2019 Organic Agriculture Research Forum

Organic Farming Research Foundation in Partnership with Organicology

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2019 Organic Agriculture Research Forum Proceedings

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Oral Presentations

Fruits & Vegetables

Matthew Kleinhenz, *Enhancing the utility of grafting in U.S. organic vegetable production*

All growers, especially organic, rely on naturally-occurring traits to help maintain crop yield and quality in the face of difficult production and market conditions. Growers need key traits to be included in varieties and plants quickly, in specific combinations, at low cost, and in ways that provide maximum benefit. Grafting assists in this process in a number of ways, although several stand out. First, as physical hybrids, grafted plants can deliver a wider range of important traits more rapidly and flexibly than traditional (single variety, genetic) hybrids. Second, grafted plants can be used in vegetable operations of nearly all scales, types (e.g., field/ high tunnel, market), and locations. Finally, grafted plants offer three types of income potential; the first from maintaining or enhancing fruit yield and/or quality, the second from the opportunity to offer novel products, and the third from preparing and selling grafted plants, much like preparing and selling standard non-grafted transplants. Still, preparing and using grafted plants adds risk and cost and creates questions, such as ideal rootstock-scion variety combinations, grafting and grafted plant distribution/shipping methodologies, and site-specific grafted plant best management practices. Therefore, additional formal and informal study and information sharing are required to assist organic and other growers in deriving greater value from grafted plants. A team supported by the USDA-SCRI and other sponsors and representing 10 U.S. universities, the USDA, and local-global industry partners was created for this purpose. Investigators and extension professionals from WA to FL are completing experiments focused on improving access to affordable, high quality, and organic certification-eligible grafted plants representing reliable and relevant rootstock-scion variety combinations. The team also experiments with grafted plants under a wide range of production conditions (e.g., soilborne disease, abiotic stress) while also testing plant responses to various cultural practices (e.g., plant spacing, pruning/trellising), fertility programs, irrigation regimens, tillage and plant-bed preparation practices, and other inputs (e.g., biostimulants/biofertilizers). The quality of cucumber, eggplant, melon, pepper, tomato, and watermelon fruit harvested from plots is also examined. Farmers contribute to many tests whether by hosting an on-farm experiment or by providing input on treatments, methods, and the interpretation and sharing of findings. Information gained from this experience is shared in publications, presentations, programs, and consultations, and via a listserv (https://u.osu.edu/vegprolab/grafting-listserv/) and various websites (e.g., http://www.vegetablegrafting.org/). This collaborative, integrated research-extension, capacity-building approach is providing U.S. organic growers with a steady supply of high quality information helping them to utilize vegetable grafting more effectively.

Jim Myers, *Northern organic vegetable improvement collaborative*

The goal of the Northern Organic Vegetable Improvement Collaborative (NOVIC) is to improve the productivity of organic farmers and the quality of organic produce for consumers by developing improved vegetable varieties adapted to organic production systems. Organic growers require vegetable varieties that are well adapted to organic production systems that retain high quality and excel in agronomic performance. Germination in cold soils, the ability to compete with weeds, limited nutrient availability and post-harvest storage issues are general barriers to overcome toward increasing the productivity of organic agriculture in the US, largely due to the lack of cultivars that have been adapted to excel in organic systems. Now in its eighth year, we seek to increase the diversity and supply of certified organic cultivars available for organic production through a combination of trialing and breeding. Partners include Organic Seed Alliance, Oregon State University, University of Wisconsin-Madison, Cornell University and USDA-PGRU-Geneva.

Erin Silva, *Impact of cultivar selection on arbuscular mycorrhizal fungi colonization and effects of biomass allocation and yield in organic carrot production*

The role of soil microorganisms in fostering and promoting resilience and plant health is vital in the function of a healthy organic agroecosystem. Increasingly, commercial soil biological inputs are available and marketed to organic farmers with promises of increasing yields and improving plant stress response. Arbuscular mycorrhizal fungi (AMF) comprise a class of soil microorganisms that colonize and impart benefits to plants, with the most commonly reported positive outcomes including improved water and nutrient acquisition. While we know that these organisms are important in the mitigation of extreme weather events and nutrient-limited conditions in organic vegetable production, the relationship between cultivar selection and degree of mycorrhizal response remains unclear, particularly in the case of modern hybrids bred under high-input conditions that may reduce reliance on symbiotic partners. This work evaluates whether genetic differences between carrot cultivars lead to differing responses with respect to plant growth under organic field conditions when inoculated with different strains of AMF. Four field experiments were conducted over two production seasons on organic land at UW-Madison’s West Madison Agricultural Research Station in Madison, WI. Carrot cultivars (‘Red Cored Chantenay’, ‘Scarlet Nantes’, ‘Nelson’, and ‘Napoli’) received inoculation with a single isolate of AMF, which was buried in a 20 cm-deep trench and covered prior to planting seeds. Four AMF species with representatives isolated from California and North Carolina served as whole inoculants (Funneliformis mosseae CA127, Funneliformis mosseae NC302C, Rhizophagus clarus CA401, Rhizophagus clarus NC112A, Rhizophagus intraradices CA502, Rhizophagus intraradices NC200, Septoglomus deserticola CA113, Septoglomus deserticola NC302A), with the International Vesicular-Arbuscular Mycorrhizal Culture Collection (West Virginia University, USA) providing the starting inocula. Treatments further included well-watered and water-limited conditions to measure the influence of AMF strain on water stress response. To control water availability, plants were grown in a randomized complete block design under caterpillar tunnels that served as rain-exclusion shelters as needed. Carrots were harvested by hand and measured for root length, weights, and above-ground biomass. Across experiments and water treatments, field-grown carrot cultivars differed significantly in their taproots' responses to inoculation with AMF. Generally, heirloom cultivars had positive responses to inoculation, indicated by more frequent gains in taproot weight. AMF isolates exhibited high inter- and intra-specific variability in terms of contributions to plant biomass, and performance of isolates differed within each experiment and water treatment. This work has implications for organic plant breeding, as it demonstrates genetic influences on the degree of response to soil microorganisms, thus indicating that it may be a parameter which should be evaluated in breeding programs. Further, the work indicates that organically-approved AMF inputs may yield varying responses in the field depending on cultivar selection.

Javier Fernandez-Salvador, *Organic strawberry production in Oregon: A case for season extension research*

Although conventional strawberry production has continued to decline over decades, organic strawberry production in the Pacific Northwest has great potential for growth as local demand has not been met with state grown berries. Organic production offers additional price premiums and opportunity for development of new markets. Low tunnels are miniature greenhouse structures that use long sheets of plastic laid over hoops to cover a single raised bed. The objective of our study was to determine the baseline production practices for efficient and cost effective organic strawberry production in low tunnels, as well as evaluate agronomic management for the crop and determine future research needs. In this presentation you will find our preliminary results and challenges, as well as determine for yourself why organic strawberries grown in tunnels may have a viable future and the need for research to make it happen.

Breeding

John Snyder, *Conventional breeding (non-GMO) of tomato for insect and spider mite resistance*

Wild relatives of crop plants often possess valuable traits, especially traits that may contribute to greater agricultural sustainability. Tomato sustainability has been improved by non-GMO transfer of traits from wild relatives to the crop. Resistance to common diseases such as fusarium and verticillium has been utilized for more than 60 years. More recently resistances to viruses such as tomato spotted wilt and tomato yellow leaf curl (TYLCV) viruses have been transferred from wild to cultivated tomato and are widely utilized. Resistance to devastating TYLCV has been notably beneficial in temperate areas where this virus and its associated tropical and subtropical vector are now present due to widespread tomato production in protected environments. Nearly twenty viral, bacterial and fungal resistances have been conventionally bred into tomato, an impressive number. Most of these traits are controlled by single genes, which are easier for plant breeders to transfer from wild relatives to cultivated crops, compared to multigenic traits.

