ORG Project Details

Award Year 2005

3 Research Projects

PROJECT INDEX

Ecological Soil Community Management for Enhanced Nutrient Cycling in Organic Sweet Cherry Orchards

Accession No.	0205203
Subfile	CRIS\
Project No.	ORE00138
Agency	NIFA ORE
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2005-51106-02389
Proposal No.	2005-04461
Start Date	15 SEP 2005
Term Date	14 SEP 2009
Fiscal Year	2009
Grant Amount	$435,020
Grant Year	2005
Investigator(s)	Azarenko, A. N.; Ingham, R. E.; Myrold, D. D.; Seavert, C. F.
Performing Institution	HORTICULTURE, OREGON STATE UNIVERSITY, CORVALLIS, OREGON 97331

NON-TECHNICAL SUMMARY

An over-application of N in orchard systems is common practice. B Nutrient supply must be synchronized with tree demand to avoid under/oversupply while meeting tree needs. C While the aim of organic orchard management is to satisfy tree nutrient demands ecologically, little information is available in this area, leaving many organic orchardists to simply substitute synthetic inputs (especially fertilizers) with rapid-release forms of approved, pelletized fertilizers made of various fish and poultry byproducts. The long-term goal of this research effort is to identify those ecological soil community management strategies which synchronize soil nutrient availability with tree demand in order to improve long-term farm health, fruit quality, and production by using existing resources in an economic and environmentally benefice nt way.

OBJECTIVES

The goal of the proposal is to identify those ecological soil community management strategies which synchronize soil nutrient availability with cherry tree demand in order to improve long-term farm health, fruit quality, and production by using existing resources in an economic and environmentally beneficient way.

APPROACH

A two-tiered approach is used: a) a comparison of the biological and economic effects of two different methods of organic fertility management during orchard establishment and early production; b) an investigation of mature orchards to evaluate the use of soil community structure as a indicator of the effects of significantly different management practices on orchard health, fruit quality, and productivity.

PROGRESS

2005/09 TO 2009/09 OUTPUTS: MAg degree, 2-year post-doc. Adapted existing model to test hypothesis that soil microbial community structure of orchards managed with synthetic fertilizers & tree residues differ in value, complexity of N- & C-based molecules, bacterial/fungal dominance & enzymatic activity from systems managed organically. Analyzed effects of 2 organic treatments on trees & soils during orchard establishment. Preliminarily characterized soil health in mature conventional orchards under contrasting climate, soil types, & management histories. 10 student workers trained & gained experience in ecological soil management via field & lab activities.Does Soil Organic Matter Ecological & Environmental Considerations. Better Fruit & Vines workshop, (Nov 9, 06), The Dalles, OR. Soil ecology. 30 participants, Jan 07. Ecological soil management in apple orchards. 3rd national organic tree fruit research symposium. 100 researchers & growers, June 05. Chemical & Biochemical Survey of Cherry Orchard Systems in PNW. ASA-CSSA-SSSA Annual Meetings, Oct 31- Nov 3, 10, Long Beach, CA. Fruit tree Rx. Gearing Up for Gardening. 125 participants, Feb 09, Corvallis, OR. Soil Microbial Communities & Activities under Different Orchard Floor Management Systems in Oregon Sweet Cherry Orchards. ASA-CSSA-SSSA Meetings, Oct 5-9, 08, Houston, TX. Soil ecology & sweet cherry organic production- NW Cherry Research Review. 100 participants Nov 07. Soil enzymes as affected by orchard floor management. ASA-CSSA-SSSA Meetings, Nov 4-8, 06, New Orleans, LA. Poster presentation: Tracking Effects of Soil Community Management in Sweet Cherry Orchards Using Nematode Community Measures. ASA-CSSA-SSSA 2007 Intnl Meetings. Nov 4-8, 07, New Orleans, LA & Am Soc for Hort Science Conference July 16-19, 07, Scottsdale, AZ. Evaluation of soil particulate organic matter as a sensitive indicator of soil fertility in sweet cherry orchards. 4th Intnl Organic Tree Fruit Research Symposium. March 3-6, 07, E Lansing, MI. & ASA-CSSA-SSSA Meeting July 16-19, 07, Scottsdale, AZ. Building Soils & Habitat for Better Fruit & Vines. 100 participants, Nov 06. Evaluation of a New Soil Health Indicator. 4th International Organic Tree Fruit Research Symposium, March 3-6, 07, E Lansing, MI. Soil management. Panel discussion. 4th International Organic Tree Fruit Research Symposium, 3-6 March 07, East Lansing, MI. Biological & Biochemical Survey of Orchard Systems in PNW. Intnl Meeting ASA-CSA-SSSA, Oct 31-Nov 4, 10, Long Beach CA. Applications of Soil Microbial Ecology to Agricultural & Ecological Questions. Oklahoma State University, Nov 16, 09, Stillwater, OK & Texas Tech University (Nov 18, 09). Orchard Floor Management Decisions Impact Nutrient Cycling. OR Hort Society Meeting. Jan 30, 08, Portland, OR. Enhancing Nutrient Cycling in Organic Orchard & Field Crop Systems. Ecological Farm Conference Jan 24, 08, Pacific Grove, CA. Early Fertility Responses in 1-3 yr old Organic Sweet Cherry Orchards. Great Lakes Fruit Vegetable & Farm Market Expo, Dec 6, 07, Grand Rapids, MI. Soil Health Indicators in Sweet Cherry Orchards in Oregon. 4th Intnl Organic Tree Fruit Research Symposium, Mar 3-6, 07, E Lansing, MI. PARTICIPANTS: Post-doc was hired into tenure track position at another institution of higher education upon completion of the project. The project supported one Master\'s of Agriculture student, who completed her degree, plus the aforementioned 2-year post-doctoral position. Ten student workers trained & gained experience in ecological soil management via field & lab activities. TARGET AUDIENCES: Audiences include orchard fruit producers in the Pacific Northwest; outputs have been generalized to serve needs of orchard producers nationally & internationally. Model and its outputs have attracted interest & attention from various ag disciplines; one publication was most cited article from HortScience for 2008. The work may guide for organic growers; NOP requires soil management for quality. Efforts: Chemical & Biochemical Survey of Cherry Orchard Systems in PNW. ASA-CSSA-SSSA Annual Meetings, Oct 31- Nov 3, 10, Long Beach, CA. Fruit tree Rx. Gearing Up for Gardening. 125 participants, Feb 09, Corvallis, OR. Soil Microbial Communities & Activities under Different Orchard Floor Management Systems in Oregon Sweet Cherry Orchards. ASA-CSSA-SSSA Meetings, Oct 5-9, 08, Houston, TX. Soil ecology & sweet cherry organic production- NW Cherry Research Review. 100 participants Nov 07. Soil enzymes as affected by orchard floor management. ASA-CSSA-SSSA Meetings, Nov 4-8, 06, New Orleans, LA. Poster presentation: Tracking Effects of Soil Community Management in Sweet Cherry Orchards Using Nematode Community Measures. ASA-CSSA-SSSA 2007 Intnl Meetings. Nov 4-8, 07, New Orleans, LA & Am Soc for Hort Science Conference July 16-19, 07, Scottsdale, AZ. Evaluation of soil particulate organic matter as a sensitive indicator of soil fertility in sweet cherry orchards. 4th Intnl Organic Tree Fruit Research Symposium. March 3-6, 07, E Lansing, MI. & ASA-CSSA-SSSA Meeting July 16-19, 07, Scottsdale, AZ. Building Soils & Habitat for Better Fruit & Vines. 100 participants, Nov 06. Evaluation of a New Soil Health Indicator. 4th International Organic Tree Fruit Research Symposium, March 3-6, 07, E Lansing, MI. Soil management. Panel discussion. 4th International Organic Tree Fruit Research Symposium, 3-6 March 07, East Lansing, MI. Biological & Biochemical Survey of Orchard Systems in PNW. Intnl Meeting ASA-CSA-SSSA, Oct 31-Nov 4, 10, Long Beach CA. Applications of Soil Microbial Ecology to Agricultural & Ecological Questions. Oklahoma State University, Nov 16, 09, Stillwater, OK & Texas Tech University (Nov 18, 09). Orchard Floor Management Decisions Impact Nutrient Cycling. OR Hort Society Meeting. Jan 30, 08, Portland, OR. Enhancing Nutrient Cycling in Organic Orchard & Field Crop Systems. Ecological Farm Conference Jan 24, 08, Pacific Grove, CA. Early Fertility Responses in 1-3 yr old Organic Sweet Cherry Orchards. Great Lakes Fruit Vegetable & Farm Market Expo, Dec 6, 07, Grand Rapids, MI. Soil Health Indicators in Sweet Cherry Orchards in Oregon. 4th Intnl Organic Tree Fruit Research Symposium, Mar 3-6, 07, E Lansing, MI.Does Soil Organic Matter Ecological &

Environmental Considerations. Better Fruit & Vines workshop, (Nov 9, 06), The Dalles, OR. Soil ecology. 30 participants, Jan 07. Ecological soil management in apple orchards. 3rd national organic tree fruit research symposium. 100 researchers & growers, June 05. Analyzed effects of 2 organic treatments on trees & soils during orchard establishment. Preliminarily characterized soil health in mature conventional orchards under contrasting climate, soil types, & management histories. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2006/09/15 TO 2007/09/14 OUTPUTS: Soil samples (0-15 cm and 15-30cm) from two Oregon State University research farms (the Mid-Columbia Research and Extension Center (MCAREC), Hood River, OR and the Lewis-Brown Farm (LBF), Corvallis, OR) were collected in May and Oct 2007. Two orchard floor management treatments: landscape cloth and bark (LBF), and landscape cloth and straw (MCAREC) mulch were applied previously in 2006. Additional soil samples were collected from eight commercial orchards within Oregon State. Leaf samples were collected in August 2007 from the two OSU research farms as well as the eight other commercial farms and assessed for nutrient composition. Two orchard floor management treatments: landscape cloth vs. bark mulch and leaf (municipal yardwaste) compost (LBF) and straw mulch (MCAREC) were initiated in 2005. Chemical analyses have been conducted on all samples. Weed control was performed using cultivation (twice during 2007) and also a spray with 30% organic acetic acid sprays. Trees were pruned and branch training continues to form well-established central leader trees. Leaf samples collected and trunk cross-sectional area measurements taken in September 2007 are used as a measure of tree performance while soil chemical and biological tests address soil quality. We have participated in four national conferences reporting results via oral and poster presentations to both scientific and growers audiences. At two of these meetings, we were invited speakers and presented a 45-min presentation targeted specifically to growers. We continue to analyze the complete suite of soil chemical and biological properties with the ultimate goal of determining a minimum data set to be used for soil quality assessment in orchard systems. PARTICIPANTS: New individuals who worked on the project include four undergraduate student workers who have been given the opportunity to take part in various field and laboratory activities related to this project to providing them with training and experience in the area of ecological soil management in orchards. Their names are Richard Nicerson, Samuel Ellison, Britta Beinan, and Mac Gillespie.

