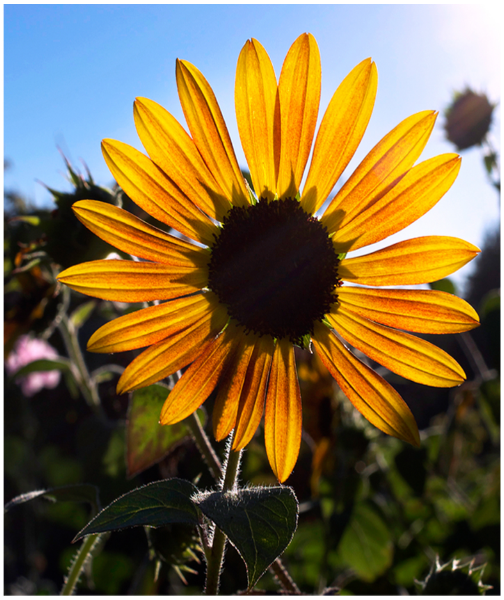

ORGANIC AGRICULTURE RESEARCH SYMPOSIUM

JANUARY 20, 2016

Presented by:

ORGANIC FARMING RESEARCH FOUNDATION

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Pacific Grove, California

Organic Agriculture Research Symposium

Presented by the Organic Farming Research Foundation (OFRF) & The Kearney Agricultural Research and Extension (KARE) Center

Program: Wednesday, January 20th

8:00 – 8:30 Registration (Surf and Sand)

8:30 – 9:00 Introductions (Heather)

Diana Jerkins, Organic Farming Research Foundation (OFRF) Research Program Director

Jeff Dahlberg, UC-ANR Kearney Agricultural Research and Extension (KARE) Center Director

Brian Baker, Belcairn Concerns, Principal

9:00 – 10:00 Opening Keynote and Thematic Presentations (Heather)

André Leu, Organics International / IFOAM President

The vital role of research to advance organic agriculture worldwide

Mathieu Ngouajio, USDA/NIFA National Program Leader in Cropping Systems

USDA- NIFA support for organic agriculture research, education and extension

10:00 – 10:30 Break / Poster Viewing

10:30 – Noon Concurrent Session 1

1.1 Soil Health (Heather)

Moderator: Heather Darby, University of Vermont

Anthony Yannarell, University of Illinois

Management affects the weed suppression potential of soil microorganisms and green manures

James Stapleton, UC-ANR-KARE

Advances in biosolarization technology to improve soil health and organic control of soilborne pests

Doug O'Brien, Doug O'Brien Agricultural Consulting

Trends in soilborne disease on two long-term organic vegetable farms in the West

1.2 Seeds and Plant Breeding (Acacia)

Moderator: Jeff Dahlberg, UC-ANR-KARE

Adrienne Shelton, University of Wisconsin

Current state of public plant breeding in the United States

Charles Brummer, University of California, Davis

A public plant breeding program to develop organic cultivars and train new plant breeders

Jared Zystro, Organic Seed Alliance

The state of organic seed

1.3 Biological Control (Toyon)

Moderator: Ruth Dahlquist-Willard, UC Cooperative Extension Fresno County

Adrian Lu, University of California Berkeley

Pest and natural enemy abundance and biological pest control ecosystem services in organic strawberry fields across gradients of local and landscape diversity

Brian Baker, Belcairn Concerns

Organic and Integrated Pest Management: opportunities for collaboration

Raul Villanueva, Texas A&M

Field and laboratory studies of plant bugs on tomato and Brassicas using organic insecticides

Noon – 1:00 Lunch (Crocker Dining Hall)

1:00 – 2:30 **Concurrent Session 2**

2.1 Long-term and Strategic Research (Heather)

Moderator: Mark Lipson, UC Santa Cruz

Amélie Gaudin, UC Davis
Long-term research in organic system at Russell Ranch: Results and opportunities to build sustainable and resilient systems

Randy Jackson, University of Wisconsin
The Wisconsin integrated cropping systems trial: 26 years of research in agricultural sustainability

Diana Jerkins, Organic Farming Research Foundation
Assessment of future organic research needs

2.2 Biodiversity (Acacia)

Moderator: Jessica Shade, The Organic Center

John Quinn, Furman University
The Healthy Farm Index Biodiversity Calculator

Joshua Arnold, UC Berkeley
An agroecological survey of urban agriculture in the East Bay Area of California

Sarah Leon Guerrero, UC Berkeley
Farming for Native Bees

2.3 Economics of Organic Agriculture (Toyon)

Moderator: Brian Baker, Belcairn Concerns

William McBride, USDA ERS
Certified organic field crop profitability

Timothy Delbridge Cal-Poly, San Luis Obispo
Farm performance during the transition to organic production

Kathleen Delate, Iowa State University
Encouraging the transition to organic grain production: linking research and extension to address knowledge gaps and practical solutions

2:30 – 2:45 **Break / Poster viewing**

2:45 – 4:15 **Concurrent Session 3**

3.1 Innovative Educational Systems (Heather)

Moderator: Mark Van Horn, UC Davis

Damian Parr, UC Santa Cruz

Integrating undergraduate interns in organic farming research and beginner farmer programming at the University of California, Santa Cruz

John Hendrickson, University of Wisconsin – Madison

Coordinating a three-ring circus with lions and cubs: Beginning grower training programs at the University of Wisconsin

Raul Villanueva, Texas A&M

Linking organic farmers and students on organic production through small projects in south texas

3.2 Organic Livestock Systems (Acacia)

Moderator: Sarah Greene Lopez, Fiesta Farm, Watsonville, CA

Kelsey Juntwait, University of New Hampshire

Feeding annual forage crops to organic dairy cows during spring and summer seasons in Northeast United States

Heather Darby, University of Vermont

Improving soil and forage quality to maximize organic dairy systems

Cynthia Dailey, CSU-Chico

Holistic animal health and nutrition, grazing and pasture management systems

3.3 Farming Systems Research (Toyon)

Moderator: Kathleen Delate, Iowa State University

Amber Sciligo, UC Berkeley

Assessing benefits, costs and trade-offs of biologically-diversified farming systems in California's Central Coast growing region

Carol Shennan, UC Santa Cruz

CAL-collaborative organic research and extension network: On-farm research to improve strawberry/vegetable rotation systems in coastal California

Eric Brennan, USDA-ARS

Can organic or conventional vegetables be produced sustainably without cover crops?

4:15 – 5:00 Audience / Participant Feedback

5:00 – 7:00 Reception: Making Connections (Heather)

Welcome and short remarks by Congressman Sam Farr

Posters

1. Robina Bhatti, CSU Monterey Bay, *Mapping organic Monterey*
2. Sandy Brown, *Organic strawberry transitions in a changing regulatory climate for soil fumigants*
3. Naomi Dailey, UC Davis, *Improving our knowledge of pastured poultry systems*
4. Julie Dawson, University of Wisconsin – Madison, *Participatory evaluation of vegetable quality and implications for breeding for organic systems*
5. Gwendolyn Ellen, Oregon State University, *Banking on beetles for biological pest management*
6. Caren Ghedini, University of New Hampshire, *Replacing corn meal with incremental amounts of liquid molasses reduced intake and milk yield linearly in organic Jersey cows*
7. David Gonthier, UC Berkeley, *Diversifying farmlands supports bird conservation and reduces bird pest damage*
8. John Hendrickson, University of Wisconsin – Madison*, Principles for transitioning to organic farming: e-Learning materials and decision case studies for educators*
9. Joanna Ory, Organic Farming Research Foundation, *Reducing water pollution from herbicides through sustainable agriculture*
10. Laura Patterson, UC Davis, *Evaluating the persistence of* Escherichia coli *in the soil of an organic mixed crop-livestock farm that integrates sheep grazing within vegetable fields*
11. Caitlin Peterson, UC Davis, *Irrigation strategies to optimize soil functions and resource use efficiency in organic tomato and corn*
12. Jessica Shade, The Organic Center, *Manure safety challenges and future research*
13. Jessica Shade, The Organic Center, *Nitrogen footprints affected by consumption of organic products*
14. Andreas Westphal, UC Riverside, *Organic soil amendment for mitigating damage caused by plant-parasitic nematodes*
15. Jared Zystro, Organic Seed Alliance, *Efficient methods to develop new sweet corn cultivars for organic systems*

Research in organic farming continues to advance in many ways. Organic producers continue to innovate and discover new techniques. Researchers can help farmers validate and improve best organic practices. Organic producers constantly face new challenges in a dynamic world. With continued expansion in the market for organic food in the face of a growing population, there is an urgent need to invest in the greater productivity, resilience and sustainability of organic food systems.

The Organic Farming Research Foundation (OFRF) and the University of California Division of Agriculture and Natural Resources (UC ANR) has forged a unique partnership to create a forum that features the latest scientific developments to advance the state of the art. Researchers will present their findings in soil health, organic crop and livestock systems, biodiversity, biological control, organic seeds and breeds, innovative education, and the economics of organic agriculture. Up and coming students as well as established researchers are here to show the results of their work, in many cases for the first time.

The Organic Agriculture Research Symposium (OARS) is organized to bring together researchers from all disciplines and regions. The submissions were peer reviewed and evaluated for innovative excellence, relevance to organic farmers, soundness of methodology, and scientific quality. Presentations and posters are expected to help organic farmers improve their long-term profitability and sustainability. Researchers have an opportunity to present the latest results from projects related to organic methods to an audience that includes farmers, practitioners, extensionists, teachers, and interested members of the public, as well as other researchers. The OARS is committed to nurturing talented researchers for the future and giving access to information to practitioners that goes beyond most scientific conferences.

The 2016 OARS is being held in Pacific Grove, California in January, in conjunction with the longest running organic farming conference in North America. We thank the Ecological Farming Association for all the help and support they have given us in organizing the OARS. We also thank our sponsors for their generous support, and the USDA-NIFA for an Organic Research and Extension Initiative (OREI) grant.

The program is structured to facilitate interaction and discussions with farmers and other interested parties. Informal discussion is encouraged at the breaks and reception. Key sessions are being live streamed as webinars via eOrganic. Other sessions are being captured on audio or video. Proceedings will also be published on-line. At the end of the formal program, we will be having an interactive evaluation. A reception will follow where participants are encouraged to informally mingle, network and exchange ideas. We want you to enjoy yourselves while you learn.

9:00 – 10:00 Plenary Session

André Leu, IFOAM / Organics International President

The vital role of research to advance organic agriculture worldwide

Organic agriculture offers the promise of a future to produce and distribute food and other farm products in a healthy, ecologically sound, truly sustainable, regenerative and fair way. The benefits of organic agriculture—from ecosystem services to the provision of healthier food - are now being realized. However, to reach its full potential organic farming needs to address many challenges. As organic agriculture has grown in strength it still does not have adequate resources to continue its expansion. Market conditions, government policies and international institutional support show organic to be on the right side of history, but fulfilling its goals and meeting demand will require research, development, innovation, and technology transfer.

In order to facilitate this IFOAM Organics International has started two important initiatives, Organic 3.0 and TIPI.

Organic 3.0 is the third paradigm shift for the organic sector with one of the aims to take organic from being a niche of 1% globally to being a constructive partner in the mainstream of agriculture and society. Science and research will have a significant role in achieving this. IFOAM Organics International / IFOAM members have organized the Technology Innovation Platform of IFOAM (TIPI), which has developed a vision and an agenda to advance organic agriculture through research, development, innovation and technology transfer. TIPI's vision recognizes that current technologies based on heavy use of external inputs that are toxic, pollute the environment and are very energy-intensive come at a price. Investments in ecosystem services and the development of technologies that are productive, stable, adaptable, resilient, and fairly shared are much more likely to sustain the world's population in a rapidly changing environment. Sustainable pathways to innovation will require engagement of all stakeholders in a science-driven multi-disciplinary approach. Such an approach seeks to:

1. Empower rural areas;
2. Provide eco-functional intensification that produces food, while harnessing and re-generating eco-system services as well as strengthening resilience to climate change; and
3. Provide food for the health and well-being available to all.