At least three species of wild tomatoes have been identified as highly resistant to arthropods e.g. insects and spidermites. One wild species, Solanum habrochaites (S.h.) is nearly immune to arthropod attack. Unfortunately, insect resistance is not controlled by a single gene, making resistance difficult to transfer by conventional breeding. Research by the author and others has revealed that S.h. is resistant to arthropods because it has specialized trichomes (plant hairs) that produce compounds that deter or repel arthropods. Neither character, the trichome or its associated anti-arthropod compound are present in cultivated tomato. Because trichomes and their associated compounds have been implicated in resistance, we are attempting to transfer or introgress these characters from wild to cultivated tomato using a modified backcross (non-GMO) breeding approach.

Success should lead to reduced pesticide applications on tomatoes and increased genetic diversity of tomato, characteristics particularly valuable for organic producers, especially those who are producing tomatoes in protected environments, an environment often be accompanied by greater arthropod pressure on the crop. S.h., the arthropod-resistant species, easily crosses with tomato to produce an interspecific F1 hybrid. However, these hybrids rarely set fruit after self-pollination, considerably delaying breeding progress. A concerted effort is underway to introgress the specialized trichome and its anti-arthropod compound from S.h. to cultivated tomato. Simultaneously efforts have been made to select hybrids having good fruit and seed set fruit after self-pollination. We now have the fifth back cross generation (BC5, the generation that has been back-crossed five times to tomato). Short-term bioassays have verified the presence of spider mite behavior consistent with resistance in advanced hybrids. Evaluation of resistance to whiteflies is also underway. A few individuals having high densities of the specialized trichome, high concentrations of anti-arthropod compound and that set fruit upon self-pollination have been identified and will be used to generate future generations. Research methods, recent results and future breeding plans will be presented for discussion. In addition, these breeding efforts will be discussed in light of the 2015 USDA publication “Roadmap for Plant Breeding” and potential benefits for organic agriculture.

Brigid Meints, *Multi-use naked barley for organic farming systems*

Small grains offer many advantages for organic farmers. Barley (Hordeum vulgare) is attractive because of its versatility as a malting, culinary, and feed grain. Selection and breeding of varieties suitable for organic agronomic and market conditions will provide organic farmers with improved options to meet the growing demand for organic barley. Currently, organic barley end-uses and markets are stratified due the presence of an adhering hull and grain β-glucan content. This OREI-funded research is focused on breeding naked (hull-less) varieties that have potential environmental and economic benefits for organic producers. The researchers are breeding for naked barley with modest levels of β-glucan to create varieties suitable for brewing, feed use, and that will meet FDA guidelines for soluble fiber in human diets. Development, assessment, and participatory breeding of naked multi-use barley is being conducted in five representative regions/states: the Pacific Northwest (OR, WA), Upper Midwest (MN, WI) and North East (NY), using three classes of germplasm: a composite targeted to K-12 students and gardeners, a large diversity panel to apply genetic data to improve barley for organic systems, and a multi-regional trial to identify varieties for release. Researchers are assessing germplasm under organic conditions in school and home gardens, university research stations, and on-farm trials. Agronomic, food, feed, malting, and brewing performance is being evaluated on the organic trials. Workshops have been held to educate stakeholders on best management practices and processing procedures. Outreach efforts are in place to help familiarize students, gardeners, growers, processors, and consumers with the benefits of naked barley varieties and provide guidance for capitalizing on the advantages these varieties can offer. Researchers will provide results from the first year of trials and outreach events.

Jared Zystro, *Efficient methods to develop new sweet corn cultivars for organic systems*

Organic systems differ from their conventional counterparts in ways that may affect the relative performance of plant genotypes. If cases where rank-change genotype by system interactions are present, selection in organic environments may be most appropriate when developing cultivars for organic systems. However, doing so requires efficient approaches. Synthetic varieties produced from intermating multiple inbred lines may be an appropriate method for developing stable and adaptable cultivars of cross-pollinated crops such as sweet corn (Zea mays). Mating designs such as North Carolina Design II (NC DII), as well as marker-based Genomic Best Linear Unbiased Prediction (GBLUP), can allow the prediction of the performance of a large number of hybrids and synthetics based on the evaluation of a smaller subset of tested hybrids and inbreds. These techniques can increase the efficiency of hybrid trials and allow testing to be done in more environments, which in turn can help to identify potentially stable material for organic systems. The goal of this research to develop efficient methods to develop new sweet corn cultivars for organic systems. The objectives of this research is to determine the utility of using structured mating designs and genotypic information to select untested sweet corn hybrids and synthetic varieties for organic environments. These objectives will be accomplished by conducting trials of sweet corn hybrids developed through a series of crosses following the NC

DII mating structure, along with the parental inbreds. These trials have been carried out in 10 organic environments total in 2015 and 2016. The results of these trials were used to predict untested crosses using both traditional methods of general combining ability evaluation from the NC DII as well as incorporating marker data and using marker-based GBLUPs. Differences among the entries were seen for all measured traits, and differences in general combining ability (GCA) among inbreds for all traits except tenderness. The results of these trials were used to predict untested hybrids and synthetics using both general combining ability (GCA) and GBLUP. Models incorporating dominance effects increased GBLUP cross-validation accuracy over models with only additive components. Validation trials across five environments were conducted to determine predictive accuracy of these systems. Both GCA and GBLUP based methods were relatively accurate for predicting hybrid performance for most traits, with little difference seen in the relative accuracy of the methods. The prediction of synthetic performance was less accurate.

Climate Change

Jessica Shade, *The real impact of organic agriculture on climate change: Adjusting LCA data to more fully account for organic systems*

A widely used database for life cycle assessment includes data for organic and conventional production of various crops. Thus, it can be used by analysts and others to assess the relative environmental advantages of organic versus conventional production. However, in relation to climate-related impacts, some of the most important aspects of soil interactions are not fully modeled in the most recent datasets that compare organic and conventional production. We therefore undertook an investigation into these factors, and have used published research to develop impact factors needed to allow their incorporation into modified datasets that are integrated with the database in order to take these key topics into account. We tested the importance of these modifications and additions by comparing results and conclusions with and without these modifications, and found that using current life cycle assessment databases grossly underestimates the benefits of organic to greenhouse gas reduction, because it includes out-of-date N2O emissions factors and sequestration of CO2 in the original datasets is restricted to CO2 that becomes CO2 in the harvested plant; build-up of carbon content of the soils is not accounted for. We used real-world crop examples to model the importance of updating life cycle assessment databases, and illustrate the net-positive impacts of organic agriculture on our climate stability.

Léa Vereecke, *Optimizing organic cover crop-based rotational tillage systems for early soybean growth*

Cover crop-based rotational tillage (CCBRT) practices continue to be adopted on organic land across the globe. In these systems, fall-planted cover crops that are mechanically terminated in the spring are used to suppress weeds and eliminate the need for tillage and cultivation in the soybean production phase of the rotation. However, challenges remain as to maximization of soybean yields due to late planting dates of the soybean and delays in early soybean growth. The contamination of the subsequent crop by volunteer cover-crop is another limit highlighted by early adopters. In this study, soybeans were planted into cereal rye and winter triticale at two planting dates, with termination with the roller crimper occurring at Zadoks' stage 69. The impacts of cover crop variety and planting dates were compared through measurements of: (1) cover crop biomass; (2) the regrowth of the cover crops; (3) soybean plant populations; (4) weed densities and biomass; and (5) soybean nodulation. Biomass production of each of the cover crops differed significantly by year, ranging from 6 128 kg DM ha^{-1} to 16 994 kg DM ha^{-1}. Significant differences in weed densities and weed biomass were found between cover crop varieties and control treatments across the different planting dates. Soybean nodulation was reduced by the CCBRT management, potentially impacting early soybean growth. Yield advantages were observed in the rye vs. triticale treatments, and in the late-planting at Zadoks' stage 69 vs. early-planting at Zadoks' stage 45. Further work must be conducted to understand the benefits and risks of different cover-crop species and soybean planting strategies in the CCBRT system and to develop best management practices to promote early soybean growth.