2005/09/15 TO 2006/09/15 Soil samples for the Mid-Columbia Research and Extension Center (MCAREC), Hood River, OR and the Lewis-Brown Farm (LBF), Corvallis, OR were collected in Oct 2005, Apr, Jun, Aug, and Oct 2006. Two orchard floor management treatments: landscape cloth and bark (LBF) and straw (MCAREC) mulch were applied. Chemical analyses have been conducted on all samples except those collected in Oct 2006. Weed control was performed using cultivation (twice during 2006) and also a spray with 30% organic acetic acid. Trees were pruned and branch training continues. The conservation biology hedgerow was modified to eliminate the 1 ft annual flower strip because it did not reseed. The hardier perennials survived and continue to proliferate. Compost (4 in layer) was applied at both sites and alleyways were sown with a mixture of trefoil, perennial rye, white and subterranean clover. The mix, when mature, will be mowed and clippings will be applied to the tree row to provide N without the use of synthetic fertilizers. We have measured tree growth for all trees and have begun comparing the two crop management systems within the plantings with respect to tree performance and soil quality. Input substitution (cloth) at both sites showed significantly greater trunk cross-sectional area, which is an indication of vigor compared to the bark mulch (LBF) or straw mulch (MCAREC). Likely, N was immobilized in the soil from the high C:N mulches, resulting in reduced N availability for trees. Leaf samples were collected and will provide more information regarding this issue. Additionally, landscape cloth alters water dynamics, which may have further influenced vigor. In July 06, the LBF was instrumented with soil moisture probes (ECH2O-20) at 15, 30, and 90 cm and temperature sensors at 15 and 30 cm. These sensors are connected to a datalogger which is programmed to collect data continuously. Soil moisture and temperature status influences the soil microbial community structure and decomposition pathways and therefore, nutrient status and tree growth. The use of landscape cloth, bark mulch, or straw likely alters the soil moisture and temperature dynamics in relation to depth and rate of the wetting front. Additionally, soil solution samplers were installed at 30 and 90 cm to measure inorganic N, dissolved organic C, and dissolved organic N. This will help us determine the relative amounts of nutrients retained within the rooting zone (30 cm) and lost from the system (90 cm). The second year of soil samples from eight participating growers throughout the state, who use compost teas, various green/brown mulches, and other amendments are currently being taken to evaluate chemical and biological properties. Our goal ultimately is to describe the ideal soil quality for a wide variety of fruit growing regions under a range of management systems. Meetings attended include the 2006 MCAREC annual field day in Hood River, OR and the 2006 American Society of Horticulture Sciences annual meeting held July. A meeting with eight cooperating growers occurred Nov 2006 as well as our organization and participation in a Soil Enhancement workshop in The Dalles, OR on 9 Nov 2006.

IMPACT

2005/09 TO 2009/09 This work contributed to and informed growers of the tree fruit production practices that could be used to qualify for NRCS EQIP soil conservation funds. These efforts were in response to and simultaneous with this research work. This work demonstrated the utility of enzyme activity, and especially N-acetyl-beta-D-glucosaminidase (b-glm), to assess N mineralization and soil quality in orchard production systems. A grower group Soil Health in Fruit Tree Systems (SHIFT) met three times during the course of this work, and participated in on farm trials. One SHIFT member, Tom Denison, noted, \"This was a most comprehensive effort between OSU and practitioners, and resulted in a greater understanding of soil community structure and practices to support productive community structures in tree fruit operations.\" Findings: Soil Chemical and Biochemical Surveys of Sweet Cherry Agroecosystems In the Pacific Northwest We evaluated the effects on soil chemical properties and biochemical functioning of four orchard floor management (OFM) practices under nine sweet cherry orchards. Our objective was to identify soil properties most sensitive to OFM regardless of soil type, texture, climate, and aboveground management. OFM treatments were: 1) herbicide-treated bare ground (BARE), 2) landscape cloth (CLOTH), 3) organic amendments (OAm), and 4) living organic amendments (LOAm). Soil samples (0-15 and 15-30cm depths) were collected in October 2006 and 2007 and analyzed for nutrients, pH and organic matter. Soil biochemical properties measured included five enzyme activities, N mineralization potential, and particulate organic matter (POM). Additionally in 2007, FAME (fatty acid methyl esther) profiles (for microbial community structure characterization) and leaf nutrient status were determined. Data were analyzed using non-metric multi-dimensional scaling (NMDS) and multi-response permutation procedures (MRPP) to determine group separations and analysis of variance to compare OFM. Using NMDS and MRPP analyses, biochemical variables were most sensitive to separating samples by treatment: LOAm was different from all other treatments and CLOTH was similar to OAm, which were different from BARE. LOAm generally had the highest biochemical properties, SOM, and available P. Soil samples under the LOAm treatment were separated from the other treatments according to chemical properties or FAME profiles, but more distinct separation among samples was observed according to geographic location with average annual precipitation and soil texture as important explanatory variables. Other variables that separated samples by location included OM, CEC, P, Zn, Mn, Cu, Mg, and NO3\--N. Of the 44 variables investigated by ANOVA, N mineralization rate, beta-D-glucosidase and N-acetyl-beta-D-glucosaminidase activities were affected by treatment at 0-15cm with LOAm samples higher than all other treatments. This survey showed that biochemical variables are most sensitive to OFM practices and should be investigated further to determine how they affect orchard performance. **PUBLICATIONS (not previously reported):** 2005/09 TO 2009/09 1. Azarenko, A.N. Chozinski, A. Brutcher, L. 2008. Nitrogen uptake efficiency and partitioning in sweet cherry is influenced by time of application. Acta horticulturae 795:717-721. 2. Moore-Kucera, J. Azarenko, A.N. Brutcher, L. Chozinski, A. Myrold, D.D. Ingham, R. 2008. In search of key soil functions to assess soil community management for sustainable sweet cherry orchards. HortScience 43: 38-44. 3. Improving Orchard Soil with Straw by Melissa Hansen. Good Fruit Grower Magazine. May 1, 2008. Vol. 59, No. 9. 4. OSU Studies Orchard Floor Management in Cherries: Landscape cloth, organic mulch focus of research tests, by John Schmitz. May 16, 2008. 5. Moore-Kucera, J. Azarenko, A.N. Brutcher, L. and Chozinski, A. 2007. Evaluation of a New Soil Health Indicator in Cherry Orchards: Particulate Organic Matter. Proceedings of the 4th International Organic Tree Fruit Research Symposium. 6. Moore-Kucera, J. Azarenko, A.N. Brutcher, L. and Chozinski, A. 2010. A Biological and Biochemical Survey of Orchard Systems in the Pacific Northwest. TBD. 7. Moore-Kucera, J. Azarenko, A.N. Brutcher, L. and Chozinski, A. 2010. Soil Microbial Communities and Activities under Different Orchard Floor Management Systems in Oregon Sweet Cherry Orchards. TBD. 8. Soil Biology Research: Part I (October 2007 newsletter) and Part II (January 2008 newsletter). Just Picked\...Newsletter of the Upper Midwest Organic Tree Fruit Growers Network. Quarterly. http://www.mosesorganic.org/treefruit/newsletters.htm. 9. Managing the Orchard Floor, by Geraldine Warner and Melissa Hansen. Good Fruit Grower Magazine. April 15, 2008. Vol. 59, No. 8.

2006/09/15 TO 2007/09/14 Overall findings to date suggest that the response of the soil microbial community structure and functioning is dependent upon an integrated effect of management and inherent soil properties. Soil microbial community structure (SMC) as assessed by fatty acid methyl ester profiles, microbial functioning as determined via five enzyme activities, particulate organic carbon (POM-C; a biologically active fraction of organic matter), and potentially mineralizable N (Nmin) were sensitive to differences in orchard floor management at both OSU research farms (less than 2 yrs in production!); direction of change dependent upon indicator and site. Application of organic amendments (mulch and compost) increased POM-C only at LBF farm; at MCAREC, lower POM-C was measured under MULCH at lower depth . Although POM-C did not increase at HR, we found a shift in SMC structure with greater fungal and gram negative bacterial markers & fungal to bacterial ratios under mulch treated soil compared with landscape cloth. At LB, greater relative % of bacterial biomarkers were found under landscape cloth. At MCAREC, the mulch treatment had greater phosphorus- & sulfur-cycling enzyme activities at 0-15cm depth and greater nitrogen- and sulfur- and 2/3 phosphorus-cycling enzyme activities at 15-30cm depth. No effect of treatments at LB. Landscape cloth treatment at MCAREC had a different nematode community structure than straw mulch compared with cloth having higher plant parasitic nematode densities and lower bacterial feeding nematode densities. Two of the commercial orchards had on-farm trials where they compared the application of straw mulch vs. bare ground under conventional management. At both sites, increased enzyme activities were measured under the straw mulch treatments suggesting enhanced nutrient cycling potential. Further analyses will provide more details regarding the impacts of OFM and biological responses. Additionally, over 10 student workers have been given the opportunity to take part in various field and laboratory activities related to this project to providing them with training and experience in the area of ecological soil management in orchards.

2005/09/15 TO 2006/09/15 Organic growers are required to maintain or improve soil chemical, biological, and physical properties and to involve and rely on, biological processes for fertility management. How N nitrogen fertilization is a key component for overall orchard productivity and has multiple environmental impacts if mismanaged through runoff to surface- or leaching to groundwater sources. Many growers simply substitute synthetic inputs with rapid-release, approved nitrogen fertilizers that have little effect on long-term soil health and fertility. We seek an alternative approach to synchronizing nutrient availability with tree demand that relies on managing the soil biological communities to maximize their potential to meet tree nutrient demand. By combining the soil information gathered from nematode analysis with data obtained by biochemical and molecular analyses of the soil samples, a new, in-depth view of soil communities and their response to management practices will be obtained. As a result, a better understanding of the effects of differing management practices on soil fertility and soil community structure will be gained. Our goal is to determine whether, in the future, soil community structure can be used to characterize soil health, diagnose soil problems, and propose remedial actions.

PUBLICATIONS

2006/09/15 TO 2007/09/14 1. Moore-Kucera, J, Azarenko, A.N., Brutcher, L.J., Chozinski, A.M., Myrold, D.D., and R. Ingham. 2008. In search of key soil functions to assess soil community management for sustainable sweet cherry orchards. HortScience (Accepted March 2007, In Press). 2. Moore-Kucera. 2007. Just Picked\...Newsletter of the Upper Midwest Organic Tree Fruit Growers Network. Quarterly. Mission is to share information and encourage research to improve the organic production and marketing of tree fruit in the Midwest, and to reperesent the interests of growers engaged in such. 3. Jennifer Moore-Kucera, Anita Azarenko, Lisa Brutcher, and Annie Chozinski. 2007. Soil enzymes as affected by orchard floor management. The ASA-CSSA-SSSA Annual Meetings (November 4-8), New Orleans, LA. 4. Jennifer Moore-Kucera, Anita Azarenko, Lisa Brutcher, and Annie Chozinski. 2007. Evaluation of soil particulate organic matter as a sensitive indicator of soil fertility in sweet cherry orchards. American Society for Horticultural Science Annual Conference (July 16-19), Scottsdale, AZ. 5. Lisa Brutcher, Jennifer Moore-Kucera, Anita Azarenko, Russell Ingham, Annie Chozinski, and David Myrold. 2007. Tracking effects of soil community management in sweet cherry orchards using nematode community measures. American Society for Horticultural Science Annual Conference (July 16-19), Scottsdale, AZ . 6. Jennifer Moore-Kucera, Anita Azarenko, Lisa Brutcher, Annie Chozinski, and David Myrold. 2007. Evaluation of Soil Particulate Organic Matter as a Sensitive Indicator of Soil Fertility in Sweet Cherry Orchards. The 4th International Organic Tree Fruit Research Symposium (March 3-6), East Lansing, MI.