Organic agriculture must build the capacity to fulfill the world's quantitatively, qualitatively and structurally adequate food needs for the entire population if it is to fulfill its mission. Farmers and scientists need to work together on solutions to overcome the challenges that organic farming systems face.

Mathieu Ngouajio, USDA/NIFA National Program Leader in Cropping Systems

USDA- NIFA support for organic agriculture research, education & extension

Co-authors: M. Ngouajio, S.I. Smith, M. O'Reilly, and M. Peet

The U.S. Organic Industry has maintained significant growth over the last decade, with organic products accounting for over four percent of total U.S. food sales. Despite this sustained growth, organic farmers and conventional farmers interested in transitioning to organic production continue to face multiple technical and scientific constraints. The needs of the organic industry are diverse. Within crop and animal management systems producers need research-proven methods to manage weeds, pests and diseases; to improve nutrient management and enhance ecosystem services; to improve product quality and reduce postharvest losses; and to improve their marketing and increase market access. They also need access to enhanced crop cultivars and livestock breeds specifically developed to thrive under organic management. Since 2001 NIFA has provided funding for many projects in organic agriculture research through two key programs: Organic Transitions (ORG) and the Organic Agriculture Research and Extension Initiative (OREI). Together, the programs have supported 1,115 projects with total funding of over $162 million. The FY2016 deadlines for application to the two programs are March 10, 2016 and April 15, 2016 for OREI and ORG, respectively. Details on the request for applications are available at http://nifa.usda.gov/ under the "Grants" tab. Other NIFA programs that have supported projects in organic agriculture include: Agriculture and Food Research Initiative (AFRI), Beginning Farmer and Rancher Development Program (BFRDP), Small Business Innovation Research (SBIR), Specialty Crops Research Initiative (SCRI), Sustainable Agriculture Research and

Education (SARE), in addition to those supported at Land Grant Universities under the Hatch Act.

10:30 – Noon Concurrent Session 1

1.1 Soil Health (Heather)

Moderator: Heather Darby, University of Vermont

Anthony Yannarell, Associate Professor of Microbial Ecology, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, acyann@illinois.edu

Management affects the weed suppression potential of soil microorganisms and green manures

Co-authors: Anthony Yannarell and Yi Lou

Agricultural soils are home to thousands of species of microorganisms with the potential to provide biocontrol of undesirable weed populations. Unlocking this microbial potential requires a mechanistic understanding of how farm management practices affect microbial functions and how these management-microbial interactions can be leveraged for desirable outcomes. The use of cover crops as green manures can suppress the emergence of early season weeds, and green manures may also stimulate microbial activity in ways that enhance weed suppression (increased plant pathogen populations) or diminish it (degradation of allelochemicals). Do soil microorganisms increase or decrease the weed suppression potential of green manures? Do these interactions vary across different management regimes, and do they depend upon microbial community composition? We conducted weed seed germination assays using live and sterilized soils from a variety of farm systems. We then partitioned the total weed suppression in these treatments into components representing the unique contribution of soil microorganisms, the unique contribution of green manures, and their interaction. We used high-throughput DNA sequencing to understand how microbial suppression and the microbe-green manure interaction depend on soil microbial community composition.

We found that green manures have a high, but temporary, suppressive effect on weed seed germination. Live soil microbial communities also have an inherent capacity to suppress weed germination. This microbial suppression was more stable over time than what was provided by green manures, but the magnitude of microbial suppression depended on microbial community composition. Microbial weed suppression was highest in organic systems and lowest in no-till systems, which suggests that different management techniques can be used to foster weed suppressive microbial communities. In general, we found live microbial communities diminished the effectiveness of green manures, leading to a negative interaction between green manures and microbes. However, the strength of this negative interaction varied along with temporal and system-based differences in microbial community composition. We conclude that understanding this microbial variation, in the context of management decisions that directly affect soil microbial communities and their activities, can help farmers optimize cover cropping and green manure strategies for maximal weed suppression.

James Stapleton, Statewide IPM Program, University of California (UC) Kearney Agricultural Center, jjstapleton@ucanr.edu

Advances in biosolarization technology to improve soil health and organic control of soilborne pests

Co-authors: James J. Stapleton, Ruth M. Dahlquist, Ygal Achmon, Megan N. Marshall, Jean S. VanderGheynst, and Christopher W. Simmons

Knowledge-based application of organic materials and soil solarization can be useful as pre-plant treatments to eliminate soil pests, without using synthetic chemical fumigants. With the goal of making both approaches more effective, predictable and flexible, we tested mortality of *Brassica nigra* (black mustard) seeds in solarized field soil amended with combinations of mature green waste compost, wheat bran, and food processing pomaces, as compared to non-amended field soil.

The soils were treated by amendment and/or solarization in the field at Parlier, CA, from 8 to 22 days in three summer experiments. Bacterial community structure in solarized soils were measured by 16s rDNA sequencing. Effects on weed seeds were determined by germination and/or tetrazolium vital staining.

Mortality of seeds buried in compost-amended soil was significantly higher than in non-amended soil in all trials. Laboratory and field studies showed that some amended soil was initially phytotoxic to lettuce seedlings, but phytotoxicity was eliminated by subsequent solarization treatment. Amended soil sometimes resulted in maximum temperatures 2-4C° higher than in soil alone, and ~85% of total organic carbon in amended soil was exhausted after 22 days of heating by solarization. Community structure changed based on soil amendment and solarization. Also, bacterial communities varied with soil depth, indicating possible enrichment of thermophiles and other niche-specific taxa.

Doug O'Brien: Doug O'Brien Agricultural Consulting, dougo.ag@gmail.com

Trends in soilborne disease incidence on two long-term organic vegetable farms in the west

Co-Authors: Doug O'Brien, Alex Stone, Helen Atthowe, Phil Foster, Jeff Falen, Jake Asplund, and Nat McKinney

A main tenet of organic farming is "a healthy soil makes a healthy plant". There is considerable evidence that organic soil management practices (organic amendments, cover cropping, rotation, sod-based rotation, tillage) improve soil health, but there is considerably less information on the impact of organic soil management on plant health. Soilborne diseases are serious problems affecting plant health on conventional vegetable farms in the west. Soilborne pathogen populations build up over time as rotations are typically too short to 'wear out' long-lived pathogens and include multiple hosts for pathogens with a broad host range. However, little is known about long-term trends in soilborne disease incidence on organic vegetable farms in the west. One goal of this project is to describe trends in soilborne disease incidence and severity on long term organic farms. A second goal is to identify critically important diseases so as to prioritize the development of solutions such as resistant varieties. Farm data sets (yields, cropping histories, disease diagnoses, scouting records) from successful long-term organic farms (Phil Foster Ranch in California and Persephone Farm in Oregon) were analyzed to document changes in vegetable crop soilborne disease incidence and severity over time. Both farms have practiced crop rotation and soil building (e.g. cover cropping, organic amendments, reduced tillage) to improve soil and plant health. At Phil Foster Ranch, anthracnose of lettuce (*Microdochium panattonianum*), lettuce drop (*Sclerotinia minor*), and root rot of pepper (*Phytophthora capsici*) declined in importance or did not change over time. In contrast, Fusarium basal rot of onion (*Fusarium oxysporum f. sp. cepae*); Verticillium wilt of watermelon (*Verticillium dahliae*), and bottom rot of lettuce (*Rhizoctonia solani*) increased over time. At Persephone Farm, clubroot of crucifers (*Plasmodiophora brassicae*), Fusarium wilt of spinach (*Fusarium oxysporum f. sp. spinaciae*), and a soilborne disease complex causing root and crown rot and vascular wilt in cucurbits (*Fusarium* and *Plectosphaerella spp*: diagnosis as yet incomplete) increased over time. Results indicate that organic soil management for soilborne disease control can be helpful, but for some diseases is unsuccessful. The diseases named above that are increasing on organic farms should be organic farming research priorities.

1.2 Seeds and Plant Breeding (Acacia)

Moderator: Jeff Dahlberg, UC-ANR-KARE

Adrienne Shelton, University of Wisconsin, Madison, acshelton@wisc.edu

Current state of public plant breeding in the United States

Co-authors: Adrienne C. Shelton and William F. Tracy

Public plant breeders at land grant universities and USDA play a critical role as collaborators in the development of improved varieties for organic farmers. However, beginning with Frey's report (1996), a series of publications have documented the decline of public breeding programs, public breeding faculty positions, and government financial support over the past 20 years. One result of this trend is that fewer and fewer public breeders are releasing finished varieties. An important, unanswered question is how to effectively re-invigorate public plant breeding programs to develop the cultivars necessary for a sustainable agricultural system in the 21st century? A survey was conducted in the summer of 2015 to assess the current state of public plant breeding programs that are releasing finished cultivars. Survey questions included funding sources, access and exchange of germplasm, size and scope of breeding programs, engagement with the private seed industry, and intellectual property rights. Results from the survey will be presented, with recommendations for future action to support this critical component of organic seed systems.

Charles Brummer, University of California, Davis, ecbrummer@ucdavis.edu

A public plant breeding program to develop organic cultivars and train new plant breeders

Co-authors: E. Charles Brummer, Raoul Adamchak, Jorge Berny, Paul Gepts, Carol Hillhouse, Dina St.Clair, Allen Van Deynze, Mark Van Horn, and Jared Zystro

Organic farming systems represent unique cropping environments distinct from conventional farming systems. Consequently, plant breeding activities focused in organic farming systems will result in cultivars well tailored to production needs of those systems. Further, a range of niche consumer markets exists for organic producers, including new and novel traits or trait combinations. The objectives of this program are to develop a framework for organic producers in Northern California to interact with faculty and students at UC-Davis to identify cultivar needs in vegetable and bean crops, prioritize development of new cultivars, and to breed and commercialize new cultivars. The public plant breeding programs at UC-Davis will develop new cultivars for organic production while providing experiential training for undergraduate and graduate students in field-based plant breeding directly in organic systems, both at the UC-Davis organic student farm and on-farm with organic producers. Students will gain familiarity with organic cropping systems, resulting in a cadre of next generation plant breeders ideally suited for organic crop improvement. By cooperating with the Organic Seed Alliance, we will have regular interactions and meetings between student researchers, faculty, organic seed companies and organic growers. We will develop and conduct on-farm trials, host extension events at trial sites, and ensure that new, publicly released cultivars derived from our program will be useful and available to organic growers and organic seed companies. We will highlight specific projects underway to meet these goals.

Jared Zystro, Organic Seed Alliance, jared@seedalliance.org

The state of organic seed

How seed is bred, produced, and managed affects the health of people and our planet, and the success of farmers and future generations. The organic seed movement is creating systems that adhere to the principles of diversity, fairness, health, and shared benefit, ensuring our plant genetic diversity remains in the hands of people, not patent holders. In this way, the organic community is committing to seed that's different from the biotechnology and chemical industry, which emphasize genetic uniformity, chemical production systems, and privatization.

Organic Seed Alliance is monitoring the success of organic seed systems in the U.S. and just completed a five-year update to its State of Organic Seed report. The report answers questions such as these: Do farmers have enough organic seed? What are our nation's organic plant breeding priorities? How are certifiers enforcing the organic seed requirement? How much of our tax dollars support organic seed research?

In 2014, we conducted our second organic producer survey for this five-year update. The survey assesses producers' attitudes and perceptions regarding organic seed, as well as their current use of organic seed and any obstacles that restrict organic seed sourcing, among many other topics. In addition to these surveys, OSA hosted eight listening sessions this past winter at organic farming conferences to gather additional input to inform our recommendations. An analysis of public investments in organic seed research and surveys of accredited certifying agencies (ACAs) and seed companies were conducted to better understand organic seed investments, organic seed enforcement issues and trends in organic seed exemptions.