Emily Evans, *Understanding the value of tillage radish and winter hardy cover crops as nutrient sources for field crops*

An indispensable component of a healthy organic system is inclusion of cover crops. While a key element in maintenance and improvement of soil properties, reduction of weed pressure, and additions and recycling of nutrients, challenges of managing these crops between cash crops can add frustration and pose risk to the grower. A recent interest in oilseed radish has organic farmers in the Midwest interested in experimenting with the scavenging potential of this new cover crop; however past research has shown inconsistent evidence of this potential being realized because of poor establishment and rapid decomposition of tillage radish. Problems with unpredictable nutrient availability to the following crop could potentially be due to inefficient management tactics. Strategies like applying manure prior to planting and planting mixes that include other annual and winter hardy cover crop species can promote quick and ample fall growth as well as establish a dynamic community of plants that are able to both scavenge as well as serve as a secondary "catch" crop.

A replicated, two-phase trial was conducted at the University of Minnesota Southwest Research and Outreach Center from 2014-2018. Establishment and growth of tillage radish alone, and within annual and winter hardy cover crop species, were evaluated amongst tillage and fertility treatments. Cover crops were planted after wheat harvest, followed by a corn crop the following year. Cover crop treatment effect on nutrient availability for the subsequent cash crop was evaluated by measuring soil nutrient status, soil biological activity and potential mineralization throughout the growing season as well as corn crop yield. Each cover crop treatment was tested within three different management systems to represent a legume-based system and two manure-based systems, in addition to two tillage methods: one with tillage prior to planting and the other without.

While previously believed that tillage radish establishment and growth is dependent on soil nitrogen, we found tillage prior to cover crop planting yielded twice as much tillage radish biomass with much larger root masses compared with no tillage plots. While the striking differences in fall cover crop growth should have influenced scavenging capacity and nutrient availability, no major treatment differences in available or mineralizable nitrogen were found among neither the system treatments nor the cover crop treatments. Additionally, corn yields for the tilled plots were much higher, especially for the single tillage radish species and radish that planted with cover crops that did not overwinter. Further investigation of the impact of soil physical properties and additional benefits related to compaction alleviation are worth investigating to determine how tillage radish improves organic rotations. Furthermore, concerns about topsoil loss and winter soil exposure based on conventional tillage practices were considered: measurements to determine winter soil cover revealed no differences among tillage treatments in all years. Thus, employing tillage in an effort to increase cover crop biomass should have minimal environmental impact.

Lauren Snyder, *Organic soil health practices for climate mitigation and farm resilience*

In 2016, the Organic Farming Research Foundation (OFRF) published findings from a national survey of organic farmers and ranchers indicating a pressing need for more research on organic soil health management practices. In response to this need, OFRF recently published two new guidebooks on soil health: 1) *Reducing Risk Through Best Soil Health Management Practices in Organic Crop Production* and 2) *Organic Practices for Climate Mitigation, Adaptation, and Carbon Sequestration*. Here, we present an overview of each guidebook by highlighting key information and resources presented in each. The first guidebook on risk management offers practical, research-based guidance for building healthy soils to increase resilience to abiotic and biotic stressors, such as droughts, floods, and diseases. The second guidebook on climate change explores research related to the capacity of organic farming systems to reduce greenhouse gas emissions, such as carbon dioxide, nitrous oxide, and methane. The guide also provides practical advice for adapting to the effects of climate change that agricultural producers are already experiencing. Both guidebooks are available to download for free at ofrf.org.

Social Science

William Tracy, *Corn earworm management: A survey of organic sweet corn growers*

Corn earworm (Helicoverpa zea) is an important insect pest for organic sweet corn growers. Earworm larvae feed on silks and kernels, and the resulting damage can cause crop loss by making the ears unmarketable. Corn earworm is an especially challenging pest for organic sweet corn growers, as few effective management strategies are permissible under the National Organic Program (NOP) regulations. To better understand the challenges that corn earworm poses for organic sweet corn growers, and the potential for agronomic and/or plant breeding solutions, a survey and set of interviews were conducted. In Fall 2017, a survey was distributed to Certified Organic sweet corn growers throughout the United States (listed in the NOP database) to attain information about their corn earworm management strategies. The survey, designed in consultation with organic sweet corn growers and other stakeholders, contained questions pertaining to farm characteristics, general pest management, corn earworm management (including inputs and labor costs), and variety selection. The survey results clearly confirmed the importance of corn earworm as a pest of organic sweet corn; with 93% of respondents reporting corn earworm damage in a typical year, corn earworm was the most widely-reported sweet corn pest. Growers reported a mean of 20% of their ears being infested by earworm. Respondents grew sweet corn at a wide range of scales and across diverse markets, and earworm infestations affected growers to varying degrees. In particular, fresh market wholesale had significantly lower tolerance of corn earworm damage compared to community supported agriculture (CSA). 56% of growers managed earworm in some way, with a wide range of approaches including scouting, trapping, organically approved pesticide applications (both foliar spray and direct ear applications), and post-harvest sorting/handling. 12 interviews were also conducted with organic sweet corn growers between 2016 and 2018. These interviews highlighted similar needs, opportunities, and constraints in organic corn earworm management. Together, the interviews and surveys highlighted the significance of corn earworm as a pest in organic sweet corn production, the need for improved management and cultivar development, and the variation in consumer acceptance of earworm damage depending on market.

Amanda Marabesi, *A phenomenological inquiry into producers' experiences growing organic produce*

Introduction

Global population growth necessitates increasing total food production while simultaneously encouraging agricultural innovation to reduce the environmental impact of intensive agricultural practices (Velten et al., 2015). Organic agricultural practices are an alternative to conventional methods and holds the promise of reducing agrochemical inputs and improving the quality of soils and nutrient value of foods (Oluwasusi, 2014). Organic agricultural practitioners seek to integrate three main objectives into their work: a sustainable environment, economic profitability, and social and economic equity.

Major challenges facing organic producers are the lack of sufficient, appropriate, and relevant research, educational programs, and Extension support. Interventions to support organic producers have considered producers' motivations and categorized them into economic and social variables that influence decision-making at the farm level (Fairweather, 1999). The research reported here addresses motivations of producers' decision-making process for growing organically in North Georgia and proposes an Extension model to support producers in becoming more effective and efficient.

Purpose Statement

The purpose of the phenomenological inquiry was to describe the essence of producers' decision-making process when selecting organic practices and to report challenges and barriers encountered as organic producers. The findings cumulated in creating a model for an Extension program to support organic agricultural production. Organic farming was defined as a production system that sustains healthy soils, ecosystems, and relies on ecological processes, biodiversity and cycles adapted to local conditions (IFOAM, 2018).

Review of Literature

Industrialization of agriculture in the 1940s brought concerns such as exhausted soils, lack of organic amendments, and improper use of chemicals (Treadwell, McKinney & Creamer, 2003). Organic agricultural practices gained prominence with the publication of the Brundtland Report in 1987 (WCED, 1987) to address these concerns.

