective 3: Preliminary analysis seems to indicate that several upstream issues present problems for organic producers. First, soil amendments are too expensive and difficult to apply in areas with drought conditions. Amendments, such as manures, do not take effect immediately and producers cannot afford to wait several years for the accumulated residual effect. Second, producers accumulate significant fuel costs due to the need for invasive tillage. Weeds cannot be fully controlled using vinegar, dense planting, or spring crops. Third, organic producers must invest heavily in storage to combat the lack of organic storage facilities at the nearest grain elevators and to combat fluctuating demand in the organic market. Fourth, many need a crop that would work well in a three-year dry land wheat-fallow rotation to increase nitrogen and improve protein content. Organic producers cannot experiment with crops to find the perfect rotation without the assistance of a program like EQIP because those experiments are too costly. Fifth, many producers are unsure of NOP regulations concerning organic amendments and fear that their organic status will be revoked if an amendment becomes restricted after it is already in use. There is uncertainty about the status of untreated manures. This confusion seems to stem from the changing status of various amendments and an unclear communication between producers and certifying agents. Finally, Wyoming lacks abundant information available to organic producers concerning organic production specific to the ecological conditions of the state. Downstream issues seem to present fewer problems to organic producers in the research area.

PUBLICATIONS

2012/08/01 TO 2013/07/31 1. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: R. Gebault King, J. Norton, J. Meeks. 2012. Soil Fertility Challenges in Northern High Plains Organic Farming Operations. Field Days Bulletin, University of Wyoming Agricultural Experiment Station. 2. Type: Journal Articles Status: Accepted Year Published: 2014 Citation: Strand, K., E.J. Arnould, M.E. Press. Accepted. Tillage Practices and Identity Formation in High Plains Farming. Journal of Material Culture. 3. Type: Journal Articles Status: Accepted Year Published: 2014 Citation: Strand, K., E.J. Arnould, M.E. Press. Accepted. Ideological Challenges to Changing Market Orientation in Commodity Agriculture. Journal of Marketing. 4. Type: Other Status: Published Year Published: 2012 Citation: Meeks, J., J. Norton, R. Gebault-King, R. Ghimire, U. Norton, J. Ritten, D. Peck. 2012. Long-term project begins yielding results. Reflections Magazine 2012:23-25. University of Wyoming College of Agriculture and Natural Resources. 5. Type: Other Status: Published Year Published: 2012 Citation: WIKOFF, R., R.OWENS AND E. ARNOULD. 2012. MARKETING OPPORTUNITIES AND CONSTRAINTS CONFRONTING ORGANIC FARMING OPERATIONS IN THE SEMIARID NORTHERN HIGH PLAINS AND INTERMOUNTAIN REGION IN WYOMING AND WESTERN NEBRASKA: COMPARATIVE OBSERVATIONS OF CONSTRAINTS AND OPPORTUNITIES FROM A NATIONAL PERSPECTIVE. Report prepared for project team and USDA.

2011/08/01 TO 2012/07/31 King, R.G, and J.B. Norton. 2012. Impact of alternative amendments on soil phosphorus in organic farming systems. Proceedings of the 2012 Great Plains Soil Fertility Conference, March 6-7, 2012, Denver, Colorado.

2010/08/01 TO 2011/07/31 Strand, K.A. 2011. Organic Agriculture on the High Plains: Re-contextualizing Symbolic Capital in the Struggle for Legitimacy and Status. M.A. Thesis. Anthropology. The University of Wyoming.

2009/08/01 TO 2014/07/31 1. Type: Theses/Dissertations Status: Published Year Published: 2014 Citation: Gebault King, Ren?e A., Phosphorus Dynamics in Calcareous Soils of the High Plains Under Organic Management, Ph.D., Ecosystem Science and Management, August 2014. 2. Type: Journal Articles Status: Published Year Published: 2014 Citation: Strand, K., E.J. Arnould, M.E. Press. 2014. Tillage Practices and Identity Formation in High Plains Farming. Journal of Material Culture.DOI: 10.1177/1359183514552240. 3. Type: Journal Articles Status: Published Year Published: 2014 Citation: Strand, K., E.J. Arnould, M.E. Press. 2014. Ideological Challenges to Changing Market Orientation in Commodity Agriculture. Journal of Marketing

2009/08/01 TO 2010/07/31 No publications reported this period

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Improving Weed and Insect Management in Organic Reduce-tillage Cropping Systems

Accession No.	0218675
Subfile	CRIS
Project No.	PEN04336
Agency	NIFA PEN
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05656
Proposal No.	2010-03391
Start Date	01 SEP 2009
Term Date	31 AUG 2014
Grant Amount	$0
Grant Year	2009
Investigator(s)	Barbercheck, M. E.; Curran, W.; Harper, J.; Hoover, R.; Voight, D.; Hostetter, G.
Performing Institution	Entomology, PENNSYLVANIA STATE UNIVERSITY, 208 MUELLER LABORATORY

NON-TECHNICAL SUMMARY

Pest and soil management remain top priorities for organic growers nationally. Our multi-institution, inter-disciplinary team will address these concerns over a range of environments in the mid-Atlantic and Upper South. Our overall goal for this long-term project is to develop sustainable reduced-tillage organic feed grain production systems that integrate pest and soil management practices to overcome production constraints associated with high residue, reduced-tillage environments. We will accomplish this goal through initiating long-term experiments on two research stations and complementary experiments on organic farms. The research team and collaborating farmers will develop and implement an outreach plan that includes activities and information products that will directly support organic producers, extension educators and other technology transfer agents, and researchers. All outreach activities and products will be evaluated for efficacy in changing attitudes, knowledge, and behavior. We will build comprehensive research and outreach programs that will have numerous benefits. This project will contribute to organic systems that are environmentally, socially, and economically sound over the long-term. Results from the proposed project activities 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; 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 strategies 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. Cooperative activities will include on-farm research, on-site meetings and regular communication between the research/extension team and farmers, and outreach events dedicated to co-learning with farmers.

OBJECTIVES

Our overall goal for this long-term project is to develop sustainable reduced-tillage organic feed grain production systems that integrate pest and soil management practices to overcome production constraints associated with high residue, reduced-tillage environments. We will accomplish this goal through initiating long-term experiments

on two research stations and complementary experiments on organic farms. Project research objectives are to: Determine the effects of 1)expressive weed management; 2) pest avoidance; 3) weed suppressive and 4) supplemental weed management tactics on pest, agronomic, soil quality, and economic indicators; and to 5) determine the on-farm performance and farmer-acceptability of a reduced tillage organic feed grain production system. Extension objectives are to 1)develop new, incorporate existing, and deliver information on organic reduced tillage crop production systems to various stakeholders; and 2)Create and disseminate easy-to-use decision support materials online and in print to help growers manage crops, cover crops and pests in reduced tillage organic feed grain production systems.

APPROACH

Penn State Univ., USDA ARS-Beltsville, Univ. of Delaware, and NC State Univ. will collaborate to address the proposed research and extension objectives. These locations represent a gradient of climate and growing season length. Penn State and USDA ARS will establish long-term systems experiments that incorporate objectives 1 through 4. Each state will include on-farm research components. Full-entry research station experiments will test the effects of sequential management to reduce weed and insect pest impacts in rotational no-till planted corn, soybean, and wheat. Four pest management approaches (experimental treatments) will be tested in a split-split-block experimental design: 1) expressive weed management (stimulating pre-plant weed seed germination followed by control); 2) pest avoidance - altering corn and soybean 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. Measure used to evaluate treatment effects include weed and seedbank dynamics, key early season pest and beneficial arthropod populations, soil quality indicators, yield, and economic performance. Stakeholders will learn about project results through extension events, regular communication, including a project newsletter, websites, and an annual stakeholder advisory board meeting.

PROGRESS

2009/09 TO 2014/08 Target Audience: Our primary target audience is the organic grain growing industry in the northeastern U.S., including both producers and the agricultural support industry. Efforts were made in 2014 to reach these stakeholders through a variety of mediums. In summary, research personnel shared our results at 9 extension workshops, 7 academic seminars, 2 extension articles and a webinar. Eight presentations concentrating on aspects of our research were given at scientific conferences. As in previous years, our research was highlighted at the 4rd Annual Sustainable Agriculture Triad Research Symposium at PSU in March 2014. Finally, we published our 8th ROSE Review newsletter in the winter of 2013, which summarizes our findings in the 2012-2013 production year and details other noteworthy events related to the experiment. The newsletter can be found online: http://agsci.psu.edu/organic/research-and-extension/rotational-no-till/publicat ions/organic-reduced-tillage-times Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Nothing Reported How have the results been disseminated to communities of interest? Presentations at Scientific meetings: Barbercheck ME, Mullen C (2014)The Seed Corn Maggot and Metarhizium are Related to Maize Yield in an Organic, Cover Crop-Based Farming Systems Experiment. Society for Invertebrate Pathology Annual Meeting Proceedings. Aug. 3 -- 8, 2014. Mainz, Germany.p 87. Curran W, Dempsey M, Keene CL, Mirsky S, Ryan M, Scott B, VanGessel M, Young L (2014) An introduction to the Reduced-tillage organic systems experiment (ROSE). Proceedings the of Weed Science Society of America, Vancouver B.C. Access: http://wssaabstracts.com/public/22/proceedings.html Dempsey MA, Ryan M, Keene CL, Curran W, Mirsky S, VanGessel M (2014) Weed management in ROSE: The power of avoidance, suppression and supplemental control tactics. Proceedings of the Weed Science Society of America, Vancouver B.C. Access: http://wssaabstracts.com/public/22/proceedings.html Keene CL (2014) Corn, soybean and wheat performance in an organic rotational no-till system in Pennsylvania. Proceedings of the Northeastern Weed Science Society, Vancouver, B.C. Keene CL, Dempsey MA, Curran W, Mirsky S, Ryan M, VanGessel M (2014) Corn, soybean and wheat performance in the ROSE. Proceedings of the Weed Science Society of America, Vancouver, B.C Access: http://wssaabstracts.com/public/22/proceedings.html Mirsky S, Curran W, Dempsey MA, Keene CL, Ryan M, VanGessel M, Young L (2014) Engineering solutions to improve the biology: making cover crop-based no-till crop production work. Proceedings of the Weed Science Society of America, Vancouver B.C. Access: http://wssaabstracts.com/public/22/proceedings.html Ryan M, Curran W, Dempsey MA, Keene CL, Mirsky S, VanGessel MJ (2014) Putting the pieces together: regional recommendations from the ROSE. Proceedings of the Weed Science Society of America, Vancouver, B.C. Access: http://wssaabstracts.com/public/22/proceedings.html VanGessel M, Keene CL, Curran W, Dempsey MA, Mirsky S, Ryan M, Scott B (2014) Cover crop management in the ROSE: the good, the bad, and the weedy.

Proceedings of the Weed Science Society of America, Vancouver, B.C. Access: http://wssaabstracts.com/public/22/proceedings.html Extension Activities: Barbercheck ME (2014)Assessment of Biological Soil Health. Gettysburg Young Farmers Twilight Field Walk. Brown Valley Farm, Littlestown, PA (Adams Co.) 22 August 2014. 50 attendees, 2 women. Barbercheck ME, Hinds J (2014) Preserving Beneficial Predators in the Home Garden. Ag Progress Days. 14 August 2014. 50 attendees, 20 women. Barbercheck, ME (2014)Biological Soil Health. Western No-Till Alliance Conference, Meadville, PA 25 March 2014. 75 attendees, 3 women. Barbercheck, ME (2014) Soil Health Assessment Western No-Till Alliance Conference, Meadville, PA 25 March 2014. 75 attendees, 3 women. Barbercheck, ME (2014)The Soil Food Web and Pest Management. Mid-Atlantic Fruit and Vegetable Convention. Hershey, PA. January 30, 2014.200 attendees. 100 women. Barbercheck, ME (2014) Biological Soil Health: The soil food web and pest management.Potter Co. Crops Conference. January 24, 2014. Ulysses, PA. 75 attendees, 3 women. Barbercheck, ME (2014) Biological Soil Health: The soil food web and pest management. Lancaster Co. Crops Conference. January 16, 2014. Lancaster, PA. 150 attendees. 3 women. Curran WS (2014) Penn State dairy cropping systems research field day -- corn and soybean insect and weed management. July 1, 2014 \30 attendees\. White, C. Organic Agriculture at Penn State. Display at FarmFest, Centre Hall Grange Fairgrounds, Centre Hall, PA, Aug. 4, 2012 Seminar/Symposiums: Curran WS (2014) Herbicide resistant weeds and resulting integrated weed management renaissance or fallacy. Botany, Plant Pathology and Weed Science Dept Seminar Series. Purdue University. April 2, 2014. \50 attendees\. Ellis, K., Barbercheck, M. 2014. Cover crops as an early-season resource for native bees in temperate annual cropping systems. 2014. 4th Annual Triad Sustainable Cropping Systems Symposium. Penn State University, University Park. March 21, 2014. Keene C, Wallace J, Curran W, Dempsey M (2014) Lessons learned from the Reduced-tillage Organic Systems Experiment (ROSE). 4th Annual Sustainable Agriculture Cropping Systems Symposium, Pennsylvania State University. March 21, 2014. Keene C (2014) Successes and challenges of cover crop management in ROSE. 4th Annual Sustainable Agriculture Cropping Systems Symposium, Pennsylvania State University. March 21, 2014. Rivers A, Barbercheck M (2013) Conservation agriculture and soil-dwelling arthropods. The Pennsylvania State University, Department of Entomology Student Colloquium. December 5, 2013. Rivers A, Barbercheck M (2014) Arthropod community composition in conservation agriculture at two North American sites. The Pennsylvania State University, Department of Entomology Student Colloquium. June 5, 2014. Rivers A, Mullen C, Barbercheck M (2014) Epigeal predators and predation in an organic cover crop-based reduced tillage cropping system (ROSE). 4th Annual Sustainable Agriculture Cropping Systems Symposium, Pennsylvania State University. March 21, 2014. Ryan M (2014) Cover crop-based, organic rotational no-till crop production in the USA. FESIA meeting. Department Agroecologie et Environement. ISARA-Lyon Ryan M (2014) Expanding the utility of cover crops in the northeast. Plant and Soil Science Seminar Series. University of Vermont. Webinars: Curran W, Hoover R, Wallace J (2014) Putting the pieces together: lessons learned from a reduced-tillage organic cropping systems project. April 8 2014. Access:https://www.extension.org Extension Articles: Barbercheck, ME (2014) Brown's Ranch: Farming in Nature's Image to Regenerate Land, Productivity, and Quality of Life. Sustainable Agriculture Newsletter, Spring 2014. http://extension.psu.edu/susag/news Ellis K, Barbercheck ME (2014) Bees and Cover Crops: Using flowering cover crops for native pollinator conservation. PSU Entomology Fact Sheet. http://ento.psu.edu/extension/factsheets/bees-and-cover-crops What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/09/01 TO 2013/08/31 Target Audience: Our primary target audience is the organic grain growing industry in the northeastern U.S., including both producers and the agricultural support industry. Efforts were made in 2013 to reach these stakeholders through a variety of mediums. In summary, research personnel shared our results at 5 field days and 3 workshops. PI Barbercheck also produced a semester course, a webinar, and an extension news article related to experimental work being conducted on this project. As in previous years, we shared our findings at the Reduced-tillage Organic Systems Experiment (ROSE) Annual Advisory Board meeting in December of 2012. We also shared our research findings with other PSU faculty, cooperative extension, post-doctoral researchers and graduate students at the 3rd Annual Sustainable Agriculture Triad Research Symposium at PSU in March 2013. Individual efforts related to extension-outreach activities are documented in the 'Other Products' section of this report. And finally, we published our 7th ROSE Review newsletter in the spring of 2013, which summarizes our findings in the 2011-2012 production year and details other noteworthy events related to the experiment. The newsletter can be found online:http://agsci.psu.edu/organic/research-and-extension/rotational-no-till/p

2011/09/01 TO 2012/08/31 OUTPUTS: The Reduced-tillage Organic Systems Experiment (ROSE) was initiated at Penn State, The USDA BARC in MD, and the University of DE. We completed one full cycle of a wheat, corn, soybean, rotation and harvested the first organic no-till planted corn and soybeans. Cover crops in \"Early\" plots 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, and in the \"Middle\" and \"Late\" plots 10 and 20 days later. Cover crop biomass increased with termination date at all sites, except with hairy vetch-triticale in PA, where there was no difference between the \"Middle\" and \"Late\" treatments. For both cover crops and across all sites, efficacy of the roller-crimper increased with termination date. 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\" than for the \"Late\" treatments in corn and soybean. Fungal infection rates of sentinel insects increased over the growing season. Crop damage from herbivores increased with planting date. Weed biomass in corn decreased with cover crop termination date in PA and MD, with the opposite trend in soybean at these two sites. Severe crop damage in DE released weeds from crop competition. High-residue cultivation consistently reduced weed biomass in corn at the PA and MD sites, and was more effective in PA compared to MD. In soybeans, high-residue cultivation resulted in a 90% reduction in weed biomass in PA compared to a 43% reduction in MD. In PA, corn silage yield was greatest in the \"Middle\" and lowest in the \"Late\" treatment. In MD, corn grain yield was greatest in the \"Early\" and lowest in the \"Late\" treatments. The greatest soybean yields in PA were in the \"Early\" and the lowest yields were in \"Late\" treatments. In MD, the greatest soybean yield was in the \"Middle\" and lowest yield was in the \"Early\" treatments. No DE yield data are reported due to early season drought stress and insect damage. On-farm research is being conducted in PA, MD, and NC. In PA, organic no-tilled beans outperformed conventionally tilled beans 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 to Aaron Cooper at the advisory board meeting in March 2012. PARTICIPANTS: Mary Barbercheck, William Curran, Matt Ryan, Clair Keene, Jay Harper, Ron Hoover, Del Voight, Greg Hostetter, Charlie White, Mark Dempsey, Christina Mullen, Ariel Rivers, Steven Mirsky, Don Weber, Lauren Young, Mark VanGessell, Barb Scott, Pennsylvania Association for Sustainable Agriculture TARGET AUDIENCES: Farmers, Extension specialists and educators, agricultural professionals, students, researchers, and academics. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: A series of experiments were conducted in 2010 and early 2011 to test different management practices and sampling protocols, including an organic short-season corn variety trial, and experiment to test different methods of using a roller crimper for controlling hairy vetch cover crops and to test different ratios of hairy vetch and triticale for improved weed suppression. On-farm research trials were implemented in PA, MD, and NC. In March, 2011, an advisory board meeting was held at the Beltsville Agricultural Research Center (BARC) to discuss project progress with advisors consisting of experienced organic farmers from PA and MD, extension educators from Penn State, and representatives from the seed industry. The project team organized or participated in 12 extension programs related to the project, and delivered two webinars on organic weed management in field crops via eOrganic.org. The Reduced-tillage Organic Systems Experiment (ROSE) was successfully implemented at Penn State (PSU), the Beltsville Agricultural Research Center (BARC), and the University of Delaware (UD) in late 2010. In September and October 2010, baseline soil samples were collected and analyzed for physical and chemical properties, cover crops were planted, and weed seed bank microplots were established. In May and June 2011, organic corn and soybean were no-till planted into a rolled cover crop consisting of hairy vetch and triticale or cereal rye, respectively. In the summer of 2011, several weed management strategies will be tested including pest avoidance (planting date), expressive (false seedbed), suppressive (mulch), and supplemental (high residue cultivation). Extensive early-season insect monitoring and weed sampling programs were initiated in Spring 2011. These data, along with cover crop biomass and soil quality indicator data will be used to explain variation in crop performance and weed suppression. All crops will be harvested to assess their performance and to determine the economic feasibility of the different strategies. PARTICIPANTS: Researchers, scientists, extension educators, agency personnel, farmers, agricultural industry representatives, other agricultural professionals, graduates students, undergraduate students, non-governmental non-for-profit organizations TARGET AUDIENCES: Researchers, scientists, extension educators, agency personnel, farmers, agricultural industry representatives, other agricultural professionals, graduates students, undergraduate students, non-governmental non-for-profit organizations PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Project activities since notification of the award address all project seven goals. These activities have focused on project planning and staffing, site preparation and preliminary trials at participating research facilities, extension programs and publications, scientific presentations, and on-farm research planning. Since notification of funding in July 2009, the project team has participated in regular planning activities. These activities include: 1)Establishment of a public project website hosted by Penn State University, http://agsci.psu.edu/organic/research-and-extension/Rotational%20No-t ill; 2) Establishment of a collaborative workspace at eOrganic.info, 3)Regular teleconferences to discuss and fine tune experimental design, project management, and to plan face-to-face project meetings. Minutes are available at eOrganic.info, and 4) Two face-to-face meetings. One project investigator meeting in State College, PA, and an investigator/farmer advisory board meeting in Beltsville, MD. Minutes available at eOrganic.info. PARTICIPANTS: Christy Mullen (Research Technician, PSU Entomology) is conducting the preliminary trials of the entomology methods, created and maintains the project website, maintains the Organic Systems Plan for the PSU research site, and has served as the project historian. A second technician, to be supervised by PI Curran will be hired with a start date of Sept. 1, 2010. At USDA BARC, PIs are in the process of hiring a full time technician, who will have a start date of Fall, 2010. At UD-REC, Barbara Scott has been assigned to the project. Two graduate students have been recruited and will join the project in August 2010. Project funds support one student directly. Claire Keene (PSU Crop and Soil Science), whose research will focus on agronomic aspects of the systems experiment, will be supervised by PI Curran. We leveraged the OREI grant to obtain PSU support for an additional student. Tom Huff (PSU Entomology), who will focus on entomological aspects of the research, will be supervised by PI Barbercheck. Both of these PhD students will participate in project extension activities. We have identified a post-doctoral researcher, Matt Ryan. Matt will join the project upon completion of his PhD (July 1, 2010). Matt is currently a student at PSU, helped in the preparation of the proposal, and has participated in all project activities to date. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/09 TO 2014/08 What was accomplished under these goals? Cover Crop Management. We demonstrated that consistently high biomass production of hairy vetch-triticale and cereal rye cover crops is achievable across a gradient of sites in the Mid-Atlantic. During the ROSE, cover crop termination with a roller-crimper was improved by adding a second pass. This also reduced volunteer hairy vetch in the succeeding rye cover crop across sites and volunteer rye in wheat at one of two sites. The ROSE results indicate that enough cover crop biomass can be grown to attempt organic no-till and that adequate control can be achieved with multiple well-timed roller-crimper passes. These results are promising for the future of cover crop-based organic rotational no-till but also demonstrate the importance of preventing cover crop seed production in all stages of the rotation. Cash Crop Performance. mproving no-till planting equipment so that it can handle the challenges of extremely high-residue environments will be necessary to increase corn and soybean populations. The highest corn grain yield was 9.63 Mg ha-1 at MD 2013 and was achieved with 70% stand. Maximum soybean yield was 4.71 Mg ha-1 at MD in 2011. The maximum soybean yield was 4.40 Mg ha-1 at MD in 2012 with a population at 49% of the seeding rate. I In this organic rotational no-till system, crop performance is limited by several factors: for corn, the most likely factor is nitrogen fertility. MD was able to band poultry manure staggered according to planting date while DE had to broadcast poultry manure across all planting dates in one application. The more targeted fertility application method used at Maryland is speculated to have increased corn yields at MD relative to DE. Visual appearance of the corn at PA suggested nitrogen stress beginning in early August in 2012 and 2013. These observations emphasize the importance of adequate nitrogen fertility in organic corn and support other research identifying nitrogen supply as the yield-limiting factor in organic corn. Weed Management. In reduced tillage organic grain production systems, cash crop planting is delayed to avoid early--season weed competition. Planting after the peak of summer annual weed germination can help minimize the number of weeds germinating with the cash crop. Delaying planting also maximizes cover crop biomass which further suppresses weed emergence. In PA, weed biomass was generally low regardless of termination timing and crop, but was somewhat greater in corn (240 kg/ha) than in soybean (130 kg/ha), especially at the middle termination date. Giant foxtail (Setaria faberi Herrm.) tended to be the most abundant species. In Maryland, weed biomass was also greater in corn than soybean (1415 vs 610 kg/ha) and tended to increase from early to late termination dates, but increased more in corn (450 to 2650 kg/ha) than soybean (405 to 775 kg/ha). Amaranthus species were most abundant. In Delaware, weed biomass was greater in soybean than in corn (1135 vs 350 kg/ha), and was greater in the early termination date compared to the middle and late termination dates. High residue cultivation decreased weed biomass by 65% in PA and about 30% in MD and DE, relative to non-cultivated plots. Insect Pest Management. Processing is currently underway of the final arthropod samples collected to

characterize the ground-dwelling arthropod community. In the data we have finalized thus far, predatory ground-dwelling arthropods have increased in abundance at the PA site over the course of the three year experiment, including abundance of the biologically important Carabidae beetles. We collected 36 species of Carabidae in the first two years (confirmed), and several species new to the site were collected in the third year. The composition of the Carabidae community has changed, with an increase in species rare to the site by the third year, and a shift to larger species. In all three cycles of the rotation, predation of live sentinel waxworms increased by the third year. This implies that the potential for biocontrol has increased over the course of the project. Confirmation of Carabidae identifications from the final year of the project is scheduled, at which time the predatory dataset will be complete. The effects of pest management strategies on the activity of Metarhizium, an entomopathogenic fungus, was monitored each year at the PA site with the use of sentinel (Galleria mellonella). Infection of G. mellonella was higher than the baseline (2010) in the first (2011) and second (2012) year of the study, but dropped to baseline levels in 2013. High residue cultivation did not affect incidence of Metarhizium. In 2011 and 2012, the incidence of Metarhizium was greater in corn than in wheat and soy. In 2013, however, there were no differences among crops. In preliminary analyses, the effect of planting date on the incidence of Metarhizium differed among years and crops. Higher incidence of Metarhizium was observed at the early and middle planting date in corn two out of three years. In soybeans, Metarhizium incidence was highest at the late planting date in two out of three years. Soil Quality. Active carbon (permangate oxidizable C) ranged from 306 mg/kg to 431 mg/kg across the site. Soil concentrations of active C were similar in 2011 and 2012 in comparison to the baseline year (2010), but fell below the baseline in 2013. Active C tended to be lower during the wheat phase of the rotation in comparison to corn. Trends suggest that active C was highest in the corn phase relative to other crops, but concentration levels were comparable to soybean in 2011 and 2013. Planting date did not produce reliable trends in comparisons of active C. In the corn phase of the rotation, active C increased with delay in planting two out of the three years; this pattern was similar in soybean. Few differences were observed in comparisons of organic matter at the beginning and end of the three-year rotation for each site. Across the three sites, total organic matter ranged from 1.0 to 3.3%. Economic Analysis. Cost of production budgets are beingprepared for each year and phase of the rotation, and will include partial enterprise budgets and break-even points for alternative management strategies. This information will also be used for analysis of energetic associated with ROSE management strategies and for an overall synthesis manuscript to be prepared in the fall of 2014 and winter of 2015. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/08 1. Type: Journal Articles Status: Published Year Published: 2014 Citation: Schipanski ME, Barbercheck ME, Douglas M, Finney DM, Haider K, Kaye JP, Kemanian A, Mortensen DA, Ryan M, Tooker J, White C (2014) A framework for evaluating ecosystem services provided by cover crops in agroecosystems. Agricultural Systems 125:12-22 2. Type: Journal Articles Status: Published Year Published: 2014 Citation: Schipanski ME, Smith RG, Pisani-Gareau TL, Jabbour R, Lewis DB; Barbercheck ME, Mortensen DA, Kaye JP (2014) The structure of multivariate relationships influencing crop yields during the transition to organic management. Agriculture, Ecosystems and Environment 189: 119-126.

2012/09/01 TO 2013/08/31 What was accomplished under these goals? Overview The Reduced-tillage Organic Systems Experiment (ROSE) was initiated in 2010 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 2012-13 production year, we completed the third full cycle of the crop rotation at each study site. Accomplishments for the reporting year (9/1/12 to 8/30/13) include data processing, analysis and summary of the 2012 production year as well as treatment implementation and data collection for the 2013 production year. Due to space constraints, a summary of 2012 research findings for Pennsylvania is provided. A detailed summary of Maryland, Delaware and on-farm research can be found in the 2013 ROSE newsletter, available online. Pennsylvania (PSU). We planted Blue River Hybrid corn and soybeans on three dates (early, middle and late) to test the effect of planting date on the performance of a single variety (Standard), and on a variety well-suited to the planting date (Variable). In addition to measuring cash crop yields and populations, we also measured cover crop biomass at time of termination (at cash crop planting), and peak weed biomass (late summer) to get a sense of weed control provided by cover crops and high-residue cultivation. The following results are for the 2012 season only. In 2012, the cover crop was rolled twice, about one week apart, and corn was planted when the cover crop was first rolled. Planting dates occurred between May 31 and June 15, in 1 week intervals. The hairy vetch-triticale cover crop dry weight at planting ranged from 4900 to 5800 lb/acre depending on planting date. Delaying planting about 7 days from the first to second date increased dry matter by about 900 lb/acre. Cover crop dry matter did not increase between the second and third planting dates. For our Standard corn variety we used a 90 day maturity hybrid, and the maturity of the Variable corn varieties depended on planting date and ranged from 85 to 99 days. Results for corn in 2012 showed that the Standard variety population averaged only 19,700 plants/acre, while the Variable variety averaged 25,800. Our target population was 34,000/acre. The low crop populations were a result of a number of issues that arose when planting corn, including planter miscalibration and issues with wet soil, slit

closure and seed placement. Establishing consistent corn populations in heavy cover crop residue remains one of our biggest challenges in Pennsylvania. Weed biomass was collected in late summer and was relatively low, averaging 115 to 135 lb/acre, and in general weed control was better in the cultivated plots. Previous research has shown that weed biomass less than 1000 lb/acre does not consistently reduce corn or soybean yield. Corn silage yield ranged from 12.6 to 14.8 tons per acre and there were no differences in yield due to planting date or cultivation because of the relatively low weed populations. Variety was significant with the Variable cultivars tending to yield better than the Standard; this was likely related to lower corn populations in the Standard variety. In general, the low corn yields in both Standard and Variable cultivars could be attributed to low corn populations and the mid-summer drought that occurred in Pennsylvania in 2012. The rye cover crop biomass at termination ranged from 4350 lb/acre at the early termination to 5350 lb/acre at the late termination. The rye cover crop was rolled twice (2nd pass about one week after the first) and soybean was planted after the second rolling starting on May 25 (early) and ending on June 11 (late) in 2012. In PA, the Standard soybean variety belongs to a 2.1 maturity group and the Variable soybean variety depended on planting date and ranged from 1.1 to 2.9. Soybean populations were more consistent and better than corn and ranged from 150,000 to 180,000 plants per acre. However, our target population was 225,000 per acre and like corn, we have had problems achieving targeted populations because of heavy residue. Weed biomass was relatively low in soybean and ranged from 90 to 190 lb/acre and as with the corn, weed biomass tended to be higher in the plots that were not cultivated. Soybean grain yields averaged 43 to 55 bu/acre and were not consistently influenced by planting date. However, both variety and cultivation affected yield with the Variable varieties yielding more than the Standard, especially with the early and mid-planted soybeans (4-5 bu/acre), and the cultivated plots yielding less than those not cultivated (6 bu/acre). We have observed a negative effect with cultivation on yield previously in soybean when weed density is low and when summer drought stress occurs during cultivation. We used emergence traps to monitor for the presence of seedcorn maggot, which can be a pest of germinating corn and soybeans. Seed-corn maggot flies lay their eggs in the soil and the maggots burrow into the seeds and destroy the seed germ. Damaged seed may germinate, but there are not enough reserves left in the seed for the plant to survive. This insect is most likely to cause losses in fields with abundant decaying organic matter such as manure and plant residue, and during years when the early growing season is cool and damp. Therefore, our manured fields in which we are also building organic matter levels by reducing tillage and incorporating cover crops into the rotation may be at risk for severe infestations. Adjusting planting date is one approach to avoiding damage by seedcorn maggot. Recommendations are to plant the field after 450 growing degree days (base temperature threshold of 40° F) have elapsed since organic matter was plowed down. This is the time required for the maggots to complete development and move to another host. Because we are rolling cover crops and leaving residue on the surface, we want to determine how cover crop management date affects the occurrence of maggots. To do this we are using emergence traps constructed of a window box into which we have inserted a glass jar on top. As insects emerge from the soil they are attracted to the light provided by the glass jar, and are trapped there, where we can later retrieve and identify and count them. The clearest result (and best news) from 2012 was that we captured very few, less than 1 per trap on average, seedcorn maggot flies (Anthomyiidae) emerging from the soil in corn. What was most interesting was the more abundant numbers of insect-parasitic wasps (average 2 -- 4 per trap), and predatory/parasitic staphylinid beetles (average 1 -- 2 per trap). Staphylinid beetles are known predators of seedcorn maggots in the soil. We are currently having the parasitic wasps identified so that we can determine if they may be playing a role in the dynamics of seedcorn maggot at the PA site.

2011/09/01 TO 2012/08/31 The team conducted 19 outreach and extension events reaching over 1000 people, and produced 13 extension articles to engage our stakeholders about our project and results. On-farm research and a summary of our third Farmer Advisory Board meeting at BARC in March, 2012 are summarized in our biennial project newsletter, \"The ROSE Review\" (http://agsci.psu.edu/organic/research-and-extension/rotational-no-til l/publications/organic-reduced-tillage-times). At a soil health workshop organized through this project, evaluations completed by 26 attendees revealed that 73% learned something that would make their operation more profitable in 2011 and 92% planned to adopt a new soil management or assessment practices in 2011. The project team delivered 15 project-related presentations at scientific conferences, and published 11 project-related peer-reviewed scientific publications. PSU faculty, cooperative extension, post-doctoral researchers, and graduate students shared ideas, and discussed 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 Triad Symposium.

2010/09/01 TO 2011/08/31 Understanding the effects of production practices, like tillage and rotation, on soil quality, weeds, naturally-occurring beneficial organisms in organic agroecosystems will help us conserve natural resources and help producers reduce their reliance on synthetic insecticides. Reduction in the use of pesticides reduces risks of environmental contamination and human exposure. Of 26 people attending a project sponsored

soil assessment and management workshop: 73 percent learned something that they thought will make their operation more profitable in 2011; 92 percent planned adopt a new soil management or assessment practice; 10, 7, 4, and 4 people increased their knowledge about 13 to 16 out of 16 topics, 10 to 12 topics, 7 to 9 topics , and 4 to 6 topics, respectively. Of 32 people participating in a project related whole farm evaluation workshop, 30 increased their knowledge of how one or more farm system components interacted with other farm system components, 25 increased their knowledge of how 6 or more farm system components interacted with other farm system components, 20 increased their awareness of how recommendations about one part of a farm system could affect other parts of a farm system, and 25 reported that they would change how they make recommendations to farmers. Of 175 people attending a project-sponsored ecological pest management workshop, 74 percent very useful, 26 percent learned something moderately useful, 70 percent absolutely expected to use the information they learned within the next year, 29 percent possibly expected to use the information they learned within the next year, 63 percent would absolutely attend another session by the same presenter, and 36 percent would possibly attend another session by the same presenter.

2009/09/01 TO 2010/08/31 Field work to address to address Objectives 1 - 4 in the original proposal has been initiated. The Reduced-Tillage Organic Systems Experiment will be implemented in late summer 2010 at the Russell E. Larson Agricultural Research Center (RELARC) near Rock Springs, PA, and at the Beltsville Agricultural Research Center (BARC) in Beltsville, MD as described in the original proposal. Preliminary trials to refine methods are being conducted at PSU and BARC. These preliminary tests include: black cutworm and armyworm pheromone trapping, soil baiting for wireworms and other soil insects, seedcorn maggot monitoring, and a predation assay using sentinel black cutworm and greater wax moth larva. In early summer 2010, a corn variety test was established on certified organic land at the PSU. The variety test is also being conducted at three other sites: in Center Co. and Lancaster Co., PA, and at the University of Delaware Research and Education Center (UD-REC) on land that is not certified organic. The performance of eleven organic corn varieties, ranging from 80 to 95 days in maturity, will inform our choice for the systems experiment and on-farm tests in PA, MD, and DE.

PUBLICATIONS

2012/09/01 TO 2013/08/31 1. Type: Journal Articles Status: Published Year Published: 2013 Citation: Mirsky, S.B., M.R. Ryan, J.R. Teasdale, W.S. Curran, C.S. Reberg-Horton, J.T. Spargo, M.S. Wells, C.L. Keene, and J.W. Moyer. 2013. Overcoming weed management challenges in cover crop-based organic rotational no-till soybean production in the Eastern United States. Weed Tech. 27:193-203. 2. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Keene, C.L., W. Curran, M. Ryan, S. Mirsky, M. Dempsey, B. Scott and L. Young. 2013. Reliance on cover crops for weed control in the Mid-Atlantic. Northeastern Weed Science Society Annual Meeting. Baltimore, MD. Feb 4-7, 2013. 3. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Schipanski, M.E., R.G. Smith, T.L. Pisani Gareau, R. Jabbour, D.B. Lewis, M.E. Barbercheck, D.A. Mortensen, J.P. Kaye. The structure of multivariate relationships influencing crop yields during the transition to organic management. Ecological Society of America, Minneapolis, MN, Aug 3-8, 2013. 4. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Ellis, K. E., M.Barbercheck. 2013. Evaluation of native bee visitation and floral resources of early-season canola (Brassica napus) cover crop mixtures. 2013 International Conference on Pollinator Biology, Health and Policy. August 14-17, 2013. University Park, PA 5. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Barbercheck, M.E., R. Jabbour, C. Mullen. 2013. Conservation of soilborne fungi and nematodes in sustainable cropping systems. Invited symposium presentation, in: Growing Towards a Sustainable Future: Current Research, Insights and Discussions on Sustainable Management. Annual Meeting, Eastern Branch Entomological Society of America, Lancaster, PA, March 16 &#65533; 19, 2013

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Summer Cover Crops for Weed Suppression and Soil Quality in Organic Vegetable Production in the Great Lakes Region

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Project No.	NYG-632528
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Investigator(s)	Bjorkman, T.; Masiunas, J. B.; Brainard, D.; Bornt, C. D.; Hadad, R. G.; Kikkert, J. R.; Gloy, B.
Performing Institution	Geneva - Horticultural Sciences, N Y AGRICULTURAL EXPT STATION, GENEVA, NEW YORK 14456

NON-TECHNICAL SUMMARY

The goal of this project is to improve the cropping system of organic vegetable growers in the Great Lakes region, by enabling them to effectively control weeds and improve soil condition through the use of short-season cover crops in niches through the whole growing season. Organic vegetable growers have identified these as their major limitations to economic and environmental sustainability. The adoption of summer cover crops can make a large difference in both of those limitations. This region has the summer precipitation to support summer cover crops, but a short growing season that is more demanding of cover crop performance. The project will provide specific techniques that improve the likelihood of success, build a record of success on farms and the grower knowledge to expand adoption, detailed description of the benefits that may be obtained, an expanded local organic market in cover crop seed, and an outreach program that makes these results part of the canon of regional organic vegetable farmers.