The updated State of Organic Seed report will be published in 2016 and will contain the following sections:

1. An introduction providing the context, history, and importance of organic seed.
2. A discussion providing an interpretation of survey data and other research in context of the bigger picture, including risks to organic seed systems and opportunities for building them. This section will also provide updates regarding the National Organic Program's organic seed regulatory requirement and guidance.
3. A methods and results section containing the specific methods and summaries of the producer, seed industry and certifiers surveys, as well as the public investment analysis, with the complete findings contained in an appendix.
4. Concluding remarks, policy recommendations, and a roadmap for change.

1.3 Biological Control (Toyon)

Moderator: Ruth Dahlquist-Willard, UCCE Fresno County

Adrian Lu, University of California, Berkeley, adhlu@berkeley.edu

Pest and natural enemy abundance and biological pest control ecosystem services in organic strawberry fields across gradients of local and landscape diversity

Co-authors: Gila Juárez, Taiki Chiba, Karina Garcia, Hurui Kifle, David Gonthier, Amber Sciligo, Claire Kremen

Plant diversity at local and landscape scales may be important factors affecting the abundance of both pests and natural enemies in agricultural fields. These factors are especially relevant to organic agriculture because these fields depend on natural enemies to provide biological pest control ecosystem services. Increased knowledge regarding the effects of local and landscape diversity on pests and natural enemies may enable growers to increase the level of biological pest control in their fields by altering local farm diversity or, when given the choice, locating fields in certain landscapes over others.

Using an array of sampling methods including a gasoline-powered arthropod vacuum, pitfall traps, and pan traps, we surveyed abundances of pests and natural enemies in 27 organic strawberry ranches across gradients of local and landscape diversity. We also performed a sentinel experiment to estimate levels of predation provided by natural enemies across the local and landscape diversity gradients. Sentinels cards are created by affixing a known number of pest individuals onto a waterproof card which is then placed in the field for a certain amount of time. After the card is collected from the field, the individuals remaining on the card are counted and the proportion of pest individuals that are missing or damaged represents an estimated predation rate. We deployed beet armyworm egg sentinels and western tarnished plant bug (*Lygus hesperus*) nymph sentinels to estimate levels of predation provided by natural enemies in the strawberry ranches.

Our results indicate that the western tarnished plant bug, an important strawberry pest, and some of its predators are more abundant in simplified landscapes and farms than more complex ones, while Coccinellids, known to be important generalist predators in agroecological systems, are more abundant in farms surrounded by complex landscapes. Results from the sentinel experiments indicate that on both local and landscape scales, more predation occurs at sites with higher plant diversity. These results suggest that growers may be able to increase the level of biological pest control by increasing plant diversity on their farms and locating farms in relatively diverse landscapes.

Brian Baker, New York State IPM Program, Cornell University, bpb33@cornell.edu

Organic and Integrated Pest Management: Opportunities for collaboration

Co-authors: Brian Baker, Tom Green, Daniel Cooley, Susan Futrell, Lyn Garling, Grace Gershuny, Thomas A. Green, Jeff Moyer, Edwin G. Rajotte, Abby J. Seaman, Stephen L. Young

Biointensive Integrated Pest Management (IPM) and organic production methods can work together to address the vital challenge to produce food for all in an ecologically responsible way. While there are significant differences that need to be understood and respected, the two approaches have much in common. Both organic and IPM share visions and mutual goals, while having complimentary approaches. The organic approach is wholly compatible with biointensive IPM and most IPM principles will work within an organic farming system.

IPM and organic production share more common ground than differences, yet collaboration between practitioners of both has been limited, each has misunderstandings of the other. Much is to be gained by working together. The prohibition of synthetic pesticides in organic production and the lack of a consensus definition for IPM are controversial and divisive. By focusing on mutual interests, organic and IPM can overcome the divide and combine efforts to advance knowledge, science and technology; communicate with one another and to a broader audience; producers; and effectively evaluate needs and report progress to farmers, researchers, practitioners, and the general public.

All producers, including organic, conventional, and those who practice true IPM share vexing pest management problems. Biointensive IPM approaches to managing pests are biologically and ecologically based and the knowledge for this practice exists in the public domain. Because systemic approaches cannot easily be exclusively controlled or marketed, input suppliers are not interested in their research and development. A viable program for innovative management alternatives that can serve both organic and IPM producers would require a paradigm shift by producers and input suppliers.

The collaboration between organic and IPM must become a public-private partnership recognizing the need and opportunity for policy and market forces to work together in both public and private spheres to address these challenges and achieve our goals.

Our key recommendations include:

- Increase public and private support for long-term, interdisciplinary systems research that provides conclusive results, innovative new strategies, and inspires a whole generation of researchers working across the spectrum to transform production systems to be truly sustainable.
- Provide incentives for sustainable practices that contribute to ecosystem services, and eliminate programs that encourage unsustainable practices based on maximizing yield and profits.
- Provide incentives through registration reform for pesticide manufacturers to develop and formulate products that are compatible with organic production.
- Expand and develop new organic and IPM networks and media outlets to reach a wider audience; and to , identify common research priorities, collaborate, and share information on what works

The collaboration between organic and IPM must become a public-private partnership recognizing the need and opportunity for policy and market forces to work together in both public and private spheres to address these challenges and achieve our goals.

Raul Villanueva, Department of Entomology, Texas A&M, rtvillanueva@ag.tamu.edu

Field and laboratory studies of plant bugs on tomato and brassicas using organic insecticides

Co-authors: Raul T. Villanueva and Gabriela Esparza-Diaz

Currently, true bugs are a problem in conventional and organic agriculture. However, in the latter there is scarce information on what to use and how to control these pests. The mortalities of *Phthiacnemia picta* and *Murgantia* *histrionica* were studied using organic insecticides in field and laboratory assays in distinct vegetables. *Phthiacnemia picta* was evaluated on tomato fruit in laboratory and caged tomato treated fruit in field trails; while *M. histrionica* was tested on cabbage leaves in the laboratory, and kale in field conditions. Mortalities for both pests were determined every 12 h for 72 h in laboratory experiments, while field observations were recorded for up to 120 h and 168 h for *M. histrionica and P. picta*, respectively. *Azadirachtin, Bacillus thuringiensis, Beauveria bassiana, spinosad,* and *pyrethrin* were the insecticides tested. Data were analyzed with an ANOVA and significant differences were separated with LSD ($p < 0.05$). Laboratory results for *P. picta* showed that azadirachtin at 4 and 6 g a.i./L caused mean mortalities of > 90% at 24 with both doses. Similar mean mortalities were obtained with spinosad at 6 g a.i./L in the laboratory. In field studies, spinosad (6 g a.i./L) caused significantly highest mortalities on *P. picta* (60%) after 48 h and azadirachtin (4 g a.i./L) reached only 10 % mortality. In laboratory tests, *M. histrionica* mortalities reached 100% at 24 h with 6 g a.i./L of spinosad and 5 g a.i./L of pyrethrin. In the field, spinosad and azadirachtin had the lowest population increases of *M. histrionica* compared with pyrethrin and the untreated control. *Murgantia histrionica* nymphs showed susceptibility in laboratory conditions to spinosad and pyrethrin. This is one of the first studies that provides basic information on the efficacy of commercial organic products to be used for two species of plant bugs.

1:00 – 2:30 Concurrent Session 2

2.1 Long-term and Strategic Research (Heather)

Moderator: Mark Lipson, UC Santa Cruz

Amélie Gaudin, Department of Plant Sciences, University of California UC Davis, agaudin@ucdavis.edu

Long-term research in organic system at Russell Ranch: Results and opportunities to build sustainable and resilient systems

Co-authors: Amélie Gaudin, Emma Tolbert, Kate Scow

The Century experiment was established in 1993 at Russell Ranch Sustainable Agriculture Facility (UC Davis) to measure productivity, sustainability and resource use efficiency of conventional, mixed (conventional with cover crop) and organic irrigated cropping systems. Properties such as crop yields and crop quality, carbon sequestration, water use and soil functioning have been continuously monitored, providing an essential dataset to assess the long-term impact of organic management practices on agricultural sustainability.

We will summarize 15 years of interdisciplinary research and published data on corn-tomato organic system to pinpoint ecological drivers of sustainability and potential mechanisms to enhance resource use efficiency and resilience to climate change in Mediterranean climate. Over the last 5 years, tomato have yielded the same in conventional and organic system. However, the organic corn-tomato systems shows increased soil carbon sequestration and soil microbial biomass as compared to the conventional and cover-cropped conventional systems, as well as increased sequestered soil potassium and phosphorus. We will also use an ecosystem services framework to discuss the implications of long-term trends in yield, soil biological and physiochemical properties, and nutrient and carbon cycling for agricultural sustainability and human nutrition. From 1994 to 2004, the concentration of flavonoids, plant secondary metabolites and anti-oxidant compounds potentially related to reduction of cardiovascular diseases and obesity, were significantly higher in organic as compared to the conventional tomatoes. Finally, we will also discuss the support provided by long-term trials for extension, outreach and education activities.

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The Wisconsin integrated cropping systems trial: 26 years of research in agricultural sustainability

Co-authors: Gregg R. Sanford and Randall D. Jackson

The Wisconsin Integrated Cropping Systems Trial (WICST) was established in 1989 by the late Dr. Josh Posner to compare productivity, profitability, and environmental impact of six alternative cropping systems. For 26 years this 25-ha randomized and replicated experiment has been managed by a coalition of farmers, extension agents, and scientists. Originally designed with six cropping systems (three cash-grain, three dairy-forage) the study was expanded for forage and bioenergy to include low- and high-diversity native grass mixes (1999) and switchgrass (2007). The experiment was designed in a statistically robust manner to evaluate long term trends while accounting for inter-annual climate and market variability.

In 2008, more than a decade and a half of production data demonstrated that the organic systems at WICST were capable of producing equivalent forage yields, and grain yields that were 90% of conventional grain systems. Moreover, in two-thirds of the years studied, organic grain yields were 99% of conventional. A follow-up study on long-term yield trends highlighted the production benefits of crop rotation in high stress years, the lack of acceleration in annual yield gains with GMOs, and the rapid improvement in organic yields with improved technologies. These results were bolstered by an economic analysis of net returns and associated risk exposure showing that organic- and pasture-based farming systems have been the most profitable at WICST.

Analysis of historic and current soils from WICST showed that, contrary to expectation, after 20 years of best management practices, every cropping system in the experiment except for the grazed pasture and native grasslands had lost significant amounts of soil organic carbon. Recently published data incorporating native perennial grasses reinforced the idea that carbon sequestration on Midwestern prairie soils is dubious under prevailing management practices dominated by annual crops. Fluxes of other greenhouse gases such as N2O appear to be lower in low input and diverse systems on a per hectare basis but equivalent per tonne of dry matter.

Sustainable cropping system management is key to addressing food security and climate change challenges. Complex and highly integrated questions related to agroecosystem function and cropping system resilience can only be answered with long term cropping system trials. It is critical therefore that experiments like WICST remain an investment priority for research in the 21st century.

Diana Jerkins, Organic Farming Research Foundation, diana@ofrf.org

Assessment of future organic research needs

With the passage of the 1990 Organic Food and Production Act and corresponding organic regulations created in 2002, the organic sector has seen tremendous growth of certified organic farms growing by 11% in 2012 to $28 billion. The USDA National Organic Program (NOP) had over 18,000 certified organic farms and processing operations at the end of 2013, which represented a 245% increase since the beginning of federal certification in 2002.

Over the last 20 years, farmers, researchers, and the USDA have become aware that only a small portion of research was being related to organic agriculture systems and the need to increase in providing scientifically based technical information to the organic industry.