Critics of organic production claimed that the global demand for food could not be met by organic methods alone and discredited organic and other low-input agricultural approaches (Youngberg & DeMuth, 2013). However, Badgley *et al.* (2006, p. 94) reported comparative yields between organic and non-organic production methods, stating "organic methods of food production can contribute substantially to feeding the current and future human population on the current agricultural land base while maintaining soil fertility."

The 2016 USDA Certified Organic Survey reported sales of USDA Certified Organic production increased in 2016 to $7.6 billion, up 23% over 2015. The number of organic farms also increased 11%, up to 14,217, and the number of certified acres increased 15% to 5.0 million acres in 2016. However, USDA Certified Organic farms represent less than 1% of total agricultural land in Georgia (Georgia Organics, 2018).

Organic producers have the option to align their operations with an accredited certification body. To become USDA Certified Organic producers must follow USDA organic regulations. Certified Naturally Grown (2018) disallows the use of synthetic fertilizers, pesticides, herbicides, and Genetic Modified Organisms (GMO), similar to USDA Certified Organic; however, CNG relies on peer inspections versus inspections by state entities or certifying agents. The process of becoming CNG is less bureaucratic and expensive than USDA certification, making it an attractive option for smallholder producers. Many producers in North Georgia are CNG or do not hold any certification but still follow organic practices.

Previous research on producers' decision to practice organic agriculture centered on health, safety, and environmental quality over profitability (Burton, Rigby & Young, 1999; Cranfield, Henson & Holliday, 2010; Naspetti, Bteich, Pugliese & Salame, 2016). Burton *et al.* (1999, p.62) reported "any analysis of the motivations for adopting organic techniques which confines itself to farm-level financial measurement may be missing important factors". Producers reported lifestyle decisions, concerns about the environment, and sustainability of food systems as primary motives for growing organic. The transition to organic practices also depended on their position in society, skills, accessible resources, traits like curiosity, flexibility and creativity in exploring innovative marketing approaches, and willingness to take risks (Darnhofer, Schneeberger & Freyer, 2005; Morshedi, Lashgarara, Hosseini & Najafabadi, 2017).

Pietola & Lansik (2001, p. 13) addressed the economic factors influencing producers' decision to grow organically. They recommended assessing non-economic factors in future research. Economic factors that led to the adoption of organic practices included large land areas and opportunities to practice differing farming technologies, farms located in low-yield regions, low returns on standard farming, and income-neutral policy reforms.

Challenges and barriers that producers faced when adopting organic practices included management and production while converting to organic and after certification, marketing, financial aspects, and infrastructure (Cranfield *et al*. 2010). Middendorf (2007) summarized challenges perceived by organic producers as related to production, marketing, education and awareness, and practical models. These challenges were comingled with a lack of organic expertise regarding inputs, production, processing, marketing, weed control, time management, labor, and certification.

Negative pressure from other producers and farm groups were also reported as challenges (Cranfield *et al*. 2010), raising questions of social acceptance of non-conventional agricultural systems. Nevertheless, findings from Burton *et al.* (1999) suggested that within the organic

community producers opt for informal networks to support each other creating communities of practice that affirm their decision making process.

Conceptual Framework and Research Methods

Fairweather (1999) found that organic producers fell into two groups: pragmatic and committed. Pragmatics sought alternatives to conventional farming systems and perceived organic farming as a good prospect for securing income whereas committed producers based their decisions on a philosophical ideal related to environmental responsibility, human health, and lifestyle. Based on this conceptual framework, the research reported here was conducted using phenomenological research methods, which seeks to capture the "common meaning for several individuals of their lived experiences" of a phenomenon (Creswell & Poth 2018, p. 75). The phenomenon addressed was producers' decision to pursue organic practices.

Seven criterion-selected participants agreed to participate in the study by participating in a one- hour face-to-face interview at their farm. The following steps were taken to collect and analyze data:

- Identification and description of the phenomenon of interest.
- Data collection from participants who experienced the phenomenon using face-to-face in-depth interviews. Participants were asked two main questions: *What* was your decision process for pursuing organic practices and *How* have you experienced the adoption of organic practices.
- Interviews were transcribed verbatim and sent back to participants for verification (member checking). None of the participants changed their statements, indicating validity of initial data collection.
- From seven verbatim transcripts, 121 significant statements were identified to provide an understanding of how participants experienced the phenomenon.
- The 121 significant statements were clustered into 11 codes to draw conclusions regarding the essence of the phenomenon through a composite description (Creswell & Poth, 2018; van Manen, 2014).

University Institutional Review Board approved the study. To address credibility and validity, participants were engaged in the research process and their quotations were included in the findings to establish truth-value. Participants were assigned pseudonyms to protect their privacy.

Findings

Producers developed an interest in organic agriculture for ideological reasons, preferred lifestyle, commitment to environmental responsibility, land-ownership history, financial viability, and ability to market produce more effectively. Our findings focus on *What* and *How* producers experienced growing organically, including challenges and opportunities faced as an organic producer.

Initially, producers chose organic agricultural practices based on their unique situations and positions within the market. Participants who viewed organic practices as a philosophy of life and a social movement valued their beliefs above a profit motive. We classified them as *committed organic producers* (Ana, Carol, Eli, Neil, and Sam) versus participants who viewed organic agricultural practices as a way to add value to their business, classified as *pragmatic organic producers* (Ben and Max).

Land access was the first criteria for growing organic. Ana, Ben, Carol and Max inherited land that was owned within the family for several generations. Inorganic inputs were never used on these farms; therefore, converting to organic production was a simple process. Eli, Neil, and Sam bought their land. Ana and Sam received a grant from the Natural Resources Conservation Service (NRCS). While it was not difficult to obtain the grant, Ana complained about the delay in the administrative process for additional grants. Eli said, “it is hard to do this without initial capital. To get some specific loans you are required to have at least two years of managing or owning a farm, so you have to function bleeding money and losing time for two years to get any assistance” (142:145). Carol and Neil never applied for a grant.

After securing financing to support production, the next challenge was learning how to grow organically. Eli said, “the biggest challenge is how to fight diseases, pests, and weeds, when you are just starting on new land and there is no system in place” (137:138). The “learning curve” (Max 128, Neil 81) was steep and gaining a strong “knowledge base” (Sam 132) were cited as difficulties for growing organic. None of the participants were served by Extension agents. They all expressed an interest in being served in the future. Eli stated, “there are not enough resources for organic farmers in regard to state universities and Extension agencies. A lot of training is geared towards conventional and big agriculture” (116:118).

Although committed organic producers valued their beliefs above a profit motive, all participants reported having financial concerns. Sam stated that growing conventional agriculture in a small- scale farm would not be feasible; however, growing organic produce returned ten times more profit per acre than conventionally grown produce. Neil reinforced that organic production on a small scale was only profitable when selling retail. Organic production aligns with committed producers’ values. They were aware that they could make more profit following conventional methods. As Darnhofer *et al*. (2005) pointed out, producers’ willingness to risk some income to grow organic produce does not imply that they expect a long-term lower net income. However, committed organic producers reported that if their organic business failed they would not use conventional methods regardless. Their strong commitment to a philosophy of life was a critical element regarding the development of marketing strategies for selling produce. Carol reported being surprised by the price difference between organic and conventional produce. She stated, “I did not look into the finance of marketing. When I got into the CNG I just knew that I wanted a better way to eat for myself and others. I wanted to share the love” (156:157). Because committed organic producers perceived profit as a secondary motivation, their marketing skills were lacking.