OBJECTIVES

Organic vegetable farmers have two persistent challenges: controlling weeds and maintaining soil health. Weed control and soil health are management goals best met in organic systems by using many complementary tools, the \"many little hammers\" approach. Summer cover cropping is the \"little hammer\" with the greatest unfulfilled potential value. We intend to make the practice of summer cover cropping common knowledge in the Great Lakes organic vegetable community through integrated regional extension and research. The Objectives of this project will overcome the limitations that have caused summer cover crops to be underused. First we will develop accurate production procedures and characterize the direct benefits of three most suitable species so that farmers can easily use them. Second, we will identify the easiest and most valuable ways for farmers integrate them into their systems effectively. Third, we will make use more economical by increasing local production of organic seed. Fourth we will develop an educational curriculum for advisors and training for growers so that there are many experienced growers. The three species are buckwheat, mustard and sudangrass, which have the

greatest potential to economically suppress weeds while building soil health. Together, they provide a tool to use at any place in the rotation, at any time during the growing season. The team includes faculty from three leading universities, with expertise in summer cover crops and economics, and a history of collaborative research, extension field staff, experienced organic farmers in research and as advisors, and seed production specialists.

APPROACH

The project has effort in four objectives. A. Characterize and enhance management benefits On research farms and on grower farms, we will develop accurate production procedures and characterize the direct benefits of three most suitable species, buckwheat, mustard and sudangrass, so that farmers can easily use them. This work will particularly identify the range of planting dates when the cover crop benefit can be obtained, the weed species that are suppressed, and the soil tilth benefits that result. All of these will be done in the context of integrated organic methods, each adding a function that complements those in the existing system. B. Integrate cover crop techniques into real farming systems. We will identify the easiest and most valuable ways for farmers integrate them into their systems effectively C. Reduce costs of use and characterize economic benefits i) reduce seed costs through development of local seed supply. In New York, Elizabeth Dyck of NOFA-NY will work with organic seed producers to enhance the supply of organic buckwehat seed, and in Michigan, Dale Mutch at the Kellogg Biological Station will work with organic seed producers to enhance the supply of organic mustard seed. ii) characterize economic value of cover crop use. Cornell Professor Brent Gloy will probe growers decision-making to identify and quantify the economic value of benefits growers obtain from cover crops. iii) identify techniques that minimize fuel use and equipment wear Identify through on-farm testing, the most efficient farming methods for establishing and terminating cover crops. iv) promote adaptive use of existing equipment Identify a range of techniques, using various equipment, to establish and terminate cover crops. D. Extension to growers and their advisors Growers will be engaged in research conducted on fourteen organic farms in New York, Illinois and Michigan to meet the objectives above. The results will be presented and ideas exchanged at conferences and field-days throughout the region. We will refine a decision tool for cover crop selection, combining the Midwest Cover Crop Consortium database and the New York Cover Crop Decision Tool. The training manuals, conference presentations and decision tool will be integrated into a curriculum for extension and advisor training. The outreach effectiveness will be assessed through surveys at each grower conference, and by an end-of-project survey of regional organic vegetable farmers to assess awareness of the project message and adoption of summer cover crops. We will have intense engagement with farms where the research is done; we will engage organic growers in person through on-farm workshops and present at the major winter conferences attended by organic growers. We will create an online and printed curriculum and tools that as permanent resources for growers.

PROGRESS

2009/09 TO 2014/08 Target Audience: The target audience is organic vegetable growers in the Great Lakes Region, and the extension educators and other advisors who provide them wiht production information. Changes/Problems: We had significant unanticipated attrition of participants during the course of the project due to changes in university staffing. In each case, there was no existing or new staff member whom we coud recruit could take on the duties. This loss of capacity at major land-grant universities is troubling. University of Illinois participants moved (Ogutu, 2012; Anderson 2013), or had changes in responsibilities (Wahle, Masiunas, 2012) that reduced the effort that the project could devote to Illinois trials. One Michigan State collaborator (Ngouajio, 2013) moved to NIFA to become program leader for OREI. Another (Mutch, 2013) retired. We were fortunate to add a PhD student (Lowry, 2011) and postdoc (Baas, 2013) at Michigan State. At Purdue University, our economics collaborator (Gloy, 2013) left for other pursuits. We are fortunate that most of these departures happened late in the project period. The research-farm experiments clearly demonstrated that we had not identified weed-suppressing cover crop protocols reliable enough to test on grower farms. Because meaningful implementation trials could therefore not be done on grower farms, we chose not to attempt them. What opportunities for training and professional development has the project provided? Information on cover-crop planting dates has been incorporated into the outreach materials that are currently used by vegetable growers in the region. Furthermore, we provided extensive training to extension educators. We provided training to the following extension educators in 2009-2011: Cornell Cooperative Extension: C. D. Bornt, R.G. Hadad, J.R. Kikkert, C. MacNeil, C. Hoepting, L. McDermott, C. Stewart; Illinois Extension: E. Wahle, M. Ogutu; Michigan State University: V. Morrone, D. Mutch, C. Lowry. The results and recommedations have been presented to outreach practitioners through meetigns of the the Midwest Cover Crops Council and the Great Lakes Vegetable Workers Group. How have the results been disseminated to communities of interest? We have reached a large proportion of the organic vegetable growers in the region either directly or conferences, indirectly through

extension educators who use our materials, and through the online resources we have provided. Information on planting dates has been incorporated into the outreach materials that are currently used by vegetable growers in the region. Furthermore, if provided extensive training to extension educators. We have reached a large proportion of the organic vegetable growers in the region either directly or conferences, indirectly through extension educators who use our materials, and through the online resources we have provided. The intended grower audience was engaged through presentations by project participants at all the regional grower meetings. We did presentations and workshops for several years at the larger ones. The venues included the Great Lakes Fruit and Vegetable Expo, Empire State Fruit and Vegetable Expo, NOFA-NY Winter Conference, NOFA-MA Summer Conference, Illinois Specialty Crops, Agritourism and Organic Conference, Ontario vegettbale Grower Conference, Ontario Cover Crops Conference, Pennsylvania Association for Sustainable Agriculture annual conference and the Northeast Buckwheat Field Day. Approximately 1400 organic vegetable growers attended the sessions featuring cover crops in the project period. Cover crop recommendations based on project results are now included in the Midwest Cover Crop Council\'s online decision tool for vegetable growers (http://mcccdev.anr.msu.edu/testVegIndex.php), and the Cornell vegetable Cover Crop Decision Tool (covercrop.net). The latter receives 50-100 searches per day, mostly from the Eastern Great Lakes Region. New producers of organic cover crop buckwheat seed received individual training and consultation from E.Dyck. During the course of this project there is been a great deal of attention paid to cover cropping in the context of soil health. In particular the efforts of USDA-NRCS in the public sector and Soil Renaissance in the nonprofit sector are having substantial impact in conventional field crop production. Because the benefits around soil health are central to organic production, our outreach efforts has benefited from the great publicity around cover crops today. The desire to use cover crops this generally strong, so growers are already eager to use cover crops and their demand is primarily for accurate information on what to use and how. We have made efforts to respond to this wave of interest with accurate information, and also to temper expectations where our results indicate that benefits will appear more slowly than the new adopters hope for. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/09 TO 2013/08 Target Audience: The target audiences are organic vegetable growers in the Great Lakes region, and the researchers and extension staff whose work benefits those growers by improving soil and weed management. Changes/Problems: University of Illinois participants moved (Ogutu), or had changes in responsibilities (Wahle, Masiunas) that reduced the effort that the project could devote to Illinois grower trials. The university did not restaff so that the roles could be transferred. One Michigan State collaborator (Ngouajio) moved to NIFA to become program leader for OREI. What opportunities for training and professional development has the project provided? The extension professional development was executed in the first years of the project. How have the results been disseminated to communities of interest? We have presented talks at grower conferences (Great Lakes Expo, Empire State Producers Expo and the Illinois Specialty Crops, Agritourism and Organic Conference. Björkman presented an overview at the Organic PD workshop in Washingtong DC, October 2012. The website covercrop.net has been updated so that the grower recommendations reflect the resaerch results. The Midwest Cover Crops Council has launched a selector tool for vegetable growers in the Great Lakes Region (http://mcccdev.anr.msu.edu/testVegIndex.php). Our work informs the database in this tool. What do you plan to do during the next reporting period to accomplish the goals? We are writing the research papers reporting the effect of cover crop on soil properties and weed pressure. We have established a model for group planning and data analysis and interpretation and have a full outline. **PROGRESS**: 2009/09 TO 2014/08 Target Audience: The target audience is organic vegetable growers in the Great Lakes Region, and the extension educators and other advisors who provide them wiht production information. Changes/Problems: We had significant unanticipated attrition of participants during the course of the project due to changes in university staffing. In each case, there was no existing or new staff member whom we coud recruit could take on the duties. This loss of capacity at major land-grant universities is troubling. University of Illinois participants moved (Ogutu, 2012; Anderson 2013), or had changes in responsibilities (Wahle, Masiunas, 2012) that reduced the effort that the project could devote to Illinois trials. One Michigan State collaborator (Ngouajio, 2013) moved to NIFA to become program leader for OREI. Another (Mutch, 2013) retired. We were fortunate to add a PhD student (Lowry, 2011) and postdoc (Baas, 2013) at Michigan State. At Purdue University, our economics collaborator (Gloy, 2013) left for other pursuits. We are fortunate that most of these departures happened late in the project period. The research-farm experiments clearly demonstrated that we had not identified weed-suppressing cover crop protocols reliable enough to test on grower farms. Because meaningful implementation trials could therefore not be done on grower farms, we chose not to attempt them. What opportunities for training and professional development has the project provided? Information on cover-crop planting dates has been incorporated into the outreach materials that are currently used by vegetable growers in the region. Furthermore, we provided extensive training to extension educators. We provided training to the following extension educators in 2009-2011: Cornell Cooperative Extension: C. D. Bornt, R.G. Hadad, J.R. Kikkert, C. MacNeil, C. Hoepting, L. McDermott, C. Stewart; Illinois Extension: E. Wahle, M. Ogutu; Michigan

State University: V. Morrone, D. Mutch, C. Lowry. The results and recommedations have been presented to outreach practitioners through meetigns of the the Midwest Cover Crops Council and the Great Lakes Vegetable Workers Group. How have the results been disseminated to communities of interest? We have reached a large proportion of the organic vegetable growers in the region either directly or conferences, indirectly through extension educators who use our materials, and through the online resources we have provided. Information on planting dates has been incorporated into the outreach materials that are currently used by vegetable growers in the region. Furthermore, if provided extensive training to extension educators. We have reached a large proportion of the organic vegetable growers in the region either directly or conferences, indirectly through extension educators who use our materials, and through the online resources we have provided. The intended grower audience was engaged through presentations by project participants at all the regional grower meetings. We did presentations and workshops for several years at the larger ones. The venues included the Great Lakes Fruit and Vegetable Expo, Empire State Fruit and Vegetable Expo, NOFA-NY Winter Conference, NOFA-MA Summer Conference, Illinois Specialty Crops, Agritourism and Organic Conference, Ontario vegettbale Grower Conference, Ontario Cover Crops Conference, Pennsylvania Association for Sustainable Agriculture annual conference and the Northeast Buckwheat Field Day. Approximately 1400 organic vegetable growers attended the sessions featuring cover crops in the project period. Cover crop recommendations based on project results are now included in the Midwest Cover Crop Council\'s online decision tool for vegetable growers (http://mcccdev.anr.msu.edu/testVegIndex.php), and the Cornell vegetable Cover Crop Decision Tool (covercrop.net). The latter receives 50-100 searches per day, mostly from the Eastern Great Lakes Region. New producers of organic cover crop buckwheat seed received individual training and consultation from E.Dyck. During the course of this project there is been a great deal of attention paid to cover cropping in the context of soil health. In particular the efforts of USDA-NRCS in the public sector and Soil Renaissance in the nonprofit sector are having substantial impact in conventional field crop production. Because the benefits around soil health are central to organic production, our outreach efforts has benefited from the great publicity around cover crops today. The desire to use cover crops this generally strong, so growers are already eager to use cover crops and their demand is primarily for accurate information on what to use and how. We have made efforts to respond to this wave of interest with accurate information, and also to temper expectations where our results indicate that benefits will appear more slowly than the new adopters hope for. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 OUTPUTS: We conducted a third season of coordinated research-farm experiments to determine the planting window that will provide sufficient growth and weed suppression to be of value. We were fortunate that despite considerable adverse weather, good results were obtained from all the trials performed in each of the three locations. In spring plantings, we confirmed prior years\' results marking an optimum window for mustard establishment and weed suppression. In fall plantings of buckwheat, sudangrass and mustard, the target planting window was further identified. We again found that each of the three target cover crops had an abrupt end to the window, early August for sudangrass and buckwheat, late August for mustard. During August, a difference of seven to ten days in planting date can result in a two-fold difference in biomass production. The biological effects of a cover crop differ if it is incorporated into the soil in the fall or the spring. Spring tillage The impacts on weed pressure in the subsequent bean crop was modest. In particular, lambsquarters populations could be reduced by appropriately timed practices. When asked to quantify their improvement, the growers had more trouble. For instance 60% of those claiming yield increases did not estimate how much. New cover crop seed producers began production, cleaning, seed testing, and marketing. New markets were successful and we anticipate expansion to continue on the merits. An economic survey identified the economic value that organic vegetable growers ascribe to cover crops. About 90% of growers identified weed suppression, tilth improvement and yield increases to their use of cover crops, with 80% also identifying disease suppression and reduced fertilizer use. Approximately 500 organic vegetable growers attended the sessions featuring cover crops in the reporting period. PARTICIPANTS: Lead investigators: T. Bjorkman, J. Masiunas, D. Brainard. Individuals Cornell Cooperative Extension: C. D. Bornt, R.G. Hadad, J.R. Kikkert. Purdue University: B. Gloy, S, Li. University of Illinois: D. Anderson. University of Illinois Extension: E. Wahle, M. Ogutu. Michigan State University: V. Morrone, D. Mutch, C. Lowry. Organic Growers Research and Information Network: E. Dyck. TARGET AUDIENCES: The intended grower audience was engaged during the preceding year through presentations by project participants at Great Lakes Fruit and Vegetable Expo, Empire State Fruit and Vegetable Expo, NOFA-NY Winter Conference , Pennsylvania Association for Sustainable Agriculture annual conference and the Northeast Buckwheat Field Day. Approximately 500 organic vegetable growers attended the sessions featuring cover crops in the reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: We conducted a second season of coordinated research-farm experiments to determine the planting window that will provide sufficient growth and weed suppression to be of value. In spring plantings, two mustards have essentially the same performance with season and weather effects being dominant. There is a clear time window when mustard establishes quickly enough to suppress cool season weeds. Mustards sown before summer vegetables can reduce weed establishment and seed production in the spring. In fields dominated by summer annuals (e.g. lambsquarters and giant foxtail), later plantings of mustard had many escapes. In contrast, the earliest plantings allowed an undergrowth of winter annuals (chickweed and shepherds purse) where those were abundant. Suppression of both weed groups was particularly strong in the transitions season, which usually lasted from mid-April to mid-May. The late summer planting window was also tested. Each of the three target cover crops had an abrupt end to the window, early August for sudangrass and buckwheat, late August for mustard. Trials to reveal the appropriate fall management for late-summer sudangrass, buckwheat and each of the cover crops. We have established relationships with target growers and are beginning the process of integrating cover crops into their production program. Allowing the cover crop to decompose intact over winter resulted in better bean growth and weed growth. Mustard and buckwheat both reduced spring weed biomass by half if left over winter. Prospective cover crop seed producers received instruction in production, cleaning, seed testing, and marketing. An economic survey instrument was developed to identify the economic value that organic vegetable growers ascribe to cover crops, to be deployed in the coming off-season. The initial results were disseminated to growers at Great Lakes Fruit and Fegetable Expo, Empire State Fruit and Vegetable Expo, NOFA-NY Winter Conference and NOFA-MA Summer Conference, and Northeast Buckwheat Field Day. PARTICIPANTS: Lead investigators: T. Bjorkman, J. Masiunas, D. Brainard. Individuals Cornell Cooperative Extension: C. D. Bornt, R.G. Hadad, J.R. Kikkert. Purdue University: B. Gloy, S, Li. University of Illinois: D. Anderson. University of Illinois Extension: E. Wahle, M. Ogutu. Michigan State University: V. Morrone, D. Mutch, C. Lowry. Organic Growers Research and Information Network: E. Dyck. TARGET AUDIENCES: The intended grower audience was engaged through presentations by project participants at Great Lakes Fruit and Fegetable Expo, Empire State Fruit and Vegetable Expo, NOFA-NY Winter Conference and NOFA-MA Summer Conference, and Northeast Buckwheat Field Day. Approximately 600 organic vegetable growers attended sessions featuring cover crops. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: We have conducted coordinated research-farm experiments to determine the planting window that will provide sufficient growth and weed suppression to be of value, and initiated experiments that will reveal the appropriate fall management for each of the cover crops. We have established relationships with target growers and are beginning the process of integrating cover crops into their production program. PARTICIPANTS: Lead investigators: Bjorkman, T.; Masiunas, J. B.; Brainard, D. Individuals working on project: Bornt, C. D.; Hadad, R. G.; Kikkert, J. R.; Gloy, B.; Wahle, E; Ogutu, M; Dyck, E.; Mutch, D. TARGET AUDIENCES: The target audience is organic vegetable growers in the Great Lakes Region. We have begun a long-term relationship with several project participants. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/09 TO 2014/08 What was accomplished under these goals? We precisely determined when the three cover crops of interest can be established and produce enough biomass to have value as a cover crop. In general, effective planting dates cover a much narrower time window than was available in existing recommendations. As a result of precisely identifying these windows, logical crop sequences were identified that allow farmers to integrate the cover crops into their systems effectively. Organic vegetable growers have more accurate knowledge to assess the expected benefits of summer cover crops. With a more precise understanding of successful planting dates, they are having fewer failures caused by planting too late. A new buckwheat cover crop seed market has developed among New York organic producers. We conducted three years of coordinated research-farm experiments to determine the planting window that will provide sufficient growth and weed suppression to be of value We found that spring-sown mustard, while sometimes impressive, fails to make useful biomass too often for this planting season to be recommended north of Champaign. In spring plantings, two mustards types have essentially the same performance with season and weather effects being dominant causes of variation. There is a short, but unpredictable, window when mustard establishes quickly enough to suppress cool season weeds. The overall suppression of weeds has been less than expected from previous reports, even when the cover crops are combined with other \"little hammers.\" By doing the experiments over several years in three locations, we have a much better estimate of the range of weed suppression growers might experience in practice.. In fall plantings of buckwheat, sudangrass and mustard, the target planting window was further

identified. We again found that each of the three target cover crops had an abrupt end to the window, early August for sudangrass and buckwheat, late August for mustard. During August, a difference of seven to ten days in planting date can result in a two-fold difference in biomass production. The mustard results of this experiment are currently under review for publication in Agronomy Journal. The biological effects of a cover crop differ if it is incorporated into the soil in the fall or the spring. We conducted this two-year experiment twice in each of the three locations. The overriding result was a demonstration that fall tillage, irrespective of cover crop, resulted in sharply weaker being growth and yield. Allowing the cover crop to decompose intact over winter resulted in better bean growth and weed growth Mustard and buckwheat both reduced spring weed biomass by half if left over winter. The impacts on weed pressure in the subsequent bean crop was modest. Further, we tested the soil impact of fall mustard, buckwheat and sudangrass crops, and whether leaving the cover crops untilled allowed the soil-sheath aggregates to stabilize and thereby improve tilth. The single-season response in a system with annual plowing was not detectable. We anticipate completing a paper on this experiment for publication a peer-reviewed research journal. An economic survey identified the economic value that organic vegetable growers ascribe to cover crops. About 90% of growers identified weed suppression, tilth improvement and yield increases to their use of cover crops, with 80% also identifying disease suppression and reduced fertilizer use. When asked to quantify their improvement, the growers had more trouble. For instance, 60% of those claiming yield increases did not estimate how much. These results were presented is a Purdue University masters thesis, and as a conference paper at the American Society for Horticultural Science. A peer-reviewed publication is anticipated. Prospective cover crop seed producers received instruction in production, cleaning, seed testing, and marketing in 2010. New cover crop seed producers began production, cleaning, seed testing, and marketing in 2011. They developed markets in several underserved parts of New York, both wholesale and by retail to other growers at farmers markets. The organic buckwheat cover crop seed market has expanded among New York organic producers, with seven producers likely to remain suppliers, and local distribution networks established that allow both seed growers and cover-crop users to receive attractive prices. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/08 1. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Li, Shasha, Brent Gloy, Thomas Bj?rkman. 2014. Cover Crop Value as Perceived by Organic Vegetable Growers. HortScience 49(9):S392 2. Type: Journal Articles Status: Submitted Year Published: 2014 Citation: Bj?rkman,Thomas. Carolyn Lowry, Joseph W. Shail, Jr., Daniel C. Brainard, Daniel S. Anderson, and John B. Masiunas. Utility of mustard as a spring and fall cover crop for weed suppression in the Great Lakes region. Agronomy Journal. 3. Type: Journal Articles Status: Published Year Published: 2013 Citation: Bj?rkman, Thomas and Joseph W. Shail, Jr. 2013. Using a buckwheat cover crop for maximum weed suppression after early vegetables. HortTechnology 23:575-58

2009/09 TO 2014/08 What was accomplished under these goals? We precisely determined when the three cover crops of interest can be established and produce enough biomass to have value as a cover crop. In general, effective planting dates cover a much narrower time window than was available in existing recommendations. As a result of precisely identifying these windows, logical crop sequences were identified that allow farmers to integrate the cover crops into their systems effectively. Organic vegetable growers have more accurate knowledge to assess the expected benefits of summer cover crops. With a more precise understanding of successful planting dates, they are having fewer failures caused by planting too late. A new buckwheat cover crop seed market has developed among New York organic producers. We conducted three years of coordinated research-farm experiments to determine the planting window that will provide sufficient growth and weed suppression to be of value We found that spring-sown mustard, while sometimes impressive, fails to make useful biomass too often for this planting season to be recommended north of Champaign. In spring plantings, two mustards types have essentially the same performance with season and weather effects being dominant causes of variation. There is a short, but unpredictable, window when mustard establishes quickly enough to suppress cool season weeds. The overall suppression of weeds has been less than expected from previous reports, even when the cover crops are combined with other \"little hammers.\" By doing the experiments over several years in three locations, we have a much better estimate of the range of weed suppression growers might experience in practice.. In fall plantings of buckwheat, sudangrass and mustard, the target planting window was further identified. We again found that each of the three target cover crops had an abrupt end to the window, early August for sudangrass and buckwheat, late August for mustard. During August, a difference of seven to ten days in planting date can result in a two-fold difference in biomass production. The mustard results of this experiment are currently under review for publication in Agronomy Journal. The biological effects of a cover crop differ if it is incorporated into the soil in the fall or the spring. We conducted this two-year experiment twice in each of the three locations. The overriding result was a demonstration that fall tillage, irrespective of cover crop, resulted in sharply weaker bean growth and yield. Allowing the cover crop to decompose intact over winter resulted in better bean growth and weed growth Mustard and buckwheat both reduced spring weed biomass by half if left over winter. The impacts on weed pressure in the subsequent bean crop was modest. Further, we tested the soil impact of fall mustard, buckwheat and sudangrass crops, and whether leaving the cover crops untilled allowed

the soil-sheath aggregates to stabilize and thereby improve tilth. The single-season response in a system with annual plowing was not detectable. We anticipate completing a paper on this experiment for publication a peer-reviewed research journal. An economic survey identified the economic value that organic vegetable growers ascribe to cover crops. About 90% of growers identified weed suppression, tilth improvement and yield increases to their use of cover crops, with 80% also identifying disease suppression and reduced fertilizer use. When asked to quantify their improvement, the growers had more trouble. For instance, 60% of those claiming yield increases did not estimate how much. These results were presented is a Purdue University masters thesis, and as a conference paper at the American Society for Horticultural Science. A peer-reviewed publication is anticipated. Prospective cover crop seed producers received instruction in production, cleaning, seed testing, and marketing in 2010. New cover crop seed producers began production, cleaning, seed testing, and marketing in 2011. They developed markets in several underserved parts of New York, both wholesale and by retail to other growers at farmers markets. The organic buckwheat cover crop seed market has expanded among New York organic producers, with seven producers likely to remain suppliers, and local distribution networks established that allow both seed growers and cover-crop users to receive attractive prices. **PUBLICATIONS** (not previously reported): 2009/09 TO 2014/08 1\. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Li, Shasha, Brent Gloy, Thomas Bj?rkman. 2014. Cover Crop Value as Perceived by Organic Vegetable Growers. HortScience 49(9):S392 2\. Type: Journal Articles Status: Submitted Year Published: 2014 Citation: Bj?rkman,Thomas. Carolyn Lowry, Joseph W. Shail, Jr., Daniel C. Brainard, Daniel S. Anderson, and John B. Masiunas. Utility of mustard as a spring and fall cover crop for weed suppression in the Great Lakes region. Agronomy Journal. 3\. Type: Journal Articles Status: Published Year Published: 2013 Citation: Bj?rkman, Thomas and Joseph W. Shail, Jr. 2013. Using a buckwheat cover crop for maximum weed suppression after early vegetables. HortTechnology 23:575-580

2012/09 TO 2013/08 What was accomplished under these goals? Organic vegetable growers have more accurate knowledge to assess the expected benefits of summer cover crops. With a more precise understanding of successful planting dates, they are having fewer failures caused by planting too late in the fall. We found that spring-sown mustard, while sometimes impressive, fails to make useful biomass too often for this planting season to be recommended north of Champaign. The overall suppression of weeds has been less than expected from previous reports, even when the cover crops are combined with other \"little hammers.\" By doing the experiments over several years in three locations, we have a much better estimate of the range of weed suppression growers might experience in practice. The organic buckwheat cover crop seed market has expanded among New York organic producers, with seven producers likely to remain suppliers, and local distribution networks established that allow borth seed growers and cover-crop users to receive attractive prices. **PUBLICATIONS (not previously reported):** 2012/09 TO 2013/08 1. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Getting the most value out of summer cover crops by planting and killing and incorporating at the right time. Proceedings of the Empire Producers Expo. New York Vegetable Growers assn. http://www.hort.cornell.edu/expo/2013proceedings.php 2. Type: Websites Status: Published Year Published: 2013 Citation: https://weedecology.css.cornell.edu/manage/manage.php?id=15

2011/09/01 TO 2012/08/31 Organic vegetable growers have more accurate knowledge to assess the expected benefits of summer cover crops. With a more precise understanding of successful planting dates, they are having fewer failures caused by planting too late. A new buckwheat cover crop seed market has developed among New York organic producers. Resarchers have a more accurate understanding of growers\' expected value of cover crops when they chose to

2010/09/01 TO 2011/08/31 New organic buckwheat cover crop seed growers developed markets in several underserved parts of New York, both wholesale and by retail to other growers at farmers markets. Cover crop information is now included in the Midwest Cover Crop Council\'s online decision tool for vegetable growers in Michigan.

2009/09/01 TO 2010/08/31 We have first-year data for each of the cover crops on the planting window that will provide sufficient growth and weed suppression to be of value.

PUBLICATIONS

2011/09/01 TO 2012/08/31 John B. Masiunas, Carolyn Lowry, Daniel C. Brainard, Thomas Bjorkman. 2012. The Right Time to Plant Fall Crucifer Cover Crops in the Great Lakes Region. http://ashs.org/abstracts/m/abstracts12/abstract id 10439.html

2010/09/01 TO 2011/08/31 No publications reported this period

2009/09/01 TO 2010/08/31 No publications reported this period

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Building on Success: a Research and Extension Initiative to Increase the Prosperity of Organic Grain and Vegetable Farms

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Subfile	CRIS
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Project Status	EXTENDED
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Proposal No.	2009-01340
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Grant Year	2009
Investigator(s)	Drinkwater, L.; Van Es, H.; Ketterings, Q.; Nelson, E.; Rickard, B.; Seaman, A.
Performing Institution	Horticulture, CORNELL UNIVERSITY, ITHACA, NEW YORK 14853

NON-TECHNICAL SUMMARY

A collaborative group of expert organic farmers, researchers, and extensionists established two long-term certified organic cropping systems experiments on Cornell research farms in 2005: one comparing grain systems and one comparing vegetable systems. We simulate real farms that follow differing approaches to organic management. Objectives of the project are (1) to measure the effects of these different organic management systems on yields, soil health, nutrients, weeds, disease, insects, and economics; (2) understand the mechanisms behind these effects; and (3) disseminate information that can inform farmer management, promote farmer research networks, and provide tools that will help farmers better understand their own systems. The vegetable and grain systems experiments will be regularly sampled for soil nutrients, soil health and soil flora, insects, and weeds in addition to yield and produce quality. Specific hypotheses regarding interactions of these factors will be tested through micro-plot experiments. Nutrient input-output budgets, carbon budgets and economic budgets will be developed for each system. The systems experiments will be used as teaching laboratories in conjunction with eOrganic and extension publications to improve understanding of farmers and extension educators regarding the effects of different organic management strategies. This project supports the OREI goals of facilitating development of organic agriculture production (Goal 1), evaluating the potential economic benefits to producers who use organic methods (Goal 2), and conducting advanced on-farm research (Goal 6).

OBJECTIVES

The long-term mission of the project is to develop more productive and prosperous organic cropping systems that are adapted to the Northeast are able to maintain ecological integrity and contribute to environmental stewardship. To achieve this mission, we are guided by three over-arching goals: (1)we aim to evaluate distinct organic management systems for grains and vegetables in terms of yield and profitability, soil quality, nutrient dynamics, weed populations, disease and insect pressure; (2) in comparing these management systems we aim to take the research a step further and investigate essential ecological processes that are the foundation of successful organic management systems but are not well understood; (3)to ensure that the research meets the

needs of growers and is available for their use we will foster social networks among farmers, researchers and extension educators and disseminate project results through a variety of channels. Our approach is based on two long-term cropping systems experiments that our researcher-farmer team has established. The project also includes use of strategic on-farm experiments. Building on and extending practices of successful, innovative organic growers, and having these expert farmers as research team members has been and continues to be vital to our success. Expected outputs from the project include 10 to 12 refereed publications including two or more each on nutrient cycling, weed dynamics, soil health, crop production and economics. Examples of the many extension publications we expect to produce include: (1) Trends in soil fertility in the organic grain cropping systems experiment and management recommendations, (2) Response of weeds to high compost rates: more compost is not always better! (3) How to draw-down the weed seed-bank by summer fallow while reducing tillage intensity, (4) Reducing tillage in organic vegetable production: results from an experimental ridge till system. Other expected outputs include: Creation of on-farm research networks to promote and facilitate farmer initiated experiments; Experimentation guides for on-farm research; Quick cover crop and weed biomass assessment tools to assist farmers in their experimentation; Several dozen extension publications and contributions to eOrganic about project results; Eight Living Lab field days reaching a minimum of 200 participants; A minimum of eight presentations and workshops at grower meetings communicating project results to at least 250 growers; A farmer friendly tool for dynamic assessment of crop profitability which is adapted specifically for organic vegetable production systems. In addition, the project is providing opportunities for field testing a nutrient budgeting tool and adaptation of the Illinois Soil Nitrogen Test (ISNT) to the high organic matter input systems used by organic farmers.

APPROACH

Two long-term organic cropping systems experiments form the core of the project. Growers in the executive leadership team plus an active grower-extension advisory committee insure that the systems represent realistic farm practices. The vegetable systems experiment compares four approaches for growing organic vegetable crops: (V1) a high compost-no legume cover crop intensive system with 6 cash crops in 4 years, (V2) an intermediate system with much of the N coming from legume cover crops and one cash crop per year, (V3) a bioextensive system with much of the N coming from legume cover crops and 2 cash crops in 4 years with alternate years having cover crops and a cultivated fallow to draw down the weed seed bank, and (V4) a ridge-till system, similar to system 2 but with minimal tillage and controlled wheel traffic. All systems follow a basic 4-year rotation with V1 having extra crops and V3 missing crops in alternate years. Plots are split, with 2 of the 4 cop-years represented each year. Comparison of V2 vs. V3 will reveal benefits of fallow for weed control and whether additional time in cover crops offsets the effect of fallow on soil quality. Comparison of V1 vs. V2 reveals effects of the type of nutrient inputs on various soil physical parameters and biological populations. System V2 vs. V4 shows the potential benefits of reduced tillage for soil quality and energy savings. The grain cropping system experiment compare 4 approaches to organic grain production: (G1) high nutrient input to maximize yields, (G2) minimum purchased input system designed to maximize net return, (G3) intensive weed management, and (G4) reduced tillage. All systems follow a soybean-winter grain-corn rotation with legume cover crops supplying most of the N. A conventional system on adjacent non-certified land allows direct comparison of soil changes under organic cropping. The logic of system comparisons is similar to the vegetable experiment. In both experiments we take extensive measures of soil physical and biological health, soil nutrients, weed population density, biomass and seed bank, pest insects, disease, crop yield, yield components and produce quality. Nutrients in cover crops, amendments and crops are analyzed to compute nutrient input-output budgets. Economic and carbon budgets will also be computed based on yield and management records. Intensive micro-plot studies will evaluate the role of N-fixation in nutrient budgets and interactions between crops and micro-flora. Intensive studies will also examine effects of organic nutrient sources on crop weed interactions and the possible role of root disturbance in promoting microbial attack on the roots of perennial weeds. Annual field days will focus on a particular topic each year and will use the experiments as laboratories for hands-on exercises. Workshops at grower meetings, extension publications and contributions to eOrganic will further disseminate project outcomes. Through our advisory committee and other organic farm organizations we intend to develop farmer-research networks to help organic farmers effectively answer questions of importance to their farm operations.