The Organic Farming Research Foundation (OFRF) has taken on the challenge of providing government and other funding organizations, farmers and ranchers, and the general public the information necessary to determine future research needs and direction. This information has been collected through 3 mechanisms.

1. This past year, OFRF has reviewed the major USDA National Institute of Food and Agriculture (NIFA) OREi and ORG organic programs

funding, analyzing the production, economic, and social topics that have been funded between 2002 and 2014. Approximately $82 million has been allocated through the 124 OREI and 64 ORG research grants awards. Initial results have found that information generated thus far and additional findings accruing from ongoing projects can play a vital role in helping current and aspiring organic producers improve the economic, agronomic, and environmental sustainability of their operations.

2. Conducted the 2nd NORA survey, a national survey directly asking organic farmers and ranchers what they perceive as their most relevant research needs. The survey was sent electronically to all NOP certified producers and announced through OFRF website and other affiliated organic organizations. Results will be compiled to reflect the top research needs by organic farmers and ranchers.
3. OFRF has reviewed its portfolio of funded projects to determine trends and gaps in topics supported for organic research and education. Results will help OFRF and other funding organizations in selecting future research support.

Results from these 3 activities will be presented at the 2016 OARS meeting to show where funds have been spent and identify future research needs. After the presentation, we would also like to host an interactive stakeholder session to continue our on-going process of collecting farmer input as to the appropriate process for collecting research needs information and respond to the proposed research needs and provide any additional research needs.

2.2 Biodiversity (Acacia)

Moderator: Jessica Shade, The Organic Center, jshade@organic-center.org
John Quinn, Furman University, john.quinn@furman.edu

The healthy farm index biodiversity calculator

The concept of healthy farms brings to mind fertile soils, clean water, and abundant wildlife. These amenities or ecosystem services were at one time taken for granted, but are now increasingly in the news and scientific literature, as we recognize that many are degraded. Global agricultural intensification, with a focus on maximum production, has resulted in decline of many ecosystem services. To address this decline, this research program has designed a Healthy Farm Index (HFI) that seeks to measure and optimize multiple ecosystem services on organic farms, communicate their value, and ensure that ecosystem services remain in the decision-making process of farmers, agency personnel, and other stakeholders. The HFI builds on past and current research efforts, an interdisciplinary organic working group, and co-development with organic producers. The tool encompasses the multi-functional nature of sustainable farm systems and reflects a vision of sustainable farming.

Agricultural systems are typically managed to maximize the provision of food and fiber. The multiple goals of farmers and society, however, include food production, ecological and environmental health, and a high quality of life now and in the future. To diversify management goals, the Healthy Farm Index incorporates multiple outputs from a farm system. The values of these outputs are reflected in groups of indicators within ecological, environmental, and socio-economic categories using measures of farm profitability, biological diversity, and ecosystem services to and from agroecosystems. Research, feedback from farmer advisory groups, and evidence of the benefits of a practice were used to set target values for each indicator. The structure of the index allows for the integration of future components as research and shared goals evolve.

This workshop will detail the use of the HFI by organic farmers to address management decisions on organic fields and farms, the area over which the farmer or landowner has the greatest level of control. Understanding the driving forces, tradeoffs, and relationships at field and farm scales will improve the effectiveness of whole farm management, as the HFI seeks to improve how decisions are made by providing a full range of outcomes from farm decisions; not just how yield or profit will change. Collective use of the index by many stakeholders in a region could shape decisions made at the watershed or larger scales, resulting in measurable benefits to all.

Although there are tradeoffs, preliminary assessment indicates that managing land cover and land use to sustain soil and water will sustain multiple ecosystem services without significant losses in total production. Ultimately, we foresee the Healthy Farm Index as a potential means to bring about payments for ecosystem services. Payments for ecosystem services benefit landowners who provide these services for the greater good with the support of society as a whole through payments or subsidies.

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An agroecological survey of urban agriculture in the East Bay Area of California

Co-authors: Miguel A. Altieri and Joshua E. Arnold

In the face of food insecurity, low-income urban residents have increasingly turned to urban agriculture to meet food and nutrition needs. In the East Bay of California, urban agriculture sites have proliferated, but little research has been done on how much these farms produce, the effectiveness of urban farming methods, benefits to the community, or the unique challenges farmers face while farming the city.

Over the past two summers, we conducted a survey assessing the state of urban agriculture in the Easy Bay area. Working from an agroecological perspective we surveyed over twenty-one sites to determine practices, challenges and impacts of these urban farms. We gathered data on physical on-farm factors, such as productivity, biodiversity, and genetic diversity. As well as pest, weed and disease pressures. In addition, farmers were surveyed to obtain qualitative data on the socio-cultural aspects of urban farming.

To assess the sustainability and resilience of these farms we adapted the MESMIS methodology (a methodology developed with smallholder farmers in Latin America) to the urban conditions. This tool can be used by urban farmers to assess the status and performance of their farms and thus develop targeted interventions to improve soil quality, plant health, and productivity. This methodology can also be adapted to assess the resiliency of urban farms under increasing threat of temperature increases and water scarcity due to climate change.

Over the summer growing seasons of 2014 and 2015 twenty-six urban farms were assessed for eighteen different criteria such as, genetic and species diversity of crop plants, productivity, agroecological best practices and a variety of social-cultural and biophysical indicators. Further, farm production surface area and total farm size were measured, and soil analysis were completed. Using the MESMIS framework farmers were taught how to assess best practices and ecological resiliency in their own urban farms.

Survey participants show strong participation in best practices including cover cropping, rotations, and incorporating on-farm natural habitat for natural enemies. We found high levels of nutrients in gardens beds tested - specifically raised beds - indicating soil amendments are heavily used by urban farmers; reduction of these inputs might be beneficial economically and ecologically. We found high species diversity (up to five spp./ m2) and low varietal diversity (< 3 spp./m2) indicating low genetic diversity in crop plants. We determined urban farms and gardens are producing more than 8.6 kg of food per m2 of production space. Participants indicated that increased research into best practices and increased extension services are necessary. By gaining a deeper understanding of the function of these farms we hope to develop participatory research projects to scale-up the use of agroecological best practices to create resilient and productive urban agroecosystems.

Sarah Leon Guerrero, UC Berkeley, sara_leon@berkeley.edu

Farming for Native Bees: a step-by-step guide for understanding, envisioning, designing, installing and maintaining wild bee habitats that contribute significantly to crop pollination

Co-authors: Dr. Gordon Frankie, Sara Leon Guerrero, Marylee Guinon

Farming for Native Bees is an innovative, farmer-initiated project that addresses a growing agricultural threat: honey bee decline. Building on emerging research, the project develops and disseminates new technologies that use diverse native bee species to enhance crop pollination, namely, high quality native bee habitat. One study estimated that 35-39% of the pollination services required by California crops are provided by native bees. Given that most farmers do nothing to encourage native bees (i.e., a third of their crops are currently pollinated “for free”), the prospects for financial gain by investing in native bee habitat are significant.

Working closely with Frog Hollow, Knoll, Enos and Dwelley Farms in Brentwood, California, we have installed high quality habitats consisting of 80+ bee-attractive plant types with exceptional results: bee populations have more than tripled, several key native bee pollinators have been recorded regularly visiting crop flowers, and the project is now being replicated in Ventura County. Habitat design is based on 15 years of survey work on over 500 ornamental plant types in 50+ urban California gardens. Using frequency counts, pan traps and aerial netting, we have found that bee species will visit specific plant types at predictable levels, allowing us to select highly attractive plants that match the seasonal progression of native bees, thus maximizing pollination opportunities.

Farming for Native Bees is also evaluating farmer knowledge, beliefs, values, and needs in relation to their financial investments in crop pollination. Regular communications about installation and maintenance, and in-depth interviews with farmers have provided important insights on the immense diversity of small farm operations, as well as how key decisions are made.

Using this information, the UCB Urban Bee Lab is developing a series of Technology Diffusion Modules that educates farmers about native bees, their role in crop pollination, and how this role can be expanded to defend against honey bee declines through habitat construction.

Formatted into 20 - 30-minute video presentations, the modules walk audiences through progressive stages of information-gathering, planning, installation and maintenance. Clips from farmer interviews present the issues from the perspective of the farmer, with the goal of sharing information (farmer to farmer) rather than top down education (researchers telling farmers what to do). Working to address the needs, knowledge, and interest level of farmers with differing interests and operations, the modules help farmers envision how habitats might be adapted to the unique conditions of individual farms.

Our vision for the panel workshop is to invite our audience to be co-creators of these groundbreaking modules by providing feedback that can then be integrated into a final version. The panel would begin with a brief introduction, followed by a screening of one of modules (or clips from a selection of modules). A panel discussion will follow with the module developers, and the audience will be invited to share their thoughts, perceptions and ideas.

2.3 Economics of Organic Agriculture (Toyon)

Moderator: Brian Baker, Belcairn Concerns, bpb33@cornell.edu

William McBride, USDA ERS, wmcbride@ers.usda.gov

Certified organic field crop profitability

Co-authors: William D. McBride and Catherine Greene

Certified organic crop acres more than doubled between 2002 and 2011, due in part to growth in major field crops, corn, soybeans, and wheat, where certified organic production increased about 280,000 acres. Despite the interest in organic agriculture and its potential to address environmental concerns, little information is available about the relative costs and returns of organic grain production on commercial farms. Most previous research is derived from results of long-term experimental field trials and offers limited economic analysis. This study provides information about potential economic returns from organic field crop production on commercial farms and the additional costs incurred by organic producers.

The profitability of organic field crop production was examined using USDA Agricultural Resource Management Survey data from corn, wheat, and soybean producers that included targeted samples of organic growers. Two estimators were used to calculate the difference between conventional and organic economic crop production costs. 1) Propensity-score matching generated a sample of similar conventional and organic producers based on observed farm and operator characteristics from which to measure the difference in organic and conventional production costs. 2) Regression with endogenous treatment-effects was employed to describe this same treatment-effect, accounting for the impact of both observable and unobservable variables on crop production costs. Results of these estimators were compared with the difference in group means. Estimated organic transition and certification costs were added to each result, and the cost differences between organic and conventional crop production systems were compared with historic price premiums paid for organic crops.

Much of the experimental research on organic field crop production has found similar yields and lower per-acre variable costs from organic relative to conventional field crop production. This observational research of commercial organic and conventional field crop production found lower yields and mostly higher per-acre total economic costs from organic systems. Per-unit operating costs from organic relative to conventional systems were similar. However, the per-unit economic costs of organic production were significantly higher, particularly for labor. The profitability of organic relative to conventional systems was primarily due to the significant price premiums paid for certified organic crops.

Additional economic costs of organic compared with conventional production were estimated at $83-$98 per acre for corn, $55-$62 per acre for wheat, and $106-$125 per acre for soybeans. These additional costs were more than offset, on average, by higher returns from organic systems for corn and soybeans, but not for wheat. These results imply that some conventional farms may be able to earn greater returns if transitioned to organic production. Despite this finding, adoption of the organic approach among U.S. field crop producers remains extremely low. Organic field crop production is particularly challenging compared with conventional production in achieving effective weed control and yields and in the processes involved with organic certification, and may be limited by climatic and market factors.

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Farm performance during the transition to organic production: analysis and planning tools based on Minnesota farm record data

Co-authors: Timothy A. Delbridge, Robert P. King, and Gigi DiGiacomo

As farmers consider transition to organic production, many express concerns about the cost of transition and the lack of information regarding costs and returns throughout the process. These concerns are significant impediments to expansion of organic production at a time when the demand for organic food products is growing rapidly. There are few published studies on the economics of organic transition, and there is very limited access to actual farm data on costs and returns during and after transition.

In this paper we summarize enterprise costs and returns as well as whole-farm financial performance measures for transitioning and recently certified organic farms in Minnesota that were enrolled in the state's Farm Business Management (FBM) program. We analyze data for crop and dairy enterprises on participating farms under conventional, transitional, and certified organic management. The analysis also includes whole-farm financial performance data for participating farms prior to the start of their transition, during transition, and after certification. We believe this is the first detailed compilation of farm record data for farms transitioning to organic production in the United States.