Six participants were CNG. Becoming a CNG member was easy and simple for participants. None of the participants held USDA organic certification due to cost and bureaucratic barriers. In north Georgia producers are required to be certified, either CNG or USDA organic, to sell at the farmers market. When asked about his decision to become CNG Ben said that the only reason was to sell the produce at the farmers market. In addition, he said that he wanted to participate in the farmers market as a way to meet consumers and other producers and to market his company. Neil reported using the farmers market as way to receive feedback from customers. Carol was raised on an organic farm. She consumed organic products. About gaining CNG she said, “I thought that it would be a really great way to continue my way of life and get some legitimacy to it” (32:33). Being a member of the farmers market offered producers the opportunity to create networks with other producers and consumers. Producers experienced support from other members of the organic community, creating positive reinforcement for growing organic. Neil followed organic practices but he was not certified because he grew hydroponic produce. Some hydroponic production practices do not align with certification standards. Committed organic producers reported following organic practices were more important than becoming certified.

A strong factor for committed producers when choosing to follow organic practices was their lifestyle, personal philosophy of environmental stewardship, and a desire to leave a legacy. Sam said, “it has always been my philosophy of life and I would not say that conventional agriculture would ever have fit into that lifestyle” (113:115). Participants reported being committed to improving natural resources by carefully using inputs, minimizing damage to the environment, and ensuring resources would be available for future generations. The need to be a better environmental steward contributed to their decision to adopt organic practices, as they wanted to produce food sustainably.

Pragmatic producers perceived organic production as an option for marketing produce to increase sales. When asked about his decision process for pursuing organic practices, Max said "at first it basically came down to a decision, we are on the fence. We could go organic or in this case CNG right away. Alternatively, we could go with conventional farming. My thought was I can do organic and learn a lot and I can always do the other side if things fail" (78:83). For Ben, health and sustainability aspects were not motivators for growing organically. He grew organically because his products did not require the use of chemicals or GMOs but he would use them if it was profitable. Ben said, "as long as it is natural, I do not see a need in going totally organic. I do not really have a problem with GMOs either. If we could use nature to our benefit, why not?" (108:111).

The essence of growing organic produce for committed producers was a commitment to environmental stewardship and a way of life. For pragmatic producers it was a commercial activity. Pragmatic producers aligned their conceptions of agricultural production with their business needs to generate income.

Discussion, Conclusion and Recommendations

A number of studies have shown a need for research and Extension efforts to extent to the organic agriculture sector (Agunga & Igodan, 2007; Lillard *et al.* 2013; Middendorf, 2007). Agunga & Igodan (2007) reported that organic agriculturalists have a strong interest in Extension and are willing to pay for Extension services; however, they think Extension agents do not know enough about organic agricultural practices and do not understand their needs to be helpful.

Lillard *et al.* (2013) recommended four ways to overcome challenges to providing information specific to organic producers. Extension agents are advised to initiate collaboration from a producers' point of interest by assessing their needs and preferences and build understanding, rapport, and trust within the organic community; be aware of farm characteristics across the region that affect producers' information needs; and deliver information in a format that aggregates value to the message. Developing specific Extension programs is necessary in order to serve organic producers and stimulate growth in this sector.

Our findings suggest that organic producers from north Georgia would benefit from more Extension programs targeted towards organic agriculture. Extension experts act as change agents (Rogers, 2003) or individuals who play a role in clients' adoption decisions. Change agents are often professionals with university degrees in technical fields and promote effective communication about new technology.

We classified organic producers into two categories: committed and pragmatic. Extension agents are advised to increase their interest and personal commitment to organic agriculture and increase their knowledge base for organic compliance and assessment mechanisms to help both committed and pragmatic producers comply with USDA and CNG policy and regulations. Pragmatic producers need more training in community engagement. Committed producers need more training in marketing strategies and new technologies adapted to the local markets (See Figure 1).

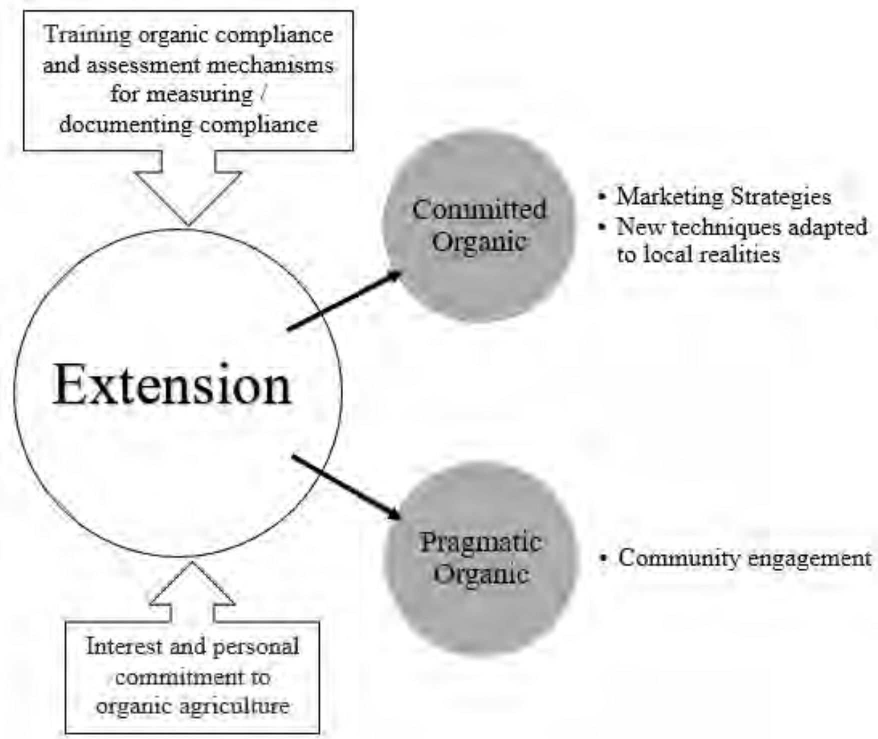

Figure 1: Model for Working with Organic Producers

Committed organic producers were motivated to grow organically by their philosophical ideals. They were willing to adapt their production to overcome a number of barriers; therefore, they need help from Extension to learn about agricultural techniques adapted to their conditions. Marketing was a challenge for committed organic producers. They would benefit from learning marketing strategies to address economic vulnerability and financial oscillations. For instance, selling at the farmers market, participating in Community Supported Agriculture, and advertising online.

Pragmatic organic producers perceived organic farming as important for securing income. They appreciated the skills required for organic agricultural production and visualized organic agriculture as something new and challenging. According to Rogers (2003), the structure of a social system could hinder the diffusion of an innovation. Pragmatic producers seek innovativeness to achieve compensatory payments by creating a strategy based on multiple uses of resources, low expenses, and few external inputs. Generally, they were informed about marketing strategies and techniques to ensure profits. Therefore, Extension would better serve them by facilitating their inclusion in the organic community so that they could engage with other producers and share their knowledge.

References

Agunga, R., & Igodan, C. (2007). Organic farmers' need for and attitude towards Extension. *Journal of Extension*, *45*(6), Article 6FEA6. Available at: https://www.joe.org/joe/2007december/a6.php

Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Chappell, M. J., Avilés-Vázquez, K., Samulon, A. & Perfecto, I. (2006). Organic agriculture and the global food supply. *Renewable Agriculture and Food Systems*, *22*(2), 86–108. doi:10.1017/S1742170507001640

Burton, M., D. Rigby, & T. Young. (1999). Analysis of the determinants of adoption of organic horticultural techniques in the UK. *Journal of Agricultural Economics*, *50*(1), 47– 63.