PROGRESS

2009/09 TO 2014/08 Target Audience: The target audiences are organic and transitioning farmers, farmers considering transitioning to organic, extension educators, university students and other researchers. We have undertaken a number of efforts to reach these audiences. Throughout the project, we reached regional organic farmers through the workshops we presented at organic farmer meetings, including the NOFA New York winter

conferences as well as field days and workshops. We partnered with extension educators, non-profit groups, farmer organization, NRCS professionals, and experienced organic farmers in our outreach program. Since Aug 2009, we have presented more than 70 outreach events including presentations, workshops and field tours, with over 8,000 contact hours. These efforts have produced concrete results. For example, after a 2013 New York Certified Organic meeting focused on soil/crop nutrition, 16 of 26 respondents said that they would change practices based on what they heard. Similarly, after a Nov 2013 cover crop workshop, all 15 respondents said they intended to use what they had learned. The project has produced information that will serve as the basis for nutrient management software that is being developed in collaboration with a software company that serves diverse, small scale farming operations (AgSquared). We will continue to maintain the project website for an additional year. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? This project directly supported two graduate students and a post-doc enabling them to receive professional training in how to carry out research in organic farming systems. Several other graduate students benefited from this project though participating in Project Team meetings. These unique meetings provided them with a model for collaborative, interdisciplinary teamwork with farmers, researchers and extension educators working together. Numerous undergraduates (30-40) worked on the project as research assistants, several of them carried out their own research through internships and honors research projects. Lastly, many classes were able to visit the research plots to learn about the design and implementation of cropping systems experiments. How have the results been disseminated to communities of interest? This project has been a collaborative endeavor between farmers, extension educators and researchers from its inception in 2004. Several expert farmers played a major role in defining the original problems and questions to be targeted and once we received funding, a highly effective Project Steering Team was formed, which includes eight expert organic farmers and continues to define research and extension priorities, provide formal, systematic feedback as well as on-the-spot advice as issues emerge. The commitment of our Farmer Advisors is demonstrated by their continued participation and enthusiasm throughout this ten-year partnership. Throughout the duration of the project, organic farmers and extension educators have been provided with information about the experiments and our findings though many different venues including workshops, field days, on-farm demonstrations, presentations at farmer conferences, articles published in various extension newsletters and farmer-oriented publications and the project website. Countless farmers and extension educators have received information generated by this project through these varied venues, and many farmers have communicated with us about how they have improved their farming practices based on information they received from this work. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09 TO 2012/08 OUTPUTS: Data collected in 2012 included soil physical, biological and chemical properties, weed counts and biomass, weed free subplot yields, insect and disease scouting, crop density, yield, yield components, produce quality and cover crop biomass and N. We are in the process of completing the analysis of 2012 spelt, soybean, squash and potato yield, pest pressure, and crop quality data. We implemented buckwheat strip plantings in the vegetable experiment to investigate their effect on Colorado potato beetle densities via attraction of natural enemies. Soil samples and plant tissue will be analyzed this winter. We initiated 15N labeled subplots to measure nitrogen fixation and the fate of cover crop N. The project conducted many extension and education activities during the 2012 reporting period, detailed under Target Audiences. We conducted on farm soybean variety trials at 3 locations. The project maintains and continues to update an extensive web site: Organic Cropping Systems Project: http://www.hort.cornell.edu/extension/organic/ocs/. PARTICIPANTS: In addition to the Laurie Drinkwater, the Project Director, researchers participating in the project during the reporting period included Brian Caldwell, Antonio DiTommaso, Charles Mohler, Quirine Ketterings, Harold van Es, Abby Seaman, Robert Schindelbeck, Brad Rickard, Betsy Leonard, Caroline Marschner, Marissa Weiss, and Greg Godwin. Farmers participating in the project include Eric and Anne Nordell, Klaas and Mary Howell Martens, Anton Burkett, Chaw Chang, Lou Johns, Louis Lego, Anthony Potenza, John Myer, and Erick Smith. Extension personnel participating in the project include Keith Waldron, Robert Hadad and Janice Degni. Undergraduate students working on the project during the reporting period included Bonnie Cherner, Leigh Archer, Maggee Anderson, Nathan August, Elizabeth Perkus, Dara Littig, and Sarah Nechamen. TARGET AUDIENCES: The target audiences are organic and transitioning farmers, farmers considering transitioning to organic, extension educators, university students and other researchers. We have undertaken a number of efforts to reach these audiences. Throughout the year researchers spoke to regional organic farmers through the workshops we presented at organic farmer meetings, including the NOFA New York winter conference as well as field days and workshops. Two field days were conducted at the vegetable and grain experiments, reaching a total of 60 people. Six other presentations about different aspects of the experiments were given to over 250 participants. The cropping systems experiments are now integrated into the curricula of three Cornell courses, with 2 class field trips during the reporting period. Two very active members of our advisory group gave several presentations to farm audiences in which they spoke about our project. They addressed over 1700 attendees for over 6000 contact hours. Altogether, in addition to this, we reached 254 growers and extension personnel for a

total of 197 contact hours, and 95 students for a total of 142 contact hours. In addition, the project has been successful at incorporating students into the research process. Seven undergraduate students worked on the project during the reporting period. Four of these worked full time on the project during the summer of 2012. All of these students gained a good understanding of the goals and methods of the research as well as obtaining a variety of skills during hands-on training. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2011/09/01 TO 2012/08/31 OUTPUTS: Data collected in 2012 included soil physical, biological and chemical properties, weed counts and biomass, weed free subplot yields, insect and disease scouting, crop density, yield, yield components, produce quality and cover crop biomass and N. We are in the process of completing the analysis of 2012 spelt, soybean, squash and potato yield, pest pressure, and crop quality data. We implemented buckwheat strip plantings in the vegetable experiment to investigate their effect on Colorado potato beetle densities via attraction of natural enemies. Soil samples and plant tissue will be analyzed this winter. We initiated 15N labeled subplots to measure nitrogen fixation and the fate of cover crop N. The project conducted many extension and education activities during the 2012 reporting period, detailed under Target Audiences. We conducted on farm soybean variety trials at 3 locations. The project maintains and continues to update an extensive web site: Organic Cropping Systems Project: http://www.hort.cornell.edu/extension/organic/ocs/. PARTICIPANTS: In addition to the Laurie Drinkwater, the Project Director, researchers participating in the project during the reporting period included Brian Caldwell, Antonio DiTommaso, Charles Mohler, Quirine Ketterings, Harold van Es, Abby Seaman, Robert Schindelbeck, Brad Rickard, Betsy Leonard, Caroline Marschner, Marissa Weiss, and Greg Godwin. Farmers participating in the project include Eric and Anne Nordell, Klaas and Mary Howell Martens, Anton Burkett, Chaw Chang, Lou Johns, Louis Lego, Anthony Potenza, John Myer, and Erick Smith. Extension personnel participating in the project include Keith Waldron, Robert Hadad and Janice Degni. Undergraduate students working on the project during the reporting period included Bonnie Cherner, Leigh Archer, Maggee Anderson, Nathan August, Elizabeth Perkus, Dara Littig, and Sarah Nechamen. TARGET AUDIENCES: The target audiences are organic and transitioning farmers, farmers considering transitioning to organic, extension educators, university students and other researchers. We have undertaken a number of efforts to reach these audiences. Throughout the year researchers spoke to regional organic farmers through the workshops we presented at organic farmer meetings, including the NOFA New York winter conference as well as field days and workshops. Two field days were conducted at the vegetable and grain experiments, reaching a total of 60 people. Six other presentations about different aspects of the experiments were given to over 250 participants. The cropping systems experiments are now integrated into the curricula of three Cornell courses, with 2 class field trips during the reporting period. Two very active members of our advisory group gave several presentations to farm audiences in which they spoke about our project. They addressed over 1700 attendees for over 6000 contact hours. Altogether, in addition to this, we reached 254 growers and extension personnel for a total of 197 contact hours, and 95 students for a total of 142 contact hours. In addition, the project has been successful at incorporating students into the research process. Seven undergraduate students worked on the project during the reporting period. Four of these worked full time on the project during the summer of 2012. All of these students gained a good understanding of the goals and methods of the research as well as obtaining a variety of skills during hands-on training. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: The 2011 growing season was a difficult one for vegetable and grain crops due to very wet weather in spring and fall. Data collected in 2011 included soil physical, biological and chemical properties, weed counts and biomass, insect and disease scouting, crop density, yield, yield components, produce quality and cover crop biomass and N. We are in the process of analyzing the 2011corn, soybean, lettuce and potato yield, pest pressure, and crop quality data. Soil samples and plant tissue will be analyzed this winter. The weed ecology graduate student conducted her second field experiment aimed at identifying which macronutrients have the greatest impact in stimulating weed growth. She is in the process of analyzing crop and weed data for 2011. The economics graduate student used data from the vegetable trial to conduct detailed modeling of interactions between management, crop yields and profitability. A paper summarizing her findings is in press. The project conducted many extension and education activities during the 2011 reporting period, detailed under Target Audiences. An effort is underway to disseminate the vegetable crop budgeting tool developed under this project through a software company. The project maintains and continues to update an extensive web site: Organic Cropping Systems Project: http://www.hort.cornell.edu/extension/organic/ocs/. PARTICIPANTS: In addition to the Laurie Drinkwater, the Project Director, researchers participating in the project during the reporting period included George Abawi, Brian Caldwell, Antonio DiTommaso, Charles Mohler, Quirine Ketterings, Harold van Es, Abby Seaman, Robert Schindelbeck, Brad Rickard, Betsy Leonard, Katja Poveda, Caroline Marschner, Marissa Weiss, and Greg

Godwin. Farmers participating in the project include Eric and Anne Nordell, Klaas and Mary Howell Martens, Anton Burkett, Chaw Chang, Lou Johns, Louis Lego, Anthony Potenza, John Myer, John Saeli, and Erick Smith. Extension personnel participating in the project include Keith Waldron, Robert Hadad and Janice Degni. Neith Little and Stephanie Chan are graduate students who worked on the project. Undergraduate students working on the project during the reporting period included Ava Ryan, Bonnie Cherner, Ross Hathaway, Andy Mellinger, Luke Gianforte, and Jing Huang. TARGET AUDIENCES: The target audiences are organic and transitioning farmers, farmers considering transitioning to organic, extension educators, university students and other researchers. We have undertaken a number of efforts to reach these audiences. Throughout the year we reached regional organic farmers through the workshops we presented at organic farmer meetings, including the NOFA New York winter conference as well as field days and workshops. Two field days were conducted at the Vegetable experiment, reaching a total of 70 people. Eight other presentations about different aspects of the experiments were given to over 450 participants. The cropping systems experiments are now integrated into the curricula of three Cornell courses, with 2 class field trips during the reporting period. Altogether, during the reporting period, we reached 452 growers and extension personnel for a total of 460 contact hours, and 26 students for a total of 36 contact hours. In addition, the project has been successful at incorporating students into the research process. Six undergraduate students worked on the project during the reporting period. Three of these worked full time on the project during the summer of 2011. All of these students gained a good understanding of the goals and methods of the research as well as obtaining a variety of skills during hands-on training. An article about the project was written for a local weekly newspaper. PROJECT MODIFICATIONS: At the advice of our grain advisory group, the chemical comparison plots were discontinued in 2011 and the crop rotation was modified in two grain experiment systems.

2009/09/01 TO 2010/08/31 OUTPUTS: The 2010 growing season was a great year for vegetable and grain crops. Data collected in 2010 included soil physical, biological and chemical properties, weed counts and biomass, insect and disease scouting, crop density, yield, yield components, produce quality and cover crop biomass and N. We are in the process of analyzing the 2010 lettuce and cabbage yield, pest pressure, and crop quality data. Soil samples and plant tissue will be analyzed this winter. The weed ecology graduate student conducted her first field experiment aimed at identifying which macronutrients have the greatest impact in stimulating weed growth. She is in the process of analyzing crop and weed samples for N, P and K contents. The economics graduate student used data from the vegetable trial to conduct detailed modeling of interactions between management, crop yields and profitability. She will be writing a paper summarizing her findings this winter. The project conducted many extension and education activities during the 2010 reporting period, detailed under Target Audiences. The project maintains and continues to update an extensive web site: Organic Cropping Systems Project: http://www.hort.cornell.edu/extension/organic/ocs/. PARTICIPANTS: In addition to the Charles Mohler, the Project Director, researchers participating in the project during the reporting period included George Abawi, Brian Caldwell, Antonio DiTommaso, Laurie Drinkwater, Quirine Ketterings, Harold van Es, Abby Seaman, Robert Schindlebeck, Melissa Madden and Greg Godwin. Laurie Drinkwater became the Project Director due to the retirement of Charles Mohler. Carrie Marschner joined the project as a research technician in Sept 2010. Farmers participating in the project include Eric and Anne Nordell, Klaas and Mary Howell Martens, Anton Burkett, Chaw Chang, Lou Johns, Casey Kunes, Louis Lego, Anthony Potenza, John Saeli, and Erick Smith. Extension personnel participating in the project include Keith Waldron, Robert Hadad and Janice Degni. Neith Little and Stephanie Chan are graduate students who worked on the project. Undergraduate students working on the project during the reporting period included John Orlowski, Daniel Demaree, Steve Pietstruska, K. C. Alvey, Brian Karlowitz, Jing Huang, Carrie Carlton, and Ariel Saffer. TARGET AUDIENCES: The target audiences are organic and transitioning farmers, farmers considering transitioning to organic, extension educators, university students and other researchers. We have undertaken a number of efforts to reach these audiences. Throughout the project we reached regional organic farmers through the workshops we presented at organic farmer meetings, including NOFA New York as well as numerous field days and workshops sponsored by various Cornell University affiliated extensionists and researchers. Field days were conducted at both the Vegetable and Grain experiments, reaching a total of 51 people. Eleven presentations about different aspects of the experiments were given to over 1000 participants in person and via web broadcasts. The cropping systems experiments are now integrated into the curricula of three Cornell courses, with 2 class field trips during the reporting period. Altogether, during the reporting period, we reached 1071 growers and extension personnel for a total of 683 contact hours, and 31 students for a total of 51.5 contact hours. In addition, the project has been successful at incorporating students into the research process. Eleven undergraduate students worked on the project during the reporting period. Three of these worked full time on the project during the summer of 2010. All of these students gained a good understanding of the goals and methods of the research as well as obtaining a variety of skills during hands-on training. Articles about the project were written for a local weekly and Grower magazine, which is targeted at NE vegetable and fruit farmers. Finally, this winter we are aiming to submit at least two

papers to journals for publication. PROJECT MODIFICATIONS: The Project Director was transferred from Charles Mohler to Laurie Drinkwater.

IMPACT

2009/09 TO 2014/08 What was accomplished under these goals? Two long-term cropping systems experiments were initiated in 2004 at the Homer C. Thompson Vegetable Research Farm (Freeville, NY) and Musgrave Grain Research Farm (Aurora, NY). The experiments were collaboratively designed and managed by a team of scientists, extension educators and organic farmers and compared four distinct organic management regimes. We studied the effects of rotation, tillage intensity and nutrient inputs on yields, economics, nutrient surpluses or deficits, soils, weeds, arthropods and greenhouse gas emissions. Strategic on-farm trials and demonstrations were carried out in conjunction with the long-term experiments and smaller, factorial experiments were embedded in the larger plots to test specific hypotheses about nutrient cycling and weed impacts on soybeans. While the vegetable cropping systems experiment was terminated this year, the grain cropping systems experiment will continue for one additional year supported by other projects that take advantage of the ten-year management legacies we've established. This work is embedded in the grain experiment and targets questions about underlying ecological mechanisms governing nitrogen cycling and crop-weed competition. Here we present highlights from the past 4 years of our project. Reduced tillage can be implemented in organic vegetable systems provided that the initial abundance of perennial weeds is low. The vegetable ridge-tillage system, while not ready for farmer-adoption, was surprisingly successful. Our focus on longer cover crop fallows alternating with vegetables aims to reduce weed pressure so that tillage reduction is possible. The weed seed bank can be reduced by alternating 1-year cover crop fallows with vegetables. This result confirms the value of complex rotations and longer cover crop fallows as a weed control strategy. The major barrier to adoption of this specific rotation is the necessity of allocating 50% of the acreage to cover crops. We address this limitation in this proposal. Intensive double-cropping of vegetables is an appealing way to manage risk and has increases income with little investment. "Quick crops" such as spinach and peas that can precede late-season crops such as brassicas increased net return/acre 88% of the time (n=8). The efficacy of strategic use of plant diversity as a pest control strategy can be extremely variable. Our efforts to use traps crops and habitat enhancement to attach natural enemies as strategies to reduce arthropod pests varied greatly in terms of their impact on arthropod herbivore abundance and crop damage. Our results suggest that the natural enemies may not have been present at the research farm and that their populations were influenced by factors beyond the scale of our experiment. Our preliminary analysis of yields over the full 10-year period of the experiment suggests that overall vegetable yields tended to decline in the second rotation. This finding, which mirrors anecdotal reports from farmers, can only be investigated though investments in either long-term cropping systems experiments or long-term on-farm research. Soil fertility and weed management have large impacts on profitability in organic grain crop production. Profits can be maximized with management that prioritizes weed management and uses small additions of poultry litter prior to corn and larger applications prior to spelt. In organic soybean production, weeds play a significant role in reducing yields. Organic soybean yields are often limited by competition from weeds and improving weed management can increase soybean yields by 32 to 95%. Annual weeds increase with greater compost additions and perennial weeds increase under reduced tillage. Weed community data show that annual weeds were greater in the higher fertility cropping systems and perennial weeds were greater in the reduced tillage in both grain and vegetable systems experiment. Many journal and extension publications resulted from this project. In addition to the journal articles that have already been published, there are currently five more in preparation and we expect that several more will follow as the final sample and data analyses are completed Key outcomes of this 10-year project include recommendations for optimizing organic nutrient management in organic grain and vegetable systems. Specifically, our findings on soil fertility management in grain systems have been adopted by many farmers in the Finger Lakes region and will serve as the basis for recommendations which can be applied more broadly to organic cash grain cropping systems. We also characterized the key connections between nutrient management and weed competition and showed that optimizing nutrient management could enable farmers to reduce tillage that is directed at controlling weeds. The resulting information is compatible with the whole-farm adaptive management approach commonly used by organic farmers and will help make their operations more prosperous, sustainable and environmentally friendly. At the same time, strategic research on underlying mechanisms such as the role of different nutrients in governing crop-weed competition and the fate of legume-derived nitrogen have generated new knowledge that is broadly applicable to organic grain and vegetable systems thought the US and other temperate regions. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/08 1. Type: Journal Articles Status: Published Year Published: 2011 Citation: Chan, S., B.A. Caldwell, B.J. Rickard, and C.L. Mohler. 2011. Economic performance of organic cropping systems for vegetables in the Northeast. Journal of Agribusiness 29(1): 59?82. 2. Type: Journal Articles Status: Published Year Published:

2014 Citation: Caldwell, B., C.L. Mohler, Q.M. Ketterings, and A. DiTommaso. 2014. Yields and profitability during and after transition in organic grain cropping systems. Agronomy Journal 106:871-880. 3. Type: Journal Articles Status: Awaiting Publication Year Published: 2015 Citation: Little NG, Mohler CL, Ketterings QM, DiTommaso. In press. A. Effects of organic nutrient amendments on weed and crop growth. Weed Science. 4. Type: Journal Articles Status: Under Review Year Published: 2015 Citation: Little NG, DiTommaso A, Ketterings QM, Mohler CL. Forthcoming. Effects of fertility management on weed growth and crop-weed competition: A review. Submitted to Weed Science in February 2013; in review

2011/09 TO 2012/08 The project compares organic cropping systems that use different approaches to building soil quality (compost, cover crops, reduced tillage), and examines how soil quality interacts with crop growth, weed, insect, and disease management to affect productivity and economic return. The vegetable experiment compares (V1) a system that relies on compost for nitrogen and uses conventional tillage, (V2) a system that relies on cover crops for N, (V3) a mixed tillage system with alternate years in cover crops and fallow, and (V4) a ridge till system that relies on cover crops for N. The grain experiment compares (G1) a system that maximizes gross income through high nutrient input, (G2) a minimal input system, (G3) an intensive weed management system, and (G4) a ridge till system. Preliminary results show: 1) Interactive crop budgets developed to document both production costs and income streams for each cropping system in the vegetable experiment were compiled for the second 4-year rotation. The systems performed similarly on the basis of net return per labor hour except for V4, which was lower. The systems differed widely in return per acre. System V1 was higher than the others in per acre return. V2 was intermediate, and V3 and V4 were lowest. 2) Spelt yields ranged from 1995 (G2)-2904 (G1) lb/acre. Soybean yields ranged from 26 bu/acre (G4) to 43 bu/A (G3). G4 had lower yields due to weed competition. 3) Potato leafhopper densities were highest in V2, but potato yields were similar in all systems, 8800-9800 lb/acre. 4) Squash yields varied from 7100 (V1) to 15,600 (V3) lb/acre. **PUBLICATIONS (not previously reported):** 2011/09 TO 2012/08 Mohler, C. L., Dykeman, C., Nelson, E. B., and DiTommaso, A. 2012. Reduction in weed seedling emergence by pathogens following the incorporation of green crop residue. Weed Research 52:467-477.

2011/09/01 TO 2012/08/31 The project compares organic cropping systems that use different approaches to building soil quality (compost, cover crops, reduced tillage), and examines how soil quality interacts with crop growth, weed, insect, and disease management to affect productivity and economic return. The vegetable experiment compares (V1) a system that relies on compost for nitrogen and uses conventional tillage, (V2) a system that relies on cover crops for N, (V3) a mixed tillage system with alternate years in cover crops and fallow, and (V4) a ridge till system that relies on cover crops for N. The grain experiment compares (G1) a system that maximizes gross income through high nutrient input, (G2) a minimal input system, (G3) an intensive weed management system, and (G4) a ridge till system. Preliminary results show: 1) Interactive crop budgets developed to document both production costs and income streams for each cropping system in the vegetable experiment were compiled for the second 4-year rotation. The systems performed similarly on the basis of net return per labor hour except for V4, which was lower. The systems differed widely in return per acre. System V1 was higher than the others in per acre return. V2 was intermediate, and V3 and V4 were lowest. 2) Spelt yields ranged from 1995 (G2)-2904 (G1) lb/acre. Soybean yields ranged from 26 bu/acre (G4) to 43 bu/A (G3). G4 had lower yields due to weed competition. 3) Potato leafhopper densities were highest in V2, but potato yields were similar in all systems, 8800-9800 lb/acre. 4) Squash yields varied from 7100 (V1) to 15,600 (V3) lb/acre.

2010/09/01 TO 2011/08/31 The project compares organic cropping systems that use different approaches to building soil quality (compost, cover crops, reduced tillage), and examines how soil quality interacts with crop growth, weed, insect, and disease management to affect productivity and economic return. The vegetable experiment compares (V1) a system that relies on compost for nitrogen and uses conventional tillage, (V2) a system that relies on cover crops for N, (V3) a mixed tillage system with alternate years in cover crops and fallow, and (V4) a ridge till system that relies on cover crops for N. The grain experiment compares (G1) a system that maximizes gross income through high nutrient input, (G2) a minimal input system, (G3) an intensive weed management system, and (G4) a ridge till system. 1) Interactive crop budgets developed to document both production costs and income streams for each cropping system in the vegetable experiment were compiled for the first 4-year rotation. The systems performed similarly on the basis of net return per labor hour, but differed widely in return per acre. System V3 was somewhat lower in labor return, but much lower than the others in per acre return. 2) A similar economic analysis of the grain systems over two rotations indicates that the net return of systems G1, G2, and G3 show substantial losses for corn and spelt during the transition period. Transitional soybeans showed a small positive return. Starting with the third harvest, the organic systems show positive returns, assuming a 30% organic price premium, while chemically-managed crops in G5 broke even or lost money. Base conventional prices were set at the average prices for the period 2005-2010. 3) In both

experiments, systems with legume cover crops have better soil health parameters like aggregate stability than those that do not. Overwintered red clover in EP2 in G1, G2 and G3 produced about 1.25 aboveground dry T/A, containing roughly 75-80 lb of N. Austrian winter peas in G4 produced about 0.68 T/A aboveground, which carried about 50 lb/A of N. Corn yields ranged from 137 (G4)-162 (G1) bu/acre. G4 yields improved this year relative to the other systems. Soybean yields ranged from 19 bu/A (G4) to 31 bu/A (G1), with G2 and G3 at 26 bu/A. G4 had lower yields due to weed competition. Soil N, P and K levels are higher in G1, which appears to be driving an increase in weed pressure in that system over time. 4) Soil tests show nutrient levels staying the same over time in the vegetable trial, with the exception of P, which has increased in V1. Aggregate stability is relatively low in the intensively-managed V1 among the vegetable systems.

2009/09/01 TO 2010/08/31 The project compares organic cropping systems that use different approaches to building soil quality (compost, cover crops, reduced tillage), and examines how soil quality interacts with weed, insect, and disease management to affect productivity and economic return. The vegetable experiment compares (V1) a system that relies on compost for nitrogen and uses conventional tillage, (V2) a system that relies on cover crops for N, (V3) a mixed tillage system with alternate years in cover crops and fallow, and (V4) a ridge till system that relies on cover crops for N. The grain experiment compares (G1) a system that maximizes gross income through high nutrient input, (G2) a minimal input system, (G3) an intensive weed management system, (G4) a ridge till system, and (G5) a non-organic chemically-managed system (not randomized with the others). 1) Interactive crop budgets were developed to document both production costs and income streams for each cropping system in the vegetable experiment. Using data from the 2009 trial, a ridge-tillage system that relied on cover crops for nitrogen (System 4) yielded the highest revenues for squash production. The results also indicated that System 1, which relies on compost for nitrogen, occasional cover crops and uses conventional tillage, had the highest revenues for cabbage. Subsequent sensitivity analyses were performed across a range of key parameters, and the results indicated that System 1 and System 4 consistently yielded the highest revenues for cabbage and squash production respectively. 2) In both experiments, systems with legume cover crops have better soil health parameters like aggregate stability than those that do not. Overwintered red clover in EP2 in G1, G2 and G3 produced 1.5-2.0 dry T/A, containing roughly 100-130 lb of N. Corn yields in G1, G2, and G3 averaged 160 bu/acre, while G5 and G4 yielded 176 and 79 bu/acre, respectively. It is possible that clover plowdown N contributions were not sufficient for highest yields in 2010. Spelt yields ranged from 1150 lb/acre (G4) to 2700 lb/acre (G5), with the other organic systems in between from 1400-2000 lb/acre. G4 had much lower yields due to problems with planting and cultivation and consequent weed competition. N, P and K levels are higher in G1, which appears to be driving an increase in weed pressure in that system over time. 3) Preliminary economic analysis of the grain systems indicates that the net return of systems G1, G2, G3, and G5 are similar, assuming a 30% organic price premium. 4) Soil tests show nutrient levels staying the same over time in the vegetable trial, with the exception of K, which has increased in all systems except V2 and P, which has increased in V1. Aggregate stability is relatively low in the intensively-managed V1 among the vegetable systems. It is also lower in G5 compared to the organic grain systems.

PUBLICATIONS

2011/09/01 TO 2012/08/31 Mohler, C. L., Dykeman, C., Nelson, E. B., and DiTommaso, A. 2012. Reduction in weed seedling emergence by pathogens following the incorporation of green crop residue. Weed Research 52:467-477.

2010/09/01 TO 2011/08/31 1. Drinkwater, L. E., and M. Gregory. 2010. Dear Vicki Vetch: The Why and How of Compost Analysis. Organic Farms, Folks, and Foods. Cobleskill, NY: The Northeast Organic Farming Association of New York. 2. Drinkwater, L.E. 2011. A Holistic View: Leguminous cover crop management in organic farming systems. The Natural Farmer Special Issue, p B20-24. Barre, MA: NOFA Education Fund. 3. Caldwell, B.A., Mohler, C.L., Ketterings, Q.M. and, DiTommaso, A. 2011. Yields and Profitability During and After Transition in the Cornell Organic Grain Cropping Systems Experiment. What s Cropping Up 21:7-11. 4. Drinkwater, L.E. 2011. It s Elemental- How Legumes Bridge the Nitrogen Gap. The Natural Farmer Special Issue, p B1-6. Barre, MA: NOFA Education Fund.

2009/09/01 TO 2010/08/31 No publications reported this period

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On-farm Research and Extension to Support Sustainable Nutrient Management of Organic Grain Cropping Systems in the Mid-atlantic Region

Accession No.	0218887
Subfile	CRIS
Project No.	MDW-2009-01361
Agency	NIFA MD.W
Project Type	OTHER GRANTS
Project Status	EXTENDED
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Proposal No.	2009-01361
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Grant Year	2009
Investigator(s)	Cavigelli, M. A.; Mirsky, S.; Maul, J. E.
Performing Institution	AGRICULTURAL RESEARCH SERVICE, RM 331, BLDG 003, BARC-W, BELTSVILLE, MARYLAND 20705-2351

NON-TECHNICAL SUMMARY

There has been limited attention given to soil fertility and nutrient management in organic cropping systems in the mid-Atlantic region. As a result, organic grain farmers find it difficult to provide nitrogen to crops without overloading soils with phosphorus. The goals of this project are 1) to develop innovative management strategies and component technologies to improve soil fertility and nutrient management of organic grain cropping systems of the mid-Atlantic region using on-farm research and 2) to synthesize and disseminate the most current research-based knowledge addressing organic grain production in the region. Results from on-farm research will be shared using six on-farm field days. Annual organic grain and forage workshops will be held to discuss organic grain production and share results from on-farm and related work. We will establish a new Organic Grain Cropping systems interest group on the eOrganic website to facilitate communications, education and collaborations among researchers, educators, agricultural professionals and farmers working with organic grain crops across the country. Development of innovative strategies to improve manure N use efficiency and integrated legume - manure management techniques will result in: i) improved agronomic and environmental performance of organic grain cropping systems; ii) increased number of successful, economically viable, organic farming operations on the landscape; and iii) increased capacity of Cooperative Extension to disseminate the most current information on Best Management Practices for organic production using eOrganic and more traditional Extension publications.

OBJECTIVES

The goals of this project are to develop innovative management strategies and component technologies to improve soil fertility and nutrient management of organic grain cropping systems of the mid-Atlantic region and to synthesize and disseminate the most current research-based knowledge addressing organic grain production in the region. The first objective is to develop component technologies and integrated management strategies that optimize the contribution of legume N and maximize the efficiency of manure N, thereby reducing the rate of

manure required to meet crop needs and making it possible to optimize yields while balancing cropping system nutrient inputs and outputs. The second objective is to increase economic returns for organic grain farmers by incorporating improved nutrient management programs into their cropping systems. The third objective is to disseminate knowledge gained from on-farm and on-station organic grain crops using on-farm field days, regional workshops, and the eOrganic website. Work will begin on this project in the summer of 2009. Research to address Objectives 1 and 2 will be initiated in August, 2009 on six farms. Research will be conducted on each farm for two years. Development of a Grain Cropping Systems group on eOrganic will begin in 2009 and will continue through the duration of the project. We will hold two on-farm field days each year, one in spring and one in fall, in one of the areas in which on-farm research is being conducted. The regional conference will be held in March of 2010, 2011, and 2012. During the last year of the grant cycle we will compile data and summarize results for peer-reviewed scientific journal articles and outreach publications.

APPROACH

On-farm research will be conducted at six locations, selected to represent the range of environmental conditions and organic grain cropping management systems found in the mid-Atlantic region. Treatments at all locations will be arranged in a randomized complete split-block design with four replications. The split treatment factors will be alternative legume treatments imposed across four poultry litter management strategies. Each experiment will be conducted twice on each farm, once in 2009 to 2010 and once in 2010 to 2011, in adjacent fields with similar soil type and management history. On the three farms with alfalfa in the rotation, the legume management alternatives will be no alfalfa, and harvested vs. non-harvested spring growth of alfalfa prior to termination and subsequent planting of the summer cash crop. On farms where perennial legumes are not part of the rotation, the legume treatments will be a comparison between crimson clover, hairy vetch and no-cover (winter weeds) to serve as the control. The poultry litter treatments will be: i) an N based application broadcast at legume termination; ii) a P based application broadcast at legume termination; iii) a P based application placed in a narrow band between the rows when corn is about 10 to 12 in. tall; and iv) a control with no poultry litter applied. We will evaluate the influence of each legume - manure management combination within and across farming systems on productivity, N use efficiency, environmental performance, profitability, and weed populations using analysis of variance with the mixed procedure of SAS. Results from on-farm research will be shared using six on-farm field days. Annual organic grain and forage workshops will be held to discuss organic grain production and share results from on-farm and related work. We will establish a new Organic Grain Cropping systems interest group on the eOrganic website to facilitate communications, education and collaborations among researchers, educators, agricultural professionals and farmers working with organic grain crops across the country. Evaluation of the project will follow the logic model. We will hold annual meetings in 2011 and 2012 with our collaborating farmers in association with the annual meeting of the Maryland Organic Food and Farming Association or of Future Harvest/Chesapeake Alliance for Sustainable Agriculture. We will seek input on outputs, outcomes, and impact of the project to date. The evaluation plan will include an assessment of the outreach materials. Success of the research portions of the project will be determined based on data analysis and summary. We will adapt surveys previously developed by the Maryland Department of Agriculture to evaluate the effectiveness of field days and the annual workshops. Surveys will be distributed to cooperating producers, field day participants and Cooperative Extension personnel to assess pre- and post-knowledge gain and adoption of Best Management Practices.

PROGRESS

2009/09 TO 2014/04 Target Audience:Our target audiences were organic farmers in the mid-Atlantic region and nationally, Extension and other agricultural professionals (e.g. NRCS, private consultants etc) that serve organic farmers, and other scientists. Changes/Problems:Due to very wet weather conditions in the fall of 2009, no farmers were able to plant cover crops that year so the project start date was delayed one year. Two farmers were not able to complete the on-farm research component due to challenging managment consideration so the originally planned 12 site years was reduced to 8 site years. The postdoc who initiated all the on-farm field work left the project during the second year of field work so the bulk of the work was subsequently coordinated by a technician who was able to process all samples\--with the help ofstudent labor\--and summarize the data. The technician, however, was not qualified to write papers to submit to scientific journals. These papers, however, are now being completed but their publication has been delayed. By being granted two years of unfunded extension we have been able to provide two additional years of support to the annual Queen Anne\'s County Organic Workshop, the primary organic workshop in the mid-Atlantic region. These extensions have provided important support to the organic farming community in the region. What opportunities for training and professional development has the project provided?Nine leading organic research and extension personnel (Ellen Mallory,

Cathleen Delate, Charles Shapiro, Lauren Kolb, Chris Reberg-Horton, Michel Cavigelli, Steven Mirsky, Jude Maul, Betty Marose) from across the US attended a Grain Cropping Systems Community of Practice Intensive Workshop on February 27 - March 1, 2012 in Maryland. Financial support for participant travel, lodging and per diem was provided by eOrganic.eOrganic personnel provided training during the intensive for all CoP participants in posting articles, tables, and photographs. Draft articles from seven authors were loaded onto the eOrganic site and contributors were identified for additional articles, webinars, and videos. Six articles have been published on the eOrganic Grain Cropping Systems Community of Practice, four have been drafterd, and four are in various stages of review. Two project members attended the national eOrganic Envisioning Workshop in November, 2012 in Portland, OR. These project members linked eOrganic with the USDA Organic Working Group to facilitate partnership opportunities. One project member attended the National eXtension Conference in Louisville, KY in 2011. The Annual Queen Anne\'s County Organic Workshop was supported for five years (2010-2014). This is the primary organic workshop in the mid-Atlantic region. Keynote speakers were selected from across the country to introduce novel ideas to the mid-Atlantic organic farming community. Regional and local speakers and workshop leaders led discussions regarding issues of organic farming. How have the results been disseminated to communities of interest?Research results have been disseminated via three newsletter articles, one factsheet, two on-farm field days, one on-station field day, and three presentations at local meetings. A poster and handouts titled \"eXtension and eOrganic: Bringing Information to You 24/7\" were presented at nine farmer meetings between 2011 and 2013 to increase public awareness of eOrganic and eXtension. Also, one talk was given at a regional meeting for the same purpose. The eOrganic Grain Cropping Systems Community of Practice was established and six articles on various aspects of organic grain management have been published on the eOrganic site. Additional articles are in the draft or review stages. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09 TO 2012/08 OUTPUTS: We finished the first year and conducted the second year of on-farm research at four locations. We held one field day at USDA-ARS-BARC in Beltsville, MD on August 28, 2012 to highlight research supported under this grant. Four SASL scientists and two graduate students gave presentations attended by about 110 people. We helped organize the 7th Annual Organic Grains, Forages and Vegetables Workshop held in Queen Anne\'s County on March 6th, attended by about 125 people. We presented results from the first year of on-farm research. The talk was highlighted in the leading local agricultural newspaper, The Delmarva Farmer, and other agricultural media. We hosted a multi-state collaborator and farmer stakeholder meeting to inform on-station and on-farm organic grain production research trials (19 participants). We continued developing the Grains Cropping Systems Community of Practice (CoP) on the eOrganic website. We organized a 3-day Intensive Workshop on February 27 - March 1, 2012, bringing together nine of the top US organic grain researchers who are also actively engaged in outreach to develop long-term and short-term plans for developing the website. Draft articles from seven authors were loaded onto the eOrganic site and contributors were identified for additional articles, webinars, and videos. We helped plan and organize and attended the eOrganic Envisioning meeting held Nov. 4-6, 2012 in Portland, OR. We linked eOrganic and USDA Organic Working Group personnel to facilitate discussion of potential partnership opportunities. We captured video footage and still photos from all stages of the research and are developing a script for a short project video to post on the web. We made 11 presentations to diverse audiences composed of farmers, scientists, agricultural professionals and policymakers regarding the research supported by this grant. We provided consultations with USDA RMA about nitrogen release from diverse materials and weed control methods used in organic farming to help evaluate farmer payments in the federal crop insurance program; with the Los Angeles Times regarding a study published in Nature on crop yields in organic cropping systems; with Chris Lawrence, NRCS, on the value of crimson vs. red clover as a cover crop; with U.S. EPA on ecosystem services provided by organic cropping systems; with Perdue AgriRecycle LLC, on results of our research on N availability of pelletized poultry litter for organic corn production; with World Wildlife Foundation on organic agriculture; with a regional and national NRCS team from the Plant Material Centers on cover crop management and approaches to removing barriers to cover crop adoption; with the Union of Concerned Scientists on organic no-till production; with the Organic Farming Research Foundation and USDA-ARS Organic Program Leader for a tour of ARS organic research; with USDA-ARS Chief Scientists on organic research and cover crops. PARTICIPANTS: John Spargo coordinated and participated in all on-farm research and outreach until October, 2011. Grace Garst helped conduct all aspects of the research. Victoria Lake helped conduct all aspects of the research until January, 2012. Betty Marose worked on all outreach aspects of the project including eOrganic, tours and video; and helped conduct on-farm research. Michel Cavigelli (PI) coordinated and helped conduct all aspects of research and outreach. Steven Mirsky (co-PI) helped plan and conduct all aspects of research and made presentations at field days. Jude Maul (co-PI) helped conduct research and make presentations at field days. Jenny Rhodes and John Hall (retired), Maryland Cooperative Extension, and Karen Fedor, Maryland Department of Agriculture, along with project PIs and co-PIs organized the Annual Queen Anne County Organic Grain, Forage and Vegetable Workshop. The workshop was co-sponsored by Future Harvest/Chesapeake Alliance for Sustainable Agriculture; Maryland ACReS, a mediation branch of the

Maryland Department of Agriculture; Maryland Agricultural And Resource-Based Industry Development Corporation; Maryland Department of Agriculture Crop Insurance; National Center for Appropriate Technology; Northeast Sustainable Agriculture Research and Extension; Organic Valley/CROPP Cooperative; Queen Anne\'s Soil Conservation District; and Walls Irrigation. Aaron Cooper, Bill Mason, and Ed Fry helped conduct the research on their farms. Gwen Bagley, Alex Welsh, Christopher Chapman, William Marose, Ruth Mangum, Chris Rasmann, Kyle Cuilla, and Louis Thorne assisted in many on-farm research and laboratory aspects of sample collection and analysis. Aaron Solomon provided advice on video equipment and technique. John McQueen, Alice Formiga, and Alex Stone of eOrganic provided technical assistance with developing an eOrganic Grains Community of Practice. TARGET AUDIENCES: Our primary target audience is organic grain farmers and those considering transitioning to organic methods in the mid-Atlantic region, who are underserved with respect to science-based recommendations for nutrient management. In addition, we also serve agricultural professionals working with organic grain farmers (Cooperative Extension, Natural Resources Conservation Service, Soil Conservation Districts, State Departments of Agricultural, crop consultants, nutrient management advisors, crop insurance agents, agribusiness personnel, etc). PROJECT MODIFICATIONS: We had to delay the start of the project by one year due to extremely wet weather in the fall of 2009, which did not allow any on-farm collaborators to plant cover crops, an important component of the on-farm research. We have received a one-year no cost extension to account for this modification.

2010/09/01 TO 2011/08/31 OUTPUTS: We conducted the first year of on-farm research at four locations, including planting cover crops in the fall, applying manure applications in the spring and collecting cover crop, soils and corn data throughout the year. We conducted one field day to highlight the research at Eden, Maryland on August 1, 2011, attended by about 50 people. We helped organize and otherwise support the 6th Annual Organic Grains, Forages and Vegetables Workshop in Queen Anne\'s County on March 8th, attended by about 100 people from Maryland, New Jersey, Delaware, Pennsylvania, and Virginia. We developed a presentation on Nutrient Management on Organic Farms, which was presented at the Queen Anne meeting and at several other occasions during the year. We also initiated the Grains Systems Community of Practice on the eOrganic website and planned the first Intensive to develop content and an executive committee to shepherd this project. PARTICIPANTS: John Spargo coordinated and participated in all the on-farm research, made presentations at field days and workshops on nutrient management in organic systems. Grace Garst helped conduct all aspects of the research. Victoria Lake helped conduct all aspects of the research. Betty Marose worked on all outreach aspects of the project and helped conduct on-farm research. Michel Cavigelli (PI) coordinated and helped conduct all aspects of research and outreach. Steven Mirsky (co-PI) helped plan and conduct all aspects of research and made presentations at field days. Jude Maul (co-PI) helped conduct research and make presentations at field day. Jenny Rhodes and John Hall, Maryland Cooperative Extension, and Karen Fedor, Maryland Department of Agriculture, organized the Annual Queen Anne County Organic Grain, Forage and Vegetable Workshop. Aaron Cooper, Bill Mason, and Ed Fry helped conduct the research on their farms. John McQueen, Alice Formiga, and Alex Stone of eOrganic provided technical assistance with developing an eOrganic Grains Community of Practice and conducting webinars. Organic Valley and Horizon Dairy helped sponsor the Annual Queen Anne\'s workshop. Training or Professional Development A postdoc, John Spargo, has been provided professional development opportunities in conducting on-farm organic research. Eight additional students and technicians (including those paid by other sources and volunteers) have been provided the opportunity to conduct certain aspects of on-farm research and have attended outreach programs. Betty Marose received training on eOrganic website management. TARGET AUDIENCES: Our primary target audience is organic grain farmers and those considering transitioning to organic methods in the mid-Atlantic region, who are underserved with respect to science-based recommendations for nutrient management. In addition, we also serve agricultural professionals working with organic grain farmers (Extension, NRCS, state agricultural agencies, crop consultants etc). PROJECT MODIFICATIONS: We had to delay the start of the project by one year due to extremely wet weather in the fall of 2009, which did not allow any on-farm collaborators to plant cover crops, an important component of the on-farm research. In addition, one farmer dropped out of the program and a second farmer made a management mistake on his plots, which negated the value of the research initiated on his farm. In response, we added a new on-station site to the program. We have requested a one-year no cost extension to account for these modifications.