Results indicate that costs and returns during and after organic transition vary considerably by enterprise. For example, median corn and soybean yields achieved by participating farms fall during transition and further still after certification, though the high organic prices available after certification more than make up for yield declines. In contrast, oat and alfalfa hay enterprises show little to no increase in crop revenue following organic certification, though production costs may decrease slightly. For the dairy enterprise, per cow milk production tends to fall while feed cost stays fairly steady. Whole-farm financial results are mixed. The median rate of farm profitability once organic certification is achieved is not substantially higher or lower than pre-transition levels. However, both types of farm report much reduced profitability and net income during transition.

The mixed and nuanced results of the empirical analysis highlight the importance of careful transition planning. To this end we develop a transition planning tool that uses the county average yields and production cost information along with our study results to forecast enterprise and whole-farm net returns for each year of the transition process. Though intended only as a starting point for economic and financial planning of an organic transition, this study will be a valuable contribution to the base of knowledge related to the economics of organic adoption.

Kathleen Delate, Department of Horticulture, Iowa State University, kdelate@iastate.edu

Encouraging the transition to organic grain production: Linking research and extension to address knowledge gaps and practical solutions

Annual certified organic soybean production in the U.S. was listed at 125,621 acres in 2011. While this amount seems vast, it remains insufficient to meet the demand for soy-based organic food and animal feed in the U.S. Foreign countries have been increasingly supplying the U.S. with organic grains to meet this demand. According to USDA-FAS-GATS (Global Agricultural Trade System), the following lost income was paid to foreign countries for organic soybean imports in 2014: India - $74,548; China - $39,523; Canada - $16,986; Ukraine - $16,606; and Argentina - $14,183. In the first part of 2015, imports of organic soybeans have increased 50% over the previous period.

In order to increase the transition to organic grain production, producers need science-based results demonstrating the benefits of organic production in terms of yields, soil/water quality improvements, and economic performance. In addition, extension programs, showcasing best organic management practices, in conjunction with working farms, will help encourage the transition to more sustainable practices. Across the U.S., long-term organic farming system trials have been established to capture baseline agronomic, economic and environmental data related to organic conversion under varying climatic conditions. These sites have proven useful in providing supporting evidence for successful transition from conventional to organic practices. The Iowa State University Long-Term Agroecological Research (LTAR) experiment was established in 1998 with local farmer input on design and management, and employs annual farmer evaluation of progress and future plans. The organic system in the LTAR, which includes perennial forage crops and small grains rotated with corn and soybeans, has demonstrated increased ecosystem services, such as soil carbon capture, nutrient cycling, and pest suppression, while maintaining yields that are comparable to the conventional system. Because adequate weed management and soil fertility are cited in OFRF and USDA surveys as the greatest constraints to organic transition, this paper examines site-specific correlations in weed populations and soil fertility with crop performance and yields and compares these results to those generated at other long-term sites. As an example, inadequate weed management, triggered by excess rainfall in spring, lowered organic and soybean yields by 20 to 25% in the LTAR experiment, but economic performance remained strong at twice the returns of the conventional system. These long-term experiments serve as valuable demonstrations of the economic viability of organic systems for farmers and policymakers interested in observing farm-scale organic operations and crop performance. Linking long-term trials to facilitate greater dissemination of research results will increase the number of farmers transitioning to organic agriculture, which is the long-term goal of the LTAR site.

2:45 – 4:15 Concurrent Session 3

3.1 Innovative Educational Systems (Heather)

Moderator: Mark Van Horn, UC Davis

Damian Parr, Center for Agroecology and Sustainable Food Systems (CASFS), Environmental Studies Department, University of California - Santa Cruz, dmparr@ucsc.edu

Integrating undergraduate interns in organic farming research and beginner farmer programming at the University of California, Santa Cruz

Co-authors: Damian Parr, Darryl Wong, Graeme Baird

Organic farming research and beginning farmer programming is increasing in higher education institutions across the United States. The University of California at Santa Cruz Center for Agroecology and Sustainable Food Systems (CASFS) has been teaching and researching organic farming for well over three decades. Students at the CASFS Farm and Gardens include degree earning undergraduates and certificate earning Apprentices. Meeting the educational needs of these two distinct cohorts, while expanding the Center's agroecological field research program has required creative curricular design efforts informed by contemporary experiential learning theory. What potential roles exist for undergraduates to meet their organic farming related educational goals? What complementary programming activities exist that spreads the benefits and costs of engagement in organic farming research and production training? How can designing interactions amongst interns, student workers, apprentices and assistant managers add productivity to educational and production goals? This presentation reports on two years of piloting our CASFS internship program, including learning outcome assessments. Discussion will focus on the key features of the CASFS internship program, what has made it successful, and what new opportunities and challenges we face in expanding on our success.

John Hendrickson, University of Wisconsin, jhendrick@wisc.edu

Coordinating a three-ring circus with lions and cubs: beginning grower training programs at the university of wisconsin

New and beginning farmers face a host of challenges as they start and build a farm business. The needs of beginning growers are many and span the gamut of needing access to information, skills, capital, land, and on-going mentorship. The Wisconsin School for Beginning Market Growers was established in 1998 to assist primarily with knowledge acquisition. This intensive, 3-day program exposes participants to what it takes to start and operate a small business growing and selling fresh produce. The school emphasizes organic production practices and direct marketing. The hallmark features of the program include our teaching team of experienced growers serving as primary instructors, a "market-first" approach to guiding participants into exploring their farming plans, a realistic assessment of income potential, work requirements, and lifestyle impacts, an emphasis on practical, how-to information, and a holistic approach to the entire educational endeavor. Due to the popularity and success of the program, the Wisconsin School for Beginning Market Growers model has been replicated to serve people interested in other farm enterprises, including: cut flowers, apples, and grapes. Together, these programs have assisted in the training of nearly 1000 new and beginning farmers. The programs continue to evolve over time but the basic formula can be easily replicated in other areas of the country.

Raul Villanueva, Department of Entomology, Texas A&M, rtvillanueva@ag.tamu.edu

Linking organic farmers and students on organic production through small projects in South Texas

Co-authors: Raul T. Villanueva, Gabriela Esparza-Diaz, and Luis Ribera

This project was based on linking small transitional organic farmers and students of South Texas College (a local 3-year institution in Rio Grande Valley region with >20,000 students) in south Texas. Some of the studies conducted by the students included the following: (a) evaluation of the effect of woven and nonwoven polypropylene mulches on the abundance of pests and beneficial insects; (b) studies on the abundance of pollinators on urban organic orchards compared with conventional sites, (c) studies of plant protection in a novel organic vineyard, (d) laboratory studies of organic pesticides on *Tetranychus urticae* and its predator *Orius spp*., and (e) studies in the economic feasibility of small farms. The results showed the following: (a) nonwoven polypropylene plastic mulch favors the abundance of leafminers and whiteflies compared with woven polypropylene; (b) the most abundant pollinators were the Africanized honey bees, followed by sphecid, and chrysid wasps and sweat bees in the organic orchard; (c) in the vineyard, none of the organic insecticides (spinosad or neem, protected grapevines from *Atta texana* (the leaf cutter ant), in this case a conventional bait (hydramethylnon) was used successfully to reduce *A. texana* populations placing bait stations near the entrance of the ant's nests; (d) in laboratory bioassays the organic insecticides azadirachtin, and spinosad caused mortalities >80% on *T. urticae* compared with the water control, whilst these insecticides caused mortalities < 20% on *Orius spp*. and were not significantly different than the control; and (e) we found that for a 3 acre farm that has community supported agriculture (CSA) program members and farmers markets/restaurant sales, the net cash income was $41,318/yr. However, if the CSA members are absent, meaning the only source of revenue is the farmers markets and restaurant sales, the net cash income is only $820/yr. Conversely, if the only source of revenue were the CSA, then the net cash income would be $18,113/yr, thus demonstrating the importance of the CSA to the farm's profitability. In addition, these studies shown that in the Rio Grande Valley organic agriculture can be profitable. Established growers can sell their high priced grapefruits at 3 to 4 times higher prices than conventional growers. The feasibility study showed that organic farming can help to support underprivileged individuals bringing an income that will benefit the entire family. Furthermore; students of STC were able to develop knowledge and discipline to carry on systematic data recording. Involving these students in research contributed not only in their professional development but also in research conduction where labor and basic knowledge is scarce. For the students alone this project was successful: fourteen (93.3%) of the fifteen students selected for this program were able to finish their program at South Texas College or switched to a four year university programs in this region or across Texas.

3.2 Organic Livestock Systems (Acacia)

Moderator: Sarah Greene Lopez, Fiesta Farm, Watsonville, CA, farmers@fiestafarm.net

Kelsey A. Juntwait, University of New Hampshire, keljuntwait@gmail.com

Feeding annual forage crops to organic dairy cows during spring and summer seasons in Northeast United States

Co-authors: Kelsey A. Juntwait, André F. Brito, Kelly S. O'Connor, Richard G. Smith, Kayla M. Aragona, and André B. D. Pereira

Annual forage crops (AFC) can provide resilience and supplemental forage during times of limited herbage biomass production, including early spring, mid-summer, and late fall in Northeast US. The objective of this study was to determine the impact of AFC on milk yield and composition in grazing dairy cows during the spring (AFC-SP experiment) and summer (AFC-SU experiment) seasons. For the AFC-SP experiment, 16 lactating organic Jersey cows (14 multiparous and 2 primiparous) were randomly assigned to 1 of 2 treatments: traditional mixed legume-grass pasture (control; n = 8 cows) or AFC-SP (n = 8 cows). The AFC-SP treatment consisted of 5 plant species (wheat, triticale, barley, cereal rye, and hairy vetch) strip-tilled into a traditional pasture. Cows used averaged 433 ± 48 kg of body weight (BW) and 83 ± 50 days in milk (DIM) for the control treatment, and 416 ± 46 kg of BW and 86 ± 43 DIM for the AFC-SP treatment. For the AFC-SU experiment, 20 lactating organic Jersey cows (16 multiparous and 4 primiparous) were randomly assigned to 1 of 2 treatments: traditional mixed legume-grass pasture (control; n = 10 cows) or AFC-SU (n = 10 cows). The AFC-SU treatment consisted of 5 plant species (millet, teff, buckwheat, oats, and chickling vetch) strip-tilled into a traditional pasture. Cows used averaged 434 ± 46 of BW and 146 ± 61 DIM for the control treatment, and 449 ± 53 kg of BW and 140 ± 57 DIM for the AFC-SU treatment. A 14-day adaptation period was followed by a 7-day sampling period in both experiments. For the AFC-SP experiment, herbage biomass averaged 3,038 and 4,052 kg of dry matter (DM)/ha for the control and AFC-SP treatments, respectively. Pasture intake averaged 5.74 and 6.01 kg of DM/day for the control and AFC-SP treatments, respectively. There was no significant difference in total mixed ration intake (10.9 vs. 10.7 kg/d) and milk yield (25.2 vs. 23.1 kg/d). Similarly, contents and yields of milk fat, protein, and lactose did not differ significantly between treatments. A trend ($P = 0.06$) for greater milk urea nitrogen (14.7 to 13.1 mg/dL) in cows fed the AFC-SP vs. control treatment was observed. For the AFC-SU experiment, herbage biomass averaged, 2,774 and 2,588 kg of DM/ha for the control and AFC-SU treatments, respectively. Pasture intake averaged 5.39 and 6.07 kg of DM/day for the control and AFC-SU treatments, respectively. There was no significant difference in total mixed ration intake (11.2 vs. 11.6 kg/d) and milk yield (18.5 vs. 17.6 kg/d). Contents and yields of milk protein and lactose, along with milk fat yield, did not differ significantly between treatments. Trends for greater milk fat content (4.85 vs. 4.32%; $P = 0.07$) and lower milk urea nitrogen (10.7 to 11.7 mg/dL; $P = 0.08$) in cows fed AFC-SU vs. control treatment were observed. Our results showed that under the conditions of these 2 short-term AFC-SP and AFC-SU grazing studies, strip-tilling AFC into established traditional pasture did not improve milk yield or consistently increase herbage biomass production.