Certified Naturally Grown. (2018). *Produce Certification*. Available at: http://www.cngfarming.org/produce

Cranfield, J., Henson S., & Holliday J. (2010). The motives, benefits, and problems of conversion to organic production. *Agriculture and Human Values*, *27*, 291–306. doi: 10.1007/s10460-009-9222-9.

Creswell, J. & Poth, C. (2018). *Qualitative Inquiry & Research Design: Choosing among five approaches* (4th ed). Thousand Oaks, CA: Sage Publications, Inc.

Darnhofer, I., Schneeberger, W., & Freyer, B. (2005). Converting or not converting to organic farming in Austria: Farmer types and their rationale. *Agriculture and Human Values*, *22*, 39–52. doi: I 10.1007/s10460-004-7229-9

Fairweather, J. R. (1999). Understanding how farmers choose between organic and conventional production: Results from New Zealand and policy implications. *Agriculture and Human Values*, *16*, 51-63.

Georgia Organics. (2018). *Farmer Services.* Available at: https://georgiaorganics.org/about- us/programs/.

IFOAM. (2018). *Definition of organic agriculture*. Available at: https://www.ifoam.bio/en/organic-landmarks/definition-organic-agriculture

Lillard, P., Parker, J., & Sundermeier, A. (2013). Recommendations for establishing Extension programming for organic farmers. *Journal of Extension*, *51*(6), Article 6TOT1. Available at: https://www.joe.org/joe/2013december/tt1.php

Middendorf, G. (2007). Challenges and information needs of organic growers and retailers. *Journal of Extension*, *45*(4), Article 4FEA7. Available at: https://www.joe.org/joe/2007august/a7.php

Morshedi, L., Lashgarara, F., Hosseini, S.J.F. & Najafabadi, M.O. (2017). The role of organic farming for improving food security from the perspective of Fars farmers. *Sustainability*, *9*, 2086. doi:10.3390/su9112086.

Naspetti, S., Bteich, M.R., Pugliese, P. & Salame, N. (2016). Motivation and values of farmers in Lebanon: A comparison between organic and conventional agricultural producers. *New Medit*, (2).

Oluwasusi, J.O. (2014). Vegetable farmers' attitude toward organic agriculture practices in selected states of South West Nigeria. *Journal of Agricultural Extension and Rural Development*, *6*(7), 223-230. doi: 10.5897/JAERD2013.0572

Pietola, K. & A. Lansink. (2001). Farmer response to policies promoting organic farming technologies in Finland. *European Review of Agricultural Economics*, *28*(1), 1–15.

Rogers, E. M. (2003). *Diffusion of innovations*. New York, NY: Free Press.

Treadwell, D., McKinney D., & Creamer, N. (2003). From philosophy to science: A brief history of organic horticulture in the United States. *HortScience*, *38*(5), 1009–1016.
USDA National Agricultural Statistics Service. (2017). *Certified Organic Survey 2016 Summary*.

van Manen, M. (2014). *Phenomenology of practice: Meaning-giving methods in phenomenological research and writing*. Walnut Creek, CA: Left Coast Press, Inc.

Velten, S., Leventon, J., Jager, N., & Newig, J. (2015). What is sustainable agriculture? A systematic review. *Sustainability*, *7*, 7833-7865. doi:10.3390/su7067833

WCED. (1987). Our common future. *Report of the World Commission on Environment and Development*. G. H. Brundtland, (Ed.). Oxford: Oxford University Press.

Youngberg, G. & DeMuth, S.P. (2013). Organic agriculture in the United States. *Renewable Agriculture and Food Systems*, *28*(4), 294–328. doi:10.1017/S1742170513000173

Jeff Schahczenski, *Is organic farming risky? The mysterious case of loss ratios*

Introduction

Is organic farming more risky than non-organic farming? Diversified organic agriculture systems of production can be resilient, protect natural resources, and have been a significant force in the expansion of local and regional food systems. At the farm level, though variable across crops and time, organic price premiums and possibly profitability may be significantly higher for organic producers when compared to their non-organic counterparts. Nonetheless despite these documented real and potential benefits, why do so few farmers choose to adopt an organic system of production?

One important area of research that can help provide answers to these questions relate to the issues of the relative financial and production risks of organic production. Our working hypothesis is that commercial-scale , diversified organic farms are no more risky than similarly situated non-organic farming enterprises.

In particular, the focus of this research is the rather arcane topic of crop insurance loss ratios. A loss ratio is simply the indemnity (pay-out) divided by the premium (pay-in). These ratios can be used generally to assess the "efficiency" of a particular type of crop insurance policy being offered. A value of one represents a policy that breaks even and higher values represent less efficient policies. Loss ratios can thus be used as a kind of "proxy" for evaluating comparisons of insurable risks. A crop insurance policy cannot be financially solvent if indemnities continue to out-run premiums, or if loss ratios are more than one year after year.

In this paper we examine the loss ratios related to a new nationwide crop insurance policy called Whole Farm Revenue Protection (WFRP). The major distinction of WFRP is that it protects whole farm revenue and not just yield. This is important because the volatility in prices and yields are significant issues when assessing financial and yield risk. We present an analysis of how WFRP loss ratios vary between organic and non-organic farmers.

Methods Used

This research is based on results of a nationwide survey of organic and non-organic farmers conducted as part of a USDA-NIFA Organic Agriculture Research and Extension Initiative (OREI) funded project. Relevant parts of this survey serve as some preliminary information about organic farmer use and knowledge of WFRP. Additional comparative analysis of loss ratios based on data analysis from the USDA Risk Management Agency is also used in this research.

Results and Conclusions

The preliminary results of our research shows that in two out of the last three years (2015-2017) organic farmers using WFRP had smaller loss ratios than non-organic farmers. This is suggestive that organic farmers are less risky than non-organic farmers considering both yield and price risks. This tentative result will require further research efforts but may imply that organic farmers should possibly be eligible for insurance premium discounts because of the less risky system of production they use.

Poster Presentations

Lexie Baker, *Finding new flavor in culinary corn: Methods for breeding savory vegetable corn*

Sweet corn is a ubiquitous summer vegetable throughout the United States. Over the past few decades consumer preference for sweet and juicy cobs have driven breeding priorities. This has led to a gap in the market for more savory vegetable corn varieties. In the Sweet Corn Breeding and Genetics Program led by Dr. Bill Tracy at UW-Madison, we are working with a number of heirloom varieties from the northern United States as well as Chilean choclos and Mexican pozoleros to breed more savory varieties of vegetable corn or culinary corn. We hope to improve these varieties for both eating quality and field performance in organic systems in order to bring a larger range of flavor, appearance and kernel quality to vegetable corn.

We are using sensory techniques, such as tastings with local Madison-area chefs with the Seed to Kitchen Collaborative, to create flavor profiles of savory heirloom corns. In addition, we are performing carbohydrate and tenderness analysis in the lab to identify favored kernel components to inform the breeding program. Carbohydrates are analyzed using sugar and starch assays which indicates the relative amount of each compound available in the kernel at eating stage. Tenderness is gauged by measuring the thickness of the outside layer of the kernel called the pericarp. The thicker the pericarp, the more challenging it is for the eater to take a bite. Both of these lab analyses allow for a further exploration of the sensory analysis by linking the favorability of corn in a sensory analysis to a qualitative measurement. These data can help inform and streamline future breeding and selection within a savory corn program.