2009/09/01 TO 2010/08/31 OUTPUTS: None of the farmer cooperators in this project were able to plant winter cover crops in fall 2009 due to very wet fall weather. Therefore, we delayed the start of on-farm research until fall 2010. During 2010 we finalized detailed experimental designs in consultation with farmers (planning experiments, identifying fields on farms where experiments will be established, and purchasing seed and other materials). We made a presentation outlining the nascent research program at the 2010 Queen Anne\'s County Organic Grain Production Workshop in March, a conference that was organized by members of our project team. About 100

people attended this conference. We have hired a postdoc to coordinate the on-farm research components of the project and we have interviewed and selected a candidate to fill the position of support scientist. PARTICIPANTS: Michel Cavigelli, PI, coordinated all aspects of the project and visited farms to finalize experimental designs with farmers. He made a presentation about the project at the 2010 Queen Anne\'s County Organic Grain Production Workshop (QACOGPW). Steven Mirsky, co-PI helped finalize experimental designs in concert with the PI and farmers and made a presentation at the QACOGPW about weed control in organic systems. John Spargo, who was hired as a postdoc using project funds, developed detailed research plans, visited farms, purchased seed and other materials and made a presentation about soil fertility on organic farms at the QACOGPW. Maryland Cooperative Extension and Maryland Department of Agriculture, along with USDA-ARS, organized the 2010 QACOGPW. TARGET AUDIENCES: About 100 members of the target audience\--farmers, agricultural professionals, and agency personnel\--attended the 2010 Queen Anne\'s County Organic Grain Production Workshop in March. PROJECT MODIFICATIONS: We delayed the beginning of the research phase of the project by one year since none of the cooperating farmers were able to plant cover crops, a major focus of the research, due to very wet weather in fall 2009. Since the outreach coordinator is also involved in the research component of the project we also delayed hiring a support scientist to fill this role by about one year. We anticipate requesting a one-year unfunded extension of the project to account for these delays.

IMPACT

2009/09 TO 2014/04 What was accomplished under these goals? Two years of on-farm research were conducted and results are being compiled for publication in scientific journals. Results show that legume cover crops are often sufficient to provide the nitrogen needs of an organic corn crop in the mid-Atlantic region and that supplemental poultry litter can be applied at phosphorus replacement levels, thereby reducing reliance on animal by products. Two on-farm field days were held to highlight on-farm research. The regional conference was held during five years, 2010-2014, since the project was extended (unfunded) for two years. The results have been disseminated infournewsletter articles and factsheets, two on-farm field days, one on-station field day, and two presentations at local meetings. In addition, aspects of the research were included in two scientific publications **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/04 1. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Marose, B.H., M.A. Cavigelli, J.T. Spargo, S.B. Mirsky, J.E. Maul, J.R. Teasdale. 2011. Establishing the e-Organic grain cropping systems community of practice. ASA-CSSA-SSSA Annual Meetings, San Antonio, TX 2. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Marose, B.H., M. Cavigelli, K. Delate, E. Mallory, C. Shapiro, L. Kolb, C. Reberg-Horton, J. Maul and S. Mirsky. 2012. Growing the eOrganic Grains Community. ASA-CSSA-SSSA Annual Meetings, Cincinnati, OH 3. Type: Websites Status: Published Year Published: 2012 Citation: O?Reilly, M. (in collaboration with B.H. Marose) 2012. Extension Tips for Organic Grains Producers. USDA Blog, June 5. http://blogs.usda.gov/2012/06/05/extension-tips-for-organic-grains-producers/ 4. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Marose, B.H. Navigating eXtension. 8th Annual Organic Grain and Vegetable Production Training. Chesapeake College, Wye Mills, MD. Mar. 12, 2013. 5. Type: Websites Status: Published Year Published: 2010 Citation: Cavigelli, M. 2010. Impact of Organic Grain Farming Methods on Climate Change Webinarhttp://www.extension.org/pages/30850/impact-of-organic-grain-farming-met hods-on-climate-change-webinar#.VfC8kBFVhHw 6. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Spargo, J., M.A. Cavigelli, S. Mirsky, J. Meisinger. 2011. Evaluation of Supplemental N Source and Timing of Application for Organic Field Corn Production Following a Vetch Cover Crop. ASA-CSSA-SSSA Annual Meetings, San Antonio, TX

2011/09 TO 2012/08 Results from the first year of on-farm research show that poultry litter can be applied at phosphorus replacement rates (\~1.5 ton/a) without sacrificing corn yield relative to when poultry litter is applied to meet corn nitrogen needs (\~3 ton/a). This is an important finding because it suggests that manure application rates could be reduced on organic farms, thereby decreasing phosphorus loading rates and the potential for subsequent losses and pollution problems. Final impacts await completion of the second year data analysis. In a post tour evaluation of the USDA-ARS-BARC Field Day on August 28, 2012, 58% of respondents said they learned a lot or a great deal and 37% learned a moderate amount about integrating cover crops and animal wastes for agricultural sustainability. When asked how they would use what was learned, 48% would seek more information, 26% would implement on their farm, 39% would advise or train others, 22% would incorporate in education materials, and 52% would use in program and policy development. A clicker-based classroom evaluation of the 7th Annual Maryland Organic Grains, Forages, and Vegetables Workshop on March 6, 2012, found that approximately 18% of attendees were gathering information to become organic farmers and 36% identified themselves as current farmers/producers. More than two-thirds of attendees had been engaged in

organic production for less than 10 years and in contrast to traditional farm audiences which are overwhelmingly male, 43% of attendees were female. Greatest challenges were identified as weather (26%), pests and diseases (25%), input costs (13%), wildlife damage (13%), regulations (10%), and markets (8%). Things that partners/stakeholders could do to assist this sector of production agriculture included: increase applied or on-farm research (34%); sponsor more outreach and education sessions (26%); have more boots on the ground, work in the field (25%); and provide more web-based information (15%). Research was highlighted in the popular press: Baragona, S. 2012. Blended Organic-Conventional Farming Could Feed World. Interviewed and filmed M. Cavigelli and farmer/cooperator W. Mason for Voice of America article and video. Delmar Daily. 2012. OREI-funded on-farm research highlighted at http://delmardaily.blogspot.com/2012/03/nutrient-management-on-organi c-farms.html Elben, M. 2012. Nutrient management on organic farms still highly variable. The Delmarva Farmer, March. http://www.americanfarm.com/publications/the-delmarva-farmer/1201-nut rient-management-on-organic-farms-still-highly-variable Khan, A. 2012. Organic farming, carefully done, can be efficient. LA Times, April 26. Quoted in article. http://articles.latimes.com/2012/apr/26/science/la-sci-organic-farmin g-20120426 O\'Reilly, M. (in collaboration with B.H. Marose) 2012. Extension Tips for Organic Grains Producers. USDA Blog, June 5. http://blogs.usda.gov/2012/06/05/extension-tips-for-organic-grains-pr oducers/ Smith, M. 2011. Organic research activities of the USDA\'s ARS. ICROFS Newsletter, September, p. 15-16. Sustainable Agricultural Systems Lab organic research highlighted. **PUBLICATIONS (not previously reported):** 2011/09 TO 2012/08 1. Cavigelli, M.A., S.B. Mirsky, J.R. Teasdale, J.T. Spargo, J.W. Doran. 2013. Organic grain cropping systems to enhance ecosystem services. Renewable Agriculture and Food Systems. Available on CJO2013. doi:10.1017/S1742170512000439. 2. Spargo, J.T., M.A. Cavigelli, S.B. Mirsky, J.E. Maul. 2012. Nutrient Management on Organic Farms: Combining Cover Crops and Poultry Litter to Improve N and P Management in Corn. USDA-ARS-SASL Factsheet.

2010/09/01 TO 2011/08/31 On-farm research provided numerous opportunities to discuss management details to improve nutrient management with organic farmers. More than 60% of farmers attending meetings identified a need for additional on-farm research to address the needs of organic farmers. Further impacts await completion of the first year of field research and further development of the eOrganic Grains Community of Practice.

2009/09/01 TO 2010/08/31 Due to the one year delay in the on-farm research component of the project, there are not yet any outcomes or impacts of the research component of the project. Participants at the Organic Grains Workshop indicated increased knowledge of organic grain crop production according to a survey conducted at the end of the workshop.

PUBLICATIONS

2010/09/01 TO 2011/08/31 1. Cavigelli, M. and J. Spargo. 2011. How does organic management impact soil nitrogen availability MOFFA newsletter, fall. http://www.marylandorganic.org/documents/MOFFAFall2010.pdf 2. Mirsky, S.B. 2011. Reduced tillage in organic grain rotations: Challenges and opportunities. MOFFA newsletter, winter. http://www.marylandorganic.org/documents/MOFFAwinter2011Newsletter-2. pdf 3. Cavigelli, M. and J. Spargo. 2010. BARC research: Nutrient management on organic farms. MOFFA newsletter, summer. http://www.marylandorganic.org/documents/MOFFANEWSSummer2010-1 000.pd f 4. Spargo, J.T., M.A. Cavigelli, J. Maul, S.B. Mirsky, J.J. Meisinger, and J. Buyer. 2010. Labile soil organic matter and mineralizable soil nitrogen pools in response to management history. ASA-CSSA-SSSA Annual Meeting, presentation 59-3. http://a-c-s.confex.com/scisoc/2010am/webprogram/Paper61024.html 5. Reberg-Horton, S.C., S. Mirsky, M. Cavigelli, J. Teasdale, R. Heiniger, A. Meijer, A.K. Culbreath, C. Crozier, G. Place, L. Grabau, H. Schomberg, J. Grossman, W. C. Johnson, and E.G. Cantonwine. 2010. Challenges and Opportunities with Organic Grain Production in the Southeast. ASA-CSSA-SSSA Annual Meeting, presentation 280-2. http://a-c-s.confex.com/scisoc/2010am/webprogram/Paper57730.html

2009/09/01 TO 2010/08/31 No publications reported this period

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Plant Breeding and Agronomic Research for Organic Hop Production Systems

Accession No.	0218882
Subfile	CRIS
Project No.	WNP06281
Agency	NIFA WN.P
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05598
Proposal No.	2009-01383
Start Date	01 SEP 2009
Term Date	31 AUG 2013
Grant Amount	$0
Grant Year	2009
Investigator(s)	Murphy, K. M.
Performing Institution	Crop & Soil Sciences, WASHINGTON STATE UNIVERSITY, 240 FRENCH ADMINISTRATION BLDG

NON-TECHNICAL SUMMARY

The recent worldwide hops shortage has led to an increase in the price of hops from \$5 to \$32 per pound. This has spurred an increase in conventional hop plantings; however, due to agronomic obstacles, organic hop acreage lags far behind. Sales of organic beer have been increasing even faster than the organic industry as a whole at a rate of 30-40% per year, reaching \$25 million in 2006. To meet this demand, large companies like Anheuser Busch are currently importing organic hops from Germany and New Zealand. Anheuser Busch and smaller microbreweries including New Belgium and Odell 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) 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. The research described within this proposal is focused on meeting the multiple critical agronomic needs of the organic hop industry.

OBJECTIVES

The long term goals of this project are to: 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 improve soil health, sequester carbon, supplement nitrogen fertility needs and ameliorate nitrogen loss, suppress weeds, provide habitat for beneficial insects, and enhance the productivity and quality of hops; 3) Evaluate differences in carbon sequestration potential between organic and conventionally managed hop systems; 4) Develop educational materials, training days and tools for Cooperative Extension personnel; and, 5) Increase acreage of low-input and organic hops and provide alternatives to high input conventional growers to use systems approaches to reduce production costs. The objectives of this research are to: 1. Formalize an advisory committee of organic and low-input hop growers and establish roundtable discussions between farmers, extension personnel and researchers; 2. Identify high quality hop varieties optimally adapted to low-input and organic production systems in different regions of the U.S. or identify parental lines carrying important traits that can be combined to develop optimal varieties; 3. Identify cover crop management strategies that suppress weeds, disease and insect pests, improve soil health and nitrogen fertility, and positive hop cultivar interactions; 4. Evaluate the potential for carbon sequestration in organic as compared to conventionally managed hop systems; 5. Use quantitative genetic techniques to determine gene action, heritability and anticipated response to selection of particular traits important to organic hop production; 6. Conduct effective outreach through field days on growers fields in WA, CO, MI and VT, and publish results in a wide range of media; and, 7. Develop an educational product, entitled the Handbook of Sustainable Hop Production, for growers focusing on organic, low-input and biologically diverse hop production. We expect to identify which leading hops varieties will perform best in organic systems. This should have immediate impacts in helping farmers transitioning to organic hop production decide which varieties to plant. In addition, this information will be utilized by breeders in the selection of parents for use in organic breeding efforts. We will identify cover crop management strategies that are optimally suited for suppressing weeds, improving soil health, sequestering soil carbon, supplementing N needs, and providing habitat for beneficial insects. In an emphasis on systems research, we will greatly increase available knowledge of hop varietal interactions with hop yard management options, specifically intercrops and cover crops. We anticipate that these interactions will be significant both statistically and agronomically when measured in terms of the many components necessary to achieve a productive low-input and organic hop growing operation. All these outcomes revolve around increasing grower knowledge, awareness and participation.

APPROACH

Multi-state Variety Trials: Rhizomes of 20 hop varieties will be planted in a lattice square design with three replicates (five rhizomes per replicate) on two farms in Washington. They will be evaluated throughout three growing seasons for resistance to the predominant races of powdery mildew and downy mildew. Significant genotype x location interactions for resistance to either disease will be considered as potential evidence for race specificity. If this occurs, isolates will be purified from each location and tested in greenhouse assays to determine if different races are present and if any of the resistances are race-specific. Aphid and mite resistance will be determined through leaf sampling and subsequent counting of pest levels on the collected leaves. Cone yield will be estimated and results will be analyzed through standard statistical analysis of variance procedure. Spearman\'s rank correlation will be used to rank varieties for all traits across locations. Breeding Line Evaluation: This research will be conducted on the Perrault Farm in Washington State. Five crosses were made in 2006 by Jason Perrault with the purpose of selection in organic systems. Rhizomes of approximately 60 progeny from each cross were planted in an organic field on Perrault Farms in 2008. We will evaluate the breeding lines for powdery mildew, mite and aphid resistance, growth habit, height, alpha and beta acid content, and cone yield. After harvest, hop cones will be dried to approximately 8% moisture for all chemical analyses. Chemical analyses will be performed using HPLC according to standard methods. Cone yield and quality, percent infection by powdery mildew, and aphid and mite thresholds will be evaluated. Both insect pests and beneficial insects will be monitored by Jason Perrault and the Perrault farm agronomist (both experienced at insect identification and monitoring) on a weekly schedule. Population levels will be determined through leaf sampling and subsequent counting of pest/predator levels on the collected leaves. Predator species are described in the cover crop trial detailed below. Cover Crop Management Trial: This research will be conducted on the Perrault farm in Washington State, and smaller trials will be conducted on one farm in both Colorado and Michigan. Cover crop strategies were chosen by farmers based on previous experience or results using these cover crops in other perennial organic systems, such as orchards and vineyards. Cover crops established in the drive row will need to be perennial, drought and frost tolerant, produce a large amount of biomass and provide a lengthy season of beneficial insect habitat. In-row cover crops will need to be low growing and good competitors against weeds while not out-competing hops, especially during emergence and early growth stages of hops. We will evaluate the impacts of cover crop treatments on soil health, carbon sequestration potential, nitrogen availability, and hop

nutrition. Additionally, we will evaluate cover crops for biomass, beneficial insect habitat and weed suppression ability; and evaluate hop varieties for agronomic traits, disease incidence and insect populations.

PROGRESS

2009/09 TO 2013/08 Target Audience: Organic hops farmers, conventional hops farmers interested in utilizing organic methods or transitioning to organic hops farming, organic brewers, home gardeners and hops consumers. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Please see the \'other products\' section of this report for extensive training and professional development opportunities provided. How have the results been disseminated to communities of interest? Please see \'products\' and \'other products\' sections of this report for extensive examples of result dissemination. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 OUTPUTS: Output highlights include the completion of the multi-year, multi-location variety trials. These were conducted in Washington State, Michigan and Vermont. Data is currently being analyzed and will be reported in 2013. Additionally, the multi-year cover crop x variety trial was completed. This was conducted in the Yakima Valley of Washington State. Results are fully analyzed and a manuscript is currently being prepared for publication. Graduate student Sam Turner completed his MS in Crop Science in 2012; his thesis focused on the cover crop trials in an organic hop yard. A second student, Erin Hightower, is scheduled to complete her MS in Agriculture in Spring 2013; her research focuses on soil fertility and organic variety trials at two locations in the Yakima Valley. PARTICIPANTS: Sam Turner, Erin Hightower, Chris Benedict, Heather Darby, Rob Sirrine, Lori Hoagland, Kevin Murphy TARGET AUDIENCES: Organic hop farmers PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: Several outputs occurred in the penultimate year of this project. First, in an effort to connect with organic hop growers, we participated in a field day at the Washington State University Organic Farm in Pullman, WA and organized a hop variety trial and short trellis demonstration. Both Sam Turner (a graduate student working on this project) and Kevin Murphy spoke at this field day during the tour and met with farmers before and after the tour for a more in-depth discussion of organic hops. Second, 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. Hops from this hop yard were planted, tended, and harvested by WSU students. Third, 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. Fourth, Rob Sirrine of Michigan State University and Brian Tennis of Michigan Hop Alliance produced a webinar titled \'Starting up Small-Scale Organic Hop Production\' through eOrganic. Fifth, over the past 12 months Heather Darby and Rosalie Madden of University of Vermont Extension conducted five workshops on organic hop production in Vermont. Sixth, Heather Darby gave a presentation titled \'Building a Hops Industry in New England\' at the New Hampshire Farm and Forest Conference. Seventh, Rob Sirrine provided consultation to over 50 farmers and potential new farmers in Michigan to assist in their start-up hop production and marketing enterprises. Eighth, 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. PARTICIPANTS: The list of individuals working on this project is the same as in the previous progress report - \"nothing significant to report in this area\". Regarding partner organizations, we worked with members of the American Organic Hop Growers Association throughout the year to further develop and improve the project. Significant effort directed toward farmer training in hop production was made over the past 12 months, with PI\'s and key personnel giving over a dozen talks, workshops and field days in Washington, Michigan, Vermont, New Hampshire and Canada. TARGET AUDIENCES: Organic hop growers are the primary target audience of this research project. Our efforts at targeting this audience over the past 12 months included regional field days, webinar development, workshops, presentations and consultations (described above). These reached well over 1000 people. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Activities: Twenty hop varieties were planted in 2010 at three locations in Washington State, two locations in Michigan and one location in Vermont in a fully replicated and randomized design to test for varietal adaptation to organic hop systems. No data have been collected at this point; hop plant establishment is the primary goal of year 1 of this study. Four hop varieties in combination with eight cover crop treatments were planted in organic hop yards in Washington State and Michigan to test for: weed suppression

ability of cover crops, fertility enhancement, effects on aphid and spider mite populations and hop cone yield and quality. As with the variety trials, hop plant and cover crop establishment were the primary goals for 2010. In-depth data collection will begin in the spring of 2011. A nitrogen use efficiency pilot study is underway in a WSU greenhouse. Eight varieties are being tested for several nitrogen-use related traits under four different nitrogen regimes. One M.S. graduate student, Sam Turner, is being advised by Kevin Murphy at WSU and Sam\'s primary project will be to conduct the cover crop field trials and greenhouse nitrogen use efficiency trials. Events: On January 23, 2010, Kevin Murphy gave an invited talk at the American Hop Convention to approximately 150 hop growers, researchers, brewers and hop commission representatives, entitled \'Plant breeding and agronomy of organic hops\'. An organic hop symposium was held in the Yakima Valley in Washington State September 6-10, 2010. This symposium was a combination of a project director\'s meeting, the bi-annual advisory committee meeting, and hop production training workshop. Approximately 40 people participated, including farmers,researchers, writers, hop commission representatives and brewers from Washington, California, Colorado, Vermont, Indiana and Michigan. This symposium also included 1) training and field trips to multiple demonstration sites for organic hop production and processing, and 2)workshops for new hop farmers delivered by WSU scientists and experienced hop growers. PARTICIPANTS: Individuals: Kevin Murphy: WSU Assistant Research Professor, serving as the plant breeder and agronomist for this project; Coordinated multi-state variety trials and cover crop trials; organized project directors meeting, advisory committee meeting and organic hop symposium in 2010; faculty advisor for a graduate student working entirely on this organic hops research project. Lori Hoagland: Purdue University Assistant Professor, serving as soil scientist for this project; Conducted preliminary soil analyses from the cover crop study in Washington and Michigan and from the multi-state variety trials; instrumental in setting up soil microbial diversity and community analyses. Heather Darby: Extension and Adjunct Faculty, University of Vermont; coordinated cover crop and variety trials in Vermont; participated in and helped organize the project directors meeting and organic hop symposium; organized hop outreach workshops in Vermont. Scot Hulbert: WSU Professor of Cropping Systems Pathology; helped develop protocol for future disease assessments. Rob Sirrine: County Extension Director, MSU Extension; coordinator cover crop and variety trials in Michigan; participated in and helped organize the project directors meeting and organic hop symposium; conducted hop outreach workshops in Michigan. Collaborators: Active on-farm collaborations were established with the following growers: Jason Perrault, Patrick Smith, Michael Roy (Washington); Roger Rainville (Vermont); Brian and Amy Tennis (Michigan). Additional collaborations include: Peter Simonson, Associate Professor of Communications, University of Colorado; Ann George, Washington Hops Commission; Lau Ackerman, Sierra Nevada Brewing Company; Meghann Quinn, Executive Director, American Organic Hop Growers Association. Training: Graduate student: Sam Turner, MS in Crop Science at Washington State University. Enrolled August 2010. Farmer training: A pilot farmer training workshop occured during the organic hop symposium in Washington State in September 2010. Additional trainings for farmers occured in Vermont and Michigan. TARGET AUDIENCES: Target audiences included organic hop growers and brewers of organic beer. Hop growers targeted were primarily in the communities of the Yakima Valley in Washington State and throughout Michigan and Vermont. Efforts to deliver science-based knowledge in 2010 included multiple workshops and trainings in Washington, Michigan and Vermont that utilized scientific knowledge and farmer experience to educate growers and brewers on organic hop production techniques, suitable varieties and small-scale harvest and processing capacities. PROJECT MODIFICATIONS: Major changes Dr. Ron Godin of Colorado State University changed positions and was no longer able to conduct field trials in Colorado. Chris Benedict, Pierce County Extension, WSU, joined the project team in Dr. Godin\'s place and organized variety trial plantings on two farms in the unique climate of western Washington. Additionally, we decided to ship live, rooted hop plants to Michigan and Vermont to enable screening for powdery mildew before shipment. This added a significant amount to the budget allocated for shipping, but can be made up elsewhere.

IMPACT

2009/09 TO 2013/08 What was accomplished under these goals? 1. Varieties which performed optimally in organic systems were identified. 2. Extensive farmer trainings occurred in target regions in the US. 3. Cover crops with the superior ability to suppress weeds in organic hopyards were identified. 4. Cover crops were identified that most improved soil quality in organic hopyards. 5. Multiple publications, webinars, videos and other outreach media were developed and shared with stakeholders. 6. Two graduate students focusing on organic hops production successfully completed their degrees. **PUBLICATIONS (not previously reported):** 2009/09 TO 2013/08 1. Type: Journal Articles Status: Published Year Published: 2011 Citation: Turner, S.F., Benedict, C.A., Darby, H., Hoagland, L., Simonson, P., Sirrine, J.R., Murphy, K. (2011). Challenges and opportunities for organic hop production in the United States. Agronomy Journal 103: 1645-1654. 2. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Turner, S.F., Murphy, K. (2011). Evaluating cover

crops for weed suppression in organic hopyards. ASA-CSSA-SSSA 2011 International Annual Meeting, Oct 16-19, San Antonio, Texas. 3. Type: Other Status: Published Year Published: 2011 Citation: Darby, H. (2011). Fertility Guidelines for Hops in the Northeast. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/HopFertility ManagementNE.pdf 4. Type: Other Status: Published Year Published: 2011 Citation: Darby, H., R. Madden, D. Badger. 2011. Organic Fungicides on Hops. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/organic-fung icides-and-hops.pdf 5. Type: Other Status: Published Year Published: 2011 Citation: Madden, R. and H. Darby. 2011. Managing Powdery Mildew of Hops in the Northeast. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/PowderyMilde w.pdf 6. Type: Other Status: Published Year Published: 2011 Citation: Kittell-Mitchell, S. and H. Darby. 2011. Leaf Hoppers a Pest of Hops in the Northeast. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/Leaf Hopper Article.pdf

2011/09/01 TO 2012/08/31 The varieties best suited for organic production were identified. These were based on traits including cone yield and quality, disease resistance, chlorophyll content, and insect pest resistance. The impact of this will be seen in upcoming years as new acreage is planted and new contracts with brewers are negotiated. Additionally, the best cover crops for hopyards in the dry environment of the Yakima Valley of Washington State were also identified. These were based on weed suppression and cover crop biomass. The impact of this study will also be seen in the adoption of cover cropping to replace tillage as the primary mode for weed control in organic hopyards. Soil fertility research is ongoing and is scheduled to be completed in 2013.

2010/09/01 TO 2011/08/31 The outcomes and impacts of this project are ongoing and will be best reflected at the end of the study. Preliminary impacts include a change in knowledge of participating scientists, extension personnel and farmers to the very real challenges inherent in organic hop production across the U. S. This led to a peer-reviewed publication in Agronomy Journal (see Publications) and a webinar that can be viewed on eOrganic (see Outputs). Changes in action occurred in the 2010 and 2011 growing seasons. Several farmers involved in the project had a successful year in organic hop production as a result of initiating innovative farming practices and novel production methods. These successful and promising changes in action led to a very significant change in conditions in the organic hop community. The American Organic Hop Growers Association spearheaded an effort to delist hops from the organic exemption list and this motion was approved by the National Organic Standards Board in November 2010. Therefore, all certified organic beer will be required to use certified organic hops beginning in 2013.

2009/09/01 TO 2010/08/31 Change in knowledge: The organic hop symposium resulted in several examples of changes in knowledge. Farmers from Michigan and Vermont discovered novel hop production techniques from speaking with Washington State farmers that will result in alterations to growing practices. Prinicpal among these novel hop production techniques included low-trellis system production, irrigation and misting practices, insect monitoring schedules and methods, hop variety x system interactions, harvest technology that will be suitable for scaled-down organic hop processing and plant spacing/tillage methods. Additionally, farmers from Washington, while well versed in hop production, learned about general organic agronomic practices from farmers and extension personnel/co-PI\'s from Michigan and Vermont. It is this union of advanced hop production expertise with knowledge and experience in organic production systems that spurred the most animated conversations during the symposium and resulted in greater knowledge for all participants. Additional changes in knowledge occured during the symposium from discussions with and presentations by WSU virologist Ken Eastwell and WSU hop breeder Stephen Kenny. We anticipate that these changes in knowledge in 2010 will result in significant changes in actions during the 2011 growing season.

PUBLICATIONS

2011/09/01 TO 2012/08/31 No publications reported this period

2010/09/01 TO 2011/08/31 1. Turner, S.F., Benedict, C.A., Darby, H., Hoagland, L., Simonson, P., Sirrine, J.R., Murphy, K. (2011). Challenges and opportunities for organic hop production in the United States. Agronomy Journal 103: 1645-1654. 2. Turner, S.F., Murphy, K. (2011). Evaluating cover crops for weed suppression in organic hopyards. ASA-CSSA-SSSA 2011 International Annual Meeting, Oct 16-19, San Antonio, Texas. 3. Darby, H. (2011). Fertility Guidelines for Hops in the Northeast. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/HopFertility ManagementNE.pdf 4. Darby, H., R. Madden, D. Badger. 2011. Organic Fungicides on Hops. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/organic-fung icides-and-hops.pdf 5.

Madden, R. and H. Darby. 2011. Managing Powdery Mildew of Hops in the Northeast. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/PowderyMilde w.pdf 6. Kittell-Mitchell, S. and H. Darby. 2011. Leaf Hoppers a Pest of Hops in the Northeast. http://www.uvm.edu/extension/cropsoil/wp-content/uploads/Leaf Hopper Article.pdf

2009/09/01 TO 2010/08/31 No publications reported this period

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Mental Models and Participatory Research to Redesign Extension Programming for Organic Weed Management

Accession No.	0218895
Subfile	CRIS
Project No.	OHO01045-SS
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Investigator(s)	Doohan, D. J.; Ernst, S.; Wilson, R.; Stinner, D.; Parker, J.; Tucker, M.; Gibson, K.; Smith, R.; Gallandt, E.; Riemens, M.
Performing Institution	Horticulture and Crop Science, OHIO STATE UNIVERSITY, 1680 MADISON AVENUE

NON-TECHNICAL SUMMARY

Despite recent USDA and land grant university engagement with organic producers, most still rely on informal farmer-to-farmer networks, the popular literature, and perceived experts for production information. Many organic farmers have not embraced practices known to mitigate ecological imbalances and contribute to long-term farm sustainability. Continued growth of organic farming will depend on efficient delivery and acceptance of research-based information. The long-term goal of our team is to facilitate full integration of scientific knowledge and technology into organic farming practice. We hypothesize that barriers to learning can be overcome through audience-specific educational programs that have been informed by in-depth understanding of what organic farmers\' know and believe along with their attitudes and current practices. We will \`lift the rug\' obscuring the barriers to effective broad-based knowledge transfer to organic farmers by using a mental models approach to address the relentless problem of weed management. Without better understanding of what and how growers think, increasing scientific knowledge about managing weeds will not efficiently facilitate growth in organic farming. This research fills a critical gap in our comprehension of the knowledge, beliefs, perceptions, values and practices of organic farmers. Understanding how they make decisions will allow us to design educational programs that match the needs of various farmers who may operate under widely divergent philosophical and economic models. Extension educators will be equipped to deliver these programs within a participatory environment that engenders trust and behavioral change. The research will yield biophysical information relating how the farmers\' different cognitive processes impact weed management strategies being used, and the outcomes in the field. In lieu of inventing new weed control procedures our goal in this long-term project, for which we request 48 months of funding, is to understand and then dismantle knowledge-based, social, and economic barriers to optimal adoption of ecologically-based practices already known to control weeds. We expect to produce immediate and tangible recommendations on how to broadly promote adoption of optimum weed management practices across diverse communities of organic producers. We anticipate that this knowledge will also be applicable to other disciplines educating organic producers.

OBJECTIVES

The projects long-term goal is to understand and then dismantle knowledge-based, social, and economic barriers to optimal adoption of current scientifically validated, ecologically-based practices already known to control weeds. Outreach will occur continuously as the project team engages growers, extension educators, and private crop advisors in participatory mental models and biological research, and development and testing of redesigned extension programming. Focused outreach opportunities will occur as the team develops and participates in the eOrganic Community of Interest focused on crop rotation, during the iterative design, delivery, and evaluation of redesigned extension programs, and through presentations made at grower organization and scientific meetings. Specific objectives are: 1. Determine the knowledge, beliefs, perceptions, and attitudes that underlie weed management practices and outcomes amongst organic farmers in Ohio, Indiana, California, northern New England, and The Netherlands. The primary expected outcome from this research is comprehensive knowledge about what farmers are doing to control weeds, why they do the things they do, and how effective these practices are. (Years 1 & 2). 2. Establish a learning community of growers, researchers and extension educators within the eOrganic Community of Practice to conduct case-study research on working farms, and outreach on the benefits of crop rotation for weed management. Tools and capacity to increase understanding of the ecological effects of crop rotations on weed communities will be developed through this aim. (Year 2 & 3). 3. Develop, disseminate, and evaluate the impact of differentiated educational programs and communication strategies designed to encourage adoption of scientifically-validated weed management practices for organic farming. The primary expected outcome from this research is deeper knowledge about educational orientations, preferences and behaviors of organic farmers and the development of differentiated educational programs that fulfill the perceived information needs of various grower segments. (Year 3 & 4).

APPROACH

1.Determine the knowledge, beliefs, perceptions, and attitudes that underlie weed management practices and outcomes amongst organic farmers in Ohio, Indiana, California, northern New England, and The Netherlands. Method: Mental models reflecting perspectives on weed control of small, medium and large organic farmers will be prepared. For each cohort we anticipate interviewing 20-30 individuals. Confirmatory surveys will be used to assess quantitatively the frequency of specific beliefs and practices determined through mental modeling. The survey instrument will include items on weed control practice, precise descriptions of actual crop rotations, perceptions of weed biology and weed management, preferred sources and means of receiving information, and attitudinal data related to the strength of such preferences. 2. Establish a learning community of growers, researchers and extension educators within the eOrganic Community of Practice to conduct case-study research on working farms, and outreach on the benefits of crop rotation for weed management. Method: We will establish an online Workspace including participants from the Northeast, Midwest, California and the Netherlands, within eOrganic focused on rotation strategies for managing weeds in organic systems. The Workspace will provide the group with an asynchronous learning community, including opportunities for threaded discussions, drafting of joint documents, and monitoring group progress. Initial efforts will focus on describing current Mental Models and developing survey devices to assess growers\' positions along this continuum of understanding. Input variables would include initial weed seed bank estimates (low, moderate, high), tillage, crop sequences, observed periods of weed seedling emergence, and flowering in each sequence, timing of weed control measures and observed efficacy, estimates of weed biomass and seed rain (light, moderate, heavy), crop harvest and residue management. Input of variables from grower case-studies will be supplemented in Year 2 with biophysical data collected from fields managed by farmers across the country and the Netherlands who participated in the mental models data collection. 3. Develop, disseminate, and evaluate the impact of differentiated educational programs and communication strategies designed to encourage adoption of scientifically-validated weed management practices for organic farming. Methods: Characteristics that set organic farmers apart from conventional farmers will be determined through mental models, focus groups and quantitative data collections. Differentiated educational programs will be designed, delivered and evaluated for impact on various grower segments. Evaluation will be conducted with growers and extension personnel. Data will be analyzed for emergent themes from which the researchers will develop differentiated audience profiles. Findings will be used in developing and assessing tailored educational programs and messages in the area of organic weed management. Progress 09/01/09 to 08/31/14 Outputs Target Audience: The project team engaged with growers, extension educators, scientific colleagues, and private crop advisors in participatory mental models and biological research, and development and testing of redesigned extension programming for weed control in organic crops. Focused outreach occurred as the team engaged with each stakeholder group, informed the science of outreach, and then developed and delivered redesigned extension programs to farmers and their advisors. Farmers were reached through invididual consults with team members, through presentations and short courses, websites, and a series of webinars offered through eOrganic and through ATTRA. Changes/Problems: Nothing Reported What

opportunities for training and professional development has the project provided? Our team did not find eOrganic to be an effective channel through which to develop a community of researchers and growers as envisioned in the original proposal. Therefore, we pursued traditional approaches to community development around the topic of weed management by engaging at the local (state) level with farmers, organizations and allied colleagues outside of the project. This approach facilitated our ability to build a team of more than 90 farmers who participated actively in mental models and case-study research (see Webinar/ Video series under Other Products). How have the results been disseminated to communities of interest? Six journal articles, one thesis and one book chapter were completed as a result of the project. Several additional journal articiles are currently in preparation. The results of the national quantitiative survey (see Other Products) when analyzed will lead to one or more addtional scholarly articles. Six articles were prepared for grower organization news letters and for those of the Rodale Insitute and MOSES. Throughout the project more than 21 hours of presentations and workshops were presented to organic farming audiences around the country and internationally. We communicated our findings extensively through 26 scientific and professional presentations at conferences and workshops in the US, Canada, Brazil, Chile, The Netherlands and Sweden. Our videos and webinar series, including three intentionally directed towards extension professionals had been viewed by more than 4600 as of May 2014. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported Impacts What was accomplished under these goals? Our trans-disciplinary team used mental models and bio-physical data to bridge farmer knowledge, perception and attitudes regarding weeds, to actual outcomes on their farms. We determined that farmers, with their varying risk tolerances and perceptions of weeds and farming practice, incorporated attributes of the farm to develop heuristics that seemed to work for them. Generally, farmers did not highly value advice provided by extension services. Whereas experts expected farmers\' applications of ecological weed management principles to be deficient, the data indicated broad-exposure and in-depth knowledge. Seed bank reduction and weed identification were particular foci of farmers\' management; however, farmers generally overestimated the longevity of seeds in arable soils, resulting in a perception of inevitability. Farmers took personal responsibility for weed problems, in contrast to many conventional farmers who blame weeds on factors outside of their control. Farmers focused on risks associated with various tactics more so than experts. For instance while relying heavily upon cultivation tools for control, farmers worried about costs, crop injury, timing and soil degradation more than did experts. Farmers valued and utilized cover crops; however, in contrast to experts, their rationale focused on sustaining healthy soils capable of withstanding extensive cultivation rather than on direct suppression of weeds. Several relationships between individual mental models and weed management outcomes were identified. Lower seed bank densities were observed on US farms where more emphasis was placed on \'experience/ risk perception\', long-term seed bank management, and less on soil cation exchange site \'balancing\', and other \'alternative\' knowledge. US farmers who expressed lower risk tolerances for cultivation and flaming, had higher seed bank densities. Like US farmers, Dutch farmers who emphasized the importance of long-term seed bank management also had lower seed bank densities than those who emphasized critical-period weed free management. In contrast to the US, soil cation exchange site balancing was not an issue in The Netherlands. These results indicate that extension teaching should place more emphasis upon farmers\' perceptions and needs regarding conservation of their resources, the experiential learning model farmers use to develop heuristics for weed management, and the importance of values in their decision making. Publications Type: Journal Articles Status: Published Year Published: 2014 Citation: Zwickle, S., R.S. Wilson and D. Doohan. (2014). Identifying the challenges of promoting Ecological Weed Management(EWM) in organic agroecosystems through the lens of behavioral decision making\". Agriculture and Human Values. 31:355-370. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Lillard, P. T., Tucker, M., & Doohan, D. (2013, June). Organic farmers: A qualitative analysis of their words and worldviews. Paper presented at the annual conference of the Agriculture, Food & Human Values Society (AFHVS), East Lansing, MI. Type: Other Status: Other Year Published: 2013 Citation: M. Riemens. (2013). The Ohio State University. Organic Weed Management in Cropping Systems in The Netherlands. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Zwickle, S., Wilson, R., & Lillard, P. T. (2012, February). The weed management decision-making process. Presented at Midwest Organic & Sustainable Education Service 23rd annual organic farming conference, La Crosse, WI. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: J. Parker, R. Smith, and D. Doohan. Lets Talk: Organic Farm Research and Conversations with Farmers that Lead to Developing Better Weed Management Programs. Annual Meetings of the Society for Applied Anthropology, Mar 18 22, Albuquerque, NM. Type: Other Status: Other Year Published: 2013 Citation: J. Parker. Why Do I Farm? Social Influences on Decision-Making and Farm Management. Plant and Soil Science Seminar Series, University of Vermont, 11 Nov, Burlington, VT. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: J. Parker. The Challenge of a Socially Sustainable Agriculture: What can Extension do to Foster a Socially Sustainable Agriculture. Joint Annual Meetings of the Agriculture and Human Values Society and the Association for the Study of Food and Society, 19 20 Jun, Lansing, MI. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Jabbour, R., Noy, S., and Gallandt, E.