2005/09/15 TO 2006/09/15 No publications reported this period

↑ Return to Index

Organic Production in the Challenging Environment of the Northern Great Plains: from Transition to Sustainability

Accession No.	0204950
Subfile	CRIS\
Project No.	MONB00356
Agency	NIFA MONB
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2005-51106-02375
Proposal No.	2005-04477
Start Date	15 SEP 2005
Term Date	14 SEP 2009
Fiscal Year	2009
Grant Amount	$471,111
Grant Year	2005
Investigator(s)	Miller, P. R.; Buschena, D. E.; Jones, C. A.; Maxwell, B. D.; Engel, R. E.; Menalled, F.; Jacobsen, B. J.
Performing Institution	LAND RESOURCES AND ENVIRONMENTAL SCIENCES, MONTANA STATE UNIVERSITY, BOZEMAN, MONTANA 59717

NON-TECHNICAL SUMMARY

The northern Great Plains has always been a challenging environment for crop production. Although considered part of the Nation\'s Breadbasket, the climate of this region is semiarid (30 to 45 cm annual precipitation), and summers are frequently punctuated by periods of high temperatures (\>34 oC) that severely stress crops. Transitioning to organic agriculture requires that a grower develop a management system that can successful operate under the environmental constraints of this region by integrating knowledge of cropping systems, soil and crop nutrition, weed and disease control, and marketing. The purpose of this project is to link current and planned research components at Montana State University into a systems-oriented study of organic agriculture in one of the driest regions of NGP, to promote economic and environmental sustainability.

OBJECTIVES

Our specific objectives are to; 1)Evaluate the average size of organic crop price premiums, their variability, and their trend; 2)Compare annual legume species, growth habits (spring and winter) and termination times for water-use-efficiency, soil N contribution, residual soil water and subsequent wheat production; 3)Compare green manure tillage termination strategies for soil N contribution, residual soil water and subsequent wheat production; 4)Determine the changes in soil N and P pools (labile and non-labile) that have occurred in long-term organic farming systems in the northern Great Plains; 5)Evaluate the effects of rock phosphate and green manure on soil nutrient status and crop yield; 6)Determine if there is a difference in alpha diversity in the weed aboveground and seedbank communities of organic versus reduced-tillage crop production systems; 7)Quantify and compare inter- and intra-specific competition between 4 weed species and 2 crops under a range of weed community diversity and density conditions; and 8)Assess the overall impact that organic farming has on seedbank dynamics

APPROACH

The methodology is integrated to serve multiple objectives where possible. Economic evaluations will compare different data sources for actual organic prices over similar periods. Comparison of the green manure effectiveness of the annual legume and other species will be conducted in small plots at Montana State University and in large plots at a long-term organic farm at Big Sandy, MT, that is 300 miles north of Bozeman. Evaluation of soil N dynamics will involve investigations of long-term (begun in 2000) organic plots at Bozeman and 2-yr crop sequences from the green manure studies. Evaluation of the effectiveness of rock phosphate will be conducted within the green manure studies. The weed ecology investigations involve plot studies with controlled crop and weed plant densities at Montana State University and data collected from organic fields of varying vintage in the Big Sandy area.

PROGRESS

2005/09 TO 2009/09 OUTPUTS: Montana organic production has grown faster than nationally during this project. Data from USDA/ERS shows the number of certified organic producers increased by 74% from 2000 to 2005 in MT relative to 54% U.S. Certified organic wheat acreage increased by 66% in MT, and by 53% in the USA during this period. Montana\'s growth in certified organic dry pea and lentil, is particularly striking. Certified dry pea and lentil acreage increased by 476% in MT but only increased by 75% in the USA Indeed, without this large increase in organic dry pea and lentil acreage in MT, total U.S. acreage of pea and lentil would have declined from 2000 to 2005. Green manure research showed clearly that winter pea is the best choice among annual crop green manures evaluated, at both Big Sandy and Bozeman, MT, due to comparatively efficient soil water use and significant nitrogen contribution to subsequent winter wheat. Nitrogen-grain yield of winter wheat was affected importantly by previous green manure crop and timing, and winter wheat cultivar and only trivially by row spacing and seeding rate. Reduced tillage strategies showed that pea green manure could be successfully terminated by a roller crimper at the plump pod stage, but not at the first bloom stage. Vinegar application and mowing were not successful. Green manure crops have a limited ability to increase P availability over a 2-yr period in semiarid climates such as north central MT. While addition of rock phosphate may increase total soil P, fractionation tests suggest that most of the rock phosphate remains in non-labile P forms that are unavailable to plants. This study increased our understanding of the mechanism driving the abundance and diversity of weed communities across cropping systems. It explored the ecological and management implications of weed community shifts associated with the transition to organically managed agroecosystems. Specific areas evaluated included: 1) the impact of management systems on weed aboveground and seedbank communities, 2) comparison of weed community composition and spatial distribution in conventional and organic small grain systems, and 3) assessment of the impact of weed diversity and density on crop performance. Four seed bio-fungicides were assessed at two sites each in 2006 and 2007 to assess Fusarium foot rot control in winter wheat. The bio-fungicides had no practical impact on the severity of Fusarium foot rot in this organic study. In Montana, the principal challenges to long-term sustainability have been identified as: 1) maintenance of strong organic crop price premiums, 2) soil P fertility, and 3) creeping perennial weeds such as Canada thistle and field bindweed. PARTICIPANTS: Perry Miller served as the lead PI coordinating reporting for all objectives in this grant; and for leading green manure research related to soil N and water management (Objectives 2 and 3) with the assistance of M.S. student Erica Izard and Research Associate Jeffrey Holmes. Dave Buschena served as a co-PI with economics expertise. He was responsible for Objective 1. Clain Jones and Rick Engel served as co-PI\'s with soil fertility expertise. They were responsibel for Objectives 4 and 5 with assistance from M.S. student Terry Rick. Bruce Maxwell and Fabian Menalled served as co-PI\'s with weed ecology expertise. They were responsible for delivery of Objectives 6, 7, and 8 with assistance from M.S. students Fred Pollnac and Kristin Harbuck. Barry Jacobsen served as a co-PI with plant pathology expertise. He was responsible for delivery of Objective 9 with assistance from Ph.D. student Ernesto Moya. TARGET AUDIENCES: A key target audience were growers affiliated with the Montana Organic Association. However, ultimately our target audience was any dryland farmer with an interest in organic farming, and their associated knowledge brokers. PROJECT MODIFICATIONS: A one-year no-cost extension was requested and granted to allow additional time for data processing, analysis, and reporting. Ultimately some reports will occur after this final report has been submitted.

2007/09/15 TO 2008/09/14 OUTPUTS: In 2008 near Bozeman, MT, the 9th year was completed for the crop diversity rotation study and the 6th year of a greenhouse gas rotation study; and investigation of soil residual herbicide effects on broadleaf crops. This research aims to intensify fallow-wheat systems sustainably in an energetically and economically sensible manner. The crop diversity rotation study compares organic and no-till management for continuous cereal-broadleaf rotations, split in high and low input management scenarios, and 2009 effectively represents the start of the 3rd 4-yr crop cycle, newly comparing oilseed-wheat and pulse-wheat no-till systems. Barley, canola, corn, grasspea, lentil, mustard, pea (spring and winter), safflower, sweet clover, sunflower, triticale (spring and winter), and wheat (spring and winter) have been grown in this study. In 2008, a severe hailstorm on July 22 severely damaged grain yields, preventing meaningful data collection. The annual weed community census included 15,100 individuals spanning 20 different species, with five accounting for 84% of total weeds; pennycress (36%), wild oat (17%), prickly lettuce (15%), downy brome (9%), and volunteer cereals (7%). Average weed density in the organic system (356/m2) was double that of the no-till cropping systems (165/m2), but the no-till system had four times the density of problematic grassy weeds (wild oat and downy brome). Weed density in the organic system was due mainly to high pennycress infestations (248/m2) which did not compete strongly with crops. However, Canada thistle threatens the sustainability of the organic system, requiring total abandonment of one in four replicates in both crop rotation studies in 2008. The greenhouse gas rotation study compares simple 2-yr systems, including conventional tillage, no-till, and organic; crop-fallow vs. continuous crop; continuous wheat vs. various pea-wheat systems; and a perennial grass-alfalfa mixture (simulating CRP). After 2006, soil organic matter showed greatest gains in CRP (675 kg C/ha/yr; P\<0.001). Importantly, annually cropped systems gained carbon at an average rate of 250 kg C/ha/yr compared with fallow - crop systems (P = 0.02). Yield loss due to soil-residual sulfonylurea herbicides occurred in all dicot crops planted 42 months after herbicide application. This information has been disseminated widely at agricultural conferences in Montana and North Dakota, in multiple curricula at Montana State University, live television of PBS program \"Montana Ag Live\", and via personal contact with agricultural knowledge transfer agents and farmers both inside and outside of Montana. PARTICIPANTS: Individuals: Perry Miller, Associate Professor and Principal Investigator Jeffrey Holmes, Research Associate who provides crucial support to conduct field operations related to soil sampling and crop growth; collect, process, and analyze field and laboratory data; manage or assist with managing undergraduate and graduate students as well as other seasonal employees hired via other funding sources. Partner Organizations: The Montana Wheat and Barley Committee (MWBC) has provided very modest annual funding support ((\$8-12K/yr) for the past five years which enables complete engagement of project operations associated with this project. The MWBC are the funding arm of a principal constituency for this research in Montana, the Montana Grain Growers Association. Collaborators: Several MSU collaborators are listed for this systems-level project but I am unsure if it is most appropriate to report anything further about them here or for them to self report under their individual CRIS projects. Training / Professional Development: At least one MSU undergraduate class per year visits the long-term rotation studies for a field trip. Various local, regional, national, and international representatives have visited this research site, ranging from Montana farmers to U.S. Department of State sponsored international visits. TARGET AUDIENCES: The target audience for this cropping systems research is broad due to the general emphasis on sustainable agriculture. Research results from this project have been used by both mainstream no-till farmers, and by organic farmers. This research holds a special emphasis on annual legume or \'pulse\' crops and has been featured in numerous seminars at agricultural conferences throughout the northern Great Plains region. In some part this research is responsible for the recent surge in pea and lentil production in Montana and North Dakota. PROJECT MODIFICATIONS: Not relevant to this project.