Heather Darby, University of Vermont, Heather.Darby@uvm.edu

Improving soil and forage quality to maximize organic dairy systems

Certified organic dairy operations heavily rely on pasture-based forages as well as perennial forage crops grown right on the farm. The challenge that these farms face include difficulty meeting the dry matter and nutrient needs of their livestock due to a) limitations of organic nitrogen sources for their perennial and annual forage crops, b) weather extremes that range from periods of prolonged wetness to drought that have caused crop failures and/or reduced forage productivity, and c) lack of research data and farmer knowledge on forage cropping systems that excel under organic management.

In this presentation, we will address some of the research and outreach currently being conducted in Vermont with support from USDA NIFA and other funds to address these challenges. We will describe our on-farm research trials to screen adaptation of perennial forages to low nitrogen field conditions and explore alternative pasture and nutrient management strategies on-farm that address weather related feed shortages.

We'll talk about our work with annual cool and warm season forage mixtures for their potential to enhance yield and quality throughout the growing season while enhancing soil productivity.

We will share results from on-farm trials focused evaluating the effectiveness of a pod irrigation system on perennial pasture production during drought conditions, particularly the "summer slump," as a climate change adaptation strategy. We will also talk about an innovative planning, recordkeeping and monitoring tool that helps farmers monitor nutrient flows, crop, soil, and economic productivity while also meeting standards of the National Organic Program.

As a result of these projects, our goal is for organic dairy farmers to become better informed about nutrient management strategies to employ on their pasture-based farms to reduce potential environmental degradation and increase soil quality and livestock feed quality and quantity, thereby creating increased milk quantity and improved farm financial viability.

Cynthia Daley, CSU-Chico, cdaley@csuchico.edu

Holistic animal health and nutrition, grazing and pasture management systems

Healthy livestock is the hallmark of a successful organic system plan. The primary focus of animal health in any organic herd is prevention. Disease prevention is predicated on a strong holistic management plan that includes nutrient dense pasture forages in adequate supply, grazing management, sound nutrition, fully mineralized soils, and a stress-free, clean working environment. This portion of the presentation will connect the dots using available data within the literature to convey the significance of the integrated nature of these parameters on herd health. The herd is only as healthy as the weakest link within the management chain.

3.3 Farming Systems Research (Toyon)

Moderator: Kathleen Delate, Iowa State University

Amber Sciligo, UC Berkeley, amber.sciligo@berkeley.edu

Assessing benefits, costs and trade-offs of biologically-diversified farming systems in California's Central Coast growing region

Co-authors: David Gonthier, Adrian Lu, Marc Los Huertos, Celine Pallud, Kathryn De Master, Alastair Iles, Daniel Karp, Claire Kremen

Biologically diversified farming systems (DFS) are thought to generate important ecosystem services that provide critical inputs to farm productivity as well as clean water, clean air, and beautiful landscapes that promote human health and well-being. By regenerating ecosystem services, such systems should be less reliant on off-farm inputs, more ecologically and economically sustainable, and more resilient to environmental shocks. Yet, DFS have not been broadly adopted. Currently, infrastructural constructs of our increasingly consolidated food system may prevent growers from adopting management practices that focus on biological conservation without considering economic risk and business aspects of farming. For long-term sustainability, farming methods that protect environmental quality also need to be economically viable and support the desired livelihood of the farmer. We seek to understand how farmers perceive and experience the effects of diversified farming practices on beneficial biodiversity and their farming operations, and identify farmer perspectives on opportunities for or barriers to adoption of these practices.

Using an interdisciplinary, systems-level approach on 27 organic farms in the Central Coast growing region of California, we examine specific ways that diversified farming practices affect beneficial biodiversity and analyze how that biodiversity influences farm productivity including: soil fertility, water retention and transport, crop pollination, pest and disease control, and water and air quality. We also evaluate how these practices affect crop yields, economic performance and the overall resilience of farm operations. Many challenges and constraints exist when conducting this kind of interdisciplinary, on-farm research. In addition to reporting our preliminary ecological and social findings, we will share reflections on our experience with setting up this project, collaborating within the academic sector and between other sectors (e.g. farmers with diverse backgrounds, non-profit organizations, industry groups, etc.), and conducting the on-farm work. For example, some of our research highlights will include: 1) Benefits of working with pillars in the agricultural community to make trusting connections with farmer participants; 2) How land tenure and lease length influence the ability to invest in long-term diversification practices; 3) How experiences with crucial regulations such as food safety differ among farmers along the diversification gradient and shape their anti-diversification strategies to avoid regulatory violations. Sharing our research experience will help facilitate the necessary conversation about how to implement a new phase of truly interdisciplinary research that will advance the understanding and implementation of agroecological practices.

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CAL-Collaborative organic research and extension network: On-farm research to improve strawberry/vegetable rotation systems in coastal California.

Co-authors: Carol Shennan, Joji Muramoto, Alex Gershenson, Graeme Baird, Margherita Zavatta, Lucinda Toyama, Diego Nieto, Janet Bryer, Marc Los Huertos, Stefanie Kortman, Karen Klonsky, Mark Gaskell, Steve Koike and Richard Smith

CAL-CORE is a network of researchers, farmers, extension professionals, industry and non-profit organizations dedicated to furthering research into organic strawberry and vegetable production in coastal California. Formed 9 years ago, we have worked on a variety of fertility, pest and disease management issues facing organic growers. Currently, our main effort centers on vegetable/strawberry rotations and different options for fertility and disease management. In a replicated field trial we compare treatments across a range of sustainability criteria: crop yield, nitrogen cycling and losses, greenhouse gas emissions, disease incidence, biocontrol of insect pests, soil carbon pools, and economics. Ultimately a full life cycle analysis for each rotation system will be developed to assess their overall environmental foot print. Main treatments are 2 versus 4 year rotations with different crop combinations believed to be either suppressive of a major soil borne disease (Verticillium wilt), or more profitable but more conducive to disease. Superimposed on the rotations are fertility treatments (legume/cereal cover crop only, legume/cereal cover crop + compost + additional fertility amendments, cereal cover crop + mustard seed meal, or untreated control) and in the two legume/cereal cover cropped treatments Anaerobic Soil Disinfestation (ASD, a promising option for controlling a range of soil borne diseases) is used for disease management prior to planting strawberries. Six network farmers also chose a sub-set of these treatments to test on their farms and compare to their own management practices. The study is in year 4 and all treatments at all locations are now planted to strawberries. Preliminary data on system productivity, nitrogen cycling greenhouse gas emissions, soil carbon, plant disease and biocontrol of cabbage aphids will be presented. This project will provide farmers with tools to improve their production systems, meet water quality regulations, and quantify climate-related impacts of these intensive organic systems.

Eric Brennan, USDA-ARS, Eric.Brennan@ars.usda.gov

Can organic or conventional vegetables be produced sustainably without cover crops?

Food consumption patterns in the United States show that most people need to eat far more fruits and vegetables to meet the current nutritional guidelines for a healthy diet. Recent analyses suggest that following these guidelines may require large increases in the acreage devoted to these crops. But this could have serious environmental implications if unsustainable organic or conventional production practices are used, and this situation will likely intensify with population growth and climate change. Cover cropping is considered a ‘best management practice’ in vegetable production because cover crops can provide a variety of ecosystem services (nutrient cycling, pest suppression, soil improvement, erosion control, etc.), but, cover cropping is still relatively uncommon in many of the most important vegetable production regions in the U.S. Are these systems without cover crops sustainable and if not, could cover crops change this? This interactive presentation will (1) draw on short and long-term research with high-value vegetable production in Salinas, California to highlight some major challenges and benefits with cover cropping, and (2) will describe some innovative cover cropping strategies.

Posters

1. Robina Bhatti, CSU Monterey Bay, rbahtti@csumb.edu

Mapping organic Monterey

“Mapping Organic Monterey” is an ongoing research project/paper that examines the scale, scope and possibilities of organic agriculture in Monterey County. The purpose of this proposal is to present initial findings of the project on organic agriculture in Monterey. Contributing about $8.1 billion or around twenty percent economic output and employment for one out of every four workers, agriculture in Monterey County is overwhelmingly conventional. The 2014 Crop Report for the county mentions organic agriculture just once – in its conclusion referring to diversity in production types. The objective of “Mapping Organic Monterey” research project and paper proposed, is to examine whether national trends of increases in organic consumption, growth in organic acreage, changing attitudes towards climate change and related issues are mirrored in Monterey County. The project seeks to track and document all things organic in Monterey County. In doing so, it also explores opportunities and challenges for an organic Monterey.

This project has evolved from a course on Global Ecology with a focus on Agriculture and Climate Change. Taught every fall semester over the past decade, it has involved fieldwork with conventional growers such as Tanimura & Antle, organic sites such as Earthbound Farms, Agricultural Land-Based Training Association (ALBA), and organizations such as the Center for Health of Mothers and Children (CHAMACOS). It also includes in-depth interviews with over 20 farm workers and organic agriculture professionals who have transitioned from conventional agriculture to organic. "Mapping Organic Monterey" builds on this knowledge base.

The project uses data in the public domain, particularly at Monterey County Ag Commissioners Office, Extension Services, California Department of Food and Agriculture, California Certified Organic Farmers, and the National Organic Program. This data is useful in locating and documenting certified organic acreage as well as tracing markets and services connected with organic production. But this is not sufficient for a social mapping of 'Organic Monterey'. This research project also includes an examination of changing attitudes and related issues of concern in everyday life. This social aspect supplements 'official' data through participatory observation and in-depth interviews of service providers, farmworkers, educators and agricultural professionals. The end goal of this research is aligned with the objective of the 2016 Organic Agriculture Research Symposium. The intent is to produce an analytical report on the current state of organic Monterey, one examining future possibilities and challenges for an Organic Monterey.

2. Sandy Brown, University of California, Santa Cruz, Division of Social Sciences, slbrown1@ucsc.edu

Organic strawberry transitions in a changing regulatory climate for soil fumigants

Co-authors: Sandy Brown and Julie Guthman

The California strawberry industry is currently under intense pressure to find alternatives to soil fumigants due to increased regulation of these chemicals, including 1) the phase-out of the ozone-depleting chemical, methyl bromide, under the Montreal Protocol, 2) the withdrawal of its proposed replacement, methyl iodide following significant activist pressure and legal action, 3) increasing restrictions on the use of other fumigants by the California Department of Pesticide Regulation.

Our research, funded by the National Science Foundation, seeks to learn what practices strawberry growers are using to deal with soil pathogens in the face of this changing regulatory climate and to assess effects on the industry as a whole. Analysis of recent pesticide use reporting data and county crop reports shows reduced use of soil fumigants and increases in organic acreage. Interviews with over 100 industry stakeholders, including growers, research and extension, buyers, and PCAs in California's four main strawberry production counties, suggest that these conversions are based on "market" conditions. First prices for organic strawberries can compensate for decreased yields and longer field rotations. Second, some growers see organics as a way to attract workers in a tight labor market (although many also justify the use of fumigants as a way to attract workers due to higher yields, given piece rate employment practices). In addition, increased regulatory pressure has led some growers to innovate. By eliminating fumigant use and/or converting to organics these growers may "get ahead of the game", to maintain or gain competitive advantage.