Quantifying the social dimension of agriculture: Integrating farmer perspectives into entomology research and education. Invited talk in symposium titled \"Entomology\'s Role in Sustaining Ecosystem Services in Agroecosystems\" at the 2014 Entomological Society of America Meeting (Portland, OR, November 16-19, 2014). Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Jabbour, R., E.R. Gallandt, S. Zwickle1, R.S. Wilson, and D. Doohan. Pest management decision-making: A comparison of farmer and scientist mental models and implications for outreach. 99th Ecological Society of America Annual Meeting, Sacramento, CA (8/14/2014). Type: Other Status: Other Year Published: 2014 Citation: Gallandt, E.R. A systems perspective on weed management: Cultivation, rotation, cover crops and the weed seedbank. Ontario Fruit and Vegetable Convention, Niagara Falls, Ontario. (2/19/2014). Type: Other Status: Other Year Published: 2014 Citation: Gallandt, E.R. Weed management in organic farming: Mental models, seedling- and seedbank management. Department of Botany and Plant Pathology, Purdue University. (1/15/2014). Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Jabbour, R., Birthisel , S., Drummond, F.A., Gallandt, E.R. Habitat effects on granivore diversity and weed seed predation in a New England farmscape. Invited talk in Program Symposium \"Impacts of Global Change on Biodiversity and Biological Control\" at annual Entomological Society of America meeting, Austin, TX. Type: Other Status: Other Year Published: 2013 Citation: Gallandt, E.R. Weed management for beginning organic farmers: Practices, pitfalls and solutions. Beginning Farmer Service Organization Professional Development Training. Latham, NY (10/28/2013). Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Gallandt, E.R. Ecologically based weed management: Theory and application of many little hammers. V SIMBRAS-Simp�sio Brasileiro de Agropecu�ria Sustent�vel. Universidade Federal de Vi�osa, Brazil (10/18/2013). Type: Conference Papers and Presentations Status: Other Year Published: 2012 Citation: Gallandt, E.R. Considering stakeholders: Incongruities of researcher and farmer mental models. Raising the Bar: International Workshop on Improving the Standard and Utility of Weed/Invasive Plant Research. B-Bar Ranch, Emigrant, MT (6/11/2012). Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Doohan, D., E. Gallandt, S. Zwickel1, R. Jabbour, J. Parker, K. Gibson, M. Tucker, R. Smith, R. Wilson, S. Ernst, M.M. Riemens. Expert and farmer Mental Models for weed management in organic farming systems. 10th European Weed Research Society Workshop on Physical and Cultural Weed Control, Alnarp, Sweden (3/17/2014). Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Jabbour, R., Zwickle1, S., Gallandt, E., McPhee, K., Wilson, R., Doohan, D. 2013. Mental models of organic weed management: Links between farmer knowledge, perceptions, and weed seedbanks. Annual Meeting, Weed Science Society of America, Baltimore, MD. (2/4-7/2013). Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Jabbour, R., Gallandt, E.R., Zwickle1, S., Wilson, R.S., McPhee, K., Doohan, D. Organic farmer mental models: Associations between weed seedbanks and management philosophies on New England farms. 97th Annual Meeting of the Ecological Society of America, Portland, OR (8/7/2012). Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: R.F. Smith & J.S. Parker. 2014. Evaluation of the impact of organic weed control practices on soil seed banks of organic farms in California, USA.10th European Weed Research Society Workshop on Physical and Cultural Weed Control, Alnarp, Sweden (3/17/2014). Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Gallandt, E.R. and R. Jabbour. Predation, preemption and burial: Managing weed seed rain. Annual Meeting, Weed Science Society of America, Baltimore, MD. (2/4-7/2013). Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: R. Smith. (2013) Ohio Ecological Food and Farming Conference, Granville, OH, Impact of organic weed control practices on soil seedbanks in vegetable production. Type: Other Status: Other Year Published: 2013 Citation: R. Smith. (2013). The Ohio State University Seminar Series, Impact of organic weed control practices on soil seedbanks in vegetable production. Type: Other Status: Published Year Published: 2010 Citation: MM Riemens, newsletter BIOM, audience: organic Dutch farmers, april 2010, Title: Start project naar onkruidbeheersing op biologische bedrijven. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: MM Riemens, Presentation, audience: KNPV (Royal Dutch Crop Protection Society) Weed Research Working Group, June 2014. Title: Mental models of organic weed management. Type: Other Status: Published Year Published: 2012 Citation: Lillard, P. (2012). Managing weeds on a Midwest farm. Rodale Institute. Available: http://rodaleinstitute.org/2012/managing-weeds-on-a-midwest-farm/ Type: Other Status: Published Year Published: 2014 Citation: Lillard, P. (2014). Friends or foes: Farmers talk about their relationships with weeds. Organic Broadcaster 22(1). Available: http://mosesorganic.org/wp-content/uploads/2013/08/Broadcaster22.1web.pdf Type: Other Status: Published Year Published: 2011 Citation: MM Riemens, Presentation, audience: Regional Study Groups Organic Farmers, Groningen, january 2011. Title: Onkruidbeheersing op biologische bedrijven. Type: Other Status: Published Year Published: 2011 Citation: MM Riemens, web site news, Wageningen UR website, march 2011, title: Mental models of organic weed management. Type: Other Status: Published Year Published: 2012 Citation: MM Riemens, Presentation, audience: Regional Study Groups Organic Farmers, Zuid West Nederland, february 2012. Title: Onkruidbeheersing op biologische bedrijven. Type: Other Status: Published Year Published: 2012 Citation: MM Riemens, Presentation, audience: Researchers Wageningen University, lunch seminar, november

2012. Title: More than technology: Linking farmers weed management behaviour with on-farm weed pressure. Type: Other Status: Published Year Published: 2014 Citation: MM Riemens, Presentation, audience: Regional Study Groups Organic Farmers, Zuid West Nederland, march 2014. Title: Zaadbank op biologische bedrijven. Type: Other Status: Published Year Published: 2014 Citation: MM Riemens, Presentation, audience: Regional Study Groups Organic Farmers, Overijssel, september 2014. Title: Onkruidbeheersing op biologische bedrijven. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Gibson, K.D. 2013. Do certified and uncertified fresh-market organic tomato growers in the Midwest manage weeds differently? American Society for Horticultural Science annual conference, Palm Desert, CA. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Lillard, P. T., Tucker, M., & Ernst, S. (2012, July). Cultural and institutional barriers to symmetrical communication between scientists and organic agriculturalists. Paper presented at the 75th annual meeting of the Rural Sociological Society, Chicago, IL. Type: Websites Status: Published Year Published: 2012 Citation: Lillard, P. T., & Tucker M. Designed, developed and maintained project website that features educational resources, contacts and project staff directory. Developed Organic Thinking logo and branding for website and video series. Available: http://www.ydae.purdue.edu/oarei/index.html Our analytics data indicate there have been 715 visitors and more than 1,100 hits to the site since its launch in March 2012. Type: Other Status: Published Year Published: 2013 Citation: E. Gallandt. 2013. Ecologically based Weed Management. Guest lecture at Colby College, Waterville, ME (1/24/2013; 26 attending). Type: Other Status: Published Year Published: 2012 Citation: E. Gallandt. Mental Models: How Northern New England organic farmers think about weeds and weed management. Wageningen University, the Netherlands (3/28/2012; 25 attending). Type: Other Status: Published Year Published: 2011 Citation: R. Smith. 2011. Vegetable weed control. Agriculture and Land Based Training Association, Salinas, (Bilingual), 29 Type: Other Status: Published Year Published: 2012 Citation: Zwickle, S., Wilson, R., Lillard, P., & Doohan, D. (2012). Organic Weed Management in Ohio and Indiana: A Report on the Knowledge, Perceptions, and Experiences of Farmers and Experts. Retrieved from http://www.ydae.purdue.edu/oarei/OWE_report.pdf Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Zwickle, S., Wilson, R., & Lillard, P. T. (2012, February). The weed management decision-making process. Presented at Midwest Organic & Sustainable Education Service 23rd annual organic farming conference, La Crosse, WI. Type: Other Status: Published Year Published: 2011 Citation: R. Smith. 2011. Weed control update in cool and warm season vegetables, Santa Maria Pesticide Applicator Professional Association, Santa Maria, 110 attendees Type: Other Status: Published Year Published: 2011 Citation: R. Smith. 2011. Basic Weed Control. Agriculture and Land Based Training Association, Salinas, (Bilingual), 31 Type: Other Status: Published Year Published: 2012 Citation: R. Smith. 2012. Weed control in coastal vegetables,Central Coast CAPCA , Santa Maria, 56 Type: Other Status: Published Year Published: 2012 Citation: R. Smith. 2012. Weed control in organic production, CAPCA Organic Production on the Coast, Salinas, 110 Type: Other Status: Published Year Published: 2014 Citation: R. Smith. 2014. Organic weed management, Agriculture & Land-Based Training Association, Salinas, (Bilingual), 26 Type: Other Status: Published Year Published: 2012 Citation: R. Smith. 2012. Vegetable weed control update, Salinas Valley Weed School, Salinas, 106 Type: Other Status: Published Year Published: 2013 Citation: R. Smith. 2013. Alternative vegetable weed control, Agriculture and Land Based Training Association, Salinas, 27 Type: Other Status: Published Year Published: 2013 Citation: R. Smith. 2013. New developments in weed control in vegetable production, PAPA Seminar, San Jose,150 Type: Journal Articles Status: Published Year Published: 2014 Citation: Jabbour, R., E.R. Gallandt, S. Zwickle, R.S. Wilson, and D. Doohan. (2014). Organic farmer knowledge and perceptions are associated with on-farm weed seedbank densities in northern New England. Weed Science. 62:338-349. Type: Theses/Dissertations Status: Published Year Published: 2011 Citation: Sarah Zwickle. Understanding weeds and organic weed management: A mental models approach. The Ohio State University. Type: Journal Articles Status: Published Year Published: 2013 Citation: Lillard, P. T., Parker, J. S., & Sundermeier, A. (2013). Recommendations for establishing programming for organic farmers. Journal of Extension, 51:6. Type: Book Chapters Status: Published Year Published: 2014 Citation: Gallandt, E.R. (2014). Weed Management in Organic Farming. In \'Recent Advances in Weed Management\', B.S. Chauhan, ed. Springer Science+Media. pp. 63-85. Type: Journal Articles Status: Other Year Published: 2015 Citation: Tucker, M., Lillard, P. T., & Doohan, D. (In Preparation) Review: Factors associated with public perceptions of organic foods. CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources. Type: Journal Articles Status: Published Year Published: 2013 Citation: Jabbour, R., S. Zwickle1, E.R. Gallandt, K.E. McPhee, R.S. Wilson, and D. Doohan. (2013). Mental models of organic weed management: Comparison of New England U.S. farmer and expert models. Renewable Agriculture and Food Systems. 29:319-333. Type: Journal Articles Status: Published Year Published: 2013 Citation: Parker, J.S., & Lillard, P. T. (2013). Initiating and sustaining conversations between organic famers and Extension. Journal of Extension. 51:6.

PROGRESS

2011/09 TO 2012/08 OUTPUTS: During Period 3, mental models and biophysical data collections were completed within all cooperating institutions. The expert model (see OAREI Continuation Application FY 2010) that formed the foundation for farmer mental model interviews (n=92) has been submitted for publication to a peer-reviewed journal, and will be followed by additional manuscripts addressing mental models of 2 farmers in CA, ME and the NL. The next and final phase of the perception research will be a national quantitative survey that will be sent to 5000 organic farmers during autumn/ winter 2012/2013. The survey instrument is currently being developed as an outcome of a May 15/16 workshop in which all PDs reviewed the mental models data from each region. In turn quantitative survey results will be used to validate and quantify the farmer mental models. Biophysical (soil weed seed bank) data collections and a review of weed control practices corresponding to each farmer who participated in mental model interviews are now also completed (Aim 1). These data will be used to inform the mental models through a combined analysis that will take place during Period 4. Specifically this will answer the question, \`How does grower knowledge, perception and attitude affect farm practice and weed control outcomes\'. This analysis will enable development of exemplary farmer illustrations that will be used in future teaching opportunities and on the project website hosted at Purdue University (http://www.ydae.purdue.edu/oarei/index.html). Additionally, the biophysical data has opened an effective and ongoing communications channel with the farmers in each state enabling us to form the learning community described in the proposal (Aim 2). This will aid the collection of time and cost data in winter 2012/2013. As we continue to interact and learn with this large international community during Period 4 and beyond we anticipate that some farmers will modify their personal mental model leading to behavioral change; in particular, greater acceptance and utilization of scientific information in their decision making process. Dr. Patrick Lillard joined the team members at Purdue as the project\'s \`message-design specialist\'. Dr. Lillard is coordinating activities under Aim 3 across the cooperating locations. The participatory communication approach emerging from our research is being used to develop the 2013 Indiana Small Farm Conference where our educational materials will be showcased. Specific outcomes in Aim 3 will be guided by a communication strategy that is currently in preparation along with a white paper on the participatory communication approach. Dr. Lillard is also coordinating the presentation of relevant outreach products at the MOSES and OEFFA conferences to be held next year in La Crosse, WI, and Granville, OH. PARTICIPANTS: The Ohio State University: Doug Doohan, Professor and Project Director (PD). Jason Parker, Research Scientist and co-PD. Robyn Wilson, Assistant Professor and co-PD. Stan Ernst, Program Manager and co-PD. Gerri Isaacson, Research Assistant. Andy Glaser, Graduate Research Assistant. Sarah Zwickle, Graduate Research Assistant. Marlon Pagan, Post Graduate Intern. University of Maine: Eric Gallandt, Associate Professor and co-PD. Randa Jabbour, Post Doctoral Associate. Purdue University: Kevin Gibson, Associate Professor and co-PD. Mark Tucker, Professor and co-PD. Partrick Lilliard, Post Doctoral Associate. Jose Garcia, Graduate Research Assistant. University of California: Richard Smith, Farm Advisor and co-PD. Wageningen University: Marlene Reimens, Research Scientist and co-PD, TARGET AUDIENCES: This project is targeted to organic farmers and their crop advisors. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: Objectives planned for year two of the project have been completed and are enumerated below. 1. The Period 2 meeting of the Stakeholder Advisory Committee was held in Columbus on November 2, 2010. Meeting notes are posted on the eOrganic website. 2. A protocol for mental model interviews was prepared including a Dutch translation for the Netherlands. 3. Mental model interviews were completed with organic farmers in CA (14), IN/ OH (24), ME/ NH/ VT (23) and The Netherlands (28). 4. The first farmer mental model of weed management was constructed using data from mental model interviews conducted in OH and IN. 5. Biophysical sampling of the soil weed-seed bank was conducted in at least one production field of each farmer who participated in the mental modeling exercise. Farmers completed a questionnaire regarding specific crop- and weed- management practices used in the sampled field. 6. Procedures are underway in each state to quantify the soil weed-seed bank from each farm. PARTICIPANTS: Katie McPhee, Research Associate University of Maine. Sarah Zwickle, Graduate Student Ohio State University. Andrew Glaser, Graduate Research Assistant, Ohio State University. Jason Parker Post Doctoral Associate Ohio State University. Gerri Isaacson Program Assistant Ohio State University. Julia DiNero Under Graduate Assistant Ohio State University. Patricia Quackenbush Research Associate Purdue University. Aaron Heinrich Research Assistant University of California. Ohio State University. The OSU team provided training to organic farmers at the Ohio Food and Farming Education and Research program field day in September 2010 and at the Ohio Ecological Farming and Food Association annual meeting in February 2011. The Purdue University team provided training to a group of agricultural county agents and presented the project at the Indiana Horticultural Congress. The team in Maine presented the program at the Maine Organic Farmers and Gardeners Association annual meeting. Articles were written by team members for publication in association news letters. TARGET AUDIENCES: 1. Purdue University County Agents 2. Maine Organic Farmers and Gardeners Association 3. Ohio Food and Farming Education and Research Program 4. Ohio Ecological Farming and Food Association. These are the primary groups we have worked with in each state; however, through the mental models and bio-physical research we have established

working relationships with 89 organic farmers who will continue to work with us throughout the life of the project. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: All objectives planned for the first year of the project have been achieved, as enumerated below. 1. Personnel have been hired at each cooperating institution. 2. The Stakeholder Advisory Committee has met and provided advice to the project team. 3. A dedicated website for the project has been developed in Google Sites. The Google Site will be used to interact with participating farmers in the US and Europe. The team also makes use of eOrganic as a repository for meeting notes, posting of work plans and blogging. 4. An Expert Model for the project has been completed. 5. Weed seed bank sampling has been completed in California, Indiana and Maine. 7. Farmers who will participate in mental modeling have been recruited in each study area. 8. The Project Team has held monthly WebEx meetings. PARTICIPANTS: Katie McPhee,Research Associate University of Maine. Sarah Zwickle Graduate Student Ohio State University. Jason Parker Post Doctoral Associate Ohio State University.Gerri Isaacson Program Assistant Ohio State University. Steven Whitten Under Graduate Assistant Ohio State University. Patricia Quackenbush Research Associate Purdue University. Aaron Heinrich Research Assistant University of California. Ohio State University Project Directors Doohan, Post Doctoral Associate Parker and Ernst provided training to participants of the Ohio Ecological Farming and Food Association annual meeting held in February 2010. TARGET AUDIENCES: Ohio State University Project Directors Doohan,Post Doctoral Associate Parker and Ernst provided training to participants of the Ohio Ecological Farming and Food Association (OEFFA) annual meeting held in February 2010. OEFFA is the primary association of organic farmers in Ohio and is the state\'s main organic farming certification body. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2011/09 TO 2012/08 The following specific outcomes and impacts were completed in FY 3 of the project. 1. Expert Model paper submitted to Journal of Sustainable Agriculture. 2. New England farmer mental models paper submitted to Weed Research. 3. Technical report Organic Weed Management in Ohio and Indiana: A Report on the Knowledge, Perceptions, and Experiences of Farmers and Experts, presented at the regional Ohio Ecological Food and Farm Association (OEFFA) annual conference 2012 and Midwest Organic and Sustainable Education Service (MOSES) annual conferences. 4. Invited symposium presentation at the North Central Weed Science Society annual meeting on the subject of OH and IN organic farmer\'s mental models. 5. Poster presentation of OH and IN farmer and expert mental models presented at OEFFA and MOSES. 6. New England and CA farmer biophysical results were presented at the Northeast Organic Farming Association in Burlington, VT. 7. An invited overview of this project was presented at the Canadian Organic Science Conference, Winnipeg, MB. 8. New England biophysical and mental models overview was presented at the 97th Annual Meeting of the Ecological Society of America, Portland, OR (August 2012). 9. Project results to date were presented at the international workshop Improving the Standard and Utility of Weed and Invasive Plant Research, Emigrant, MT. 10. A paper on the effect of cultural and institutional barriers to symmetrical communication between scientists and organic farmers was presented at the 75th Annual Meeting of the Rural Sociology Society (July 2012). 11. Purdue undergraduate students participated in an independent study with project staff in the spring of 2012 and conducted interviews with organic farmers for the development of educational resources. **PUBLICATIONS (not previously reported):** 2011/09 TO 2012/08 No publications reported this period

2010/09/01 TO 2011/08/31 Year 2 has been an intense data collection period that is now being followed by data analysis. The farmer mental model for Ohio and IN is completed but not yet published as it is the subject of a graduate research thesis (to be defended in early September 2011). Analysis of mental models data from CA, ME and the NE is underway (at Ohio State) and will be the subject of future publications. At this point in the project we have achieved an improved understanding of the role of weed tolerance levels in the management decisions made by organic farmers. Greater knowledge of weed biology and experience managing weeds leads to lower weed tolerance. Less tolerance, in turn, leads to prevention strategies rather than \"putting out fires\" year to year with control strategies. However, farm scale, cropping systems, and access to time/labor. Large scale organic producers tend to follow production methods that look more like conventional farming; highly mechanized, capital intensive, and market oriented.

2009/09/01 TO 2010/08/31 At this early stage of the project the following finding has been made as a result of developing an expert model of weed management on organic farms. Specifically, we have achieved an improved

understanding of the role of weed tolerance levels in the management decisions made by organic farmers. Greater knowledge of weed biology and experience managing weeds leads to lower weed tolerance. Less tolerance, in turn, leads to prevention strategies rather than \"putting out fires\" year to year with control strategies. However, there are mitigating variables within the assumption that greater knowledge and experience leads to adoption of prevention techniques. These factors include farm scale, cropping systems, and access to time/labor. Large scale organic producers tend to follow production methods that look more like conventional farming; highly mechanized, capital intensive, and market oriented. Previous research has shown that a very low or \"zero\" tolerance level for weeds accompanies these production methods, and accordingly a high perceived risk of weeds. Large-scale producers who have access to labor and large markets are more likely to pay the costs of yearly control for economic benefits. The type of crop being cultivated also plays a mitigating role in the choice of weed management strategies. A farmer growing grain row crops is able to efficiently and cheaply control weeds using existing equipment. Such a farmer may be less likely to adopt prevention strategies. Smaller organic farmers, on the other hand, have less access to labor, work under a different market structure, and therefore may be less influenced by economic considerations. Their expert model shows that they may be more influenced by experience and values. They may view prevention strategies not only as ecologically sound, but also as a way to eventually save labor, time, and stress.

PUBLICATIONS

2010/09/01 TO 2011/08/31 No publications reported this period

2009/09/01 TO 2010/08/31 No publications reported this period

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Practical Perennials: Partnering with Farmers to Develop a New Type of Wheat Crop

Accession No.	0218691
Subfile	CRIS
Project No.	MICL05027
Agency	NIFA MICL
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05513
Proposal No.	2009-01332
Start Date	15 AUG 2009
Term Date	14 AUG 2013
Fiscal Year	2009
Grant Amount	$0
Grant Year	2009
Investigator(s)	Snapp, S. S.; Swinton, S.
Performing Institution	Kellogg Biological Station, MICHIGAN STATE UNIV, EAST LANSING, MICHIGAN 48824

NON-TECHNICAL SUMMARY

Our major outcomes will be the adoption of new perennial cultivars, and use in producing organic grain, new products and to support organic livestock production. Enhanced knowledge of the experimentation process is our goal, both new PR methods being more broadly understood and used by researchers and extension educators, and farmer capacity to conduct on-farm research. Scientific understanding of the processes involved in soil carbon sequestration will be advanced through the research station based trials, where we will be documenting the role of perennial plant traits vs annual plant traits under organic and conventional (with nitrogen fertilizer and herbicide inputs) management. Information will also be generated on genetic by environmental interaction of new perennial grain varieties tested under a wide range of environments in the PR methodology of systematically linked on-farm and research station trials. To reach these outcomes of advancements in knowledge and in farmer-relevant technologies, an iterative cycle of planning meetings, activities and evaluation of progress is planned

OBJECTIVES

Organic field crop and livestock farmers face economic challenges of increasing severity, with shifting market opportunities and fluctuating prices. Developing new crops would provide a wider range of market options, and diversify rotations. Our long-term project goals are to develop new perennial crop varieties from breeder lines, and to develop farmer participatory research methodologies that enhance local capacity, and broaden options for organic livestock and small grain producers. Objectives: 1. Evaluate productivity, ecosystem services and profitability potential of organic perennials a. Quantify NPP , marketable yield and economic returns associated with PW and IW varieties compared to annual wheat in a long-term, organic managed trial b. Evaluate resilience of PW to mowing, to test for dual use in livestock grazing and grain production c. Quantify carbon sequestration associated with perennial wheat vs rotated annual wheat, under conventional and organic management 2.

Develop and disseminate on-farm PR methods and new perennial grain varieties a. Participatory, multi-location testing of PW and IWG, linking on-farm trials systematically with research station long-term trials b. Variety selection and dissemination with organic farmers, enhancing farmer capacity to test and develop new varieties c. Document and disseminate participatory research methods, varieties and management guidelines along with dynamic economic assessment tools

APPROACH

The initial on-farm experiments in 2008 involved farmers planting one PW line, to observe and gain experience with the new type of crop. With support from this grant we will expand the on-farm work to conduct participatory variety assessment and training of farmers to conduct on-farm variety selection. Seed from the top performing perennial wheat varieties will be made available to farmers, and information provided about performance. Organic farmers will choose a subset of these cultivars - 4 or more depending on farmer goals - to be evaluated on their farm using a RCB with 2 to 3 replicates per farm (Witcombe et al., 2003). Experiments#1, and #2 conducted at research stations will provide opportunities to assess all of the lines being evaluated, and are also part of undergoing seed increase efforts, which is essential to support this participatory research approach. Experiment #2 This on-going assessment of a wide range of PW and IWG genotypes is a multi-state, RCB design trial involving 4 states (WA, KS, TX and MI). It is led by our plant breeder collaborators Dr. Steven Jones, Dr. Kevin Murphy and Dr. Lee DeHann at WSU and at TLI in Kansas (see letters of support). If funded, we will be able to support augmentation of this trial through agronomic measurements and testing in quadrats (imposing split plots) the impact of different mowing management systems to evaluate potential of lines for dual use in livestock grazing and grain production. We will also assess the impact of row and plant spacing arrangements on PW genotype performance within this multi-state variety testing research.

PROGRESS

2009/08 TO 2013/08 Target Audience: The audience for this research project to develop a perennial grain crop has included farmers interested in organic farming practices, dual cropping (forage and grain), and new crop rotation options that support soil fertility building with lower labor input. Extension and crop advisors interested in farming practices that potentially could mitigate greenhouse gases and protect the environment has also been a major audience, with a number of \'training of trainer\' opportunities to reach a broad audience. Researchers and scholars, as well as students has been an important audience, with broad interest in learning about the agronomic aspects of this potential novel type of crop to build soil fertility, while protecting fragile environments such as riperian zones. Finally, policy makers potentially will be interested in an entirely new type of environmentally friendly farming Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Three graduate students have finished degrees with the project, a MS degree in Ag Economics addressing perennial wheat, an economic evaluation of ecosystem services and valuation that would compensate for lower grain yields; a MS degree in Crop and Soil Sciences on dual use of perennial wheat as a forage and grain crop and a dual degree PhD in Crop and Soil Sciences and Ecology. The PhD student addressed plant ecophysiology of perennial cereals and their annual cereal counterparts. One graduate student has half-way through a PhD addressing belowground growth and effects on ecosystem services of perennial grains. Four research and extension meetings have been held, with participants from Canada and Australia, as well as multiple states. Out of these meetings a new professional community was established addressing perennial grains, as part of the American Society of Agronomy. The first meeting of the perennial grain group met in October of 2012 in Cincinnati, Ohio and a symposium will be sponsored by the perennial grain group at the Tampa Floridia meeting in November of 2013. The project will participate in an August 2013 FAO meeting in Rome, Italy that brings together experts from around the world on perennial grain crop development and research. How have the results been disseminated to communities of interest? Farmer interest remains high in this novel crop type. Newsletter articles, presentations at farmer meetings and an extension bulletin are ways that we have reached out to a broad audience, including many organic farmers. Our project has presented posters and talks on perennial wheat and perennial grain systems for multiple years at the MOSES Midwest Organic farmers meeting in LaCrosse WI held every February which is attended by over 3000 farmers. The project has also helped the Organic Seed Alliance produce an extension bulletin on \'Participatory Plant Breeding\' methods, and the PI has presented through e-Organic a webinare on farmer participatory experimentation methodology, which was attended by over 100 extension educators, farmers and researchers. Recently supplementary funding from the CERES Trust has supported a series of planning meetings with farmers in Michigan, including a miller who produces organic flour, to explore the potential for, and challenges, associated with producing perennial cereals on-farm. There remain serious problems with the current varieties of perennial wheat available, as regrowth is uncertain and yields are poor, but farmers are aware of these risks and remain

interested in being pioneers to try out this novel type of cereal crop that has the potential to perennialize farming systems. Investments in plant breeding, a as well as agronomic research are all needed to take on this long-term project of developing perennial wheat as a viable crop, but interest is there. An article in the August 2013 issue of the \'Organic Broadcaster\' by Midwest Organic and Sustainable Education (MOSES) on perennial wheat was distributed through electronic and hardcopies of the newsletter to a circulation of over 10,000. Combined with our \'participatory plant breeding tool kit\',produced in cooperation with the Organic Seed Alliance, we have reached out to and made a different by providing new information to a broad audience of extension educators, farmers and researchers serving sustainable and organic agriculture. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/08/15 TO 2012/08/14 OUTPUTS: One perennial grain trial just finished, and the results were just accepted to be published in the Agronomy Journal, and two other long-term perennial grain trails are now in the third year of implementation at the Kellogg Biological Station in southwest Michigan. We are developing new perennial wheat lines and documenting the environmental services, plant-soil biological processes and agronomic production potential of perennial wheat and intermediate wheatgrass. The hottest summer on record in 2011, combined with a severely dry late summer/fall in 2010, has provided strong selection pressure and only a few lines have shown vigorous regrowth, and strong performance as perennial grains. We have discovered through an irrigation treatment that soil moisture not soil heat is the limiting factor for regrowth, thus sufficient fall moisture is the key to perenniality in the current genetic materials we are testing. We have also written up initial findings from a comparison of organic and conventional management of annual wheat and intermediate wheatgrass. Through complementary support from the CERES Foundation, we expanded the extent of soil food web analysis on perennial vs. annual wheat cropping systems, under organic and sustainable management practices in a second long-term experiment. Four meetings involving farmers, extension and researchers have been held, including two winter planning session of the entire project team, followed up by summer field days that have included visitors from several states, Canada and Australia. To promote collaboration among scientists and extension educators, we have just launched a new community within the American Society of Agronomy professional organization, a community of professionals that focus on perennial grains. Our first meeting will be held at the 2012 annual ASA meetings held in Cincinnati, Ohio. The perennial wheat website has been launched and contains information intended to serve our research team and farmers curious about perennial wheat. We continue to input information about our partners\' work through a blog which can be accessed by the public and researchers to include work or share articles - see http://www.carrs.msu.edu/public/pwheat/. The website provides the project team members, their contact information, journal articles written by the team members that have relevance to Perennial Wheat, and notes from the various team meetings. A graduate student in agricultural economics finished her MS thesis evaluating the potential of perennial wheat to be a profitable crop, including valuing environmental benefits associated with enhanced soil erosion control and tradeoffs at different grain quality characteristics and grain yield levels. PARTICIPANTS: One graduate student completed MS thesis in Agriculture Economics. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/08/15 TO 2011/08/14 OUTPUTS: Three long-term trials are now in the second year of implementation at the Kellogg Biological Station in southwest Michigan. We are developing new perennial wheat lines and documenting the environmental services, plant-soil biological processes and agronomic production potential of perennial wheat and intermediate wheatgrass. The selection trial is duplicated at the Mason research station site in central Michigan in addition to KBS. The regrowth environment was harsh in 2010, providing strong selection pressure and only a few lines have shown perennial traits, thus our research is now focused on testing 6 new potential varieties of perennial cereals, primarily those developed at Washington State University, and intermediate wheatgrass derived lines (25) from The Land Institute in Kansus. Core to this research is a long-term study comparing organic and conventional management of perennial wheat, annual wheat and intermediate wheatgrass. Through complementary support from the CERES Foundation, we expanded the extent of soil food web analysis on perennial vs. annual wheat cropping systems, under organic and sustainable management practices in a second long-term experiment. Two meetings were held in 2010-2011, a winter planning session of the entire project team, followed up by a Jule, 2011 multi-state, multi-disciplinary meeting of 25 researchers and extension educators. These included two scientists from Australia and Canada, and forty scientists,educators and farmers from Michigan, Maryland, Minnesota, Nebraska and Kansas. The meeting was held at the Kellogg Biological Station to assess current findings in perennial grain development and agronomy, and extension and research priorities. PARTICIPANTS: Scientists from a broad range of biological and social science disciplines, including plant breeders, agronomists, soil scientists, grazing ecologist, weed scientist, agricultural economists, biometrics, and participatory modeling. Extension educators from MSU Extension have been integrally involved throughout this researhc project. Two graduate students in agronomy and soil science have initiated novel

research projects, in addition to an agricultural economist graduate student who is well into her research project on assessing profitability of new perennial grain options. A new graduate student in rural sociology and ecology has just joined with interests in modeling simultaneously the soil impacts of a new perennial crop option, and farmer assessment, a unique example of multidisciplinary research. Partners also include the wheat breeding program at WSU, and perennial grain breeders at The Land Institute in Kansas. TARGET AUDIENCES: Recent invited talks related to this project show the broad scale interest in perennial crops and onfarm participatory research as means to improve soil management in sustainable cropping systems design. These include: Beyond the randomized complete block design: Statistical and onfarm design analysis S. Snapp, American Society of Agronomy Symposium. Oct 17, 2011, San Antonio, TX. Advanced soil organic management S. Snapp. Michigan Organic Conference, East Lansing, MI March 5, 2011. Ecology and organic matter management: Lessons from Long-term experimentation S. Snapp, Organicology Soils Intensive, Portland, OR Feb. 10, 2011. Jaikumar, N.S., Snapp, S.S., Murphy, K. and Jones, S. A field assessment of the agronomic potential of two novel, perennial cereal crops. Overall the audience for this project include farmers who follow organic and sustainable management, especially those looking for new perennial crop rotation options, dual cropping (forage and grain), and new crop rotation options that support soil fertility building and lower labor input requirements. Extension and crop advisors interested in farming practices that potentially could mitigate greenhouse gases and build soil fertility, while protecting fragile environments such as riperian zones. Finally, policy makers interested in new cropping system options for environmentally friendly farming, and enhanced market opportunities. PROJECT MODIFICATIONS: Not relevant to this project.