2006/09/15 TO 2007/09/14 This project is near completion on schedule. For Obj. 1, organic and conventional prices for key crops were evaluated across time assessing trends and variability. National data was compiled for wheat, pulse crops, oilseeds, and feed grains. Montana data was assessed as too thin for analysis given confidentiality concerns. For Obj. 2 and 3, two years of field research were completed for both green manure and wheat test crop phases at two (Big Sandy and Bozeman, MT) during 2005-2007. Winter pea was superior among green manures, especially when terminated at early flower, resulting in the best balance of stored soil water and N content. Roller crimping (i.e. no tillage) termination of winter pea at the pod stage was successful while vinegar application without subsequent tillage, was not. For the wheat test crop it was determined that the choice of green manure and timing of termination were more important than wheat variety or plant arrangement/density. Spring crop manures were inferior to winter pea manure. However, pea green manures may not provide adequate grain protein levels in wheat. All field research and half the soil and plant analyses related to the P research (source, rate, and green manure type) have been completed toward Obj. 4 and 5 with results coming soon. Weed Obj. 6-8 were fully met. Confirming previous studies, organic wheat systems had greater weed species diversity compared with conventional systems. Using regression models, we found that weed species richness had no effect on spring wheat biomass, yield, growth rate, or inter-specific competition between neighboring weed species. However, additional analysis suggested that increased species richness may limit the competitive ability of dominant weed species, potentially creating a more stable weed community. We also assessed seedbank declines of common agricultural weeds. Between 5 and 29% of the original wild oat seedbank remained viable in the soil after 2 yr. For green foxtail, only between 0 and 9% of the initial seedbank remained viable. For Obj. 9, four bio-fungicides were assessed at two sites each in 2006 and 2007 to assess Fusarium foot rot control. Based upon 2006 results, bio-fungicides did not affect severity of Fusarium foot rot.

2005/09/15 TO 2006/09/15 Substantive progress has been made toward nearly all objectives in this integrated study. For Objective 1, several local and national sources of organic and conventional prices for key crops have been evaluated. National data was purchased and compiled for wheat, pulse crops, oilseeds, and feed grains. Toward Objectives 2 and 3, the green manure phase was completed with 2 yr (2005-2006) at two sites (Big Sandy and Bozeman, MT). Winter pea was superior among green manures, especially when terminated at early flower, resulting in stored soil water and soil N content similar to a bare fallow control. The practice of roller crimping (i.e. no tillage) termination of winter pea at the pod stage appears promising as a potential method for reducing tillage. Conversely, vinegar application did not appear promising. Also, the effects of green manure, crop variety, and seeding management, were measured in subsequent winter wheat in 2006 at Big Sandy. Winter pea green manure produced wheat with equal or greater grain N yield than bare fallow, while all spring green manures were inferior. Wheat grain protein was very low (except following winter pea terminated at pod stage), raising concern about the viability of pea to augment soil N sustainably. Considerable progress for Objectives 4 and 5 has been made. In 2006 at Big Sandy, rock phosphate was surface broadcast at three available P rates on plots to be seeded with spring pea, buckwheat, and mustard. In a related greenhouse study, spring pea, buckwheat, spring wheat, and a non-crop control (fallow) were fertilized with a subsurface band of rock phosphate, bone meal, and monocalcium phosphate at three rates. Shoot biomass of each green manure was collected for tissue P analysis in both studies. Preliminary results for Objective 6 indicate that species richness, alpha-diversity, and beta-diversity were higher in organic spring wheat systems than in conventional no-tillage systems. Preliminary results for Objective 7 indicate that while inter-specific competition in the weed community did not affect spring wheat growth, increased weed species richness may inhibit the growth of certain weeds. For Objective 9, four bio-fungicides were assessed at two locations in 2006 to assess Fusarium foot rot control. Preliminary results show that the bio-fungicides did not affect severity of Fusarium foot rot but one treatment increased wheat yield (P=0.10) at one location.

IMPACT

2005/09 TO 2009/09 All results have been well communicated to growers at field days and Montana Organic Association annual conferences, in extension publications, and to the scientific community. It has been difficult to assess trends in organic crop price premiums in Montana due to thinness of data. Based on the fact that organic wheat, pea, and lentil production in Montana has exceeded national rates of increase, it appears that price premiums remain sufficiently strong to attract new growers. Four impacts stand out from the green manure research. First, winter pea was superior to other green manures due to soil water conservation and N cycling. This should encourage greater producer adoption of winter pea among organic growers in Montana considering annual crop green manures. Second, crimp-roll termination at the plump pod stage is a viable no-tillage strategy for organic production that merits on-farm experimentation by growers. This enables a new level of soil conservation that protects organic farm\'s most valuable asset. Third, green manure management (crop choice and termination timing) and wheat variety were key components of an integrated crop management strategy for winter wheat, while seeding rate and row spacing were not. This instructs growers where to focus agronomic attention. Lastly, annual legumes may not supply sufficient N to maintain adequate protein levels in winter wheat. This key concern instructs growers on the need to manage a portfolio of N-providing green manures ranging from annual to perennial legumes, with associated risk of excess soil water use. The major impact of the P research is twofold. First, since green manure crops, including buckwheat, did not affect P uptake by subsequent winter wheat it is important that green manures are managed for their N contribution. Second, the agronomic value of the addition of rock phosphate was questionable in high pH soil typical of Montana. These results should encourage growers to manage soil P availability in other ways, such as with the use of animal manure. Results of this P study have been presented to growers at two Montana Organic Association conferences, two agricultural experiment station field days, and two organic agriculture awareness workshops. Growers have expressed interest in our project and are integrating the conclusions of this study into their crop management decisions. This study provided integrated weed management knowledge for both conventional growers interested in adoption organic practices as well as for established organic farmers. Multiple conversations with organic growers reveal that these growers are less threatened by weeds in general than conventional growers. However organic growers reserve an appropriate fear of very difficult to manage creeping perennial weeds such as Canada thistle and field bindweed, that are easily spread by tillage. Deployment of seed bio-fungicides for wheat production does not appear to be cost-effective for Fusarium foot rot control based on this research and so growers should consider crop rotations carefully to manage this disease. **PUBLICATIONS (not previously reported):** 2005/09 TO 2009/09 1. Miller, P.R., Buschena, D.E., Jones, C.A., and Holmes, J.A. 2008. Transition from intensive tillage to no-till and organic diversified annual grain cropping systems: Agronomic, economic, and soil nutrient analyses. Agronomy Journal 100: 591-599. 2. Miller, P.R., Lightheiser, E.J., Holmes, J.A., Jones, C.A., Rick, T.L, and

Wraith, J.M. 2010. Effect of green manures and termination timing on organic winter wheat. Agronomy Journal \In Preparation\ 3. Pollnac, F.W., Rew, L., Maxwell, B., and Menalled, F. 2008. Spatial patterns, species richness, and cover in weed communities of organic and conventional no-tillage spring wheat systems. Weed Res. 48:398-407. 4. Rick, T.L., Jones, C.A., Engel, R.E., and Miller, P.R. 2007. Ability of a Green Manure Crop to Increase Availability of Organic Phosphorus Fertilizers. ASA-CSSA-SSSA Annual Conference. November 4-8, 2007. New Orleans, LA. 5. Rick, T., Jones, C., Engel, R., and Miller, P. 2008. Synergistic Effects of Rock Phosphate and Green Manure on Soil Phosphorus Availability. GSA-ASA Annual Conference. October 5-9, 2008. Houston, TX. 6. Harbuck, K., Pollnac, F., and Menalled, F. 2009. Impact of cropping systems on weed seedbanks in the Northern Great Plains. Weed Biol. Mgmt. 9:160-168. 7. Pollnac, F.W., Maxwell, B., and Menalled, F. 2009. Weed community characteristics and crop performance: a neighborhood approach. Weed Res. 49:242-250. 8. Pollnac, F., Maxwell, B., and Menalled, F. 2009. Using species-area curves to examine weed communities in organic and conventional spring wheat systems. Weed Sci. 3:241-247. 9. Rick, T.L, Jones, C.A., Engel, R.E., and Miller, P.R. 2010. Green manure and phosphate rock effects on phosphorus availability in northern Great Plains dryland organic cropping systems. Plant and Soil \In Preparation\ 10. Buschena, D. 2008. Constructing an organic price series: Not as easy as expected. Policy Issue Paper No. 26. Agricultural Marketing Policy Center, Dep. Agric. Econ. and Econ., Montana State University, Bozeman, MT. \http://www.ampc.montana.edu/\ 11. Menalled,F., Bass, T., Buschena, D., Cash, D., Malone, M., Maxwell, B., McVay, K., Miller, P., Soto, R., and Weaver, D. 2008. An Introduction to the principles and practices of sustainable farming. Montguide MT200813AG. Montana St. Univ. Extension. \http://msuextension.org/publications/AgandNaturalResources/MT200813A G.pdf\ 12. Menalled, F., Jones, C., Buschena, D., and Miller, P. 2009. From conventional to organic cropping: what to expect during the transition years. Montguide MT 200901AG, Montana St. Univ. Extension. \http://msuextension.org/publications/AgandNaturalResources/MT200901A G.pdf\ 13. Harbuck, K. 2007. Weed seedbank dynamics and composition of northern Great Plains cropping systems. M.S. thesis, Montana State Univ., Bozeman, MT. 126 p. 14. Izard, E.J. 2007. Seeking sustainability for organic cropping systems in the northern Great Plains: Legume green manure management strategies. M.S. thesis, Montana State Univ., Bozeman, MT. 154 p. 15. Pollnac, F. 2006. Diversity, spatial patterns, and potential effects of competition in conventional no-tillage and organically managed spring wheat systems in Montana. M.S. thesis, Montana State Univ., Bozeman, MT. 133 p. 16. Menalled, F. 2006. Spatial distribution of weed communities in conventional and organic spring wheat systems. Western Soc. Weed Sci. Ann. Mtg., Reno, NV, 03/14/2006 17. Menalled, F. 2006. Spatial distribution of weeds in conventional and organic spring wheat agroecosystems. Ecol. Soc. Am. Ann. Mtg., Memphis, TN, 08/08/2006 \Invited\ 18. Miller, P.R. 2006. Pursuing sustainable agriculture from an agronomists view. Presented in symposium, Beyond Labeling: Comparing The Sustainability Of Conventional And Certified Alternative Farming Systems, Ecol. Soc. Am. Ann. Mtg., 08/08/2006, Memphis, TN \Invited\ 19. Miller, P.R., Buschena, D.E., Jones, C.A., Smith, R.G., and Hulting, A.G. 2006. Agroeconomic analyses of organic and no-till diversified cropping systems in the northern Great Plains. In Abstracts, Ecol. Soc. Am., 08/07/2006, Memphis, TN. 20. Pollnac F, Maxwell, B and Menalled F. 2007. Effects of weed community species richness on the performance of spring wheat: A neighborhood competition approach. Ecol. Soc. America Ann. Mtg. San Jose, CA

2007/09/15 TO 2008/09/14 Rotation studies address long term questions related to resource use efficiency and soil quality. These studies are providing data for the first measurement of crop energy budgets performed in Montana, especially critical with uncertain energy costs. Evaluation surveys of recent farm conferences in Montana highlight strong producer interest in diversified crop rotations. Pulse crops (pea, lentil, chickpea) are featured prominently in this research project and pulse crop acreage in Montana exceeded 300,000 acres in 2008 despite very high wheat prices, due in part to the contributions of this research project. This has meant an important new source of income for Montana farmers, and an important tool in improving on-farm energy balance by offsetting N fertilizer. An on-farm phase of crop energy budget research was initiated in 2008 to quantify this aspect at the field scale. Results from the greenhouse gas rotation study is contributing key knowledge about the rates of soil carbon sequestration and nitrous oxide emission, critically underpinning soil C credit markets. This research project continues to investigate optimal agronomic practices for alternative crops so inclusion in cropping systems will have a greater chance of being successful.