However, access to land, technology, market outlets, and other resources affect the possibilities that growers have for transitioning. This paper details trends in organic and other transitions (including anaerobic soil disinfestation, use of biofumigants, and other alternatives. We also discuss what types of growers are converting and on what kind of land (leased or owned, previously transitioned, greenfields etc.) and what these newly converted conventional growers are doing to address soil pathogens. Most are doing less than a 4-5 year rotation that successful organic growers use to grow strawberries and few have had much success with other emerging alternatives on a large scale. We will therefore also discuss the implications of these conversions when "scalable" alternatives have not been developed.

While these transitions present promising alternatives to soil fumigant use, they also present new risks for growers and for the industry, including the potential for market price volatility, land grabs, and pathogen outbreaks. As such, we will also explore the implications of these transitions, how they intersect with the changing regulatory environment, and how they affect grower decision-making.F

3. Naomi Dailey, UC Davis, ncreimer@ucdavis.edu

Improving our knowledge of pastured poultry systems

Co-authors: Naomi Dailey, Deb Niemeier, Ph.D., Maurice Pitesky

The Pastured Poultry Innovation and Research Farm at UC Davis is an opportunity for partnership between research and on-farm applications of new poultry technologies. Born out of collaboration between the UC Davis

Civil and Environmental Engineering Department and School of Veterinary Medicine, the Farm presents an opportunity to increase understanding of pastured poultry systems. Little research has been conducted on pasture-raised poultry, and the lack of a standardized rotation process and mobile coop construction leaves the system at risk of occupational and hen health risks. The Farm hopes to mitigate these issues through experimentation with different feedstocks (i.e., black soldier fly larvae), worker-friendly mobile coops, and rotation systems that optimize pasture use. These tests will help to develop strategies for egg producers and processers to prevent and detect food borne contamination, as well as and evaluate technologies that decrease ammonia and harmful airborne particulates. Pastured poultry represents a sustainable food system, mitigating the impacts of climate vulnerability and groundwater contamination via nitrogen leaching. The Farm will be the nexus of research on food and occupational safety and alternative farming technologies to be shared with the surrounding community.

4. Julie Dawson, Department of Horticulture, University of Wisconsin-Madison, dawson@hort.wisc.edu

Participatory evaluation of vegetable quality and implications for breeding for organic systems.

Co-authors: Julie Dawson, Kitt Healy, Terri Theisen, Thomas Hickey, Brian Emerson

The growing interest in high quality local foods presents an opportunity for local farmers, and a need to focus on flavor and fresh-market quality in addition to agronomic performance on diversified farms. Often farmers, gardeners and chefs choose to use heirloom vegetable varieties known for their flavor because they have found many modern varieties disappointing in terms of quality. With the industrialization of the food system and consolidation of seed companies, flavor has often not been a priority because of the importance of traits such as shelf life and tolerance to shipping in long-distance food systems. However, in recent years we have seen renewed interest in breeding for organic and local food systems, and in prioritizing flavor in varieties developed for these systems. There has also been an increase in the number of independent regional seed companies focused on organic systems, which provides a ready outlet for successful varieties developed for these systems.

We are working with farmers, gardeners, plant breeders and farm-to-table chefs to evaluate selections from heirlooms and new varieties for diversified direct-market farms where flavor and adaptation to organic/low input agriculture are of primary importance. This collaboration presents a unique opportunity to focus on vegetable variety characteristics important to local food systems. We collect agronomic performance data including yield, marketability, disease resistance and stress tolerance (heat and cold) on organic land at the West Madison Agricultural Research Station, and conduct qualitative evaluations with 15 participating farmers who each take a subset of the trials using a mother-baby trial design. Based on farmer priorities, we are trialing beets, carrots, cucumber, kale, greens, melons, onions, peppers (sweet and hot), winter squash, and tomatoes (high tunnel and field grown). We also have collaborations with sweet corn and potato breeders.

Farmers use a simple score sheet to rate varieties and describe their marketability and flavor. We also involve the public and culinary professionals such as chefs in flavor evaluation of varieties. While trained sensory panels are effective at quantifying different components of flavor, they are expensive and may not provide the most relevant information to farmers or plant breeders. Many plant breeding programs rely exclusively on tasting done by the breeder or their crew, which is effective as a rapid screening method but not easily communicated with others such as farmers, chefs and consumers. We are using a method for sensory evaluation that includes an initial screening by breeders and crew to rate flavor on a large number of samples, followed by expert evaluation using similarity-based profiling on a smaller number of samples. Analysis is performed using a common method of multivariate statistics (principle component analysis), which provides visually interpretable results (see Figure 1). We will present results from the first two years of trials, with a focus on the methods we have found to be successful in increasing participation and providing useful information to farmers and breeders on varietal performance and flavor.

5. Gwendolyn Ellen, Horticulture Department, Oregon State University

Banking on beetles for biological pest management

Co-Authors: Gwendolyn Ellen and Michael Russell

Predacious ground beetles are known to feed on crop pests and attribute to lower pest abundances. In fact, predacious ground beetles are top predators in the in-field ecological niche they occupy, the bottom of the crop plant to the first 4-6 inches of the soil. They play an important role in limiting crop pest outbreaks by concentrating their feeding activities to areas of high pest abundance. They can also reduce the amount of weed seeds in the soil and work synergistically with other beneficial species to reduce pest populations.

There are many different species of predacious ground beetles and they came in various size and shapes and preferences for prey. Some have the ability to inhabit and disperse across wide areas like a medium-sized field of 15-30 acres whereas others will only move out into the field 50 – 200 feet depending on food sources. Field and gut studies have shown that predacious ground beetles readily prey upon many crop pests including aphids, weevils, slugs and snails adults and eggs, numerous fly larvae and pupae (including cabbage maggot) and various caterpillars such as codling moth larvae, cutworms, corn earworms, wireworms and Colorado potato beetle.

Beetle banks are perennial, in-field, insectary plantings that provide shelter and over-wintering habitat for generalist predators such as predacious ground beetles, spiders and centipedes. Predacious ground beetles do not perform well in fields where disturbances such as plowing, tilling, or spading the soil, cultivating or mowing weeds or spraying pesticides occurs on a regular basis so beetle banks are formed to provide in-field refuges from these activities. Research in the United Kingdom demonstrates that predacious ground beetles seek out and benefit from the microclimates of beetle banks. Our studies in Oregon's Willamette Valley show that beetle banks had the highest population of predacious ground beetles than any other farm habitats studied. We will present the results and how these studies were done on commercial organic farms as well as how we worked with farmers to develop beetle bank technology using participatory outreach methods. We will also present a snapshot of the most common predacious ground beetles on western farms and their importance in providing biological pest management.

6. Caren P. Ghedini, University of New Hampshire

Replacing corn meal with incremental amounts of liquid molasses reduced intake and milk yield linearly in organic Jersey cows

Co-authors: Caren P. Ghedini, André F. Brito, Simone F. Reis, André B. D. Pereira, Kelsey A. Juntwait, and Ronan Santana

There is a growing interest in using sugarcane liquid molasses (LM) in organic dairy farms in the United States. For instance, organic dairy farmers in the northeastern United States are feeding LM as the sole energy supplemental source to forage-based diets in amounts (dry matter basis) ranging from 1.1 to 2.4 kg/cow/day with inconsistent results in milk yield. The current study was carried out to evaluate the effects of replacing corn meal with incremental amounts of LM on intake, and milk yield and composition in organic Jersey cows during the winter season. A total of 16 multiparous organic Jersey cows averaging 99 ± 41 days in milk and 462 ± 38.2 kg of body weight in the beginning of the study were randomly assigned to treatment sequences in a replicated 4×4 Latin square design. The study lasted 84 days with the first 14 days of each period ($n = 4$ periods) used for diet adaptation and the last 7 days for data and sample collection. Cows were fed twice a day a total mixed ration containing (dry matter basis) 60% forage and 40% concentrate. All 4 experimental diets consisted (dry matter basis) of 52% mixed grass-legume baleage, 8.0% grass hay, 8.5% soyhulls, 2.5% roasted soybean, and 15% flaxseed meal. Corn meal was replaced by increasing amounts of LM at 0, 4, 8, or 12% of diet dry matter. Cows were milked twice a day and milk samples were collected during 4 consecutive milkings in the last 2 days of each period. Samples of feeds, total mixed ration, and orts were collected every day during the sampling week. Replacing corn meal with LM reduced dry matter intake linearly ($P = 0.02$) with values averaging 19.3, 18.5, 17.8, and 17.3 kg/d for cows fed 0, 4, 8, or 12% LM, respectively. Similarly, there was a linear reduction ($P < 0.01$) on milk yield, which averaged 18.9, 18.0, 17.8 and 16.8 kg/day for cows fed 0, 4, 8, or 12% LM, respectively. The percentage of milk fat and protein did not differ across treatments, whereas milk lactose percentage was reduced linearly ($P = 0.05$) with replacing corn meal with incremental amounts of LM. There were linear reductions ($P < 0.01$) in the yields on milk fat, protein, and lactose with feeding increasing amounts of LM. Feeding LM did not change both milk urea nitrogen and average daily weight gain. Overall, replacing corn meal with LM reduced intake and yields of milk and milk components particularly at the greatest substitution rate (i.e., 12% diet dry matter).

7. David Gonthier, UC Berkeley, gonthierd@berkeley.edu

Diversifying farmlands supports bird conservation and reduces bird pest damage

Co-authors: Daniel Karp, Adrian Lu, Amber Sciligo, Claire Kremen

A goal of much of agricultural diversification is to improve habitat quality for wildlife throughout farmlands. However, many argue that diversified practices promote pest species, including some species of birds that eat crop fruits. Indeed, many farmers remove natural features from farms to reduce the abundance of pest bird species. Contrary to farmers' intent, maintaining natural features on farms and in surrounding landscapes could reduce the abundance of pest species by limiting their resource availability and increasing the abundance of their natural enemies. Further, although some bird species damage crop plants, other species consume arthropod pests and thereby may benefit farmers. To shed light on this controversy, we set up 18 pairs of bird exclosure and control (open to bird access) plots on 6 organic strawberry ranches in the Central Coast of California. Additionally, we surveyed bird species abundance and strawberry damage across 27 strawberry ranches to understand how diversification modified the bird community. Our bird exclosure experiment revealed that bird damage was minor compared with arthropod pest damage and that birds also benefited farmers by reducing arthropod pest damage to berries. Interestingly, the number of berries damaged by birds roughly equaled the number of berries that birds saved from arthropod damage. We also found that bird diversity increased with farmland diversification and therefore benefited the conservation of bird biodiversity. Simultaneously, the abundance of pest birds and some measurements of bird damage to strawberries decreased with farmland diversification. Together, these results suggest that although birds cause some economic damage to strawberries, they also provide some pest control services that roughly equate to their costs. We conclude that farmland diversification promotes bird conservation and transforms the bird community from one dominated by pest species in simplified landscapes to one dominated by insectivorous birds in diversified landscapes.

8. John Hendrickson, University of Wisconsin, jhendrick@wisc.edu

Principles for transitioning to organic farming: e-learning materials and decision case studies for educators

Co-authors: Craig Sheaffer, Jeff Gunsolus, Tom Michaels, Michelle Miller, Steve Simmons, Kristine Moncada, Jill Sackett, Carmen Fernholz

Transitioning to organic farming is a risky proposition so producers need comprehensive and accessible learning materials on the best production strategies for transitioning. To meet this demand, our project team is designing complementary materials that include online educational modules and decision case studies. The online, interactive modules will focus on the fundamentals of organic production and how to transition to organic farming for selected agronomic and horticultural crops of the Upper Midwest. The decision case studies will engage higher-level learning through the study of actual situations and dilemmas facing organic producers in our region. Our materials will be used by our team, as well as by other agricultural professionals, Extension educators and regional organizations, to educate transitioning farmers and crop advisers as part of workshops, classes and training sessions with a high instructor-student interaction. We will also use these materials in undergraduate courses taught in the newly created Food Systems major at the University of Minnesota, and they can be used by other professors in the region for their agriculture classes. Our long-term goals are to increase the number of successful organic producers in our region and to educate the next generation of farmers about organic agriculture.