2009/08/15 TO 2013/08/14 Target Audience: The audience for this research project to develop a perennial grain crop has included farmers interested in organic farming practices, dual cropping (forage and grain), and new crop rotation options that support soil fertility building with lower labor input. Extension and crop advisors interested in farming practices that potentially could mitigate greenhouse gases and protect the environment has also been a major audience, with a number of \'training of trainer\' opportunities to reach a broad audience. Researchers and scholars, as well as students has been an important audience, with broad interest in learning about the agronomic aspects of this potential novel type of crop to build soil fertility, while protecting fragile environments such as riperian zones. Finally, policy makers potentially will be interested in an entirely new type of environmentally friendly farming Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Three graduate students have finished degrees with the project, a MS degree in Ag Economics addressing perennial wheat, an economic evaluation of ecosystem services and valuation that would compensate for lower grain yields; a MS degree in Crop and Soil Sciences on dual use of perennial wheat as a forage and grain crop and a dual degree PhD in Crop and Soil Sciences and Ecology. The PhD student addressed plant ecophysiology of perennial cereals and their annual cereal counterparts. One graduate student has half-way through a PhD addressing belowground growth and effects on ecosystem services of perennial grains. Four research and extension meetings have been held, with participants from Canada and Australia, as well as multiple states. Out of these meetings a new professional community was established addressing perennial grains, as part of the American Society of Agronomy. The first meeting of the perennial grain group met in October of 2012 in Cincinnati, Ohio and a symposium will be sponsored by the perennial grain group at the Tampa Floridia meeting in November of 2013. The project will participate in an August 2013 FAO meeting in Rome, Italy that brings together experts from around the world on perennial grain crop development and research. How have the results been disseminated to communities of interest? Farmer interest remains high in this novel crop type. Newsletter articles, presentations at farmer meetings and an extension bulletin are ways that we have reached out to a broad audience, including many organic farmers. Our project has presented posters and talks on perennial wheat and perennial grain systems for multiple years at the MOSES Midwest Organic farmers meeting in LaCrosse WI held every February which is attended by over 3000 farmers. The project has also helped the Organic Seed Alliance produce an extension bulletin on \'Participatory Plant Breeding\' methods, and the PI has presented through e-Organic a webinare on farmer participatory experimentation methodology, which was attended by over 100 extension educators, farmers and researchers. Recently supplementary funding from the CERES Trust has supported a series of planning meetings with farmers in Michigan, including a miller who produces organic flour, to explore the potential for, and challenges, associated with producing perennial cereals on-farm. There remain serious problems with the current varieties of perennial wheat available, as regrowth is uncertain and yields are poor, but farmers are aware of these risks and remain interested in being pioneers to try out this novel type of cereal crop that has the potential to perennialize farming systems. Investments in plant breeding, a as well as agronomic research are all needed to take on this long-term project of developing perennial wheat as a viable crop, but interest is there. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2009/08/15 TO 2010/08/14 OUTPUTS: We established a long-term trial at the Kellogg Biological Station testing 6 new varieties of perennial wheat and screening 20 more lines. Further, we are investigating organic and conventional management of perennial wheat, annual wheat and intermediate wheatgrass. Through complementary support from the CERES Foundation, we expanded the extent of soil food web analysis on perennial vs. annual wheat cropping systems, under organic and sustainable management practices in a second long-term experiment. Two meetings have been held, a planning session of the entire project team, followed up by a June, 2010 multi-state, multi-disciplinary meeting of 25 researchers and extension educators from Michigan, Maryland, Minnesota, Nebraska and Kansas held at the Kellogg Biological Station to assess current findings in perennial grain development and agronomy, and extension and research priorities. A trip to Washington State University by Snapp and Culman broadened knowledge and expanded collaboration in this emerging research area of perennial wheat variety development. Well known and novel soil biological methods were also deployed along with soil, water and plant nitrogen monitoring, to investigate the processes influenced by organic management practices and perennial plant traits. Two graduate students started at MSU, in agricultural economics and agroecology, who will focus on this perennial wheat project. PARTICIPANTS: Scientists from a broad range of biological and social science disciplines, including plant breeders, agronomists, soil scientists, grazing ecologist, weed scientist, agricultural economists, biometrics, and participatory modeling. Extension educators from MSU Extension were integrally involved. Graduate students have just joined the project and are developing research projects. Partners also include the wheat breeding program at WSU, and perennial grain breeders at The Land Institute in Kansas. TARGET AUDIENCES: Farmers who follow organic and sustainable management, especially those looking for new perennial crop rotation options and new cropping opportunities. Extension and crop advisors interested in farming practices that potentially could mitigate greenhouse gases and build soil fertility, while protecting fragile environments such as riperian zones. Policy makers interested in new cropping system options for environmentally friendly farming, and enhanced market opportunities. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2009/08 TO 2013/08 What was accomplished under these goals? Three field trials have investigated agronomic potential of perennial grain varieties, the interaction of agronomic management (organic and conventionall fertilized) with perennial grain and associated soil biological processes was well as agronomic production potential of perennial wheat and intermediate wheatgrass in use as dual forage and grain crops. After two of the hottest summers on record in 2011 and 2012, combined with a severely dry late summer/fall in 2010, has provided strong selection pressure and only a few lines have shown vigorous regrowth, and strong performance as perennial grains. We have discovered through an irrigation treatment that soil moisture not soil heat is the limiting factor for regrowth, thus sufficient fallmoisture is key to perenniality in the current genetic materials we are testing. We have also written up initial findings from a comparison of organic and conventional management of annual wheat and intermediate wheatgrass, and have published four journal articles, as well as an extension bulletin that is now in review. We have demonstrated that nitrate-leaching can be reduced to almost zero in the second year of a perennial grain production system, at recommended or high N fertilizer rates (120 kg N/ha). As published in the Agronomy Journal, an additional 35 kg of nitrate-N was retained in perennial grain plots compared to annual wheat plots. This is the first reported demonstration that high water quality is associated with a 'perennial grain' crop. Further environmental services were shown in terms of soil enzymes and nematode communities -- two types of soil biology indicators that show complex, and generally positive responses to the presence of a perennial grain, particularly under organic management (poultry compost for nitrogen fertility). Total soil carbon has not yet changed in a detectable manner although labile carbon (as indicated by a chemical oxidation test) has increased by 20% in organically managed perennial grain plots, compared to conventionally, fertilizer managed annual wheat plots. More time will be required to elucidate soil carbon changes, and to fully understand the role of management versus perennial growth type. We used mini-rhizotrons and destructive soil cores to measure root systems. Roots were shown to be markedly higher in perennial grain vs. annual cereal systems: over three-fold greater biomass belowground in the second year of the experiment. Finally, dual use of perennial wheat as part of a forage and grain production system appears to have potential. This was indicated by a multi-year field experiment, and photosynthetic field studies that showed that perennial grain photosynthesis was often upregulated, due to the presence of carbohydrate \'sinks\' in the form of regrowth and winter survival. This was consistent with higher spring regrowth in perennial wheat, compared to wheat, which could be used for forage. This indicates that there is potential for plant breeding to select for greater grain and forage yield in perennial wheat, which is currently only about 50% of annual wheat under southwest Michigan environmental conditions. The economic results have been providing some unique insights as documented in Anne Weir's MS thesis and a manuscript just submitted to Agronomy Journal called "An economic analysis guiding the

development of perennial wheat." A detailed profitability analysis was conducted of a 4-year dataset of perennial wheat and annual wheat grain yield; this comprised of annual costs and returns for a 4 year investment analysis. From 4-year net present values, the study reports annualized net return values (using a standard financial annuity formula).In most cases, perennial wheat survived no more than 2 years, so the economic analysis focused on the 4 most profitable lines. Because perennial wheat frequently was not perennial or survived only 2 years, it had to be replanted, causing tillage and planting costs to be much more similar to annual wheat than if perennial wheat survived for the full 4 year period. Consequently savings in fuel and labor time were small relative to the large reductions in yield of perennial wheat. These findings highlight that improved genetic material is needed to both improve grain crop yield (up from the current \~50% of annual wheat) and reliable regrowth is also a necessary feature. Overall, absent changes in other crop traits, grain yields must increase three- to fivefold in order to match the performance of annual grains, because the 50% yields were rarely sustained more than two years and the payment of a justifiable subsidy for the environmental benefits generated by perennial wheat had a negligible effect on its relative economic performance as the literature shows that taxpayers are willing to pay only small sums for the soil conservation benefits generated. The small value associated with grazing young perennial wheat also has negligible effect on profitability. Through complementary support from the CERES Foundation, we expanded the extent of soil food web analysis on perennial vs. annual wheat cropping systems, under organic and sustainable management practices in a second long-term experiment. Plant physiology research in our agronomic plots has shown that there is strong potential to improve both yield and forage growth in perennial analogs of annual wheat and rye, based on improved \'up regulation\' of photosynthesis in perennial cereals. This indicates the long-term potential to develop this new type of crop. However, there is clear need for improvements in weed control, agronomic management information and genetic by environment testing to document growth, yield, grain traits and regrowth potential across different environments. We found overall that the perennial wheat lines currently available are not high performing, with variable regrowth potential under recent droughty weather conditions, and thus were not suitable to be tested on farmers fields. A few farmers -- with full awareness of the highly experimental nature of these lines -- did try to grow perennial wheat lines and provided preliminary assessments and discussions at farmer field days. One important outcome of our farmer-partnering efforts was the first participatory plant breeding 'tool kit' for North American farmers, jointly produced with the Organic Seed Alliance and our research group at Michigan State University. **PUBLICATIONS (not previously reported):** 2009/08 TO 2013/08 1. Type: Journal Articles Status: Awaiting Publication Year Published: 2014 Citation: Jaikumar, N.S., S S Snapp, J. A. Flore, and W. Loescher. Source versus sink regulation of photosynthesis in annual rye, perennial wheat and perennial rye subjected to modest source/sink ratio changes Crop Science, in press 2. Type: Journal Articles Status: Published Year Published: 2013 Citation: Culman, S.W., S.S. Snapp, M. Ollenburger, B. Basso and L.R. DeHaan. 2013. Soil and water quality rapidly responds to the perennial grain Kernza wheatgrass. Agronomy J. 105:735-744. 3. Type: Journal Articles Status: Accepted Year Published: 2014 Citation: Jaikumar, N., S S Snapp, T.D. Sharkey, and J. A. Flore. Life history and resource acquisition: Photosynthetic traits in three perennial cereal species compared to annual cereal relatives. American J. Botany 4. Type: Journal Articles Status: Published Year Published: 2012 Citation: Jaikumar, N., S.S. Snapp, K. Murphy, and S. Jones. 2012. A field assessment of the agronomic potential of two novel perennial cereal crops. Agronomy J. 104:1716-1726 5. Type: Theses/Dissertations Status: Accepted Year Published: 2012 Citation: Tinsley, S.G. MS Thesis ?An evaluation of perennial wheat and intermediate wheatgrass as dual-purpose, forage-grain crops under organic management? Department of Plant, Soil and Microbial Sciences, Michigan State University, December, 2012. 6. Type: Theses/Dissertations Status: Accepted Year Published: 2013 Citation: Jaikumar, N. 2013. PhD dissertation, Perennial cereal crops for the cold temperate zone: agronomy, photosynthetic physiology, sink regulation and disease resistance, Department of Plant, Soil and Microbial Sciences, Michigan State University. 7. Type: Other Status: Accepted Year Published: 2013 Citation: S.S. Snapp and V.L. Morrone. 2013. Perennial Wheat. Michigan State University Extension Bulletin, MSUE, East Lansing MI 8. Type: Journal Articles Status: Submitted Year Published: 2015 Citation: Reeling et al. submitted to Agron J on Aug. 7, 2013: An economic analysis guiding the development of perennial wheat

2011/08/15 TO 2012/08/14 Through our perennial wheat website we are building an informed audience through providing information to interested stakeholders, including farmers and extension educators as well as millers, seed producers and other agricultural industry members. We have photos, research studies, and descriptions of perennial wheat, including anticipated uses. More descriptions and information is being developed as we identify lines that have desirable traits and are useful for farmers and society. We continue to expand the website as information becomes available., and a community of practioners working with perennial grain is starting to grow. Research findings have been published, including an Agronomy Journal paper currently in press. This study documents our initial findings from SW Michigan, including the high yield potential of perennial rye, the modest yield (\~50-60% grain yield of annual wheat) of perennial wheat, and the absolute requirement for robust perennial traits in both species. We also published in the Soil Sci Soc of America journal, a seminal study that documented the role of labile carbon and the value of monitoring using a permaginate oxidizable carbon (POXC)

assay to evaluate carbon sequestration potential and the role of perennial versus annual management systems. A related article was published in eOrganic on building soil organic matter. Finally, we contributed to the first Participatory plant breeding tool kit, an educational booklet that provides a step-by-step manual on how to conduct farmer participatory research. This tool kit is being promoted by the Organic Seed Alliance to a wide audience, which will support knowledge dissemination of participatory research approaches.

2010/08/15 TO 2011/08/14 This long-term project to develop a new perennial grain crop is off to a very strong start. The perennial wheat variety development work has been initiated, with two years of variety screening and testing already conducted. We have been instrumental in hosting two meetings to support an emerging community of practice, one dedicated to developing this new type of cereal crops. Perennial wheat and intermediate wheatgrass can be dual use (forage and grain) and extraordinarily effective crop plants for soil rehabilitation and improving water quality. We have shared initial findings on perennial grain crops effective role in reduction of nitrate loss and improvements in soil C labile pools. The data has provided inspiration for a team that includes international (Australian and Canadian) scientists, US wheat breeders, soil scientists, modelers and agricultural economists from three universities in addition to Michigan extension educators and farmers. Collaboration with colleagues interested in farmer decision making and participatory on-farm research is underway. Broader societal recognition of the role perennial grains can play in environmental and food security was achieved through Culman and Snapp contributing to an article published in Science 328:1638-1639, in 2010, lead by collaborator Jerry Glover.

2009/08/15 TO 2013/08/14 What was accomplished under these goals? Three field trials have investigated agronomic potential of perennial grain varieties, the interaction of agronomic management (organic and conventionall fertilized) with perennial grain and associated soil biological processes was well as agronomic production potential of perennial wheat and intermediate wheatgrass in use as dual forage and grain crops. After two of the hottest summers on record in 2011 and 2012, combined with a severely dry late summer/fall in 2010, has provided strong selection pressure and only a few lines have shown vigorous regrowth, and strong performance as perennial grains. We have discovered through an irrigation treatment that soil moisture not soil heat is the limiting factor for regrowth, thus sufficient fallmoisture is key to perenniality in the current genetic materials we are testing. We have also written up initial findings from a comparison of organic and conventional management of annual wheat and intermediate wheatgrass, and have published four journal articles, as well as an extension bulletin that is now in review. We have demonstrated that nitrate-leaching can be reduced to almost zero in the second year of a perennial grain production system, at recommended or high N fertilizer rates (120 kg N/ha), which quantifies the water quality services potential of this novel crop type. In addition, soil carbon pools and nematode communities as soil biology indicators show complex, but generally positive responses to the presence of a perennial grain, particularly under organic management (poultry compost for nitrogen fertility). Root systems are markedly higher in perennial grain vs. annual cereal systems. FInally, dual use forage and grain production appears to have potential, and photosynthetic field studies show that perennial grains are often upregulated, apparently due to the presence of carbohydrate \'sinks\' in the form of regrowth and winter hardieness potential. This indicates the plant breeding could be used to expand the yield potential of perennial wheat, which is currently only about 50% of annual wheat under southwest Michigan environmental conditions. Through complementary support from the CERES Foundation, we expanded the extent of soil food web analysis on perennial vs. annual wheat cropping systems, under organic and sustainable management practices in a second long-term experiment. Economic findings highlight that improved genetic material is needed to both improve grain crop yield (up from the current \~50% of annual wheat) and reliable regrowth is also a necessary feature. Plant physiology research in our agronomic plots has shown that there is strong potential to improve both yield and forage growth in perennial analogs of annual wheat and rye, based on improved \'up regulation\' of photosynthesis in perennial cereals. This indicates the long-term potential to develop this new type of crop. However, there is clear need for improvements in weed control, agronomic management information and genetic by environment testing to document growth, yield, grain traits and regrowth potential across different environments.

2009/08/15 TO 2010/08/14 This is a new project. Initial needs were identified in terms of research and extension priority areas and steps undertaken to initiate a \'community of practice\' focused on perennializing row crop production systems. The perennial wheat variety development work was initiated through planting of varieties, and agroecology trials. This research involved extensive collaboration among wheat and small grains breeders, agronomists, soil scientists, statistian, agricultural economics and extension. Education of our team and collaboration with colleagues interested in farmer decision making and participatory on-farm research is underway. Broader societal recognition of the role perennial grains can play in environmental and food security

was achieved through Culman and Snapp contributing to an article published in Science 328:1638-1639, lead by collaborator Jerry Glover.

PUBLICATIONS

2011/08/15 TO 2012/08/14 1. Jaikumar, N., S.S. Snapp, K. Murphy, and S. Jones. 2012. A field assessment of the agronomic potential of two novel perennial cereal crops. Agronomy Journal, In press. 2. Zystro, J., A. Shelton and S.S. Snapp. 2012. Participatory plant breeding tool kit, Organic Seed Alliance, Port Townsend, WA.

2010/08/15 TO 2011/08/14 1. Snapp, S.S., L. Gentry, and R.R. Harwood. 2010. Management intensity not biodiversity the driver of ecosystem services in a long-term row crop experiment. Agriculture Ecosystems and Environment. 138:242-248. 2. Culman, S., S.S. Snapp, Schipanski, M.E., Freeman, M.A. Beniston, J., Drinkwater, L.E., Franzluebbers, A.J., Glover, J.D., Grandy, S.A., Lal, R., Juhwan, L., Maul, J.E., Mirksy, S.B., Six, J., Spargo, J.T., Wander, M.M. 2011. Permanganate oxidizable carbon reflects a processed soil fraction that is sensitive to management. Soil Sci. Soc. Am J, ms. in press.

2009/08/15 TO 2013/08/14 1. Type: Journal Articles Status: Awaiting Publication Year Published: 2014 Citation: Jaikumar, N.S., S S Snapp, J. A. Flore, and W. Loescher. Source versus sink regulation of photosynthesis in annual rye, perennial wheat and perennial rye subjected to modest source/sink ratio changes Crop Science, in press 2. Type: Journal Articles Status: Published Year Published: 2013 Citation: Culman, S.W., S.S. Snapp, M. Ollenburger, B. Basso and L.R. DeHaan. 2013. Soil and water quality rapidly responds to the perennial grain Kernza wheatgrass. Agronomy J. 105:735-744. 3. Type: Journal Articles Status: Accepted Year Published: 2014 Citation: Jaikumar, N., S S Snapp, T.D. Sharkey, and J. A. Flore. Life history and resource acquisition: Photosynthetic traits in three perennial cereal species compared to annual cereal relatives. American J. Botany

2009/08/15 TO 2010/08/14 Glover, J.D., Reganold, J.P., Bell, L.W., Borevitz, J., Brummer, E.C., Buckler, E.S., Cox, C.M., Cox, T.S., Crews, T.E., Culman, S.W., DeHaan, L.R., Eriksson, D., Gill, B.S., Holland, J., Hu, F., Hulke, B.S., Ibrahim, A.M.H., Jackson, W., Jones, S.S., Murray, S.C., Paterson, A.H., Ploschuk, E., Sacks, E.J., Snapp, S., Tao, D., Van Tassel1, D.L., Wade, L.J., Wyse, D.L., Xu, Y. 2010. Increasing food and ecosystem security through perennial grain breeding. Science 328:1638-1639.

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Researcher and Farmer Innovation to Increase Nutrient Cycling on Organic Farms

Accession No.	0218765
Subfile	CRIS
Project No.	CA-D-LAW-2029-OG
Agency	NIFA CALB
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-19827
Proposal No.	2009-01415
Start Date	01 SEP 2009
Term Date	31 AUG 2013
Fiscal Year	2009
Grant Amount	$0
Grant Year	2009
Investigator(s)	Jackson, L.
Performing Institution	Land, Air and Water Resources, UNIVERSITY OF CALIFORNIA, DAVIS, 410 MRAK HALL

NON-TECHNICAL SUMMARY

Organically-farmed crops are susceptible to N limitations, which reduce yields, and to pulses of N losses. Current soil N testing approaches were developed for conventional agriculture, which relies mainly on inorganic N inputs rather than organic matter inputs. More sophisticated tools are needed to indicate N availability, increase crop N uptake on organic farms, and provide other environmental benefits (Overview on p. 1). New plant-soil N testing methods, using plant expression of N metabolism genes, can potentially increase N uptake by crops, increase yields and profits, and reduce pulses of N loss. Losses of N cause environmental degradation through leaching of nitrate to groundwater, and emission of nitrous oxide, a potent greenhouse gas. This research will occur on organic farmers### fields in a region of California where processing tomatoes are an important crop (Yolo County). The project will build on previous work on soil N transformations and plant gene expression in organic tomatoes in this region. Results from on-farm experiments on plant gene expression in relation to soil N availability, and subsequent validation with a landscape survey will form the basis for other outreach activities to increase awareness and interest in plant-soil N testing. These include focus group discussions, semi-structured interviews, workshops, website materials, and eXtension documents. A steering committee of local farmers and Cooperative Extension personnel will provide guidance for research and outreach.

OBJECTIVES

Nutrient cycling is an excellent model for testing the sustainability of organic agriculture since it is an inherent component for production and economic success. Careful N management can avoid degradation of environmental quality and can avert environmental impacts on human health while improving social well-being at various spatial scales. The central hypothesis of the proposed research is: The development of innovative plant-soil N testing approaches in the context of researcher-farmer collaborations will result in an improvement in N utilization by organic crops and in the precision of soil nutrient cycling, so that soil quality and C sequestration

increase, especially when supported by advance planning for compliance with long-term environmental policies. The specific objectives of this research are: Examine the potential for a new N testing approach for organic farmers that more accurately reflects soil N availability based on plant gene expression. Conduct a landscape survey to assess variables that could serve as new plant-soil testing approaches for diagnostic tools for N management. Work with farmers and other decision-makers to improve N cycling for organic farms, based on the results of the rhizosphere and landscape studies, and as relevant to recent policies for water quality, C sequestration and reduction of GHG emissions.

APPROACH

Nutrient management on organic farms is inherently complex, as it relies on the cycling of OM, which is mediated by microbial N transformations. Our long-term goal is to develop a comprehensive set of approaches for nutrient management decisions for organic vegetable production. Developing new plant-soil N testing tools based on plant gene expression, soil bioassays and chemical properties would require substantial effort over the next decade by many stakeholders. This project proposes to explore the potential of this approach, rather than provide end products. Since genetic pathways regulating N uptake are highly conserved across plant species, studies on these N metabolism genes in a model plant such as tomato are highly relevant to other crops. On an organic tomato farm in Yolo Co., CA., the up-regulation of plant nutrient transport and metabolic genes will be studied in response to gross mineralization and nitrification, and organic matter inputs. To validate these responses, and identify novel combinations of nutrient management practices, a landscape survey of organic and conventional farms will be conducted, with site selection guided by GIS analysis. Participatory activities with stakeholders will demonstrate needs, obstacles, and time frames for implementation.

PROGRESS

2009/09 TO 2013/08 Target Audience: The primary audience for this nitrogen (N) cycling project was farmers of organic crops. Current plant and soil N testing approaches were developed for conventional agriculture, which relies mainly on inorganic N inputs rather than organic matter inputs. New techniques were tested on tomatoes in this project, so the initial audience is organic tomato growers, but the information gained is relevant to many other crops, and to conventional farmers who utilize organic matter inputs (e.g. manure and cover crops) to meet plant N demand. During the course of this project, there were several target audiences: organic farmers participating in the research project (8 different farms), local extension personnel (farm advisors in Yolo County, CA), a non-governmental organizations involved agriculture and climate change adaptation (CalCAN), national participants in an eExtension webinar, scientific communities in soil science and agroecology (via publications and presentations described below), and undergraduate and graduate students at the University of California Davis, who worked on or learned about the project in Jackson's courses. For each of these different types of audiences, there were a unique set of deliverables intended to capture interest on different topics including: new types of indicators for improving nutrient management; how the participatory approach was conducted; or the scientific results on linking plant gene expression with soil processes. The project was successful in reaching this broad range of audiences because its scope went from gene- to landscape-level approaches. Changes/Problems: The FTIR spectroscopic analysis of soil organic matter was not part of the original proposal, but was added to give an intermediate set of indicators, in between the very labile soil pools (e.g. MB and PMN) and total soil C and N, which are largely composed of recalcitrant compounds. The FTIR approach was used rather than particulate organic matter, or humified fractions associated with microaggregates and minerals, as was written in the original proposal because FTIR is rapid and inexpensive compared to these other methods and thus has more potential to be adopted by commercial testing facilities. By conducting a greenhouse compost study vs. an on-farm cover crop study, there was an improvement in the quality of the response measurements to an organic matter input. It enabled very frequent measurements of plant and greenhouse gas emission responses to dry downs in a controlled environment. Not only did the farm site require a 45-minute drive, but water, temperature, and solar radiation are unpredictable in the field environment. Soils for the greenhouse study were from the same location as the on-farm experiment in Objective 1. More data was collected than was anticipated (such as soil sampling three times over the growing season in the survey), and while this slowed down the completion of the project, it also offered additional resolution on plant-soil-microbial C and N dynamics. Also, much of the work was conducted by a PhD and a MS student, who had coursework to attend to, rather than by postdocs or technicians, as had been expected. But their longer-term commitment to the research (e.g. 5 years by Tim Bowles for his entire dissertation) is resulting in very thorough and well-written scientific papers, as well as a continuity of interaction with the farmers in the study. Thus, a major reason for the delay is that the project expanded its scope because it gained over 3 years of FTE from other funds that paid the salaries of Tim Bowles (NSF Graduate Fellowship) and Cristina Lazcano (Fellowship from the Spanish Government). Due to this delay, we are still very

involved in the final stages of outreach, and will continue to give presentations and produce scientific publications for another couple of years. The outcomes of the project will continue to increase during this period. What opportunities for training and professional development has the project provided? Training and development of graduate students was a bigger aspect of the project than originally planned. The two graduate students on the project, Tim Bowles and Andrew Margenot, were encouraged to present their work at conferences (see below) and to co-author review articles based on the literature reviews that they conducted in designing their research (see publications above). Tim contributed 4 years of work to the project and will finish his dissertation in a year, and is starting to look for a postdoc position. Andrew was an MS student on the project, and has decided to go on for a PhD on a biogeochemistry project in African agriculture. Support was sought amongst other colleagues to train them to use or analyze specific methods. Francisco Calderón and Verónica Acosta-Martínez are USDA ARS scientists who worked with the students on FTIR analysis of the soil samples, and soil potential enzyme and FAME analyses, respectively. A UC Davis professor, Sanjai Parikh, helped supervise Andrew's work on the FTIR analysis. Another UC Davis professor, John Yoder, helped Tim fine-tune the plant root gene expression analysis. Each of the four postdocs was only on the project for short periods of time, or took responsibility for only one aspect of the research. They were encouraged to work on review papers, and give presentations and guest lectures, but they were not as engaged as the graduate students. Three of the postdocs have moved into new postdoctoral positions at UC Davis in plant-soil relationships (e.g. water relations and root structure, irrigation and nitrogen management, monitoring of greenhouse gas emissions). Graduate students and postdocs received substantial field and lab help from undergraduates. The undergraduates on the project were trained in increasingly sophisticated methods as they spent more time in the lab. Several worked in the lab for over a year, so that they learned the ins and outs of research. About half of them have decided to pursue scientific careers (e.g., agronomist, veterinarian, pharmacist). How have the results been disseminated to communities of interest? Much of the information dissemination to the farmers involved with the study was done through a series of informal one-on-one meetings. With the farmer of the on-farm experiment (Durst farm), there have been many meetings to discuss experimental design and results, as well as the ways to improve N cycling and retention particularly in fields newly transitioned to organic production (e.g. more organic matter inputs, less soluble organic N inputs). There have been at least three meetings with each of the 8 farmers in the landscape survey, and preliminary results on soil C and N pools, plant N and crop yields were presented to them for each of their fields. At present, we are preparing separate presentations for each farm that include the soil potential enzyme activity, microbial community, and FTIR data. Their fields will be categorized into three general types: tight N cycling, N deficient and N saturated. Recommendations for changes will be developed together with each farmer. These meetings will take place in December, 2013. The growers were not keen to be part of a focus group on their respective practices, but we will hold a group meeting in 2014 to ask their opinions on what research needs to be done next. Many different audiences were targeted as was explained above. Some of the types of audiences that heard presentations related to the project were field day participants, stakeholders involved in agricultural responses to climate change, national and international groups dedicated to organic agriculture, scientists at national meetings in ecology and soil science, and scientists at workshops on biogeochemistry, agrobiodiversity, and participatory research. At these different types of meetings, we gained insights on the way to structure the project to become most useful, often because the presentations were made before the data set was complete. The general public can access information about the project at the USDA eOrganic Nationwide Webinar http://www.youtube.com/watch?v=v69ZWghk34A and the Jackson lab's website http://ucanr.edu/sites/Jackson Lab/, with specific pages on N gene expression in tomato roots, the landscape survey and the FTIR analysis, and nitrogen cycling in organic vegetable production. The following formal presentations were made by the PI and graduate students to either introduce the project, explain some of the findings, or focus on one aspect of the research. 2009 Jackson, L.E. Oral Presentation. Agro-biodiversity and Organic Research in the USA and Internationally. International Workshop on Organic Farming and Development in China. China Agricultural University. Beijing, China. October. 2010 Jackson, L.E. Oral Presentation. Soil Processes, Soil Biology and Soil Fertility. Master Gardener Lecture. Placerville, CA. February. Jackson, L.E. Oral Presentation. Soil Ecology, the Rhizosphere and Agricultural Resilience. Wageningen University Soil Ecology Course on \"Soil Ecology: Taking Global Issues Underground\". Wageningen, NL. June. Jackson, L.E. Oral Presentation. Effects of Organic Management on Soil Biology and Nutrient Cycling. Lecture for Japanese agriculture students. Davis, CA. July. Jackson, L.E. Keynote Oral Presentation. Biodiversity as a Basis for Agroecosystem Functioning: Investigating Mechanisms at Multiple Scales. Symposium on Ecological intensification of cropping systems. European Society for Agronomy Agro2010 Conference. Montpellier, France. August. Jackson, L.E. Oral Presentation. Agrobiodiversity as a Component of an Integrated Landscape Approach for Sustainable Agriculture. Workshop/seminar on Agro-biodiversity and Ecosystem Services. International Center for Organic Food Systems. Danish Embassy, Washington DC. December. 2011 Jackson, L.E. Oral Presentation. Soil Processes, Soil Biology and Soil Fertility. Master Gardener Lecture. Rohnert Park, CA. January. Jackson, L.E. Oral Presentation. Research on Soil Quality in California: Processes, Justification and Long-term Benefits. American Society of Agronomy CA Chapter's Plant and Soil Conference. Fresno, CA. February. Jackson, L.E. Oral Presentation.

What are Agriculture's Best Strategies for Coping with Climate Change? Climate & Agriculture Summit. California Climate Action Network. Davis, CA. February. Jackson, L.E. Oral Presentation. Agrobiodiversity, Ecological Intensification and Ecosystem Services. Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) and Center for Agronomy Research and Development (CATIE). Turrialba, Costa Rica. April. Jackson, L.E. Oral Presentation. Landscape Inventory: Biodiversity and Ecological Function Indicators. Russell Ranch Field Day. UC Davis. Davis, CA. June. Jackson, L.E. Keynote Oral Presentation. Agricultural Land Use, Soil Biota and Ecosystem Services. International conference on Functions and Services of Biodiversity. Göttingen University. Göttingen, Germany. June. Jackson, L.E. Oral Presentation. Nitrogen Cycling, Soil Biota, and Agricultural Intensification. \'Soil Science in a Changing World\' Conference. Soil Science Centre of Wageningen University. Wageningen, The Netherlands. September. Jackson, L.E. Oral Presentation. Agrobiodiversity and Ecological Functions for Improving the Sustainability of Intensive Agriculture. Workshop on Agroecology at Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD). Martinique, France. November. 2012 Margenot, A. How Significant is Management in Influencing SOM Content, and More Importantly, Quality? Taking a (Molecular) Look at SOM of Organic Tomato Fields Along Various Gradients. Western Soil Science Society of America Meeting. Davis, CA. July. Bowles, T.M. Poster Presentation. Rapid changes in Root Gene Expression in Response to Nitrogen Availability: Linking Molecular Biology, Plant Physiology, and Soil Biogeochemical Processes. Ecological Society of America Annual Meeting. Portland, OR. August. Jackson, L.E. Oral Presentation. Research on Organic Food Systems in North America. Board Meeting of the International Center for Research on Organic Food Systems. Zanzibar, Tanzania. September. Jackson, L.E. Oral Opening Address. Biodiversity and Agricultural Sustainagility: from Assessment to Adaptive Management. Workshop on "A quelle échelle évaluer les services rendus par les écosystèmes prairiaux?" Institut National de la Recherche Agronomique (INRA). Lusignan, France. December. 2013 Jackson, L.E. Oral Presentation. Experience with the Co-Development Process in California: Climate Change Case Study in Yolo County. Co-author: Tim Bowles. Workshop on: Ranching with Drought in the Southwest: Conditions, Challenges, and a Process to Meet the Challenges. University of Arizona. Santa Rita Range Experimental Station, AZ. February. Bowles, T.M. and L.E. Jackson. Poster presentation. Nutrient Cycling on Organic Farms Across a Gradient of Soil Organic Matter in Yolo Co., California: On-farm research to improve nitrogen availability and retention. CalCAN conference. Davis, CA. February. Jackson, L.E. and T.M. Bowles. Webinar. Research and Farmer Innovation to Increase Nitrogen Cycling on Organic Farms. USDA eOrganic Nationwide Webinar http://www.youtube.com/watch?v=v69ZWghk34A . April. Jackson, L.E. Oral Presentation. Agrobiodiversity and its Relevance to Recent Studies of Organic Agriculture. Board Meeting of the International Center for Research on Organic Food Systems. Humlebæk, Denmark. June. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 OUTPUTS: Dissemination and discussion of preliminary results has been an important activity this year. Meetings were held with each farmer collaborating in this study (eight in total) to discuss preliminary results from the 2011 field season, when extensive on-farm sampling occurred in Yolo County, California. The data, tailored to each farmer\'s operation, provided a platform to discuss how the farm\'s management practices affect nitrogen cycling, nitrogen availability and crop yields, and were based on the field sampling conducted on plants and soil in 2011. Farmers\' awareness of how different organic management practice affects nitrogen processes increased through these discussions, particularly in relation to maximizing nitrogen availability while minimizing potential losses. These data were also presented in a variety of venues with an emphasis on the heterogeneity of organic farms across an agricultural landscape and the implications for improving management through innovative approaches. These presentations included a regional meeting at UC Davis hosted by the California Climate Action Network, at which 20% of attendees were farmers and 20% were extension personnel; the Ecological Society of America conference; a workshop on co-development at the University of Arizona. These PowerPoint presentations have been posted on the lab\'s website and are available to the general public.TARGET AUDIENCES: Direct contact with farmers was the main audience, and extension agents were targeted this year. PROJECT MODIFICATIONS: Not relevant to this project. PARTICIPANTS: The project is the research of a PhD student, Tim Bowles, and MS student, Andrew Margenot. Tim Bowles was responsible for conducting the landscape field sampling, analysis of root gene expression, and data analysis. Andrew Margenot is analyzing soil organic matter composition through infrared spectroscopy. Collaborators at UC Davis as well as USDA ARS scientists, Francisco Calderon and Veronica Acosta-Martinez, have also contributed to the project. The latter are providing assistance with soil microbial community ecology and soil organic matter composition analysis. Four undergraduates and two junior specialists provided assistance with laboratory analysis of plant and soil tissue and root gene expression. Mentorship of these young researchers contributed to one entering a PhD program. Farmers involved in the field sampling have continued to support the project through discussions and help interpreting results. TARGET AUDIENCES: As described in the Outreach section, continued contact with the eight organic farmers participating in this project has improved understanding of nitrogen processes on organic farms through discussion of measurements from the farmers\' own fields. In

addition, discussion with farmers, extension personnel, NGOs, and the broader research community through presentations at several conferences has heightened interest in the rationale and preliminary results of this project. PROJECT MODIFICATIONS: Not relevant to this project.

2010/09/01 TO 2011/08/31 OUTPUTS: Outreach has been an important activity this year. Discussions with more than a dozen organic farmers took place in order to recruit eight farms for the 2011 field program. Farmers\' awareness of the issues and processes in nitrogen cycling increased through discussions for choosing their fields and their nitrogen management practices. Participatory research over a 6-month sampling period meant frequent sampling and data collection during the summer. The first summer\'s data set (2010) on soil 15N fates and rates of nitrogen transformations, root gene expression, and tomato nutrient uptake was explained in presentations, along with the rationale for the project\'s emphasis on variation in nitrogen cycling in the organic farms across an agricultural landscape. These included the American Society of Agronomy CA Chapter\'s Plant and Soil Conference, a UC Davis Farmer Field day, a Master Gardener lecture, a workshop in Costa Rica and a conference in the Netherlands. PARTICIPANTS: The project is the PhD research of a graduate student, who has become proficient in soil biological assays, root gene expression and quantitative PCR, and soil nutrient analysis. An analyst created the geographic information system to choose a representative set of field sites. A MS student has begun to work on analysis of organic matter constituents in the soils. Other faculty at UC Davis are collaborating on aspects related to molecular biology and soil chemistry. Four undergraduates assisted in the summer field work, and worked during the winter on the analysis of plant and soil samples. Farmers on eight farms and thirteen fields have provided a great deal of involvement and support. Conversations have continued with University of California Cooperative Extension and non-governmental organizations. TARGET AUDIENCES: Direct contact with farmers was the main audience, and UC Cooperative Extension was also targeted, but the outreach of the project is being extended to a much wider set of state, national and international audiences. PROJECT MODIFICATIONS: Not relevant to this project. PARTICIPANTS: A PhD student, Tim Bowles, was responsible for conducting the landscape field sampling project in 2011, and also did much of the lab work for the 2010 on-farm experiment on N fates and root gene expression in tomato. A GIS analyst, Allan Hollander, compiled the data for choosing the fields for this project. For the 2010 field experiment, Dr. Philipp Raab was responsible for the root gene expression work. During the year, there were five undergraduates on the project. Contacts and farmer collaborations were described in the first section of the report. TARGET AUDIENCES: As described in the first section of this report, direct contact with more than a dozen organic farmers in Yolo County, California, over a period of several months has caused heightened interest in nitrogen cycling and in management methods using organic practices. The data from the 2011 field season will provide more information and the ability to compare different management approaches and types of farming systems. PROJECT MODIFICATIONS: Not relevant to this project.