2006/09/15 TO 2007/09/14 When analyses are complete, the size, variability, and robustness of organic price premiums will be determined. As the organic industry grows domestically and internationally, these aspects of price premiums will be critical for producers, consumers, and all participants in the organic food industry. Four impacts stand out from the green manure research. First, winter pea was superior to other green manures due to soil water conservation and N cycling. Second, crimp-roll termination at the plump pod stage may be a viable no-tillage strategy. Third, green manure management (crop and termination timing) greatly outweighed the choice of variety or seeding management (seeding rate, row spacing) on wheat yield. Lastly, annual legumes may not supply sufficient N to maintain adequate protein levels in winter wheat consistently. The results of this study will be used to advise organic farmers on green manure and organic P fertilizer management strategies that optimize P availability. This study shed light on the importance of assessing weed competition at the community level. For example, increased knowledge of the spatial distribution of weed communities will foster site-specific management practices in organic systems. Also, understanding the temporal dynamics of seedbanks will allow producers to develop preventive weed management strategies. The deployment of bio-fungicides could provide an important crop management tool missing in organic wheat production. Collectively, these findings will reduce risk and increase sustainability of organic farming in the northern Great Plains.

2005/09/15 TO 2006/09/15 At this point we can speak only about potential impacts. When price analyses are completed, the size, variability, and robustness of organic price premiums will be determined. As the organic industry grows, the direction of these price premiums will be critical for producers, consumer, and all participants within the industry. Two potential impacts stand out among the many preliminary results from the green manure research. First, it appears that winter pea is an excellent choice for organic farmers. Second, the effect of green manure greatly outweighs the choice of genetic variety or seeding management (i.e. seeding rate, row spacing) on wheat yield. The results of this study will be used to advise organic farmers on green manure and organic P fertilizer management strategies that optimize P availability. Our preliminary findings confirm previous observations of increased species richness in organic systems, and knowledge of the levels of alpha- and beta-diversity will help to tailor future ecologically based research within organic systems. Increased diversity in the weed community could impact the way in which weed communities are managed, as these findings show that increasing weed species richness could be beneficial for containing weed species that may be most problematic for organic systems. The deployment of bio-fungicides could provide an important crop management tool missing from organic wheat production. Collectively, these findings should reduce risk and increase the sustainability of organic farming in the northern Great Plains.

PUBLICATIONS

2007/09/15 TO 2008/09/14 1. Buteler, M., D.K. Weaver, and P.R. Miller. 2008. Wheat stem sawfly infested plants benefit from parasitism of the herbivorous larvae. Agric. Forest Entomol. 10: 347-354 2. Dusenbury, M.P., R.E. Engel, P.R. Miller, R.L. Lemke, and R. Wallander. 2008. Nitrous oxide emissions from a northern Great Plains soil as influenced by N management and cropping systems. J. Environ. Qual. 37: 542-550. \Invited\ 3. Engel, R., D. Liang, P. Miller, and R. Wallander. 2008. Effect of granular urea placement on nitrous oxide production from a silt loam soil. Montana Fertilizer Facts, Number 50. 2p. \http://landresources.montana.edu/FertilizerFacts/\ 4. Miller, P.R., D.E. Buschena, C.A. Jones, and J.A. Holmes. 2008. Transition from intensive tillage to no-till and organic diversified annual grain cropping systems: Agronomic, economic, and soil nutrient analyses. Agron J. 100: 591-599. 5. Miller, P., D. Wichman, and R. Engel. 2008. Nitrogen cycling from pea forage to wheat in no-till systems. Montana Fertilizer Fact No. 51. 2 p. \http://landresources.montana.edu/FertilizerFacts/\ 6. Watts, J.D. 2008. Satellite monitoring of cropland-related carbon sequestration practices in north central Montana. M.S. thesis, Montana State Univ., Bozeman, MT. 180 p. (Committee member)

2006/09/15 TO 2007/09/14 1. Harbuck, K. 2007. Weed seedbank dynamics and composition of northern Great Plains cropping systems. M.S. thesis, Montana State Univ., Bozeman, MT. 2. Izard, E.J. 2007. Seeking sustainability for organic cropping systems in the northern Great Plains: Legume green manure management strategies. M.S. thesis, Montana State Univ., Bozeman, MT. 154 p. 3. Menalled, F. 2006. University of Guelph, Department of Plant Agriculture. Shifting gears in weed science: from population- to community level studies \Invited presentation\ 4. Menalled, F. 2007. Michigan State University. Departments of Horticulture, Crop & Soil Science, Entomology, and Plant Pathology. Can ecology help us manage pests in organic farms? \Invited presentation\ 5. Menalled, F. 2007. University of Alberta, Edmonton, Canada. Dept of Agricultural, Food and Nutritional Science. Exploring the functional importance of diverse weed communities in agroecosystems \Invited presentation\ 6. Menalled, F. 2007. University of Vermont. Department of Plant and Soil Sciences. Research and teaching supporting sustainable agriculture. An interdisciplinary task \Invited presentation\ 7. Miller, P. 2006. Crop sequence effects on water and nitrogen: Getting to the root of the matter. p. 5-18 In Proc. 13th Ann. Reduced Tillage Conf., Southern Alberta Conserv. Assoc., Dec 5-6, 2006, Medicine Hat, AB. 8. Miller, P. 2007. Energy use in cropping systems. Proc. for AERO on-farm energy workshops, Havre and Great Falls, MT. 9. Pollnac, F. 2006. Diversity, spatial patterns, and potential effects of competition in conventional no-tillage and organically managed spring wheat systems in Montana. M.S. thesis, Montana State Univ., Bozeman, MT. 133 p. 10. Pollnac F, Maxwell, B and Menalled F. 2007. Effects of weed community species richness on the performance of spring wheat: A neighborhood competition approach. Ecological Society of America Annual Meeting. San Jose, California \Volunteered presentation

2005/09/15 TO 2006/09/15 1. Menalled, F. Spatial distribution of weed communities in conventional and organic spring wheat systems. Western Soc. Weed Sci. Ann. Mtg., Reno, NV, Mar 14, 2006 2. Menalled, F. Spatial distribution of weeds in conventional and organic spring wheat agroecosystems. Ecol. Soc. Am. Ann. Mtg., Memphis, TN, Aug 8, 2006. Invited. 3. Miller, P.R. 2006. Pursuing sustainable agriculture from an agronomists view. Presented in symposium - Beyond labeling: comparing the sustainability of conventional and certified alternative farming systems, Ecol. Soc. Am. Ann. Mtg., Aug 8, 2006, Memphis, TN. Invited. 4. Miller, P.R., D.E. Buschena, C.A. Jones, R.G. Smith, and A.G. Hulting. 2006. Agroeconomic analyses of organic and no-till diversified cropping systems in the northern Great Plains. In Abstracts, Ecol. Soc. Am., Aug 7, 2006, Memphis, TN.

↑ Return to Index

Reducing Off-farm Grain Inputs on Northeast Organic Dairy Farms

Accession No.	0205089
Subfile	CRIS\
Project No.	ME02005-04474
Agency	NIFA ME.
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2005-51106-02390
Proposal No.	2005-04474
Start Date	15 SEP 2005
Term Date	14 SEP 2010
Fiscal Year	2009
Grant Amount	$827,058
Grant Year	2005
Investigator(s)	Reberg-Horton, S. C.; Marcinkowski, D. P.; Halloran, J. M.; Griffin, T. S.; Gallandt, E. R.; Jemison, J. M.; Kersbergen, R. J.; Stokes, M. R.; Anderson, G. W.; Schwab, C. G.; Erickson, P. S.
Performing Institution	PLANT, SOIL, & ENVIRONMENTAL SCIENCES, UNIVERSITY OF MAINE, ORONO, MAINE 04469

OBJECTIVES

Overview This project will contrast four cropping systems for supplying conserved forages and grains to an organic dairy herd. The four cropping systems characterize farmers with different answers to two important questions, \"Should I grow grain?\" and \"Should I grow corn silage?\" These systems were chosen by a team of organic dairy farmers, processors, and non-profit farm organizations to represent the cropping systems and rotation sequences typical in New England. The merits of each of these systems is a frequent source of debate within the agricultural community, and determining which is the best fit for an organic dairy farmer requires a holistic analysis of each system. An interdisciplinary team of farmers and researchers will analyze the systems for their impact on profitability, risk management, herd nutrition, nutrient cycling, and weed management. The project will be a collaboration of the University of Maine, the University of New Hampshire, USDA-ARS New England Plant, Soil and Water Lab and the Maine Organic Milk Producers (MOMP). Objective 1: To evaluate the milk yield and forage quality of four contrasting cropping systems and to identify the level of grain importation needed for each system. Objective 2: Identify systems that reduce the importation of grain and prevent the accumulation of nutrient excesses to enhance the sustainability of organic dairies. Objective 3: Quantify the efficacy of direct weed control tactics in the cropping systems, and determine the effect of weeds on total yield, quality and net return. Objective 4: Quantify the net return and exposure to risk and identify the economies of scale for each system. Objective 5: Host conferences, field days and on-farm trials that will be followed up with personal interviews with organic farmers to assess impact.

APPROACH

The cropping systems will be planted at the Witter Research Farm at the University of Maine and at the Fairchild Dairy Teaching and Research Center at the University of New Hampshire. Both research stations are certifying substantial acreage as organic. At Maine, 40 acres are being certified to form an Organic Dairy Research Unit. At

New Hampshire, 65 acres have already been certified and another 200 are being certified to feed an organic dairy herd that is being started in 2005. This new herd will be getting a new barn and facilities separate from the herd of 130 conventional cows on the station. Both universities will host farm-scale, unreplicated plots of each cropping system. These multi-acre plots will allow for realistic assessments of labor demands and equipment time for each system and provide ample forage for feeding trials. Multi-acre plots also allow for larger scale ecological processes to operate as they would in a working organic system. Yields in the unreplicated, farm-scale plots will be taken using a silage wagon and a drive-over scale. The same cropping systems will also be planted on smaller plots in a randomized complete block design with four replications at the University of Maine. While these plots will be smaller than typical agricultural fields, they will still be substantially larger than in most research trials (1/12th hectare each). This size will allow us to use normal farm machinery in the planting and maintenance of the plots. Measurements of yield, forage quality, weed pressure, and nutrient uptake will be analyzed using analysis of variance (ANOVA). Feeding trials at New Hampshire and Maine will monitor the milk production of each system for three years. Herds at both schools will be divided into four treatment groups and fed rations based on each of the systems for six months of the confinement season. Some of these organic systems are substantially different from conventional systems and the impact on milk production is difficult to predict. Maine does not have an organic herd, but the cows will be managed organically during the course of the experiment, simulating a transitional herd. How these cows respond to the treatments will be compared to how the certified organic cows at New Hampshire respond. During the course of the feeding trials, forages from each system will undergo the intensive and thorough analysis for nutrient composition and nutrient digestibility measurements as required for inclusion in the database of the newly created Ruminant Feed Analysis Consortium. Measurements will include a variety of chemical, in vitro, and in situ measurements. Forages will be analyzed for all fatty acids, including conjugated linoleic acid and other fatty acids hypothesized to have a positive role in human nutrition (Banni et al. 2003; Belury 2003; Kritchevsky 2003; Pariza 1999) and trans fatty acids that have been shown to have profound effects in the regulation of milk fat synthesis in the cow (Bauman and Griinari 2003). Samples from the project will likely be the first organic forages submitted to the consortium database.