Along with the sensory and lab analysis, collaboration between stake-holders is important in developing a savory corn breeding program. As part of this participatory breeding project we have included many outside participants including chefs and farmers. Chefs are instrumental in introducing novel flavors and textures of vegetables into dishes that can be shared with the public. With input from chefs we have identified a few heirlooms that have been crossed to create populations with both satisfying flavors and appearance. Farmers and chefs together grew and cooked choclo, a savory corn in the upper Midwest. With this participation surveys have shown that there is a market for savory varieties of vegetable corn. We are continuing to work with chefs and farmers each growing season to advance culinary corn and expand the market for it. This project contributes to the regional cuisine of Wisconsin, using insight from the farmers and tastemakers in the community, to develop vegetable varieties with benefits for both the local environment and economy.

Tessa Barker, *On-farm production of containerized, organic strawberry transplants: Effects of container size and bare root cold storage on leaf development, plant growth, yield, and cost of production*

The Oregon strawberry industry has traditionally focused on growing June-bearing cultivars sold primarily for processing. However, as this market declines over time, strawberries grown for fresh market have increased in acreage and proportion of sales. Fresh market fruit may be more profitable for farmers, with increased price premiums and longer harvest seasons. When organic production is considered, price premiums increase even more. A recent study of consumer trends found that the supply of fresh, organic strawberries produced in Oregon is not meeting the current demand for a locally grown crop. As market trends and choice of cultivars shift in Oregon, there is a growing need for region-specific, research-based organic production guidelines for fresh market strawberries, particularly day-neutral cultivars. Day-neutrals are ideal for fresh market as their fruit production is not limited by day-length, which allows an extended harvest season. Studies show that containerized strawberry transplants have better field establishment with higher plant survival and earlier yields than fields planted with bare-roots. However, guidelines are needed on best practices for producing organically approved transplants on-site. The objective of this study is to determine the optimal size of transplant container for sufficient plant development, growth, and yield, as well as production costs, in an organic strawberry production system. 'Albion' and 'Seascape' bare-roots were planted in two container sizes (234 cm^3 and 614 cm^3) using organically approved planting media (peat-moss, plus forest product and perlite with fertilizer). Trays were potted up in March at the North Willamette Research and Extension Center (Aurora, OR). In addition to comparing cell sizes, a second component of the experiment explored the impact of bare-root cold storage duration on transplant survival, growth, and yield, due to a need for research-based information for optimal season extension. While most farmers use cold-stored bare-roots for strawberry field establishment, this may be the first study to examine organic containerized plant production for season extension. Data was collected every week on leaf area and mortality. Total leaf area was significantly greater for plants grown in larger size cells, with large cell transplants showing an average leaf area of 7856 mm^2, and small cell transplants an area of 6811 mm^2. The effect of cold-storage duration was significant but varied based on cultivar. Plants stored for longer periods of time did not necessarily perform less well than those stored for shorter periods of time. The cost of transplant production supplies and labor costs for each container size were compared. Total transplant production cost for a one-acre field using smaller size cell transplants is 55% of that for larger size cell transplants. Transplants from the two container sizes and different lengths of cold storage are currently being grown in a certified organic field to collect continued growth, biomass, and yield data.

Brook Brouwer, *Managing wireworms (Agriotes spp.) in Western Washington organic vegetable crop production*

Wireworms, the larval stage of click beetles (Coleoptera: Elateridae), can cause substantial damage to a wide range of agronomic and vegetable crops. Two introduced species of wireworm, *Agriotes lineatus* and *A. obscurus* have spread in Washington State, resulting in serious economic damage to high value vegetable crops. Wireworms thrive on pasture and grain rotations, which are commonly used by organic growers to maintain and build soil organic matter. Growers in western Washington have indicated that wireworms are a primary pest challenge; yet options for control of this pest are very limited. Using a preferred host as a trap crop planted near the cash crop is potentially a low cost, environmentally friendly option for wireworm management. In this project, research personnel and cooperating farmers are using lettuce production beds to compare effects on wireworms of (1) trap cropping with wheat; (2) a spinosad insecticidal bait product; (3) combination of treatments and (4) a no-management control. On-farm trials were conducted at five western Washington locations in Thurston, Skagit, and San Juan counties during the 2018 growing season. This study will be continued for two more growing seasons. At each site, lettuce survival and wireworm density were measured weekly in each plot. Soil temperature, a parameter which can influence wireworm activity, was recorded throughout the trial. Lettuce biomass was recorded at the end of the trial. Preliminary results indicate that trap cropping may reduce loss of lettuce transplants to wireworm feeding.

Micaela Colley, *Carrot improvement for organic agriculture*

Organic growers need vegetable varieties that are adapted to organic growing conditions and have market qualities desired by organic consumers. In carrots, weed competition, nutrient acquisition, parasitic nematodes, and disease pressure are particularly critical challenges to fresh market carrots. Carrot Improvement for Organic Agriculture 2 (CIOA 2) builds upon accomplishments of the CIOA 1 project funded by the USDA OREI. Plant breeding is a long-term effort and the proposed project will maximize impacts of prior research by delivering new, improved carrot cultivars and breeding lines to the organic seed trade; and developing new breeding populations that combine valuable traits identified during CIOA 1.The long-term goals of CIOA 2 are to: 1. Deliver carrot cultivars with improved disease and parasitic nematode resistance, improved nutrient acquisition, seedling vigor and weed competitive traits, increased marketable yield, superior nutritional value, flavor and other culinary qualities, and storage quality for organic production; 2. Determine how carrot genotypes interact with, or influence, the root microbiome to access key nutrients under limiting environments and limit heavy metal uptake; 3. Inform growers about cultivar performance to maximize organic carrot production, markets, and organic seed usage; 4. Inform consumers about the positive environmental impacts of organic production systems and about carrot nutritional quality, flavor and culinary attributes; and 5. Train undergraduate and graduate students, and post-doctorates in issues that are critical to organic agriculture. Project partners include University of Wisconsin-Madison, USDA Agricultural Research Service, Organic Seed Alliance, Washington State University, Purdue University, University of California Cooperative Extension, and University of California-Riverside.

Claire Hodge, *Yield of leafy greens and microclimate in deep winter greenhouse production in Minnesota*

The Deep Winter Greenhouse (DWG) uses passive solar technology to create an environment where cold tolerant DWG crops like leafy greens can be grown during the coldest winter months to satisfy consumer demand for fresh local produce year--round and increase revenue for small- and medium- scale farmers. Research is currently underway to understand the degrees to which DWG crops thrive in three winter sub--seasons (when sunlight is diminishing, stable sunlight, and ascending sunlight) in these dynamic environments. A cultivar trial was conducted in partnership with farmers in distinct locations within Minnesota in order to determine suitable cultivars and evaluate microclimate conditions in these unique systems. Yield and days to maturity (DTM) were collected for salad green harvests, and light, temperature, and relative humidity were tracked throughout the season. The newly designed DWG v2.0s appear to be consistently warmer than the drafty DWG v1.0. Correspondingly, yields among the cultivars also varied given their micro-climate within these systems, whereas all crops had higher yields and matured faster in the DWG v2.0s. Trials suggest that lettuces, mustards, and Asian greens such as “Florence”, Tokyo Bekana and “Vitamin Green” generally grow well, though there is some seasonal preference related to light quality and temperature in the greenhouses. These variety trials, coupled with other horticultural trials and economic analyses, could assist growers in their cultivar decisions and DWG microclimate management strategies to produce fresh salad mixes for the local market during the winter season and provide a general model for growers in northern cold climates.