2009/09/01 TO 2010/08/31 OUTPUTS: The outputs of the project are mainly in the form of disseminated information to different types of endusers about the project\'s design and purpose. No data sets have been finalized at this early stage in the project. Presentations that have mentioned the current project\'s activities, skillsets and/or goals have been given to local grower audiences, for an eOrganic webinar, at the UN Food and Agriculture Organization, Wageningen Univ. (NL), the International Center for Research in Organic Food Systems (DK) etc. In several seminars, the project has been mentioned for its innovative potential to address N limitation and losses in organic farming systems. In addition, many conversations with members of University of California Cooperative Extension and non-governmental institutions and growers in the Sacramento Valley region of California have been useful in finding growers for the on-farm research and alerting stakeholders about the forthcoming results. PARTICIPANTS: Three undergraduates assisted in the execution of the summer field project and are now working on the analysis of plant and soil samples. The Durst organic farm generously allowed us to conduct the summer experiment and provided valuable support. Conversations have been occurring with University of California Cooperative Extension and non-governmental organizations, in order to be prepared to distribute results and elicit further support from local farmers for next summer\'s field project. TARGET AUDIENCES: UC Cooperative Extension is the main target audience, but the outreach of the project will be extended to a much wider set of state, national and international audiences. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2009/09 TO 2013/08 What was accomplished under these goals? This project showed new testing approaches to aid organic farmers in determining N needs and management, and improve crop performance while minimizing N

losses. The major activities were completed largely as planned, using participatory research with organic tomato farmers in Yolo County, California. The most promising techniques were: 1) quantitative expression of root N uptake and metabolism genes (indicators of a plant's 'eye view' of N availability even when N cycling is so rapid that little soil nitrate or ammonium is detectable); 2) potential activities of soil enzymes involved in C, N, and P processing (indicators of soil processes favoring tightly-coupled plant-soil N cycling); and 3) spectroscopic FTIR bands for labile and more recalcitrant forms of soil organic matter (indicators of the types of pools available for N mineralization). These techniques could be streamlined into rapid and inexpensive assays, given sufficient agricultural and commercial interest. Objective 1 was on a potential N testing approach that reflects soil N availability based on root gene expression. The hypothesis that "the up-regulation of plant nutrient transport and metabolic genes would indicate actual soil N availability and N turnover, even when soil inorganic N pools are low" was confirmed. In an on-farm experiment, tomatoes were fertilized with 0, 10 and 65 µg-N g-1 soil. These concentrations were 4 and 27 times greater than ambient soil inorganic N. Several hours later, roots and soil samples were removed. A subset of plots received a pulse of 15N to test gross mineralization and nitrification rates. Bioassays included potentially mineralizable N (PMN), chloroform fumigation extraction for microbial biomass (MB), and nitrification potential. Inorganic N and Olsen phosphorus were also measured. The 15N analyses will be completed by the end of 2013. One particularly strong response was for root cytosolic glutamine synthetase GTS1, which is responsible for the assimilation of ammonium, derived from both direct ammonium uptake and reduction of nitrate taken up, into glutamine through the condensation of glutamate with ammonia to yield glutamine. Expression levels of this gene increased \~32-fold vs. 3-fold in the high N and low treatments, respectively, compared to the water control. The pulse of N caused few changes in bioassays for available N and microbial biomass, because it was so rapidly assimilated. The increase in root gene expression showed how N additions were effectively utilized, even when not detectable in the soil, serving as a good indicator of plant N use. A greenhouse study in compost-amended soil used dry downs to examine emissions of carbon dioxide and nitrous oxide (N2O). The arbuscular mycorrhizal symbiosis improved the capacity of the plants to adapt to changing soil moisture, increasing photosynthetic rates and stomatal conductance at high soil moisture but decreasing them when soil moisture was lower. In addition, the symbiosis helped to regulate N2O emissions at high soil moisture, driven partly by higher use of soil water. Objective 2 was a landscape survey to assess variables to serve as diagnostic tools for N management. The hypothesis that "across a wide range of farms and landscape positions, expression of plant N transport and metabolism genes will show marked differences in response to management regimes, and will correlate better with soil biological activity indicators than simple measurements of N pools" was confirmed. Field selection used a two-stage process to a) ensure that sampling encompassed the variability of the Yolo County arable landscape using spatial analysis; and b) identify all organic Roma-type tomato fields, both processing and fresh-market, to be transplanted within a two-week period. Three samplings during the 2011 season used similar soil and plant variables described above, but no use of 15N or experimental treatments. Soil texture and pH layer were similar across the 13 fields, but there was a three-fold range of soil C and N, and high variation in inorganic N and available P. For the landscape survey of organic farms, two of three phases of data analysis are complete. 1) Redundancy analysis showed distinct profiles of soil potential enzyme activities across the fields, such that C-cycling enzyme potential activities increased with inorganic N availability while those of N-cycling enzymes increased with C availability. Differentiation of microbial community composition (fatty acid methyl esters (FAMEs)) by organic amendments (manure vs. composted green waste vs. legume crops) was detected, but variation in potential enzyme activities better accounted for soil N and C pools than microbial community composition. 2) With infrared (FTIR) spectroscopy, the ratio of band areas at 1620 cm-1 to 2930 cm-1 exponentially decreased with increasing total soil C, confirming this as useful indicators of chemically labile and refractory organic matter components in bulk soil, respectively, but even more so with a subtractive method of hypochlorite oxidation, which also identified five other band areas as indicators of these components. These could be used in rapid and low cost assessments of nutrient cycling capacity and soil quality. 3) Relationships among all variables will be assessed using regression and multivariate approaches, such as principal components analysis or Kohonen self-organizing maps. Preliminary analysis reveals situations of "tight" N cycling, as indicated by low inorganic N pools, high soil C pools, high root N gene expression, and above average crop productivity, as well as other potential N cycling scenarios (e.g, N deficit or N saturated). Classification and regression tree analysis will be used to show how inorganic N pools, FTIR bands, soil bioassays, and characteristics of the microbial community (e.g. potential enzyme activities and FAMEs) contribute to plant N content, expression of particular root N metabolism genes, and crop yield. Objective 3 was to work with farmers and other decision-makers to improve N cycling for organic farms. The hypothesis that "stakeholders will want to obtain multiple benefits for investments they make in plant and soil N testing, e.g., higher yields, yield reliability, lower input costs and credits for environmental stewardship" was only partially confirmed. Through more than 25 meetings with and presentations to farmers, farmers did not show much confidence that environmental stewardship would be publically rewarded. Instead there was more interest in tailoring results to their own management decisions. Differences in biophysical factors were often associated with the type of farming operation and marketing strategy, such that farm size, labor, harvesting method, and market

delivery system influenced the costs, time, and effort spent on nutrient management, and also on the potential expenditures on soil testing. The new methods might be more attractive to growers for which N inputs were a higher fraction of their total costs, i.e., the processing tomato growers. Overall, the project resulted in a change in knowledge about N cycling, soil organic matter processes, and useful N and C indicators relevant to the diverse management and innovations on this set of farms. Detailed information exchange with each farmer has shown ways to improve N and C management on each of the studied fields. Changes in actions for improved soil testing may occur elsewhere too; presentations were made to other audiences, such as the national eExtension webinar. It is too soon understand changes in societal conditions, but presentations made to science-policy audiences emphasized that many organic farms in the study were effectively supplying N to grow tomato crops with yields at or above the county average, with little excess nitrate in the soil, and thus less potential for loss due to leaching or denitrification. **PUBLICATIONS (not previously reported):** 2009/09 TO 2013/08 1. Type: Journal Articles Status: Published Year Published: 2012 Citation: Jackson, L.E., T.M. Bowles, A.K. Hodson, C. Lazcano. 2012. Soil microbial-root and -rhizosphere processes to increase nitrogen availability and retention in agroecosystems. Current Opinion in Environmental Sustainability. 4:517-522 2. Type: Journal Articles Status: Awaiting Publication Year Published: 2014 Citation: Bowles, T.M., V. Acosta-Mart?nez, F. Calder?n, and L.E. Jackson. 2014. Soil enzyme activities, microbial communities, and carbon and nitrogen availability in organic agroecosystems across an intensively-managed agricultural landscape. Soil Biology and Biochemistry 68:252?262 3. Type: Journal Articles Status: Submitted Year Published: 2014 Citation: Lazcano, C., F.H. Barrios-Masias, and L.E. Jackson. Arbuscular mycorrhizal effects on plant growth and soil greenhouse gas emissions under changing moisture regimes. Soil Biology and Biochemistry, submitted. 4. Type: Journal Articles Status: Submitted Year Published: 2014 Citation: Margenot, A.J., F.J. Calder?n, T.M. Bowles, S.J. Parikh, and L.E. Jackson. Differences in soil organic matter composition characterized by subtractive Fourier-transform infrared (FTIR) spectroscopy across a landscape of organic agroecosystems Soil Biology and Biochemistry, submitted. 5. Type: Journal Articles Status: Submitted Year Published: 2014 Citation: Parikh, S.J., K.W. Goyne, A.J. Margenot, A.J., F.N.D. Mukome, and F.J. Calder?n. Soil chemical insights provided through vibrational spectroscopy. Advances in Agronomy, submitted. 6. Type: Other Status: Accepted Year Published: 2013 Citation: Citation: Timothy M. Bowles, Veronica Acosta-Mart?nez, and Louise E. Jackson. Soil enzyme activities and carbon and nitrogen availability in organic agroecosystems across an intensively-managed agricultural landscape. Poster presentation at Soil Science Society of America Annual Meeting, Tampa FL. November, 2013. 7. Type: Other Status: Accepted Year Published: 2011 Citation: Timothy M. Bowles. Rapid changes in root gene expression in response to nitrogen availability: Linking molecular biology, plant physiology, and soil biogeochemical processes. Poster presentation at Ecological Society of America Annual Meeting. Portland, OR. August, 2011.

2011/09/01 TO 2012/08/31 Preliminary results of the 2011 field sampling have yielded several unique outcomes and impacts. One activity was to use quantitative PCR to measure expression of 20 different tomato root genes involved in nitrogen and phosphorus uptake and assimilation from 78 samples taken at mid-season from the 13 organic fields. Multivariate analysis of these data suggests that plant nitrogen status is better associated with measures of soil biological activity than traditional measures of nitrogen availability, i.e. nitrate. This reflects the rapid nitrogen cycling in these organic fields. As this analysis and outreach progresses, we anticipate this knowledge to make an impact on how organic farmers understand and interpret measures of nitrogen availability. A second activity was to examine soil microbial community composition and soil enzyme activities through collaboration with USDA ARS researchers (see Participants) from the 2011 landscape samples. A third activity was to thoroughly investigate soil organic matter composition and pools using infrared spectroscopy as well as chemical and physical fractionation. A fourth activity was to process nearly 700 soil samples for detailed nutrient analysis and edaphic properties and 250 plant samples for nutrient status. Finally, a fifth activity has been multivariate statistical analysis of these data. Since the same soil and plant samples from 13 organic fields were subjected to this unique combination of analyses, we anticipate finding unique relationships that will contribute to process-based understanding of plant-soil-microbial interactions in organic systems. Two manuscripts are in preparation and two more are planned. The manuscript from the 2010 on-farm experiment is nearly complete and will be submitted by summer 2013. Other publications are also in progress.

2010/09/01 TO 2011/08/31 The scientific approach of the project in 2011 will lead to a unique set of outcomes and impacts, because it uses a set of multi-scale tools to understand plant-soil nitrogen relationships and the factors affecting nitrogen management in different types of organic farms across a landscape. During 2011, one activity was to use a geographic information system (GIS) to map all the organically-managed tomato fields in Yolo County, California, and compile a data set for all the fields using publically-available information on soils, topography, neighboring land forms and land use etc. A second activity was to choose a representative set of thirteen fields using a multivariate statistical approach with the GIS data. A third activity was to interview farmers for the management methods and specific issues related to production and markets for their tomatoes. Then, a

fourth activity was to monitor soil N pools, bioassays for N availability, soil microbial biomass, plant growth and allocation, and plant nutrient content on the thirteen fields several times through the growing season. A fifth activity was a very intensive mid-season sampling phase in which roots were sampled for expression of genes related to nutrient uptake and assimilation, along with relevant soil variables. The 2011\'s field season data will be processed in 2011-12, just as the 2010\'s field season data was analyzed before the 2011 field season. The 2010 on-farm experiment was successful in demonstrating that the root gene expression methods could be combined with 15N fate studies, and rates of microbial N transformations to show that the timing of soil nitrate and ammonium availability corresponded to different patterns of gene expression, respectively. This data set is nearly complete and will be synthesized and written up in 2012. This experiment served as a \"proof of concept\" exercise that justified the multi-site sampling for root gene expression along with soil N pools during the landscape survey project in 2011.

2009/09/01 TO 2010/08/31 Nitrogen cycling in agricultural ecosystems spans multiple scales, from genes to landscapes. We are exploring multi-scale processes as related to farmer adoption of sustainable nitrogen management practices on organic tomato farms in Yolo County, California. Our first field season has been successfully completed. We hypothesized that expression of particular genes would be responsive to soil nitrogen supply and would indicate plant-available nitrogen, even when pools of inorganic nitrogen are low. This hypothesis was tested with a barrage of soil and tomato plant measurements following addition of three nitrogen treatments at a commercial organic farm. Soil nitrogen transformation rates were measured with a 15N pool dilution experiment. Data was gathered on nitrogen and carbon pools, microbial biomass and community composition, and plant nitrogen. Gene expression is now being assessed with quantitative PCR techniques. Preliminary results indicate that expression of plant genes are related to nitrogen uptake and assimilation and are quickly induced by nitrogen additions, and altered as nitrogen is consumed by soil microbes. Other activities that are now underway are compiling data for a geographic information system (GIS) analysis of the organic farms in the landscape, including their soils, topographic position and hydrologic features. These data will be used for determining the most information-rich situations for a landscape survey of farms next summer. A preliminary survey of growers is starting to identify the major obstacles for nitrogen management and innovative solutions on specific farms.

PUBLICATIONS

2011/09/01 TO 2012/08/31 No publications reported this period

2010/09/01 TO 2011/08/31 No publications reported this period

2009/09/01 TO 2010/08/31 No publications reported this period

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Enhancing Productivity and Soilborne Disease Control in Intensive Organic Vegetable Production with Mixed-species Green Manures

Accession No.	0218692
Subfile	CRIS
Project No.	OHO01039-SS
Agency	NIFA OHO
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2009-51300-05512
Proposal No.	2009-01402
Start Date	01 SEP 2009
Term Date	31 MAY 2014
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Grant Year	2009
Investigator(s)	McSpadden-Gardener, B. B.; Miller, S. A.; Kleinhenz, M.; Everts, K.; Meyer, S.; Norton, G.; Parmeter, C.; Smart, C.
Performing Institution	Plant Pathology, OHIO STATE UNIVERSITY, 1680 MADISON AVENUE

NON-TECHNICAL SUMMARY

The use of mixed species green manures can provide added value in terms of the benefits conferred to the soil and subsequent cash crops through improved plant health. However, detailed science-based recommendations regarding their value and use in different organic agro-ecosystems have not been formulated. And, the underlying ecological basis for their disease suppressing capacities have not been characterized. The goal of the proposed work is to improve on-farm production efficiency and soilborne disease management through effective and value-driven applications of mixed-species green manures and associated microorganisms that suppress crop diseases in organic vegetable cropping systems. We will achieve this goal by conducting innovative and participatory research and extension programs that address the following questions: i) what are the effects and economic value of using mixed-species green manures in various organic vegetable cropping systems; ii) to what extent can mixed species green manures be used to predictably restructure and manage functionally-important microbial populations (i.e. pathogens and their antagonists) in the root zone of cash crops; and, iii) how can the technical and economic barriers to adoption of the most effective mixed-species green-manures for improved productivity and soilborne disease suppression be effectively over come The results of the proposed research and extension program will improve the ability of stakeholders to develop a more effective Organic System Plan.

OBJECTIVES

The goal of the proposed work is 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 will be 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 hypothesize that the benefits of mixed-

species green manures are conferred by substrate-induced shifts in structure and activities of soil microbial communities and such shifts result in the associated soilborne disease suppression we have recently documented . We aim to test this hypothesis in coordinated field research and to assist in the practical application of results through integrated, user-driven outreach activities based on thorough socioeconomic analyses. This project will provide a thorough synthesis of the effects and value of mixed-species green manures in organic vegetable crop production systems. The results of the proposed research and extension program will improve the ability of stakeholders to develop a more effective Organic System Plan as it relates to soil quality and soilborne disease management. Specific products of the proposed research will include: a) transformational research papers describing how green manures alter soil and 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, videoclips, 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 various cropping 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.

APPROACH

Under Objective 1, we propose to evaluate the efficacy and economics of using individual and mixed species green manures containing components previously shown to reduce soilborne disease and/or weed pressure and be of particular interest to growers in each region based on stakeholder input. Based on first year results and additional stakeholder input, the Project Directors will select a subset of treatments to be evaluated at multiple locations, each varying in cropping history, soil type and prevailing soilborne pathogen pressure. Economic analyses of the green manure treatments will include steps to assess their economic profitability to producers, relative to current practices, and to project their value at the market level to society. Under Objective 2, we propose to use a variety of molecular methods to identify and characterize the functionally important pathogen and antagonist populations that are significantly affected by the organic amendments evaluated in the field trails of Objective 1. Specifically, we hypothesize that several groups of bacteria, including those recently discovered in our laboratory, will mediate pathogen suppression in a substrate-dependent fashion. TRFLP-based community profiling and DNA macroarrays analyses will be used to quantify the relative abundance of diverse microbes, and those data will be linked to disease assessments at plant, plot, and field scale using multivariate statistical analyses of data provided by all cooperators. Under Objective 3, we propose to investigate the feasibility of developing microbes into useful inoculants to enhance green manure-induced soilborne disease suppression. Specifically, we will evaluate the use of several bacteria linked to durable soilborne pathogen suppression. Such treatments, by virtue of their novelty, are hypothesized to express new mechanisms of action, thus providing the basis for further innovation in the biopesticide industry. Based on the results of the initial screen and feedback from stakeholders, the four most effective inoculum treatments will be selected for further field testing in year 3. Under Objective 4, we will develop uniquely effective Extension and education deliverables throughthe application of a mental models approach combined with an adaptive management plan based on multi-criterion decision analysis (MCDA) to communicate, promote, and analyze stakeholder involvement in this proposed project. This approach provides a systematic framework from which effective communication of project results and benefits can be conveyed To enhance our effectiveness as a collaborative team, we will create an eOrganic research/outreach group that will allow us to communicate efficiently with each other and with the public through private and public workspaces. The public workspace will be used to communicate with other eOrganic groups and deliver extension programming and materials. **KEYWORDS:** cover crop; green manure; organic vegetables; disease suppression; plant-associated microbe; biocontrol; biological control; hairy vetch; rye; red clover; buckwheat; mixed hay; microbial inoculant; microbial biopesticide; disease control; microbial community; community profiling; soilborne disease; vegetables; tomato; watermelon

PROGRESS

2009/09 TO 2014/05 Target Audience: Agricultural scientists, Extension researchers, and organic farmers. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? The project allowed for multiple training opportunities, not only of graduate students but also for undergraduate interns. Four different graduate students were involved with the project, conducting field trials at multiple locations which taught them about soil preparation, planting, pruning, sampling, and harvesting plants for scientific research. Additionally, they gained experience supervising undergraduate interns who assisted with sampling and sample processing. Coordination of research across states taught the lead graduate student how to work effectively on interdisciplinary teams and multi institutional projects. Graduate students collected and

learned how to analyze the complex multivariate data sets, and they made presentations of this work at the American Phytopathological Society meetings over the last two years of the project. How have the results been disseminated to communities of interest? The results of this project were broadly disseminated to multiple communities of interst. Academic researchers were made aware of research progress and results at multiple scientific meetings (i.e. annual meetings of the American Phytopathological Society and Society of Nematologists) over the past four years. Extension educators and organic farmers were made aware of the project through multiple in person and online connections. The project included multiple presentations on-station and off-site at conferences, such as the annual Ohio Ecological Food and Farming Association meetings, as well as online, i.e. through eOrganic webinars, provided growers with the results and synthesis of our survey and field research results. Such training provided the latest science-based guidance on cover crops, soilborne disease control, and biopesticides to those target audiences. Lastly,the broader general public was touched by this project through outreach activities in Ohio and elsewhere that included programming for K-12 students each year on \"what is organic\". What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2012/09/01 TO 2013/08/31 Target Audience: Agricultural scientists, Extension researchers, and organic farmers. Changes/Problems: The complexity of the data sets were daunting. The work included data collection over multiple locations for a total of nineteen site years. Variations by state in implementation of protocols and data organization, as well as the departure of a post doc from Ohio from the project, slowed the analytical and delayed publication of final project results. What opportunities for training and professional development has the project provided? The graduate students and post docs assigned to this project were able to present their work at the American Phytopathological Society meetings. Their writing skills were refined with coaching from multiple PI\'s. How have the results been disseminated to communities of interest? Presentations related to research Objectives were made at the annual meeting of the American Phytopathological Socieity (APS) and the North Central APS meeting. What do you plan to do during the next reporting period to accomplish the goals? An applications for a six-month extension has been requested so that finalized analytical work, journal article submissions, and presentations related to this project can be reported.

2011/09/01 TO 2012/08/31 OUTPUTS: Several preliminary reports were made that included new information on the utility and value of mixed species cover crops. Under Objective 1, data was collected on a multi-state field trial of single and mixed cover crops on station for a third year and, for the first time, on cooperator farms. In addition, data on the effects of using cover crops as a vehicle to more effectively deliver microbial biopesticides were obtained across the three locations. The microbial community profiling work describe under Objective 2 was completed and analyses of the data are still being conducted. Preliminary assessments have highlighted the occurrence of soilborne pathogens on organic tomato roots and the significant environmental variation occurring in rhizosphere microbial communities. Bacteria belonging to the genus Mitsuaria have been recovered from the research fields and were tested as biological control agents in field trials. Data for Objective 4 indicated that the net present value of cover crops tracked efficacy and varied by location. Assessments of grower knowledge and gaps related to cover crops and microbial inoculants were also conducted. Two Master\'s students were graduated in the past year. PARTICIPANTS: Technical training over the past year included the mentoring of one post-doctoral research, four graduate students and a visiting scholar across locations. Two Master students graduated. Collaborations with organic growers and grower organizations (e.g. Ohio Ecological Food and Farm Association, OEFFA) have continued in all three states and were strengthened through the presentation of relevant extension materials at grower meetings. TARGET AUDIENCES: Target audiences included other researchers, extension agents and farmers interested in sustainable organic management of plant diseases. Target audiences were reached through webinars on eOrganic, publication of fact sheets on eOrganic, published abstracts of meetings, and through active engagement in the work associated with Objective 4 of the grant. PROJECT MODIFICATIONS: A one-year no cost extension was requested and approved to complete the analysis and publication of project results.

2010/09/01 TO 2011/08/31 OUTPUTS: According to the established timetable, the first half of the biological and social science research components of this project were completed. Under Objective 1 a multi-state field trial of single and mixed cover crops was conducted, and second year establishment was much more consistent across locations. The microbial community profiling work describe under Objective 2 has been completed for year 1 and is in process for year 2 field samplings. The profiling data are being used to assess contributions of different microbial populations to crop health and pathogen suppression. Collections of \>10,000 rhizosphere bacteria have been assembled at all three locations. Bacteria that have been associated with suppression of soilborne diseases are being recovered from these collections using the marker-assisted approach described under Objective 3. Work on Objective 4 nears the half-way point. The expert model of factors influencing organic

vegetable farmer decision-making regarding soilborne disease management has been developed and reviewed by peers. A first survey of growers has been sent out and responses received. Assessments of grower knowledge and gaps have been conducted. PARTICIPANTS: Technical training over the past year included the mentoring of two post-doctoral researchers, one graduate student and a visiting scholar in OH, one graduate student in NY, MD, and VA, respectively. Collaborations with organic growers and grower organizations (e.g. Ohio Ecological Food and Farm Association, OEFFA) have continued in all three states and were strengthened through the presentation of relevant extension materials at grower meetings. TARGET AUDIENCES: Target audiences included other researchers, extension agents and farmers interested in sustainable organic management of plant diseases. Target audiences were reached through publication and through active engagement in the work associated with Objective 4 of the grant. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Field plots for the project were established and sample collection was initiated. Specifically, mixed species cover crop along with four to five different cover crops had been established in the fall of 2009 in three states (OH, MD and NY). After incorporating cover crop biomass into soil, tomato cv. Celebrity was transplanted. Throughout the season, sampling was conducted four times; 1. cover crop biomass prior biomass incorporation, 2. soil samples post biomass incorporation, 3. soil, rhizosphere samples and plant health measurement post transplanting, and 4. rhizosphere samples and plant health measurement at flowering stage of tomato. Soil fertility test have been completed twice from each cover crop treatment plot. From all the soil and rhizosphere samples, microbial DNA has been extracted. In OH, an experiment testing a subset of factors regarding current cover crop practices (e.g. timing of main crop planting after cover crop incorporation, no till vs. conventional till) on plant disease suppression and soil microbial community was conducted. According to the established timetable, the social science component of the project has been initiated. Specifically, an expert model of factors influencing organic vegetable farmer decision-making regarding soilborne disease management has been developed and reviewed by peers. A questionaire for phone interviews with extension agents and expert growers in three states is currently being developed based on the expert model. PARTICIPANTS: Training over the past year included the mentoring of two post-doctoral researchers, one graduate student and two visiting scholars in OH, one graduate student in NY and VA, respectively, and technical staff in MD. Collaborating organic growers and extension agents have been identified and contacted. TARGET AUDIENCES: Target audiences included other researchers, extension agents and farmers interested in sustainable organic management of plant diseases. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2009/09 TO 2014/05 What was accomplished under these goals? The following accomplishments contributed to this project meeting its primary goal of the project was to improve on-farm production efficiency through effective applications of mixed species green manures in organic vegetable cropping systems. Under Objective 1, yield and disease responses of cash tomato crops to cover crop treatments planted over sixteen site years were assessed. Overall, cover crops had a significant effect on marketable yields of subsequent cash crop tomatoes only 25% of the time, indicating that their value cannot be easily quantified in the year of their application. We also found that individual tomato diseases were affected to varying degrees by cover crops, i.e. from 0 to 44% of the time depending on the disease. Additionally, we discovered that while mixed species cover crops provided extra value at some sites, site specific variables determined the value of cover crops across the multi-site region. Overall, our results indicate that, while the benefits of multi-species cover crops makes intuitive sense, responses on individual farms may vary dramatically. Under Objective 2, we determined that the linkages between root-microbial community structure and crop health were relatively weak and strongly influenced by site-specific variables. Furthermore, we determined that the majority of healthy tomato root samples harbored detectable levels of multiple pathogens, indicating that vigorous plants can tolerate a fairly substantial level of asymptomatic root infections. When comparing the macroarray approach to the ITS-based molecular profiling, we found that the former did a superior job at detecting putative root pathogen populations. Overall, the diversity detected by the molecular community profiling methods applied indicated that individual sample sizes larger than those used in these studies will be required to meaningfully quantify the associations between phytobiome microbial populations and plant health. Under Objective 3, we observed that organically-acceptable commercial and experimental biocontrol inoculants could improve tomato crop yields under some conditions. Applications in concert with cover crops did seem to improve marketable yields, but a comprehensive assessment of the yield responses was precluded by poor harvests at some sites. Thus, the cost effectiveness of such treatments remains unclear and further work will be needed to assess this question. Finally, under Objective 4, we surveyed the knowledge and experience of certified organic vegetable growers regarding cover crops, soilborne diseases,

and biopesticides. We found that most use mixed species cover crops already, but that they were uncertain of the added value provided by them. The survey also revealed that knowledge of soilborn plant diseases and their control with organically acceptable biopesticides was lacking. We were able to address these knowledge gaps by providing several webinars and fact sheets through eOrganic and our state-wide Extension programming. Overall, our assessment of the aggregate benefits of the green manures and microbial inoculants showed mixed results. The costs of applying each to an individual farm for the purposes of soilborne disease do not alone justify their use. These results suggest that a more comprehensive review of the multiple benefits of cover crops be conducted in order to properly guide organic growers to more profitable applications of green manures. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/05 1. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Summers, C.F., C. D. Smart, B. B. McSpadden Gardener, K. L. Everts, A. R. Dunn, S. Park. 2012. The impact of mixed-species cover crops on rhizosphere pathogens of organically managed tomato crops in New York, Ohio, and Maryland. Phytopathology 102:S4.115 2. Type: Theses/Dissertations Status: Published Year Published: 2011 Citation: Parajuli, K.J. 2011. Economic Impact Analysis of Mixed-Species Green Manure on Organic Tomato: Evidence from the Northeastern United States. Masters Thesis. Virginia Polytechnic Institute, Blacksburg, VA. 3. Type: Journal Articles Status: Published Year Published: 2011 Citation: Kim YC, Leveau J, McSpadden Gardener BB, Pierson EA, Pierson III LS, and C-M Ryu. 2011. The multifactorial basis for plant health promotion by plant-associated bacteria. Applied and Environmental Microbiology. 77:1548-1555. 4. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Meyer, S.L., Everts, K.L., and B.B. McSpadden Gardener. 2011. Effects of green manures on nematode population densities in an organic tomato field. \Abstract\. Phytopathology. 101: S120. 5. Type: Other Status: Published Year Published: 2010 Citation: Park, S-J., Cao, C., McSpadden Gardener, B.B. 2010. Inoculants and soil amendments for organic growers. OSU Fact Sheet http://ohioline.osu.edu/sag-fact/pdf/0017.pdf 6. Type: Other Status: Published Year Published: 2010 Citation: Cao, C., Park, S-J., McSpadden Gardener, B.B. 2010. Biopesticide controls of plant disease: Resources and products for organic farmers in Ohio. OSU Fact Sheet http://ohioline.osu.edu/hyg-fact/3000/pdf/HYG 3310 08.pdf 7. Type: Other Status: Published Year Published: 2010 Citation: McGrath, M., Vallad, G., and McSpadden Gardener. B. 2010. Biopesticides for Plant Disease Management in Organic Farming. eXtension. Published Aug 23 online at: http://www.extension.org/article/29380 8. Type: Other Status: Published Year Published: 2010 Citation: Cao, C., Vallad, G., McGrath, M., and McSpadden Gardener, B. 2010. Efficacy of Biochemical Biopesticides that may be used in Organic Farming. eXtension. Published Aug 23 online at: http://www.extension.org/article/29381 9. Type: Other Status: Published Year Published: 2010 Citation: Raudales, R., Cao, C., Vallad, G., McGrath, M., and McSpadden Gardener, B. 2010. Efficacy of Microbial Biopesticides that may be used in Organic Farming. eXtension. Published Aug 25 online at: http://www.extension.org/article/29382 10. Type: Journal Articles Status: Published Year Published: 2014 Citation: Summers, C.F., Park, S., Dunn, A.R., Rong, X., Everts, K.L, Kleinhenz, M.D., McSpadden Gardener, B., and Smart, C.D. 2014. Fungal and oomycete pathogen detection in the rhizosphere of organic tomatoes in cover crop-treated soils. Applied Soil Ecology 80:44-50. 11. Type: Journal Articles Status: Published Year Published: 2014 Citation: Summers, C.F., Park, S., Dunn, A.R., Rong, X., Everts, K.L, Meyer, S.L.F., Rupprecht, S.M., Kleinhenz, M.D., McSpadden Gardener, B., and Smart, C.D. 2014. Single season effects of mixed-species cover crops on tomato health in multi-state (organic) field trials. Applied Soil Ecology 77:51-58. 12. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: C.F. Summers, A. Dunn, C. Smart, B. McSpadden Gardener, K. Everts, S. Park. \"Fungal and oomycete pathogen detection in the rhizosphere of organic tomatoes grown in cover crop treated soil.\" \Abstract\. Phytopathology. Vol. 103. Minneappolis: APS Press. (Jul 2013): S2.141. 13. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Meyer S, Everts K, McSpadden Gardener B. \"Mixed species cover crops green manures for management of soilborne diseases of tomato.\" \Abstract\. J of Nematology. a: Society of Nematology. (Dec 2012) 14. Type: Other Status: Published Year Published: 2012 Citation: Baysal Gurel, F., B McSpadden Gardener, B., and Miller, S.A. 2012. Soil-borne Disease Management in Organic Vegetable Production. Online report eOrganic 7581. 15. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Baysal Gurel, F., B McSpadden Gardener, B., and Miller, S.A. 2012. An expert perspective on the organic vegetable grower decision-making process related to soilborne disease management. Phytopathology 102:S4.10. 16. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Baysal Gurel, F., Parajulu, K., B McSpadden Gardener, B., Norton, G., and Miller, S.A. 2012. Assessing organic vegetable grower beliefs regarding soilborne disease management. Phytopathology 102:S4.11. 17. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Meyer, S. L. F., K. L. Everts, and B. B. McSpadden Gardener. 2012. Mixed species cover crop green manures for management of soilborne pathogens on tomato. Society of Nematologists 51st Annual Meeting Program Book, August 12-15, Savannah Georgia, page 81. 18. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Meyer, S. l. F., K. L. Everts, and B. B. McSpadden Gardener. 2011. Effects of green manures on nematode population densities in an organic tomato field. Phytopathology 101:S120.

2012/09/01 TO 2013/08/31 What was accomplished under these goals? This past year, data from all objectives were collated, assembled, and analyzed. Specifically, under Objective 1, yield and disease responses of cash tomato crops to cover crop treatments planted the preceeding year, were assessed. We found that site variables had the greatest effect on outcomes in this multi-year, multi-site study. Under Objective 2, we assessed the relative strength of the linkages between root-microbial structure and crop health in tomatos. Because of the relative high degree of soil health in the tested fields, and the high degree of site to site and year to year variability, definitive associations were not found. Further efforts were made to assess the relative value of profiliing root pathogens with ITS-based macroarrays and terminal restriction fragment-based profiling. That work indicated that the the two methods revealed very distinct and non-overlapping subsets of root colonizing fungi. Under Objective 3, we observed that organically-acceptable commercial and experimental biocontrol inoculants could improve tomato crop yields under some conditions. Applications in concert with cover crops did seem to improve marketable yields, but the cost effectiveness of such treatments remains unclear. Further work is needed to assess this question. Finally, under Objective 4, we began finalizing our assessments of grower knowledge of cover crops and soil-based disease suppression. Additional work remains on reporting these findings to growers.

2011/09/01 TO 2012/08/31 IMPACTS: Changes in knowledge included a greater appreciation of the complex linkages between rhizosphere bacteria, crop growth & health, and the relative importance of the prevailing environmental conditions in determining disease status. Still, this project demonstrated that soilborne diseases could significantly affected by the choice of cover crops in one of three growing years, on average. Differential responses by location indicate that mixed species cover crops such as rye vetch combinations can provide better outcomes for growers, but the consistency of such effects will be limited to just more than half of the site years that such combinations are used. Economic assessments showed that such site to site variability translates into significant net present values that vary by cover crop choice and location. Multivaraiate statistical analyses of community profile data revealed the importance of soil type and cover crop biomass in determining microbial population structure and abundance. Macroarray analyses revealed a high frequency of infection by several pathogenic genera across locations, even in apparently asymptomatic plants indicating the extent to which asymptomatic infections occur in the field. Information on cover crops and soilborne diseases of organic vegetables was shared with growers and researchers through two eOrganic webinars.

2010/09/01 TO 2011/08/31 Changes in knowledge included a greater appreciation of the quantitative linkages between rhizosphere bacteria, crop growth & health, and prevailing environmental conditions. Differential responses by location indicate that mixed species cover crops cannot provide qualitatively better outcomes for growers than certain single species cover crops, and that crop benefits may be heavily dependent on location characteristics. Multivaraiate statistical analyses of community profile data indicate a higher than expected variation in community structure by field site and cover crop, highlighting the need for a third year of data collection in order to determine the significance of the observed associations. Macroarray analyses revealed a high frequency of pathogen infection, even in apparently asymptomatic plants indicating the extent to which asymptomatic infections occur in the field.

2009/09/01 TO 2010/08/31 Technical training over the past year included the mentoring of two post-doctoral researchers, one graduate student and two visiting scholars in OH, one graduate student in NY and VA, respectively, and technical staff in MD. The research team became more fluent in the mental models approach to problem identification and solution discovery. Collaborations with organic growers and grower organizations (e.g. Ohio Ecological Food and Farm Association, OEFFA) have been initiated in three states and were strengthened through the presentation of relevant extension materials created by project participants.

PUBLICATIONS

2012/09/01 TO 2013/08/31 1. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: C.F. Summers, A. Dunn, C. Smart, B. McSpadden Gardener, K. Everts, S. Park. \"Fungal and oomycete pathogen detection in the rhizosphere of organic tomatoes grown in cover crop treated soil.\" \Abstract\. Phytopathology. Vol. 103. Minneappolis: APS Press. (Jul 2013): S2.141. 2. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Meyer S, Everts K, McSpadden Gardener B. \"Mixed species cover crops green manures for management of soilborne diseases of tomato.\" \Abstract\. J of Nematology. a: Society of Nematology. (Dec 2012) 3. Type: Journal Articles Status: Under Review Year

Published: 2013 Citation: Carly F. Summers1, Sunjeong Park, Amara R. Dunn, Xiaoqing Rong, Kathryne L. Everts, Susan L. F. Meyer, Shannon M. Rupprecht, Matthew D. Kleinhenz, Brian McSpadden Gardener, and Christine D. Smart. 2013. Multi-State Field Trials Demonstrate Infrequent and Site-Specific Effects of a Single Season of Mixed-Species Cover Crops on Productivity and Disease Severity in Tomato. Applied Soil Ecology xx:xxx 4. Type: Journal Articles Status: Other Year Published: 2014 Citation: Carly F. Summers, Sunjeong Park, Amara R. Dunn, Xiaoqing Rong, Kathryne L. Everts, Matthew D. Kleinhenz, Sally Miller, Christine D. Smart, and Brian McSpadden Gardener. 2014. Use of cover crops as vehicles for enhancing efficacy of biocontrol inoculants. Biological Control. xx:xxx 5. Type: Journal Articles Status: Other Year Published: 2014 Citation: Fulya Baysal-Gurel, B. McSpadden Gardener, G. Norton and Sally A. Miller. 2014. Assessing Organic Vegetable Growers' Beliefs Regarding Soil-borne Disease Management. Plant Health Management xx:xxx

2011/09/01 TO 2012/08/31 1. Baysal Gurel, F., B McSpadden Gardener, B., and Miller, S.A. 2012. Soil-borne Disease Management in Organic Vegetable Production. Online report eOrganic 7581. 2. Baysal Gurel, F., B McSpadden Gardener, B., and Miller, S.A. 2012. An expert perspective on the organic vegetable grower decision-making process related to soilborne disease management. Phytopathology 102:S4.10. 3. Baysal Gurel, F., Parajulu, K., B McSpadden Gardener, B., Norton, G., and Miller, S.A. 2012. Assessing organic vegetable grower beliefs regarding soilborne disease management. Phytopathology 102:S4.11. 4. Meyer, S. L. F., K. L. Everts, and B. B. McSpadden Gardener. 2012. Mixed species cover crop green manures for management of soilborne pathogens on tomato. Society of Nematologists 51st Annual Meeting Program Book, August 12-15, Savannah Georgia, page 81. 5. Meyer, S. l. F., K. L. Everts, and B. B. McSpadden Gardener. 2011. Effects of green manures on nematode population densities in an organic tomato field. Phytopathology 101:S120. 6. Parajuli, K.J. 2011. Economic Impact Analysis of Mixed-Species Green Manure on Organic Tomato: Evidence from the Northeastern United States. Masters Thesis. Virginia Polytechnic Institute, Blacksburg, VA. 7. Summers, C.F., C. D. Smart, B. B. McSpadden Gardener, K. L. Everts, A. R. Dunn, S. Park. 2012. The impact of mixed-species cover crops on rhizosphere pathogens of organically managed tomato crops in New York, Ohio, and Maryland. Phytopathology 102:S4.115

2010/09/01 TO 2011/08/31 1. Kim YC, Leveau J, McSpadden Gardener BB, Pierson EA, Pierson III LS, and C-M Ryu. 2011. The multifactorial basis for plant health promotion by plant-associated bacteria. Applied and Environmental Microbiology. 77:1548-1555. 2. Meyer, S.L., Everts, K.L., and B.B. McSpadden Gardener. 2011. Effects of green manures on nematode population densities in an organic tomato field. \Abstract\. Phytopathology. 101: S120.

2009/09/01 TO 2010/08/31 1. Park, S-J., Cao, C., McSpadden Gardener, B.B. 2010. Inoculants and soil amendments for organic growers. OSU Fact Sheet http://ohioline.osu.edu/sag-fact/pdf/0017.pdf 2. Cao, C., Park, S-J., McSpadden Gardener, B.B. 2010. Biopesticide controls of plant disease: Resources and products for organic farmers in Ohio. OSU Fact Sheet http://ohioline.osu.edu/hyg-fact/3000/pdf/HYG 3310 08.pdf 3. McGrath, M., Vallad, G., and McSpadden Gardener. B. 2010. Biopesticides for Plant Disease Management in Organic Farming. eXtension. Published Aug 23 online at: http://www.extension.org/article/29380 4. Cao, C., Vallad, G., McGrath, M., and McSpadden Gardener, B. 2010. Efficacy of Biochemical Biopesticides that may be used in Organic Farming. eXtension. Published Aug 23 online at: http://www.extension.org/article/29381 5. Raudales, R., Cao, C., Vallad, G., McGrath, M., and McSpadden Gardener, B. 2010. Efficacy of Microbial Biopesticides that may be used in Organic Farming. eXtension. Published Aug 25 online at: http://www.extension.org/article/29382 **SUPPLEMENTARY DATA:** **Institution Type:** SAES **Coop Dept:** Horticulture and Crop Science **Coop States:** MD; NY; VA **Region:** 3 **Process Date:** 2009/06/12 **Progress Update:** 2014/10/08 **Program Code:** 113.A

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Northern Vegetable Improvement Collaborative (novic)

Accession No.	0218837
Subfile	CRIS
Project No.	ORE00480
Agency	NIFA ORE
Project Type	OTHER GRANTS
Project Status	EXTENDED
Contract / Grant No.	2009-51300-05585
Proposal No.	2010-03392
Start Date	01 SEP 2009
Term Date	31 AUG 2014
Grant Amount	$539,344
Grant Year	2009
Investigator(s)	Myers, J.; Mazurek, M.; Silva, E.; Colley, M.
Performing Institution	Horticulture, OREGON STATE UNIVERSITY, CORVALLIS, OREGON 97331

NON-TECHNICAL SUMMARY

We wish to create a robust national network of organic vegetable breeders working collaboratively with each other and regional growers to benefit the organic community with improved vegetable varieties that are adapted to organic systems combined with disease resistance, nutritional and flavor quality, and contemporary productivity traits crucial to modern markets. We will focus on four hubs in the Northern US because of the similarities of our growing environments. Five crops that span a growing season were selected that integrate grower needs and plant breeding expertise: pea, broccoli, sweet corn, carrots and winter squash. Variety trialing and evaluation of material at various stages of development will provide key information regarding adaptability and will be ideal for soliciting regional participant grower input regarding their evaluation of the suitability of the vegetables to their needs and guidance for further improvement toward cultivar development. This engagement will take the form of trialing material at various stages of development along with existing varieties as well as engaging in participatory breeding. Outreach activities will make the results of this work more accessible. Graduate student training and summer internships at each hub will be key aspects of the work. Workshops will be conducted and media will be developed to reinforce grower collaborations regarding the breeding, trialing and seed saving methods for each crop.