PROGRESS

2005/09 TO 2010/09 OUTPUTS: Objectives 1: Evaluate the milk yield and forage quality of four contrasting cropping systems and to identify the level of grain importation needed for each system and: Objective 2: Identify systems that reduce the importation of grain, and enhance the sustainability of organic dairies. Data from feeding trials at University of Maine and University of New Hampshire have been complied and published in journals (Dairy Science), poster presentations (American Dairy Science Association) and professional presentations (Agronomy Society of America annual meetings). Modeling tools were utilized to evaluate the trials and are leading to the development of producer friendly decision matrixes to evaluate risk and rewards for associated cropping systems. These activities address major cropping decisions faced by producers, including whether or not to produce grain and/or corn silage on their farms. Objective 3: Quantify the efficacy of direct weed control tactics in cropping systems, the effect of weeds on total yield, quality and net return. Multiple trials on weed control strategies in organic grains included standard planting density with increased density, narrow and wide row spacing with various mechanical weed control options. Objective 4: Quantify the net return and exposure to risk and identify the economies of scale for each system. We have been using several techniques to evaluate profitability including the IFSM (Integrated Farming System Model) from ARS at Penn State and a \"bootstrap\" method developed by Efron at Stanford. Both methods will be published in Journal of Dairy Science. Objective 5: Host conferences, field days and on-farm trials. Results have been disseminated via abstracts to numerous professional meetings as well as grower meetings such as Northeast Organic Dairy Producers Association (NODPA) and state organic conferences. Presentations on yield and quality were presented at the 2009 American Society of Agronomy annual meetings in Pittsburgh, Pa. Other outreach includes poster presentations at national Dairy Science meetings, Colorado, Midwest Organic Farming Conference, European Weed Research Society, Northeast Branch Crops, Soils and Agronomy Conference and the Canadian Organic Cereal Grain Symposium. Presentations in Maine and New Hampshire include the Maine Agricultural Trades Show, Northeast Organic Farming Association (NOFA-Vt) winter meetings, Maine Organic Farmers and Gardeners Association (MOFGA) Spring Growth Conference, University of Maine Rogers Farm field days and organic dairy seminars in Northern Vermont. Published articles include Maine Extension fact sheets, eOrganic fact sheets (http://www.extension.org/article/24980), and articles in popular press such as NODPA and MOMP newsletters and Hoard\'s Dairyman. An eOrganic webinar focused on winter feeding was also conducted. PARTICIPANTS: Graduate Students: Gabrial Clark University of Maine Animal Vet Science (MS matriculated 2008) Lauren Kolb University of Maine Plant Soil and Environmental Sciences (PhD candidate) Susan P. Marston University of New Hampshire (PhD matriculated 2010) Patrick Heacock University of Maine Animal Vet Science (MS Candidate) Zach Conrad Tufts University (MS Candidate) Maine Organic Milk Producers, ARS New England Plant Soil and Water Lab (Wayne Honecutt and John Halloran) University of New Hampshire (Charles Schwab and Pete

Erickson) University of Maine Extension(Richard Kersbergen project PI) University of Maine (Eric Gallandt, David Marcinkowski, Gary Anderson, Martin Stokes) University of Maine (Thomas Molloy, Research associate) Aaron Hoshide University of Maine Adjunct Professor School of Economics, Producer organizations: Maine Organic Milk Producers (Henry Perkins President, Mia Morrison, Director) and cooperating farmers from this group, including Jeff Bragg, Doug Hartkopf, Steve Russell, Mark McKusick, George Nuite, Ralph Caldwell, Steve Morrison. Northeast organic Dairy Producer Alliance Ed Maltby, Director, Maine Organic Farmers and Gardeners Association Diane Schivera, Technical Services Livestock. Many educational programs from this project were co-sponsored by partner organizations and included staff from the University of Maine, University of New Hampshire and the USDA Natural Resources Conservation Service. TARGET AUDIENCES: The target audience for this project was Northeast Organic Dairy Producers. While this project was composed of researchers from Maine and New Hampshire, the majority of organic dairy farmers impacted were in Maine and Vermont who both have high percentages of organic dairy farms as compared to conventional dairy farms. PROJECT MODIFICATIONS: Several researchers accepted new positions at other institutions or retired during the course of this project. Tim Griffin is now at Tufts University, Chris Reberg-Horton is now at North Carolina State University, Wayne Honeycutt is now at USDA NRCS in Washington D.C. and Chuck Schwab retired from the University of New Hampshire.

2008/09/15 TO 2009/09/14 OUTPUTS: Objectives 1: Evaluate the milk yield and forage quality of four contrasting cropping systems and to identify the level of grain importation needed for each system and Objective 2: Identify systems that reduce the importation of grain, and enhance the sustainability of organic dairies. Activities represent a combination of replicated plot experiments, field or sub-field production on commercial organic dairies, and larger scale organic feed production. In year 3, both UNH and UMaine completed the third and final year of feeding trials. All three years are being compiled and evaluated. Modeling tools are being utilized to evaluate the trials and develop producer friendly decision matrixes to evaluate risk and rewards for associated cropping systems. These activities address major cropping decisions faced by producers, including whether or not to produce grain and/or corn silage on their farms. Replicated cropping system experiments started in 2006 and 2007 ended in 2009 with final year of data collection. Yield and quality varies widely between these crops. From both this replicated experiment and from field level data, meeting nutrient needs of small grain crops like triticale (which can be used for either forage or grain), and also multiple harvest crops like sorghum-sudangrass, can be difficult in organic systems given New England growing seasons. Objective 3: Quantify the efficacy of direct weed control tactics in cropping systems, the effect of weeds on total yield, quality and net return. In a replicated cropping system trial with the various rotation strategies listed above, yields of subplots in weedy and weed free plots have been examined. Weed seedbank measurements were taken each cropping year. An additional study on organic weed control in cereal grains was initiated to evaluate various tillage and planting densities on weed populations and yield of organic grains. Objective 4: Quantify the net return and exposure to risk and identify the economies of scale for each system. We have been using several techniques to evaluate profitability including the IFSM (Integrated Farming System Model) from ARS at Penn State and a \"bootstrap\" method developed by Efron at Stanford. Objective 5: Host conferences, field days and on-farm trials that will be followed up with personal interviews with organic farmers to assess impact. Meetings have been held both spring and fall each year of the project with researchers and producers. Two field days focused on organic grains were held in 2009. Results have been disseminated via abstracts to numerous professional meetings as well as grower meetings such as Northeast Organic Dairy Producers Association (NODPA) and state organic conferences. Presentations on yield and quality were presented at the 2009 American Society of Agronomy annual meetings in Pittsburgh, Pa. Maine Organic Milk Producers (MOMP) is creating a web site for information dissemination. A graduate student (Tufts Univ.) was hired to compile case studies of participating farms and to model those farms with the IFSM model. PARTICIPANTS: Graduate Students: Gabrial Clark University of Maine Animal Vet Science (MS matriculated 2008) Lauren Kolb University of Maine Plant Soil and Environmental Sciences (PhD candidate) Susan P. Marston University of New Hampshire (PhD Candidate) Patrick Heacock University of Maine Animal Vet Science (MS Candidate) Zach Conrad Tufts University (MS Candidate)Maine Organic Milk Producers, ARS New England Plant Soil and Water Lab (Wayne Honecutt and John Halloran) University of New Hampshire (Charles Schwab and Pete Erickson) University of Maine Extension(Richard Kersbergen project PI) University of Maine (Eric Gallandt, David Marcinkowski, Gary Anderson, Martin Stokes) University of Maine (Thomas Molloy, Research associate) TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Change in PI for University of NH due to retirement of Chuck Schwab. Pete Erikson is now the PI for UNH. No-Cost Extension was granted until September 15, 2010