9. Joanna Ory, Organic Farming Research Foundation, joanna@ofrf.org

Reducing water pollution from herbicides through sustainable agriculture

Water pollution from the herbicide atrazine impacts public health worldwide, as atrazine is used extensively and is a common water contaminant. My research investigates how restrictions on atrazine and different environmental policies have led to changes in water quality, sustainability of farming practices, and farmer decision-making. My research consists of two case studies. The first case study is on the complete ban of atrazine in Italy. My second case study was performed through the USDA NIFA predoctoral program and is on atrazine application rate restrictions and prohibition areas created in Wisconsin. In the two case studies I combine interview data, surveys, water quality analysis, and archival research to investigate if the environmental policies in these case studies led to cleaner water and the greater adoption of organic farming or integrated pest management. Results from both case studies show that atrazine pollution has improved through use reductions, yet it remains a problematic water contaminant and its alternatives pose their own risks. This research has implications for policy strategies to reduce pesticide use and protect water quality through organic and low-input agriculture.

10. Laura Patterson, UC Davis, lpatters@ucdavis.edu

Evaluating the persistence of Escherichia coli in the soil of an organic mixed crop-livestock farm that integrates sheep grazing within vegetable fields

Co-authors: Laura Patterson, Nora Navarro-Gonzalez, Michele Jay-Russell and Alda Pires

Mixed crop-livestock farms, those that integrate crops and livestock and use their animals to graze crop residues or cover crops, are sustainable farming systems that utilize grazing because it enhances soil fertility, recycles farm nutrients and provides another source of revenue through meat production. Yet third-party food safety auditors have directed attention toward these farms, due to possible risks associated with grazing vegetable fields. Raw manure from grazing animals may introduce zoonotic foodborne pathogens, such as Shiga toxin-producing Escherichia coli (STEC), into fields planted to high-risk crops (e.g., spinach, lettuce, melons) and these pathogens can exist in the soil for extended periods of time. STEC remains one of the leading causes of foodborne outbreaks. Leafy greens accounted for 21% of E. coli O157 outbreaks between 2002-2013.

Although farmers want to ensure that the food they raise is safe, they are also concerned about complying with guidelines that make it burdensome to continue these mixed crop-livestock systems. Current National Organic Program (NOP) standards require 120 days between raw manure application and harvest, if the crop touches the soil. However, third-party food safety auditors may have stricter guidelines and upcoming federal regulations remain vague on interval times between grazing and harvest.

Research on the persistence of E. coli in the soil, within mixed crop-livestock environments, is limited and this pilot study provides baseline data to assess any risk associated with these types of farms.

Soil samples were collected from a mixed crop-livestock organic farm to ascertain the concentration and persistence of generic E. coli and fecal coliforms, as indicators of microbial contamination. Fecal samples were tested to establish the baseline prevalence of STEC within the farm's sheep flock (sheep are asymptomatic reservoirs for STEC and fecal shedding may increase during periods of stress).

A five-acre cover crop plot was grazed by sheep in the spring of 2015 and later planted to summer crops. This plot was divided into three fields and twelve random soil samples were collected from each field on each sample day: Day 0, 7, 14, 21, 28, 56, 84 and 122. The MPN (most probable number) of generic E. coli was measured. Information regarding farming practices and environmental parameters was also collected, including type of irrigation, soil temperature and humidity.

The overall STEC prevalence in the sheep flock was 4.2%. Since STEC exists in this sheep flock, estimating generic E. coli persistence in the soil is important for developing guidelines for food safety. Preliminary results indicate that in late spring to early summer, generic E. coli levels in the soil peaked at 14-43 days post grazing and declined to near zero by day 105 in all fields.

Although environmental conditions and farming practices vary by season and region, this pilot study indicates that E. coli in the soil post grazing is undetectable by the 120 day NOP standard. Establishing research-based waiting periods between grazing and harvest, allows mixed crop-livestock farmers to continue integrating grazing within production fields, while keeping food safe from farm to fork.

11. Caitlin Peterson, UC Davis, capeterson@ucdavis.edu

Irrigation strategies to optimize soil functions and resource use efficiency in organic tomato and corn

Co-authors: Caitlin Peterson, Kaylie Marr, Emma Tolbert, Kate Scow, Amélie Gaudin

Attempts to improve agronomic water use efficiency by introducing subsurface drip irrigation have met with mixed results in organic systems. Growers point to unavailability of nitrogen from organic inputs as a potential cause of poor performance when crops are grown under drip irrigation, but little information exists on organic nutrient cycling under different irrigation schemes. The objective of this study was to examine the effects of irrigation scheme on soil and plant characteristics of an organic production system. We examined the following key aspects of carbon and nitrogen cycling as they relate to soil water movement under two different drip irrigation arrangements and compared them to furrow irrigated plots in organic tomato and corn rotations: 1) crop root system, 2) microbial activity, 3) cover crop decomposition and nitrogen mineralization, 4) total plant nitrogen uptake. We also examined the impact of irrigation schemes on weed pressure and will present an economic analysis of production costs and benefits at Russell Ranch long-term organic cropping system experiment for 2015. The knowledge acquire will help improve the feasibility of drip irrigation in organic agriculture.

12. Jessica Shade, The Organic Center, jshade@organic-center.org

Manure Safety Challenges and Future Research

Co-authors Alda Pires, Tracy Misiewicz, Jessica Shade

In 2014, FSMA released a proposed rule that suggested wait times for manure that directly conflicted with Organic Standards. The organic sector managed to keep those regulations from being passed, but the ruling was just a postponement until more research was conducted. It is critical for the organic sector to be involved in research on manure use and safety, and organic stakeholder input will be foundational for developing a long-term research plan.

To ensure that organic stays at the forefront of manure safety research, a multidisciplinary team from the USDA to a team including non-profits, academic researchers, and governmental agencies was recently awarded an OREI planning grant. This session will link in to the planning grant by combining presentation and discussion about manure safety.

The session will be structured as a short presentation setting up the discussion topics and focus areas. Participants will be asked about specific topics such as microbiological contents, practices, compost and manure management, grazing practices in crop and fruits producing fields or orchards for human consumption. In addition, beliefs and attitudes regarding food safety and the use of animal-based soil amendments, and potential economic or other barriers to using compost or treated animal-based soil amendments will be assessed.

This discussion group will address the challenges associated with manure and animal rotational grazing. Organic and transitional farmers are the target audience. It will be part of a national effort to address issues surrounding animal-based soil amendments and animal rotational grazing. Listening sessions will be conducted regionally, with the results being gathered in a white-paper that will inform a long-term research plan addressing the most pressing needs of the organic community.

13. Jessica Shade, The Organic Center, jshade@organic-center.org

Nitrogen footprints affected by consumption of organic products

Co-authors: James Galloway, Laura Cattell Noll, Allison Leach, Verena Seufert, Jessica Shade

Reactive nitrogen is necessary for crop and animal production, but when it is lost to the environment, it creates a cascade of detrimental environmental impacts including smog, acid rain, eutrophication, climate change and stratospheric ozone depletion. The nitrogen dilemma is to maximize the food production benefits of reactive nitrogen, while minimizing losses to the environment. Organic practices in food production attempt to reduce the detrimental impacts of agricultural systems on the environment and human health. This study explores the effects such practices have on nitrogen (N) pollution, in comparison to conventional food production practices.

To examine the effects of farming system on nitrogen lost during food production we used virtual nitrogen factors (VNFs) that quantify the amount of nitrogen lost to the environment per unit nitrogen consumed. Virtual N factors determine the amount of nitrogen released to the environment during the production of a food product per unit of nitrogen endogenous to that food. These calculations sum the reactive nitrogen lost to the environment and recycled at each stage of food production.

The calculations for organic virtual nitrogen factors modified the calculations of the conventional virtual nitrogen factors in two areas – 1) the crop's nitrogen uptake factor, or the amount of nitrogen taken up by the crop per unit of nitrogen applied, and the recycling factor for processing waste. The nitrogen uptake factor was calculated by dividing the nitrogen content of crop yield by the amount of nitrogen applied in organic production practices. Average yield and nitrogen input information were obtained by a literature review.

Our preliminary results suggest that there is no statistical difference between organic crop VNFs and conventional crop VNFs. However, because conventional production relies heavily on the creation of new reactive nitrogen (Haber-Bosch, biological nitrogen fixation) and organic production primarily recycles existing reactive nitrogen (manure, crop residue) and only creates some new reactive nitrogen (BNF), our data suggest that organic production contributes less new reactive nitrogen to the environment than conventional production. Therefore, on a local scale, nitrogen pollution from organic crop production is comparable to conventional, but organic crop production introduces less new reactive nitrogen to the global pool. Since there are larger differences between organic and conventional livestock production, the animal protein VNFs reflect a more complicated picture for which the VNF calculation must be adjusted.

In order to minimize the negative impacts of reactive nitrogen, consumers must make lifestyle choices that minimize their nitrogen footprint. With a deeper knowledge of the N losses from organic production relative to conventional, consumers will be more equipped to determine the potential sustainability of purchasing organic products.

14. Andreas Westphal, UC Riverside, andreas.westphal@ucr.edu

Organic soil amendment for mitigating damage caused by plant-parasitic nematodes

Co-authors: Andreas Westphal, Celina Teuner, Holger Heuer and Martin Kücke

Worldwide, crops are at risk for damage by plant-parasitic nematodes. These soil dwelling microscopic roundworms are difficult to diagnose. Their damage is first noticeable as an overall unthrifty growth and lack of productivity. In vegetable and field crops, there are limited strategies for suppression of these soil-borne pests available. These crops are attacked by a variety of cyst and root-knot nematodes. In regards to agronomic practices, crop rotation, cover crops and soil amendments have allowed for mitigation of their damages. Large amounts of organic by-products are generated during the production of food and fiber materials and other agricultural commodities. For example, generation of bioenergy with anaerobic digesters provides copious amounts of digestate that needs disposal in a most efficient way. These materials offer the potential for closing the recycling gap of nutrient fluxes in agricultural production. In this research program, digestates not only contributed to plant nutrient supply but also to soil health improvements. In these studies, different Beta vulgaris species infection by Heterodera schachtii was suppressed when nematode-infested soils were amended with digestate before cropping susceptible plants. These findings showed alternative principles for successful cycling of organic materials in the agricultural process for improving sustainability of production systems.

15. Jared Zystro, Organic Seed Alliance and the University of Wisconsin–Madison, jared.zystro@wisc.edu

Efficient methods to develop new sweet corn cultivars for organic systems

Co-authors: Jared Zystro and William Tracy

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 Best Linear Unbiased Prediction (BLUP), 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 is to develop efficient methods to develop new sweet corn cultivars for organic systems. The objectives of this research are three-fold:

1. Determine the utility of using structured mating designs and genotypic information to select untested sweet corn hybrids and synthetic varieties for organic environments.
2. Determine whether synthetic varieties are more stable than hybrids in a range of organic environments.
3. Determine whether certain traits are more stable than others across locations.

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 will be carried out in 12 organic environments total over two years. The results of these trials will be extended 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 BLUPs. The results of tested and untested crosses will be used to predict high performing hybrids and synthetic varieties. A subset of the hybrids and synthetics predicted to be high performing, as well as a random set of hybrids and synthetics will be tested across six organic environments to determine the predictive power of this testing system for identifying high performing and stable material. The results of these trials will be used to measure the relative stability of key phenotypic traits in order to determine which traits can be more readily evaluated in a few locations and which traits require extensive testing across environments. Preliminary results from the first year of trials will be presented during the Organic Agriculture Research Symposium.

Together, we can reach the next 5 million acres of organic.

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