OBJECTIVES

Our overall goal is to increase the proportion of US agriculture that is managed organically by increasing the availability of vegetable varieties that are adapted to organic systems over a wide seasonal window. Secondary goals are to enhance compliance with the National Organic Program (NOP) requirement for use of certified organic seed and to create a robust multistate network among researchers working on organic vegetable breeding and trialing. To facilitate these goals, the project has two main objectives: 1) to breed vegetables for adaptation for production in organic systems, and 2) to establish a variety trialing network through the Northern tier of the U.S. Outputs from the program include germplasm developed and cultivars released of vegetables (with priority on broccoli, peas, sweet corn, carrots, and winter squash). Additional outputs are to create in eOrganic, a relational database of all published organic variety trialing results, host variety trial field days and participatory plant breeding workshops, contribute to plant breeding content on eOrganic, and to develop publications on quality organic seed production, and variety trial results.

APPROACH

All breeding and trialing activities will be conducted in organic production systems. Four regional hubs with research farms will cooperate with local fresh market organic farms. Traditional breeding methods appropriate to the specific vegetable crop will be used. Farmers will be involved in all aspects of breeding activities, from deciding what traits are relevant, to growing and making selections, to participating in seed production and release. Advanced lines will be trials at the four regional hubs to identify lines with broad adaptation. Varieties will be joint releases among institutions. Variety trials will be conducted using a mother-daughter trialing approach where replicated trials at the regional hubs (mother sites) will be supplemented with single rep trials grown on multiple organic farms (daughter sites). We will assess progress in our breeding material in comparison to existing cultivars through replicated trials on research farms and working organic farms across the northern US and comparison to existing cultivars. Hub sites will be subjected to standard analysis of variance (ANOVA) individually and across locations in each year, and across environments with accumulation of data by year. Farmer sites in each region will combined in an analysis, and will be analyzed separately from hub site data as a randomized complete block design where each farm represents a replicate. Farm-derived data will also be examined across years and locations. We will focus outreach activities on delivering education and information to organic farmers while also providing useful information, dialog, and research models for agricultural professionals and university research and Extension personnel. Outreach activities will include developing eOrganic outreach materials; hosting variety trial field days; hosting workshops on participatory organic plant breeding, on-farm variety improvement, and organic seed production; and developing a series of publications, training modules, and brochures to promote participatory plant breeding, testing of varieties under organic conditions, and production of high quality organic seed of vegetables.

PROGRESS

2009/09 TO 2014/08 Target Audience: Target audience was fresh market organic farmers, vegetable seed companies and other public researchers working on breeding seed initiatives for organic production systems. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Three graduate students were trained in organic plant breeding. One has found employment with High Mowing Seeds, a vegetable seed company selling exclusively certified organic seed. Another is working as the Pacific Northwest research and education associate for Organic Seed Alliance. The third is continuing a PhD breeding for downy mildew resistance in Impatiens. A fourth graduate student continues her Ph.D. program at University of Wisconsin. Training modules on participatory breeding and small-scale organic vegetable seed production were developed and are now available through OSA\'s website. Information and varieties have been disseminated through trialing on organic farms, at field days and training workshops, through brochures and on the internet through eOrganic and eXtension. Over 300 farmers have learned on-farm plant breeding skills at the OSA \"Fundamentals of Organic Variety Improvement\" workshops. As a result many, including project farmer-participants, have initiated their own on-farm breeding projects. Over 2,000 farmers have attended OSA organic seed educational workshops and events, many hosted in partnership with OSU and WSU. OSA, OSU, and WSU have also co-hosted the last 6 biennial, national Organic Seed Growers Conferences.Training and professional development activities for the project include: Plant Breeding Workshop. Jun. 16-17, 2010. Common Ground Farm, Olympia, WA. NOVIC sponsored training program co-organized and co-taught with Organic Seed Alliance. Plant Breeding Workshop. Jul. 27-28, 2011. Gathering Together Farm, Philomath, OR. NOVIC sponsored training program co-organized and co-taught with Organic Seed Alliance. Farmer Field Day, Oct. 20, 2011. Nash\'s Organic Produce, Sequim, WA. NOVIC sponsored field day highlighting field trials at WA mother site. Tilth Producers of Washington Annual Conference, Nov. 11-12, 2011. Port Townsend, WA. NOVIC workshop taught as part of agenda and project poster presented in research poster session. On-farm participatory plant breeding workshop. July 20-21, 2012. Seed Savers Exchange Conference, Decorah, IA. NOVIC sponsored workshop presented as part of conference agenda. Student Training. Aug. 5-8, 2012. Student Organic Seed Symposium, Greensboro, VT. Fundamentals of On-Farm Plant Breeding Workshop and Field Day. Aug 12-13, 2012. University of Wisconsin-Madison, Madison, WI. NOVIC sponsored training taught by Organic Seed Alliance and tour co-hosted with WI project partners. Seed Saving Workshop. Oct. 26-27, 2012. Carolina Farm Stewardship Association Conference, Greenville, SC. NOVIC sponsored training taught by Organic Seed Alliance. Field Day and Tasting. Nov. 12, 2012. Finnriver Farm and Cidery, Chimacum, WA. Field day touring and tasting NOVIC trials. On-Farm Variety Trial Workshop. Jan 16-17, 2013. Greenbank Farm, Greenbank, WA. NOVIC sponsored training taught by Organic Seed Alliance. Fundamentals of On-Farm Plant Breeding Workshop, Tasting, and Research Poster. Feb. 8-9, 2013. Organicology Conference, Portland, OR. NOVIC sponsored training and tasting included in conference agenda, and project poster included in research

poster session. Organic University: Art and Science of Organic Seed Production and Poster. Feb. 22-23, 2013. MOSES Conference, LaCrosse, WI. NOVIC sponsored training include in conference agenda and project poster included in research poster session. On-Farm Field Day. Aug. 4-7, 2013. Student Organic Seed Symposium, Mount Vernon, WA. Tour of NOVIC trials as WA mother site. Plant Breeding Workshop. Aug. 21-22, 2013. Stone Barns Center for Food and Agriculture, Pocantico Hills, NY. NOVIC sponsored training program co-organized and co-taught with Organic Seed Alliance. Field Tour. September 15, 2013. Jefferson County, WA Farm Tour and Field Walk, Jefferson County, WA. Field tour of multiple NOVIC trial sites in WA. On Farm participatory plant breeding workshop. March 10, 2014. Wedgewood Resort, Fairbanks, AK. How have the results been disseminated to communities of interest? Results and information have been distributed through 5webinars, a podcast, 3press releases, and 22 presentations as detailed below. Webinars: How to Breed for Organic Production Systems, Oct. 18, 2011. Plant Breeding and Genomics Webinar Series. http://www.extension.org/pages/60431/how-to-breed-for-organic-production-system s-webinar. Breeding Peas, Sweet Corn, Broccoli, Winter Squash and Carrots as part of NOVIC. (Introduction and Pea breeding) eOrganic live broadcast. Jan. 19-21, 2012. http://www.extension.org/pages/61925/organic-seed-growers-conference-2012:-sele cted-live-broadcasts#novic. Breeding for Nutrition in Organic Seed Systems Webinar. Part 2: Breeding Tomatoes for Increased Flavonoids. eOrganic Webinar. Mar. 23, 2012. http://www.extension.org/pages/62564/breeding-for-nutrition-in-organic-seed-sys tems-webinar. Cuckoo for Cucurbit Vine Crop Breeding. http://www.extension.org/pages/70436/cuckoo-for-cucurbit-vine-crop-breeding#.VR q XPnF-AU Research Update: Vegetable Crops NOVIC Results eOrganic live broadcast. Jan. 30-Feb1, 2014. https://www.youtube.com/watch?v=Q00NQfqB6 c&list=PLZMuQJAj6rOpFS40cWZ8Xn4O9 6tKisMHb&index=7 Podcasts and press releases Margaret Roach talks with@BillTracy1about organic plant breeding collaborations and \'WhoGetsKissed?\' sweet corn (http://podcasts.am1020whdd.com/\~am1020wh/shows/category.php?id=119) A new corn, bred for organic farms and gardens, tells a bigger story http://awaytogarden.com/new-corn-bred-organic-farms-gardens-tells-bigger-story/ University of Wisconsin researchers breed supersweet organic corn http://www.jsonline.com/features/food/university-of-wisconsin-researchers-breed -supersweet-organic-corn-b99403594z1-285971461.html? SKOL: UW gives the state a corny gift (http://lacrossetribune.com/courierlifenews/news/opinion/editorial/columnists/s kol-uw-gives-the-state-a-corny-gift/article 8d1fb9ee-c67c-55ab-bc9d-fdc7b776363 d.html) Conference presentations: Twelve extension talks in WI where NOVIC data was highlighted were given. Additional talks include: Lyon, A. and E. Silva. 2013. Seed and Plant Breeding for Wisconsin\'s Organic Vegetable Sector: Understanding Farmers\' Needs and Practices. American Society for Horticultural Science Conference, July 21-24, Palm Desert, CA. \"Participatory Vegetable Breeding and Variety Trialing\", Organic Farming Conference, La Crosse, WI, February 25, 2012. \"Organic Vegetable Production: Latest Research and Recommendations\", Iowa Organic Conference, Ames, IA, November 21, 2011. \"Variety Selection and UW Organic Research\", North Dakota Organic Conference, July 14, 2009. Mazourek M. \"Research updates: Vegetable Crops\". Organic Seed Growers Conference. Corvallis, OR. January 31, 2014. McKenzie, L. \"Research updates: Vegetable Crops\". Organic Seed Growers Conference. Corvallis, OR. January 31, 2014. Mazourek M. \"Food Security through Valuing Food.\" UC Davis. Pioneer Student Plant Breeding Symposium. Davis, CA. April 11, 2014. Morton F and Mazourek M. \"Two Perspectives on Plant Breeding\" Blue Hill-Stone Barns Restaurant. G9 Chefs Summit. Pocantico Hills, NY. September 23, 2013. Navazio J and Mazourek M. Plant Variety Improvement for Organic Ag. Stone Barns Center, Growing Farmers Initiative/NOVIC. Pocantico Hills, NY. August 2013 McKenzie L. Variety trials and Plant Improvement. Stone Barns Center, Growing Farmers Initiative/NOVIC. Pocantico Hills, NY. August 2013 Mazourek M. \"A Perspective from Cornell\" USDA Listening Session. Washington, DC. July, 2013 Algiere J and Mazourek M. \"Plant Breeding Part 1 - Values of Seed Saving.\" Stone Barns Center, Young Farmers Conference. Pocantico Hills, NY. Dec 2012. Algiere J and Mazourek M. \"Plant Breeding Part 2 - Build-a-Veggie Workshop.\" Stone Barns Center, Young Farmers Conference. Pocantico Hills, NY. Dec 2012. Algiere J and Mazourek M. \"Values of Seed Saving.\" Growing farmers initiative workshop. Pocantico Hills, NY. October 26, 2012. Myers J, Mazourek M, Navazio J, Tracy W, McKenzie L. \"Breeding Peas, Sweet Corn, Broccoli, Winter Squash, and Carrots as part of NOVIC.\" Organic Seed Alliance Winter Conference. Port Townsend, WA. January 20, 2012. Lew-Smith J and Mazourek M. \"Organic variety commercialization.\" Organic Seed Alliance Winter Conference. Port Townsend, WA. January 21, 2012. Algiere J and Mazourek M. \"Adventures in Plant Breeding.\" Growing farmers initiative workshop. Pocantico Hills, NY. November 19, 2011. Mazourek M and Silva E. \"NOVIC.\" OREI Project Directors Workshop, ASHS Conference, Waikoloa, HI. September 26, 2011. Mazourek M. \"Pepper, Squash, Cucumber, Watermelon and Snap Pea Breeding at the Cornell University Agricultural Experiment Station in Ithaca\". Cornell Seed Conference, Geneva, NY. December 2, 2010. McKenzie L. \"Participatory Strategies for Organic Plant Breeding\". Organicology Conference, Portland, OR. 2011 McKenzie L. \"A Collaborative Approach to Strengthening Organic Seed Systems\". Organicology Conference, Portland, OR. 2013 McKenzie L. \"On-Farm Vegetable Breeding and Variety Trials\". Washington Tilth Producers Annual Conference, Spokane, WA. 2011 What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09 TO 2012/08 OUTPUTS: Farmers and researchers met regionally to report on and coordinate trials and select farmers\' choice crops. New varieties were added and worst performers were dropped from entry lists based on farmer input. The 5 main crops and farmers\' choice were evaluated in a mother-daughter trial design. WA substituted Delicata for Butternut winter squash because few Butternut varieties reach maturity in western WA. OR also grew the Delicata trial. For farmers\' choice trials, NY farmers chose tomatoes, WI chose table beets, WA had dry beans, and OR grew sweet peppers and overwintering kale. Seven daughter farms in NY, 7 in WI, 9 in WA and 5 in OR participated. Data were posted to NOVIC and OSA websites and disseminated through outreach events. Breeding efforts continued for the 5 main crops. At Cornell, F3 butternut families were evaluated for disease, quality and yield. The best F3 selection was selfed and backcrossed to \'Honeynut\' to produce F5 and BC1F1 material in addition to F4 families for 2012. Snap pea parental lines evaluated in NY for heat tolerance were backcrossed to stringless lines. A snap and snow pea from OSU performed well and are slated for release. WI and OSA cooperators and a farmer-breeder performed the 4th generation selection for two OP sweet corn varieties in MN. One population was deemed ready for release. For winter hardy, tall top carrots we continued selfing plants to develop early generation inbreds. A broccoli population composed of 50 half-sib families was grown in 3 reps in two locations. Ten families ranking in the top 20 at both locations were advanced to 2012 with 510 single plants massed into 21 families. We continued work with farmer-breeders Jonathan Spero and Julie Puhich to refine broccoli OPs for their locations in southern OR and western WA. Outreach efforts in NY included presentations at 12 field days and meetings with over 2800 individual contacts. The WI hub held one field day and presented at five regional meetings reaching \~330 individuals. The WA group held one field day and participated in 8 outreach events including seed saving workshops in CA (3), WA (2) and ND. The OR program held a field day and engaged stakeholders in a sweet pepper tasting in Portland, OR. OR coPIs participated in 4 invited presentations in WA and OR in addition to winter squash tastings and farmers\' meetings. Myers was invited to lecture on breeding for organic systems to an OSU issues in agriculture class. He was also invited to present to the National Association of Plant Breeders, College Station, TX. NOVIC cooperators had several presentations at the Organic Seed Alliance Winter Conference, Port Townsend, WA. A fundamentals of plant breeding workshop was co-taught by Myers and Navazio in Philomath, Oregon. The NOVIC website is active and the trial database is populated with \~90 trial reports. Guidelines for each of the focus crops have been published on the NOVIC website. Production information includes online tutorials and crop specific production publications. Several modules on vegetable seed production (squash, snap pea, broccoli, sweet corn, carrot) are in progress in NY. PARTICIPANTS: Descriptions are provided below organized regionally. In Oregon, Dr. Jim Myers (project PD) is responsible for the broccoli breeding program, and cooperates with Cornell University on the pea breeding program. He is assisted by Lane Selman, who coordinates the variety trialing program and Shinji Kawai who provides field technical support. Laurie McKenzie is a M.S. student working on the broccoli breeding project. Kara Young is an OSU student who interned with the program in 2011. Organic Seed Alliance in Washington has Micaela Colley as co-PD who oversees the regional effort. Dr. John Navazio conducts the carrot breeding program and Catherine Hubbard and Jared Zystro provide program support and variety trial database management, respectively. In Wisconsin, Dr. Erin Silva is co-PD and the University of Wisconsin Organic Production Scientist. She is responsible for overseeing the variety trialing and outreach components of this project. Dr. William Tracy is the University of Wisconsin Sweet Corn Breeder. He is responsible for the variety improvement/breeding component of this project. Adrienne Shelton is a PhD student working under Dr. Tracy. Her research is focusing on breeding improved su1 se1 sweet corn varieties under organic conditions. Alexandra Lyon is a PhD student working under Dr. Erin Silva. Her research is focusing on analyzing the consistency of variety trial results and understanding the social component of participatory variety trials. In New York State, Dr. Michael Mazourek is program co-PD, oversees the butternut squash breeding project, and jointly conducts the pea breeding program. Michael Glos oversees the variety trial program and has coordinated the acquisition and distribution of trial and breeding seed. James Keach and Bill Holdsworth are Ph.D. students assisting on the project at Cornell. The USDA-ARS PGRU outreach effort in New York is led by Dr. Larry Robertson with assistance from several staff. Activities of the group are coordinated through periodic conference calls and an annual winter meeting held this year in conjunction the OSA Organic Seed Conference, in Pt. Townsend, WA, January 20-21, 2012. Each of the regions works with a set of farmers, both those interested in breeding their own varieties and those who use the information on varietal performance to determine selections for production. Farmer-breeders include Martin Diffley, Farmington, MN (sweet corn); Julie Puhich, Olympia, WA (broccoli); Jonathan Spero, Williams, OR (broccoli). Nash Huber, Sequim, WA (carrots). Growers from over 30 farms participated in NOVIC trials in 2011. TARGET AUDIENCES: Information on target audiences can be found in the outputs section of the report. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/09/01 TO 2011/08/31 OUTPUTS: Data collection protocols were revised in 2011 to acquire useful information while minimizing visits to field sites. Seed used in variety trials was acquired by Cornell and

distributed to regional sites. Each region had a farmers\' choice trial: cabbage (WI), tomato (NY), beets (WA), and peppers (OR). The broccoli breeding program was conducted at 3 PNW sites with 2 farmers participating. Four OP populations were entered in trials. Sweet corn breeding at UW progressed with cycle 3 advanced in Chile and MN. Carrot breeding in WA advanced with selfs made in a winter population in 2010. S1 seed was planted in the field in fall and roots dug in spring were returned to the greenhouse. In the pea breeding program, BC1F1 populations were selected for stringlessness at Cornell. Three advanced lines from OSU were evaluated in regional variety trials in 2010. Winter squash breeding at Cornell focused on a new hybrid butternut which is also being dehybridizing to release as an OP targeted to organic growers. A prototype variety trial database is in the final stages of testing with a call for trial results as part of the NOVIC website launch. A field day (7/27/10) highlighting NOVIC variety trials at the UW West Madison Agric. Res. Sta. drew 70 participants. UW hosted an Organic Vegetable Seed and Variety roundtable (30 participants), and the NOVIC regional planning meeting (50 farmers) at MOSES in 2011. Michael Mazourek, Larry Robertson and Teri Balch presented workshops on breeding, trialing and seed saving at Mother Earth News Fair 9/25-26/10 in Seven Springs, PA. Cornell trials were visited by Horticultural Science and Systems class (Cornell, 50 students) Power of Plants class (Ithaca College, 20 students), Home Garden Seed Association, and Vegetable Breeding Institute Field Days for seed industry breeders. In WA, seed saving was demonstrated at Greenbank Farm, Whidbey Island, WA (15 people) and Port Townsend, WA (23 people); and Nash\'s Organic Produce, Sequim, WA (40 people). In OR, NOVIC was showcased in the Summer Sustainability Series (7/20, \~25 people). The OR regional growers meeting was held at Silver Falls State Park (20 people) on 12/14-15/10. A field day at Gathering Together Farm, Philomath, OR, 8/25 attracted about 15 participants. Washington and Oregon jointly led a plant breeding fundamentals workshop at the Common Ground Farm, Olympia WA (6/16-17/10, 34 people). NOVIC was discussed at several professional meetings, including Innovaciones Technologicas en la Produccion de Granos y Semillas, Saltillo, Mexico, 10/11-13/10 (invited, organic plant breeding and seed production, \~50 people); Organicology, Portland, OR (panel presentation, 2/11/11 \~75 people); Organic Farming Systems Research Conference, Washington, DC, March 16-18, (poster on NOVIC, and participated in panel discussion); National Association of Plant Breeders Conference, 5/23 (invited, \~150 people). News articles and blogs that have featured NOVIC include: Capital Press - 10/10, Culinate.com - 10/28/11. OFRF Bulletin - 1/11, Oregon Small Farm News - Winter 2011, Growing Produce - 2/11, Growing Magazine - Winter 2011, and Organic Seed Alliance blog and newsletters. PARTICIPANTS: Descriptions are provided below organized regionally. In Oregon, Dr. Jim Myers (project PD) is responsible for the broccoli breeding program, and cooperates with Cornell University on the pea breeding program. He is assisted by Lane Selman, who coordinates the variety trialing program and Annie Chozinski who provides field technical support. Laurie McKenzie is a M.S. student working on the broccoli breeding project. Michelle Bullock is an OSU student who interned with the program in 2010. Organic Seed Alliance in Washington has Micaela Colley as co-PD who oversees the regional effort. Dr. John Navazio conducts the carrot breeding program and Catherine Hubbard and Jared Zystro provide program support and variety trial database management, respectively. In Wisconsin, Dr. Erin Silva is co-PD and the University of Wisconsin Organic Production Scientist. She is responsible for overseeing the variety trialing and outreach components of this project. Dr. William Tracy is the University of Wisconsin Sweet Corn Breeder. He is responsible for the variety improvement/breeding component of this project. Adrienne Shelton is a PhD student working under Dr. Tracy. Her research is focusing on breeding improved su1 se1 sweet corn varieties under organic conditions. Alexandra Lyon is a PhD student working under Dr. Erin Silva. Her research is focusing on analyzing the consistency of variety trial results and understanding the social component of participatory variety trials. In New York State, Dr. Michael Mazourek is program co-PD, oversees the butternut squash breeding project, and jointly conducts the pea breeding program. Michael Glos oversees the variety trial program and has coordinated the acquisition and distribution of trial and breeding seed. James Keach joined the project at Cornell as a PhD student and Jennifer Randall (Ithaca College) interned in the program in 2010. Cornell undergraduates Jessica Kristoff, Leah Piao Li assisted with trials. The USDA-ARS PGRU outreach effort in New York is led by Dr. Larry Robertson with assistance from Teri Balch. Activities of the group are coordinated through periodic conference calls and an annual winter meeting held this year in conjunction the Ecofarm, Asilomar, Monterey, CA (January 26). Each of the region works with a set of farmers, both those interested in breeding their own varieties and those who use the information on varietal performance to determine selections for production. Farmer-breeders include Martin Diffley, Farmington, MN (sweet corn); Frank Morton, Philomath, OR (sweet corn); Julie Puhich, Olympia, WA (broccoli); Jonathan Spero, Williams, OR (broccoli). Nash Huber, Sequim, WA (carrots). Growers from over 30 farms participated in NOVIC trials in 2010. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: The project start date of September 1, 2009 did not allow seasonal field work, but we established the personnel and infrastructure for the project, and prepared for the 2010 field season. A National Planning Meeting of co-PD\'s, key personnel and advisors (including international advisor Edith Lammerts Vanbeuren, and OREI program leader Mary Peet) was held on Feb 24, 2010 in conjunction with the

Midwest Organic and Sustainable Education Service (MOSES) meetings, in La Crosse, Wisconsin. Regional Variety Trial Planning and Coordination: Grower surveys and meetings were held in each of the four regions to identify organic farms for variety trials, and to obtain farmer input on varieties and traits of importance for each of our five target crops. Seed company members of the Vegetable Breeding Institute (VBI) were contacted to solicit feedback on cultivars and trait priorities. The NOVIC team discussed evaluation protocols and final versions posted on eOrganic for each hub and satellite to follow. Cornell University coordinated seed acquisition, and seed was distributed to each hub along with a soil health analysis kit. Much of the seed needed for the trials was donated by participating VBI member companies. At Oregon State University, an email survey was distributed in November 2009 to about 25 organic growers. The feedback obtained from this survey was compiled and presented in a meeting on Dec. 4, 2009 attended by growers from 10 farms and six seed company representative and two farmer breeders. Growers identified peppers as the farmer selected variety trial for Oregon. Cornell University distributed an online survey, and obtained input from 44 growers on their breeding needs in the five crop types and a list of the varieties that they currently grow. The grower selected trial for Northeast growers were tomatoes, with the main objective being to find late blight resistant varieties. At University of Wisconsin, an online survey of Wisconsin and Minnesota organic vegetable growers was conducted. Nine certified organic farms from across Wisconsin and Minnesota were enrolled in the trialing efforts for 2010. Organic Seed Alliance consulted farmers in Western Washington through a number of avenues. Fifteen completed questionnaires from target farms were compiled for trial planning purposes. Vegetable Breeding Efforts: Broccoli breeding and selection nurseries were planted at two locations in Oregon and one in Washington. Sweet Corn breeding nurseries were planted at locations in Oregon and Minnesota. Carrot breeding trials were planted at one location in Washington. For the Edible Podded Pea Breeding program, nine stringless snap lines selected by the Cornell program for crosses to Cascadia and Sugar Ann. Winter Squash Breeding efforts were focused in New York on screening a panel of 20 heirloom C. moschata accessions representing 16 distinct cultivars for storage, quality and disease resistance. These were crossed to Bugle and Honeynut to initiate the breeding program. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2009/09 TO 2014/08 What was accomplished under these goals? In the area of plant breeding and variety release, two cultivars (\'Solstice\' broccoli and \'Who Gets Kissed\' sweet corn) were released. At the time of termination of the project, additional germplasm was in the pipeline with release planned after fixation of lines and evaluation. Included in this list are two additional open pollinated broccoli cultivars (one adapted to the Pacific Northwest, the other to the Eastern Seaboard), a snap and a snow pea (excellent cold germination and emergence, tall vines and an extended harvest period for multiple pickings), and an additional sweet corn cultivar (excellent cold germination and emergence). Several butternut squash breeding lines have been released to industry with the official publication in preparation. These butternuts have received rave reviews most notably at Blue Hill restaurant http://www.nytimes.com/2014/10/29/dining/restaurant-review-blue-hill-in-greenwi ch-village.html? r=0. In total, 92 butternut breeding lines remain in the program at Cornell. Sixteen stringless snap pea breeding lines are under development. Carrot breeding material was developed for creation of a variety with winter field holding ability without development of undesirable (market) characteristics and strong, large tops that withstand cold temperatures to facilitate harvest in late winter and early spring. In addition to materials directly bred by NOVIC researchers, NOVIC trials facilitated the release of and/or publicised \'Honeynut\' butternut winter squash (available in 6 catalogs), \'Bling\' and \'My Fair Lady\' sweet corn, \'Columbia\' cabbage, \'Iron Lady\' tomato, and \'Stocky Red Roaster\', \'Joelenne\'s Red\' and \'Gatherers Gold\' sweet Italian peppers. In terms of trialing activities, over 80 trials in five crops were conducted in the four regions over the four years of the project. An additional16 trials of farmers\' choice crops were conducted each year in all the regions. In some cases, the same crop was grown in a second year. The crops included Italian sweet peppers, cabbage, dry beans, tomato, delicata winter squash, table beets, tomatoes, kale and chicory. Data from the majority of these trials was published in the on-line organic trial database (http://varietytrials.eorganic.info/) that was established by NOVIC. For this database, we also solicited organic trial data nationally for vegetable and field crops and the database currently houses 114 trial reports. Outreach activities of the project included four years of seed saving demonstrations at the Common Ground Fair at Unity, Maine with an average of 70,000 attendees each year. During these events the goals of the project were demonstrated and results were transmitted to attendees. Lists of equipment for seed cleaning, guides to seed production of both self and cross pollinated vegetable crops were distributed. Also, a number of participatory breeding guides, developed by the project, were distributed the last two years of the project. This outreach activity was instrumental in distributing information about and the results of

the project in the Northeast. Through this activity we developed keen interest in several groups for organic seed production and we provided training, loan of equipment and guidance to the persons that now run a successful organic seed company in New York called Fruition Seeds, which provides organic seed of vegetable crops. The results of the project were also transmitted through the NOFA-NY winter conference each year and several years at the NOVA-VT winter conference where a seed saving workshop was conducted that had an overflowing attendance with people standing in the hallway to try to watch. At the NOFA-NY conference taste tests were conducted for carrots being tested and bred for organic production. Below are additional outputs and impacts of NOVIC: In the Pacific Northwest, we have conducted organic stakeholder listening sessions, titled \"Eaters and Breeders\" at Organicology (2011 and 2013). In New York, through interactions with growers at the annual NOVIC field day, workshops at the NOFA-NY winter conference, and from visits to growers farms we have learned of their specific pest challenges and traits they need for varieties to meet their marketing and production needs. Many of the farmers involved in NOVIC over the last four years have changed their seed sourcing habits, started or increased seed saving on their farms, and become involved in on-going breeding and crop improvement work as a result of their participation. In terms of impacts, 100% of the fresh market farmers and seed growers surveyed in Oregon in January 2013 indicated that they have made changes in their variety selections based on NOVIC results. The same survey conducted in Washington found that participating growers in both Oregon and Washington most often mentioned how valuable it was to have the opportunity to collaborate with other farmers and seed growers. Farmers in Washington indicated a particular interest to continue involvement in participatory breeding projects, specifically for their unique climatic challenges. Alaskan growers have requested seed of the early maturing OP sweet corn population (not yet set to be released) to adapt to their short and stressful growing season. Because of the participatory nature of this work, growers have seen a broad range of crops and varieties they would not ordinarily have planted. Multiple highly marketable peppers have come from farmers\' choice trials. The sweet pepper \'Stocky Red Roaster\' is requested by name by chefs in the Portland, OR area, who sometimes publish the variety name on their menus. This variety has had a strong economic impact for the organic seed producer who developed it; his sales of this seed have quadrupled as a result of trialing and outreach efforts. Six national catalogues now carry \'Stocky Red Roaster\'. Other trialing projects adopting mother-daughter trial designs after we described the application of this methodology to organic systems through NOVIC. Regional seed companies in NY and the Northeast continue to grow and expand. Honeynut and the other squash developed as part of this project serve these seed companies. High Mowing Seeds (http://www.highmowingseeds.com/blog/the-story-of-a-seed-from-pollination-to-yo ur-plate/) and Fruition Seeds now both offer Honeynut seed. We have also been able to support the growth of this industry with workshops conducted in conjunction with NOVIC and other resources created as part of the grant. **PUBLICATIONS (not previously reported):** 2009/09 TO 2014/08 1. Type: Journal Articles Status: Submitted Year Published: 2015 Citation: Shelton, A.C. and W.F. Tracy. 2015. Recurrent selection and participatory plant breeding for improvement of two organic open-pollinated sweet corn (Zea mays L.) populations. Sustainability (submitted). 2. Type: Journal Articles Status: Published Year Published: 2015 Citation: Lyon, A., E.M. Silva, M. Bell, and J. Zystro. 2015. Seed and Plant Breeding for Wisconsin?s Organic Vegetable Sector: Understanding Farmers? Needs and Practices. Agroecology and Sustainable Food Systems. Posted online: 18 Feb 2015. 3. Type: Books Status: Published Year Published: 2012 Citation: Navazio, J. 2012. The Organic Seed Grower. Chelsea Green Publ: White River Junction, VT. 4. Type: Book Chapters Status: Awaiting Publication Year Published: 2015 Citation: de Milliano, Walter A.J., Edith T. Lammerts van Bueren, Roeland E. Voorrips, and James R. Myers. Resistance and resistance breeding. In: Maria Finckh (ed.) Plant Disease Management in Organic Agriculture. (in press) 5. Type: Theses/Dissertations Status: Published Year Published: 2012 Citation: Shelton, Adrienne. 2012. GENETIC VARIATION AND PHENOTYPIC RESPONSE OF 15 SWEET CORN (Zea mays L.) HYBRIDS TO POPULATION DENSITY. MS. 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Update: Vegetable Crops NOVIC Results eOrganic live broadcast. Jan. 30-Feb1, 2014. https://www.youtube.com/watch?v=Q00NQfqB6 c&list=PLZMuQJAj6rOpFS40cWZ8Xn4O96tKi sMHb&index=7 12. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Mazourek M. ?Research updates: Vegetable Crops?. Organic Seed Growers Conference. Corvallis, OR. January 31, 2014. https://www.youtube.com/watch?v=0AHp-57Ms1Q&index=10&list=PLZMuQJAj6rOpFS40cWZ8 Xn4O96tKisMHb

2011/09 TO 2012/08 In all regions farmers report adoption of new varieties based on trials. In some cases farmers now grow new crops, such as the dry beans. We have not formally surveyed farmers, but a survey is planned in FY 13. In WI, impact on adoption is most marked in winter squash trials where \'Honeynut\' has garnered exceptional interest, particularly among CSA growers. With sweet pepper trials in OR, we engaged Portland chefs and culinary professionals in determining which varieties had the best qualities for their needs (in addition to presenting results to growers). Chefs now ask farmers market vendors for pepper varieties by name and often advertise them on their menu, which has increased sales for growers, and seed sales for pepper breeders. For one OR pepper breeder, pepper seed sales for 2011 totaled about \$2,500. In the first two months of 2012 after results from trials were published, seed sales more than doubled. A recent sale to one organic seed distributor was worth more than all of last year\'s sales totaled. Representatives from commercial seed companies that have purchased seed have referenced the NOVIC trial results when inquiring about availability. A regional seed company states that they closely follow the NOVIC project and its results. It has brought new varieties to their attention and has provided much needed comparative analysis. They find information from NOVIC trials to be well organized and accessible. They have used trials to communicate results through their catalog, website, and directly to customers. Another OR organic seed company reports that \"The NOVIC program has been very valuable our business, exposing us to new varieties and sources, inviting us to be involved in taste tests and to view trials. We value their scientific approach to variety trials, and the reliability of their results. The NOVIC program has done an excellent job of disseminating their results and other pertinent information gained from their trials and growers. This outreach has made them desirable as partners for seed companies and breeders.\" In addition to the farmer impacts, this project has impacted student training with 4 graduate students nearing completion of their research. Sarah Obellianne, 2011 WI NOVIC intern, was inspired by her participation in NOVIC and subsequently interned at Le Reseau Semences Paysannes, the French network for the exchange of farmers\' seed. The Jefferson County WSU Extension program coordinates the FIELD farm internship program. Several farms involved in NOVIC have interns through FIELD and report that in most cases interns were involved in the variety trial planting and evaluations, and the trials were an excellent educational addition to their internship program. Jonathan Spero (farmer-breeder) released \'Solstice\' from his broccoli population in 2012, carried by Bountiful Gardens Seed Co. A selection from the OSU OP broccoli population is being sold by Oatsplitter Farm, Pt. Townsend, WA as \'Myers Best\'. We see increased use of the NOVIC research and outreach model in other programs and have established cooperative linkages to new programs such as a SARE winter radish project and an OREI funded carrot breeding project. **PUBLICATIONS (not previously reported):** 2011/09 TO 2012/08 1. Desclaux, D., S. Ceccarelli, J. Navazio, M. Colley, G. Trouche, S. Aguirre, E. Weltzien and J. Lacon. 2012. Centralized or decentralized breeding: The potentials of participatory approaches for low-input and organic agriculture. In: Lammerts van Bueren, E., and J.R. Myers (eds.) Organic Plant Breeding. Wiley-Blackwell pp.99-123. 2. Horneburg, B. and J.R. Myers. 2012. Tomato: Breeding for improved disease resistance in fresh market and home garden varieties. 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2010/09/01 TO 2011/08/31 Overall, the variety trialing project was successful in identifying certified organic sources and evaluations from the trials and interest generated may stimulate organic production of seed currently only available from convention production. In the Oregon regional meetings, we asked \"will you make changes to your variety selections this season based on NOVIC results\" and received positive answers from about 63% of respondents. Many farmers who attended the WA NOVIC field day intended to change the varieties of beet and winter squash they grew based on the variety trial results. In 2010, a grant was awarded by the Ceres Trust to the UW NOVIC team will provide additional funds to complete survey work related to NOVIC. These surveys will address two lines of inquiry regarding organic seed use by the organic vegetable sector in the Upper Midwest: grower perceptions of organic seed and the potential of participatory plant breeding. Growers who participated in 2010 New York trials continued to express support for the development of a high-performing open-pollinated broccoli variety. Farmer interest in squash was strong, and two growers expressed enthusiasm about the Cornell-developed variety called Honeynut because of its good flavor and its unique small \"single-serving\" fruits, which they thought would work well in their markets. We received requests for breeding material (mostly broccoli and squash) from organic and conventional seed companies. Seed companies, producers, and consumers have attended our field days and presentations and thus have increased knowledge of breeding and trialing that is being done, and varieties that work in organic systems. We have been invited to engage in variety trialing collaboration efforts with seed companies and have received strong interest and involvement from independent seed growers and breeders. Field days and events have drawn conventional as well as organic producers. Many producers showing interest are not certified organic but want to learn more about farming approaches that maximize sustainability and use IPM methods. The UW-Madison group is also working with High Mowing Seeds, a Vermont based organic seed company, on commercializing three UW-Madison developed sugary enhancer hybrids. Seed of these hybrids will be produced organically. Additional spin-offs have been that a farmer participatory sweet corn breeding effort has been initiated using eight populations of sugary enhancer sweet corn, based on WI and OR germplasm, which are being grown in Shively, CA. Secondly, an Expert Culinary Panel for variety tastings has been initiated in Oregon. We received strong interest in culinary tastings and describing variety attributes from a group of highly regarded Portland OR chefs as well as project exposure through Culinate.com.

2009/09/01 TO 2010/08/31 As our first publication, a four-fold color brochure summarizing the NOVIC project was developed by the USDA-PGRU team. It has been distributed at MOSES, as well as at regional meetings (approximately 200 copies). The Common Ground Country Fair was held September 25 - 27, 2009 at Unity Maine. NOVIC was represented by the Seed Production and Processing Team from Geneva, NY (USDA - ARS, Plant Genetic Resources Unit). Three seed processing demonstrations were conducted on the 25th and 26th throughout the day and two were attempted on the 27th (but were cancelled due to rain). Both manual and mechanical seed cleaning were demonstrated. Many visitors brought seed to be cleaned including Brassica seed, Allium seed, and various flower and herb seeds. Over forty visitors appreciated hands-on training in seed

processing given in-between demonstrations. In addition to seed production demonstrations and education on seed processing; general information was given about the scope of the NOVIC grant, getting involved in farmer-led plant breeding and how to become involved in on-farm vegetable variety trials. The Freeville Organic Farm, Cornell\'s Hub site, hosted two grower field days and one seed company field day that featured squash and pea breeding and observation trial materials from NOVIC . Cornell\'s Hort 1010 class visited the hub as well to learn about the role of Plant Breeding in sustainable organic vegetable production.

PUBLICATIONS

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