2007/09/15 TO 2008/09/14 OUTPUTS: Objectives 1: Evaluate the milk yield and forage quality of four contrasting cropping systems and to identify the level of grain importation needed for each system and 2: Identify systems that reduce the importation of grain, prevent the accumulation of nutrient excesses and enhance the sustainability of organic dairies. Activities associated with this project represent a combination of replicated plot experiments, field or sub-field production on commercial organic dairies, and larger scale organic feed production at both the University of Maine and New Hampshire. These activities address major cropping decisions faced by producers, including whether or not to produce grain and/or corn silage on their farms. Replicated cropping system experiments were started in 2006 and 2007 in Maine, with treatments representing four alternative systems: 1) corn silage with grain production; 2) corn silage without grain; 3) no corn silage with grain; and 4) no corn silage or grain. A series of annual crops are included in each system, including not only corn (for silage or grain), but also winter triticale (as forage or grain), sorghum-sudangrass hybrid, barley, and soybean. Production data and inputs are being compiled into enterprise budgets for each system. In addition to measuring crop yield and quality in each system, we have also measured crop growth and nutrient uptake, soil nutrient availability, and weed competition. Yield and quality varies widely between these crops. From both this replicated experiment and from field level data, meeting nutrient needs of small grain crops like triticale (which can be used for either forage or grain), and also multiple harvest crops like sorghum-sudangrass, can be difficult in organic systems given New England growing seasons. Objective 3: Quantify the efficacy of direct weed control tactics in cropping systems, the effect of weeds on total yield, quality and net return. In a replicated cropping system trial with the various rotation strategies listed above, yields of subplots in weedy and weed free plots are examined. Weed seedbank measurements are taken each cropping year. Objective 4: Quantify the net return and exposure to risk and identify the economies of scale for each system. The project will use the Integrated Farm System Model (IFSM) to evaluate net returns and risk associated with the various cropping systems. Data from three years of University trials in replicated plots along with data from framer participants will be used to establish costs and yields associated with rotations. Objective 5: Host conferences, field days and on-farm trials that will be followed up with personal interviews with organic farmers to assess impact. Meetings have been held both spring and fall each year of the project with researchers and producers. Results have been disseminated via abstracts to numerous professional meetings as well as grower meetings such as Northeast Organic Dairy Producers Association (NODPA) and state organic conferences. Posters have been presented at the Integrated Organic Program annual meetings in Kansas City, and \"Understanding Organic Conference\" in Auburn N.Y. PARTICIPANTS: Graduate Students: Gabrial Clark University of Maine Animal Vet Science (MS candidate) Lauren Kolb University of Maine Plant Soil and Environmental Sciences (PhD candidate) Susan P. Marston University of New Hampshire (PhD Candidate) Patrick Heacock University of Maine Animal Vet Science (MS Candidate) Maine Organic Milk Producers (Mia Morrison) ARS New England Plant Soil and Water Lab (Wayne Honecutt) University of New Hampshire (Charles Schwab) University of Maine Extension(Richard Kersbergen project PI) University of Maine (Eric Gallandt) University of Maine (Thomas Molloy, Research associate) TARGET AUDIENCES: Maine Organic Milk Producers and Northeast Organic Dairy Producers Alliance. Presentations at monthly and annual meetings of both organizations. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2006/09/15 TO 2007/09/14 OUTPUTS: On-going activities associated with this project represent a combination of replicated plot experiments, field or sub-field production on commercial organic dairies, and larger scale organic feed production at both the University of Maine and New Hampshire. These activities address major cropping decisions faced by producers, including whether or not to produce grain and/or corn silage on their farms. Replicated cropping system experiments were started in 2006 and 2007 in Maine, with treatments representing four alternative systems: 1) corn silage with grain production; 2) corn silage without grain; 3) no corn silage with grain; and 4) no corn silage or grain. A series of annual crops are included in each system, including not only corn (for silage or grain), but also winter triticale (as forage or grain), sorghum-sudangrass hybrid, barley, and soybean. Production data and inputs (labor, machinery, seed, etc.) are being compiled into enterprise budgets for each system. In addition to measuring crop yield and quality in each system, we have also measured crop growth and nutrient uptake, soil nutrient availability, and weed competition. Yield and quality varies widely between these crops. From both this replicated experiment and from field level production at the two Universities, it is clear that meeting nutrient needs of both fall-seeded small grain crops like triticale (which can be used for either forage or grain), and also multiple harvest crops like sorghum-sudangrass, can be difficult in organic systems. The dairy facilities at both University of Maine and University of New Hampshire produced these same feeds on a scale sufficient to conduct a 100 d feeding trial at each farm (as detailed elsewhere). The University of New Hampshire Burley-DeMerritt farm became the first certified organic dairy at a land grant university in December 2006. As part of this project, we have conducted field-level soil sampling in order to develop a whole-farm nutrient and conservation plan for the farm (with assistance from the Natural Resources Conservation Service, NRCS). We have also conducted a high-resolution soil sampling of the pasture system at the farm. By collecting and analyzing soil samples from more than 150 geo-referenced points, we established a baseline to examine nutrient distribution across the pasture system. In a new collaboration effort with USDA-ARS scientists from University Park, PA, pasture productivity and plant diversity are also being monitored at these same points. Additionally, scientists from the USDA-ARS Tilth Lab (Ames, IA) will be collecting soil samples from across the certified organic acreage at UNH as part of the national Conservation Effects Assessment Project (CEAP). These efforts contribute to our ability to assess the interaction of productivity, profitability, and environment at this farm. PARTICIPANTS: Maine Organic Milk Producers ARS/New England Plant Soil and Water Lab University of New Hampshire University of Maine University of Maine Cooperative Extension TARGET AUDIENCES: Northeast Organic Dairy Producers

2005/09/15 TO 2006/09/15 The advisory group of producers, industry leaders and NGO staff met with researchers from Maine and New Hampshire three times since the fall of 2005. These meetings helped formulate the cropping systems included in the replicated experiment and the on-farm trials conducted by the cooperating producers, and also to produce forage for feeding trials. The most recent of these meetings (Nov 2006) has led to a modification of the feeding trials due to inclement weather for the 2006 growing season and a request by the farmer advisory group. A replicated cropping systems experiment was initiated at the Smith Farm in Old Town, ME, on the campus of the University of Maine. This experiment will provide data concerning nutrient flows, weed seed bank changes and yield/quality of organic forages in the different rotation strategies. This component of the project (objectives 2 and 3) is overseen by Timothy Griffin (USDA/ARS) and Eric Gallandt, Associate Professor. Eric Gallandt has a graduate student hired under this project for this component of the study. The feeding trials in Maine and New Hampshire are scheduled to begin in January 2007. These trials have been modified to answer additional questions raised by the farmers in the advisory group. The project will still contain four diets, but with two different grain supplementation strategies. In Maine, a graduate student has been hired under David Marcinkowski, Associate Professor, to facilitate this component. Objective 4 of the project is being coordinated by John Halloran (USDA/ARS). John is collecting risk analysis data with the assistance of a graduate student at the University of Maine assigned to this project. Economic production data from the systems trials, farmer trials and other production databases will be used to develop budgets for the various systems being investigated. Maine farmers and the Maine Organic Milk Producers hosted on farm trials on 8 different farms that are modeling the forage production systems. Three forage conferences were held (fall 2005, spring and fall 2006) to discuss progress and report on changes in the organic industry that impact the project. The Northeast Organic Dairy Producers Alliance (NODPA) held their summer annual meeting in Durham, NH. This meeting featured a discussion of the research project with the 130 participants from throughout the Northeast and was featured in an Associated Press news article.

IMPACT

2005/09 TO 2010/09 This project \"paved\" the way for the development of numerous organic research projects in Maine and NH. Additional research projects in 2009 and 2010 include an OREI grant, \"Enhancing Farmers\' Capacity to Produce High Quality Organic Bread Wheat\" funded at \$1,300,000 that will allow for continued research on the replicated cropping system plots established in this current project. Other recent projects include: \"Addressing the Research and Extension Needs of the Organic Dairy Industry in the Northeast\" (USDA/NIFA-OREI Planning grant: \$31,300); \"Molasses as an Alternative Energy Source for Organic Dairies\" (Organic Farming Research Foundation; Research grant: \$15,000); \"Molasses as an Alternative Energy Source for Organic Dairies\" (Northeast SARE; Graduate student grant: \$14,200); \"Addressing the Nutritional and Reproductive Research and Extension Needs of the Organic Dairy Industry in the Northeast\" (NERA: Northeastern Regional Association of State Agricultural Experiment Station Directors; Planning grant: \$10,000); \"Feeding High-Sugars Forage and Molasses to Organic Dairy Cows\" (Hatch Research Development: \$36,000); \"The Economic and Environmental Sustainability of Small and Medium Size Dairy Farms in New England\" (AFRI: \$404,966). To measure the effects of the Organic Dairy Cropping Systems on weed population and community dynamics, we sampled the weed seedbank at the start of each phase of the rotations, and each spring thereafter. Annuals average 80 germinable weed seeds per square meter in the first year following moldboard plowing the sod, increasing to 1,000 germinable weed seeds per square meter after one year of annual crops (corn in Systems 1 and 2; sudangrass in Systems 3 and 4); by the end of the four year rotation this had increased to 5,000 seeds per square meter. Perennial weeds increased in Systems 3 and 4 which lacked a fallow period prior to the final year of alfalfa (230 perennial seeds per square meter in Systems 1 and 2 vs. 375 in Systems 3 and 4, P=0.024). The change in the total seedbank, represented mostly by the large increase in annual weeds, differed among systems. Notably, System 1, Corn silage with homegrown grain, included soybean in the third year of the rotation displayed significant increases in the seedbank following this position in the rotation. The Systems that featured a preponderance of cereals following the initial warm-season silage or sudangrass crops were successful in keeping the seedbank at a low level. The combination of a full season high-moisture corn crop, followed by soybean, resulted in the largest increase in the seedbank. Because feed costs are generally the highest input cost on organic dairy operations, our studies compared production parameters and the economic efficiency of rations for organic dairy cows is necessary. Results from Maine and NH indicated that feeding a grass silage based diet supplemented with commodity concentrates may provide the greatest economic return for New England organic dairy producers. Organic dairy farms in Maine and Vermont now represent more than 20% of all dairy farms in those states. **PUBLICATIONS (not previously reported):** 2005/09 TO 2010/09 1. Heacock, P.S., D.P. Marcinkowski, G.W. Anderson, M.R. Stokes and R. Kersbergen. (2010) Winter Feeding Strategies for Lactating Organic Dairy Cows. ADSA-PSA-AMPA-CSAS-ASA Annual Meeting, Denver Co. (poster presentation) 2. S.P. Marston, K.L. Brussell, C.G. Schwab, N.L. Whitehouse and P.S. Erickson. (2008). Reducing Off-Farm Grain Inputs of Northeast Organic Dairy Farms: An Evaluation of Alternative Forage Cropping and Concentrate Feeding Systems (Year 1). Midwest Organic Farming Conf., LaCrosse, WI. 3. S.P. Marston, K.L. Brussell, C.G. Schwab, N.L. Whitehouse and P.S. Erickson. (2008). Reducing Off-Farm Grain Inputs of Northeast Organic Dairy Farms: An Evaluation of Alternative Forage Cropping and Concentrate Feeding Systems (Year 2). Understanding Organics Conf., Auburn, NY. 4. S.P. Marston (2010). Maximizing Profit on New England Dairy Farms: An Economic Comparison of Four Total Mixed Rations for Organic Holsteins and Jerseys. PhD Thesis, University of New Hampshire, Durham, NH. 5. G.W. Clark (2009) An Economic Evaluation of Winter-Feeding Strategies for Lactating Organic Dairy Cows Utilizing Different Forage and Concentrate Feeding Systems in Maine. MS Thesis, University of Maine, Orono, ME. 6. Kolb, L. (2010). Alternative Weed Management Strategies for Organic Cereals: Enhanced crop-weed interference and physical weed control. PhD Thesis, University of Maine, Orono, ME. 7. Kersbergen, R. (2007) Organic Dairying- Can it Work For You Proceedings of the 25th Annual Western Canadian Dairy Seminar, Alberta, Canada. http://www.wcds.afns.ualberta.ca/index.asppage=/Proceedings/Index 8. Kolb, L.N., E.R. Gallandt, and T. Molloy (2010). Improving weed management in organic spring barley: physical weed control vs. interspecific competition. Weed Research (50: 597-605). 9. Marston, S. P., G. W. Clark, G. W. Anderson, R. J. Kersbergen, M. Lunak, D. P. Marcinkowski, M. R. Murphy, C. G. Schwab, and P. S. Erickson (2011)Maximizing Profit on New England Organic Dairy Farms: An Economic Comparison of Four Total Mixed Rations For Organic Holsteins and Jerseys. Journal of Dairy Science (accepted 12-1-2010) 10. Kersbergen, R. (2010). Maximizing Organic Milk Production and Profitability with Organic Forages. eOrganic. http://www.extension.org/article/24980 2010 11. Kolb, L. (2008). System-level Comparison of Weed Control Strategies in Spring-Sown Barley. 5th International Weed Science Congress, Vancouver, B.C. Canada. 12. Clark, G.W.C., D. Marcinkowski, M. Stokes, G. Anderson and R. Kersbergen (2008). Reducing Off-farm Grain Inputs on Northeast Organic Dairy Farms: An Evaluation of Alternative Forage Cropping and Concentrate Feeding Systems: Holstein Herd. Proceedings of Midwest Organic Research Symposium. La Crosse, WI.