Patrick Holden & Adele Jones, *Harmonising on-farm sustainability assessment*

There is growing evidence that agriculture is one of the most significant contributors to the transgression of ‘planetary boundaries,’ particularly in the areas of greenhouse gas emissions, biodiversity, soil, water, and nitrogen use. However, a wide scale transition of our mainstream farming systems towards more sustainable alternatives is prevented by several significant barriers to change.

One of these barriers is the lack of a unified means of measuring food system sustainability. At present, there is a diverse range of overlapping assessment tools and certification/labelling schemes for monitoring and communicating on-farm sustainability. This makes it impossible for consumers, farmers, food businesses, and policymakers to gain an accurate understanding of the comparative sustainability of products resulting from different methods of production, as well as having a polarising effect on farming communities due to the, “you’re either certified or you’re not,” approach.

This poster will highlight progress to-date on a farmer-led initiative led by the Sustainable Food Trust which is encouraging convergence of metrics and indicators for measuring sustainability – a project which has been taken up by the UK government to help deliver future farm support. It will address two fundamental questions - how can farmers better utilize data to drive more positive decision making and how can we use this data to encourage better buying habits in the marketplace?

Matthew Kleinhenz, *Microbe-containing crop biostimulants in organic vegetable production: Lessons and messages from farmers, researchers, and manufacturers/suppliers*

Commercial microbe-containing crop biostimulants are advertised to maintain or enhance crop growth, perhaps especially under sub-optimal conditions (e.g., drought, nutrient deficiency, high temperature). Approximately two-hundred such products ranging in composition (e.g., bacterial, fungal, both; cfu/ml) are currently available, complicating product selection. Moreover, regulation of the product category is inconsistent, with unwanted downstream effects on product content, labeling, documentation of efficacy, etc. Regardless, to be effective, users must establish and maintain conditions supporting plant-microbe interactions from which they look to profit. These conditions are largely unknown, thereby: a) helping to explain the erratic and context-specific outcomes from inoculation in field and high tunnel settings reported to date, b) impeding key research, and c) slowing the transmission of related research-based recommendations for product use, all of which raise serious questions about the product category. In response, a program consisting of ongoing sets of integrated and complementary on-station and on-farm experiments (many involving a citizen-science/farmer-led approach) testing hypotheses specific to the effect of product composition, crop, application timing, application rate, and/or experimental setting on crop yield and quality was developed. Since 2015, program experiments have been completed in seven states (IA, IL, MI, MO, OH, PA, TN), on fifteen farms and two research stations, on seven crops (broccoli, carrot, lettuce, pepper, spinach, squash, tomato) grown in field or high tunnel settings, and with ten OMRI-listed products (Azos Blue, Biogenesis 1 TM NP, BioYield, EcoFungi, Environoc 401, Hydroguard, MycoApply All Purpose Granular, MycoApply Endomax Concentrated WP, Mycogenesis, NP Bioplin). Individual on-station experiments begin spring, summer, or fall with treatment factorials including multiple levels of product (e.g., four-six) and multiple levels of either rate or timing (e.g., seeding, transplanting, after transplanting), with plots arranged in a randomized complete design and applications made as a root-zone drench. On-farm experiments, however, while also collectively completed over much of each calendar year, involve fewer experimental variables and levels of each. To date, outcomes from standard statistical approaches common in product evaluations, variety trials, and cultural management comparisons show that significant increases in yield or quality have been rare, regardless of inoculation parameters or experimental conditions. When found, yield increases were most common following the application of mixed inocula (single products containing multiple species or strains of bacteria, fungi, or both) and typically below eight percent. Analysis of crop data using approaches (e.g., transformation) common in other areas of study in which skewed data are common (e.g., pathology, entomology, weed science) and economic analyses exploring the return on investment from microbe-containing crop biostimulant use are also underway.

Matthew Kleinhenz, *Soil balancing in organic crop production: Concepts, practices, and big questions*

Many ways to organize the complex task of building and maintaining soil health are available. “Soil Balancing” (SB) is one approach that has gained much attention. Opinions on SB among growers and private- and public-sector grower advisors and researchers range wide and, so far, rarely achieve consensus. Proponents, including increasing numbers of agronomic and horticultural crop farmers and milk producers and some advisors, emphasize that (SB) is a holistic approach with many facets, the ratio of calcium, magnesium, and potassium in the soil being one. They report that soil chemistry -- specifically, percentages and ratios of calcium, magnesium, and potassium – can be altered through applications of lime, gypsum, and other materials to improve soil physics (tilth) and biology and, thereby, crop yield and quality and weed control, also. Investigators and other advisors, however, report that soil balancing claims are unsupported by the data (at minimum) and potentially injurious to farms (at worst). That disconnect is both a problematic trend and important opportunity. Developed carefully, systematically, and in partnership with stakeholders, a shared understanding of SB that reflects the combined experience of growers, their advisors, and scientists will benefit many. At minimum, this shared understanding will help SB enthusiasts employ its principles successfully. We have been working to that end since 2015 – relying on dozens of coordinated and comprehensive studies completed on farms and at research stations, extensive discussion with SB practitioners, input from a fully engaged Stakeholder Advisory Committee, and assistance from grower organizations and cooperatives throughout. These resources set this effort apart from previous related ones often focused on single effects (e.g., yield) recorded in short-term studies completed with little stakeholder input. What has been learned to date from farmer interviews and experiments regarding SB effects on soils, crops, weeds, and farms is stretching the perspectives of both farmers and researchers and prompting a new set of questions best addressed by their continued collaboration.

Meredith Melendez, *Organic production and compliance with the Food Safety Modernization Act Produce Safety Rule*

The fresh produce industry is under increased pressure to improve their food safety practices, including organic producers. Historically food safety has been market access driven through buyer required third party audits. The Food Safety Modernization Act Produce Safety Rule (FSMA PSR), which went into effect for the largest of farms on January 26, 2018, makes food safety regulatory for fresh produce growers. This rule is the result of large scale human pathogen outbreaks associated with produce typically consumed raw. While these outbreaks are commonly associated with large scale wholesale production, farms of all sizes and distribution types are affected by the FSMA PSR. Organic produce growers use production practices that are impacted by the regulation and should understand how the regulation affects their farm. Growers of produce typically consumed raw who sell more than $25,000 worth of produce need to comply with some or all of provisions of this federal regulation depending on their sales method. Those selling primarily through wholesale channels will need to comply with the entire rule. Those selling primarily through direct market channels will be exempt provided they sell less than $500,000 of food, both human and animal, on average each year. Some New Jersey organic farms producing fresh produce will be exempt from the FSMA PSR regulation, others needed to be in compliance as of January 2018, and for others it will only be a matter of time before their sales exceed the exemption threshold.

Extension educators, and other organic outreach organizations, have been the primary educational provider for FSMA PSR preparedness through offering the FSMA PSR grower training course and On-Farm Readiness Reviews. The Rutgers On-Farm Food Safety team has been working with organic producers since 2012 on fresh produce safety and conducts farm walk throughs to better understand how the regulation will impact organic production in New Jersey. The team provides full day certificate based educational workshops, farm visits, and On-Farm Readiness Reviews regardless of operation size or production designation. Collaboration with existing organic support organizations in the state has been important in building trust with the community, as has word of mouth from grower to grower. Since July 2015 over thirty produce food safety farm visits have been made to “non-traditional or beginning farmer” operations who are typically certified organic or using organic practices. Additionally, three On-Farm Readiness Reviews to assess preparedness for compliance with the FSMA PSR have been conducted on organic farms in New Jersey, with several more scheduled. The most common areas of improvement needed on organic farms visited are improved hand washing facilities, consideration of livestock animal manures impacting produce safety, development of health and hygiene standards and training, and the handling, cleaning and sanitizing of product contact surfaces.