2008/09/15 TO 2009/09/14 This project \"paved\" the way for the development of numerous organic research projects in Maine and NH. Since October 2005, over \$1,300,000 has been committed to the UNH organic dairy farm initiative, \$100,000 from the UNH Office of Sponsored Research, \$200,000 from the University, and over \$1,000,000 from companies and the public sector. Additional research projects include \"UNH Organic Dairy Farm agroecosystem study\" LNE08-277 funded by Northeast SARE for \$379,087 and OAREI grant, \"Enhancing Farmers\' Capacity to Produce High Quality Organic Bread Wheat\" funded at \$1,300,000 that will allow for continued research on the replicated cropping system plots established in this current project. Over the course of the three year rotation in the replicated cropping system plots, the germinable seed bank, when averaged over all of the four systems increased from 354 seedlings m-2 in 2006 to 3136 seedlings m-2 in 2009. There was a significant increase in the number of species present over time. There was not a significant difference or increase in perennial weeds between systems or years. Annuals ended up dominating the seed banks of systems 1 and 2 (corn silage based rotations). Annuals and perennials were nearly evenly mixed in systems 3 and 4 (non-corn based annual crops). System 1 saw the largest increase in annual weeds (121 seedlings m-2 in 2006 to 7253 seedlings per m-2 seedlings in 2009) and was significantly different from systems 3 and 4. Amaranthus retroflexus and Chenopodium album were the dominant two species in System 1,comprising 47% and 33% of the annual weeds present respectively. Results from the feeding trials in Maine and NH both indicate that the use of organic commodity grains produced a higher income over feed cost (IOFC). Cows in Maine that were fed the commodity diets produced significantly higher levels of fat corrected milk, and there was a trend for haylage or perennial sod based rations to have a higher IOFC. Haylage rations were significantly cheaper to formulate due to the high cost of protein supplements. In 2009 we evaluated two possible solutions for weed control in organic spring-sown cereals: systems that i) facilitate better physical weed control through the use of wide rows and inter-row cultivation or (ii) enhance crop-weed competition. Increasing the competitive ability of wheat was done using three methods: elevated crop density at standard row width (17 cm), elevated crop density in combination with narrow (11 cm) row spacing, and elevated crop density while broadcasting a third of the seed and using a seed drill to plant the remainder. These tactics were contrasted with a standard organic practice and a wide row system with inter-row hoeing. Standard seeding rates were established at 400 plants m-2 and high density seeding rates were 600 plants m-2. Standard organic practice had significantly higher weed density and weed biomass at harvest than the other management systems. Wide rows with cultivation had the lowest weed density, but there were no significant differences in weed biomass. Any of these four strategies could be a viable option for weed management in organic spring grains.

2007/09/15 TO 2008/09/14 Results from the feeding trials in Maine in year two indicate that based on the current value of organic milk in New England, (\$26.00/cwt base price) the corn/pellet ration resulted in the highest daily milk income and the grass commodity was the lowest. In year two the grass/commodity diet was the most profitable, followed respectively by corn/pellet, corn/commodity and grass pellet diets. In NH, twenty-four multiparous Jersey cows from the UNH Organic Dairy herd were randomly assigned to one of four treatment diets testing the main effects of corn silage or grass silage as the forage source and homegrown grains versus a commercially available pellet. There were no differences among treatments in milk yield, fat, SCC or BCS. Income over feed costs were \$3.56 (corn silage with pellet), \$5.20 (corn silage with homegrown grains), \$4.91 (grass silage with pellets) and \$5.67 (grass silage with homegrown grains). The results from year two of this study indicate that feeding commodity grains has an economic advantage over feeding a commercial pellet, and that feeding a grass silage based diet may have a greater economic benefit to New England dairy producers. Production data and inputs are being compiled into enterprise budgets for each system. In addition to measuring crop yield and quality in each system, we have also measured crop growth and nutrient uptake, soil nutrient availability, and weed competition. The number of germinable weed seedlings in the plots is on the increase, indicating that rotating out of perennial sod into annual crop production can increase the weed seedbank. The phase 1 plots, which have been in production since 2006 had an average weed seedbank of 1905 seedling m-2. The phase 2 plots, which have been in annual crop production since 2007 were significantly lower with 321 seedlings m-2. In both phases, systems that had corn in them were found to have significantly more weed seedlings. In the phase 1 plots, the two systems with corn averaged 2399 seedlings m-2 versus the two systems without which had 1411 seedlings m-2. The phase 2 plots, which at the time of sampling had only one year of crop production, had similar results. The systems with corn had 407 seedlings m-2 versus those without, 236 seedlings m-2. We compared standard organic practice of 15 cm row spacing in barley with and without pre-and post emergence harrowing to narrow rows (11 cm) with and without pre-and post emergence harrowing, wide rows (22 cm) with harrowing and inter-row cultivation, and a uniform crop spatial arrangement. The wide row system had 50% less weed biomass than the standard organic practice of 15 cm row spacing and pre-and post-emergence harrowing. Increasing levels of weed control in this experiment corresponded to barley yield gains. The Maine Organic Milk Producers (MOMP) are research participants. In 2008, eight farmers have been growing crops in accordance with crop rotations similar to the University trials on over 80 acres including annual crops such as soybeans, winter grains and corn. Producers will present their findings at winter conferences.

2006/09/15 TO 2007/09/14 Yield and quality varies widely among forage crops. In 2006 corn silage yields were 11 000 lb DM/acre, about twice the yield of sorghum-sudangrass (4 600 lb DM/acre in 2006 and 5 800 lb DM/acre in 2007), and about six times the yield of triticale harvested at the boot stage (1 800 lb DM/acre). However, systems that do not include corn silage are able to produce a more diverse crop mix (both grain and forage) and distribute field operations more evenly through the season. Meeting nutrient needs of both fall-seeded small grain crops(either forage or grain), and multiple harvest crops like sorghum-sudangrass, can be difficult in organic systems. The first of three annual feeding trials was conducted using two different organic forage systems, (all grass diet vs. grass/corn silage based diet) and two concentrate supplementation strategies (commercial 20% protein pellet vs. mix of commodities consisting of ground corn, roasted soybeans, soybean meal) analyzed in a 2-by-2 factorial system. Each ration was balanced to equalize milk production and fed as a TMR to separate groups of Holstein cows in early to mid lactation. The cost/cow/day of the rations ranged from \$5.84 (for corn/pellet) to \$6.89 (for corn/commodity). Milk production and milk fat percentage were higher for the two rations balanced using commodities (P\< 0.05), but milk protein was unchanged. Based on the current value of organic milk in New England, (\$26.00/cwt base price), the grass/commodity ration resulted in the highest daily milk income (\$17.71) and the corn/pellet was the lowest (\$16.16). With regard to daily milk income over feed costs it was found that the grass/commodity diet was the most profitable (\$11.24), followed respectively by corn/commodity (\$10.78), corn/pellet \$10.32) and grass/pellet (\$10.20) diets. From the first year data, there appears to be an advantage to commodity based concentrate supplementation. At the UNH Organic dairy, thirty-two primiparous Jersey cows were randomly assigned to one of four treatment diets testing the main effects of corn silage or grass silage as the forage source and homegrown grains versus a commercially available pellet. There were no differences among treatments in milk yield. Cows fed the grass silage diet containing homegrown grains had higher (P\< 0.05) milk fat concentrations and body weights. Cows fed the grass silage diets had higher true protein (P\< 0.01), MUN (P\< 0.01) and crude protein (P\< 0.05) concentrations than those fed diets containing corn silage. Cows fed the commercial pellet had higher true protein and crude protein concentrations, while cows fed the homegrown grains had higher MUN (P\< 0.01) and BCS (P\< 0.05). Treatment diets ranged from \$4.11/cow/d (corn silage with pellet) to \$5.19/cow/d (grass silage with homegrown grains). Income over feed costs for the treatments were \$5.92 (corn silage with pellets), \$5.77 (corn silage with homegrown grains), \$5.38 (grass silage with pellets) and \$5.73 (grass silage with homegrown grains). The results from year one indicate that feeding a corn silage based diet with a commercially available pellet may have the greatest economic benefit to New England organic milk producers.

2005/09/15 TO 2006/09/15 Impacts/Milestones In 2006, organic dairy farmers faced multiple weather challenges that altered the systems under development. As a result, the advisory panel altered rotations and feeding strategies to better suit their research needs. As a result of dairy forage conferences and NODPA (Northeast Organic Dairy Producers Alliance) summer conference more that 150 producers, industry representatives and researchers now know about the project and the research objectives.

PUBLICATIONS

2008/09/15 TO 2009/09/14 1. Griffin, T., R. Kersbergen, T. Molloy, C. Honeycutt and J. Halloran (2009)Yield Potential of Alternative Cropping Systems for Organic Dairy Farms. American Society of Agronomy Annual Meeting Abstracts #53040 2. Kersbergen, R., T. Griffin, T.Molloy, John Halloran and C. Honeycutt (2009) Forage Quality of Alternative Cropping Systems for Organic Dairy Farms in New England. American Society of Agronomy Annual Meeting Abstracts #55108 3. Kolb, L., E.R. Gallandt, and T. Molloy. (2009) Combining Enhanced Competition and Cultivation for Improved Weed Control in Organic Cereals. European Weed Research Society Physical and Cultural Weed Control Working Group, Zaragoza, Spain 4. Kersbergen, Richard (2009) A summary of the Organic Dairy Cropping System. Northeast Branch Crops , Soils and Agronomy Conference Abstracts

2007/09/15 TO 2008/09/14 1. Posters:Integrated Organic Program Annual Meeting Kansas City, Missouri March 25, 2008 Alternative cultural and physical weed control strategies in spring cereals Reducing off-farm grain inputs on northeast organic dairy farms Project (2005-51106-02390) Lauren Kolb, Eric Gallandt, and Tom Molloy 2. Reducing off-farm grain inputs on northeast organic dairy farms Project (2005-51106-02390) An evaluation of forage cropping and concentrate feeding systems. S.P. Marston, G.W. Clark, D. Marcinkowski, P.S. Erickson, C.G. Schwab, R. Kersbergen 3. International Presentations: System- level comparisons of weed control strategies in spring-sown barley Lauren Kolb 5th International Weed Science Congress Vancouver, British Columbia, Canada June 24, 2008 4. Invited symposium presentation at 2007 International Meeting of American Society of Agronomy: Building a Research Database for Organic Dairy in New England. New Orleans LA, 4 November 2007 \80-100 scientists and educators present. Symposium title: Building Sustainable Ecosystems Through Organic Agricultural Research and Education.\ Tim Griffin 5. University of New Hampshire. Farming for the Future Lecture Series. Durham, NH 2008. The Role of Pasture in Organic Dairy Systems. Richard Kersbergen

2006/09/15 TO 2007/09/14 1. Upper Midwest Organic Growers Conference March 2008 Abstracts accepted: Reducing off-farm grain inputs on northeast organic dairy farms: An evaluation of alternative forage cropping and concentrate feeding systems Jersey Herd S.P. Marston*, P.S. Erickson, C.G. Schwab, N.L. Whitehouse and K.L. Brussell. 2008. University of New Hampshire, Durham, NH 2. Reducing off-farm grain inputs on Northeast organic dairy farms: An evaluation of alternative forage cropping systems and concentrate feeding systems. Holstein Herd G.W.C. Clark*, D. Marcinkowski, M. Stokes, G. Anderson and R. Kersbergen. 2008.

2005/09/15 TO 2006/09/15 No publications reported this period

↑ Return to Index