# OREI Project Details

## Award Year 2023

23 Research Projects

## PROJECT INDEX

**18.** Develop Yeast-based, Immune Inducing Biocontrols of Fire Blight with Improved Efficacy and Minimized Fruit Russeting Grant No: 2023-51300-40727

**19.** Advancing Organics in Kentucky: Adopting Practices, Increasing Resilience, and Strengthening Systems Grant No: 2023-51300-40728

**20.** Climate-smart Organic Sorghum Partnership for Grain and Silage Production Grant No: 2023-51300-40854

**21.** Onion-iq (improve Quality): Improving Quality, Resilience, Soil Health and Food Safety in Organic Onion in the Southeastern and Southwestern U.s Grant No: 2023-51300-40913

**22.** Building Partnerships for Farmer-led Research in Ohio Grant No: 2023-51300-40856

**23.** Development of an Organic Agriculture Curriculum Grant No: 2023-51300-40911

# Extending the Scope of Scope: Sharing Tools and Expanding Partnerships for Organic Cultivar Development

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| **Contract / Grant No.** | 2023-51300-40963 |
| **Grant Year** | 2023 |
| **Investigator(s)** | E. Charles Brummer |
| **Performing Institution** | University of California, Davis |

## NON-TECHNICAL SUMMARY

Organic farmers need to have adapted crop cultivars to be optimally productive and profitable. Breeding crops under organic management will result in cultivars well-suited to production needs of those systems, such as improved disease resistance or novel traits that are particularly relevant for organic production. The objectives of this program are to breed new varieties of tomato, wheat, zinnia, common bean, celtuce, and spinach for organic producers in California and neighboring states. This project builds on our existing OREI-funded breeding pipelines that are led by students who gain experiential training in field-based plant breeding directly in organic systems. In this project, we add new crops and expand our program to UC Santa Cruz, who will be focusing on breeding for dry farming. With both self- and cross-fertilized crops and vegetable, agronomic, and ornamental species, students will gain familiarity with a broad complement of breeding systems and variety types, including pure line, open-pollinated, and hybrid cultivars and develop new cultivars to meet the needs of diverse organic growers. We will develop instructional information to help new students and farmers understand and undertake breeding, selection, and evaluation trials. The Organic Seed Alliance will organize 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.

## OBJECTIVES

The long term goals of the Student Collaborative Organic Plant-breeding and Education (SCOPE) Project are to provide hands-on plant breeding opportunities to university students and to collaborate with farmers and seed companies to release cultivars useful to organic growers and seed producers.The specific objectives of this project will involve, assist, and empower students and growers in all aspects of the project to:1. Develop and release cultivars of vegetables, grains, and flowers suitable for organic farming systems.2. Understand organic plant breeding programs through experiential education and engagement with instructional modules.3. Facilitate long term relationships among farmers, seed producers, and community members through on-farm trials, participatory breeding programs, and in-person and virtual events.

## APPROACH

We will conduct breeding programs of six crops: wheat, tomato, zinnia, common bean, spinach, and celtuce in this project. The methods used will be those typically used in conventional plant breeding programs for each crop, with modifications as needed to account for the specific biology of the crop. Populations segregating for traits of interest will be developed by controlled hybridization. Data will be collected from replicated, multi-location trials among breeding lines and for advanced experimental germplasm. Seed production will be done on research stations on in conjunction with private organic seed companies. Interested farmers will be involved in trialing experimentals and in some case, direclty particpate in making breeding decisions and selecting desirable genotypes. Selected experimental germplasm will be officially released and made available to seed companies and/or to organic farmers directly.A key component of this project is training young breeders by doing the activities of a plant breeding program directly. Both graduate and undergraduate students will be involved in all phases of the breeding programs, from making decisions on selection targets to making crosses between desirable genotypes, collecting data to conducting statistical analyses, summarizing project performance and making presentations at field days and on social media. We will develop internships at each participating

university for students to formally investigate particular plant breeding activities.Undergraduate and graduate students in education-related majors at UCD and UCSC will be recruited to develop educational modules on organic farming and plant breeding. Modules will include demonstration videos, lectures, and recorded field walks. Module content, such as crossing, experimental design, seed production, and selection demonstrations, will be developed, leveraging existing information from project participants where possible. This information will be formatted into modules (Sharable Content Object Reference Models or SCORMS) that can be used in either in- person or on-line instruction, integrated into course management software (Canvas or similar Learning Management Systems), and easily exported to other institutions.On-farm field trials will be conducted for the breeding programs of all crops. Farmers interested in hosting trials will typically evaluate 2-4 experimental cultivars along with 2-4 standard check cultivars, with details determined based on the crop, the scale the farm can handle, and the seed availability. Trials will typically be planted in replicated designs to enable statistical analysis of data. We expect that farmers may take very limited data on desirability, interest in growing the cultivar again, etc. More in depth data collection on various traits will be done by SCOPE personnel using the Field Book app. ** **

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# Advancing Organic High Tunnel Sustainability Through Legume Cover Crop Based Fertility Management and On-farm Learning

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| **Contract / Grant No.** | 2023-51300-40984 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Julie Grossman |
| **Performing Institution** | University of Minnesota |

## NON-TECHNICAL SUMMARY

Organic high tunnel (HT) production is expanding rapidly due to season extension benefits, but intense cultivation strategies may pose challenges for sustainability that could offset economic gains. Previous OREI-supported research showed challenges to be mitigated through soil-enhancing practice of cover cropping, but on-farm evaluation of HT rotational strategies is sorely lacking. Our long-term goal, based on extensive grower feedback, is to increase cover crop adoption to improve HT resilience. We will accomplish this by conducting extensive on-farm and replicated experimentation across northern-climate research sites (Upper Midwest and New England), by training students and farmers, and by deepening relationships with farmers excited about using season extension. Our supporting objectives include to 1) Improve our understanding of agronomic trade-offs associated with legume cover crop integration across working organic farms; 2) Create educational case studies to support decision making about cover crops, with an emphasis on economic outcomes; and 3) Meet farmer demand for education and networking opportunities for HT producers in cold regions. Outcomes include research data from on-farm trials and on the impacts of long-term manure and cover crop inputs on soils; four farm case studies emphasizing cover crop use, costs, and benefits; a Beginning Organic High Tunnel Vegetable Production course for rural Minnesota growers; and conference workshops and field days. If successful, our project will have far-reaching implications for how farmers manage their HTs for optimizing system resilience and long-term sustainability.

## OBJECTIVES

Organic high tunnel (HT) production has been expanding rapidly, but intense cultivation strategies may pose challenges for sustainability that could offset economic gains that HT production offers. Previous OREI-supported research showed that challenges can be mitigated through soil-enhancing practice of cover cropping, but on-farm evaluation of HT rotational strategies is sorely lacking. Our long term goal, based on extensive grower feedback, is to increase cover crop adoption to improve HT resilience. We will accomplish this by conducting extensive on-farm and replicated experimentation across northern-climate research sites (Upper Midwest and New England), by training students and farmers, and by deepening relationships with farmers excited about using season extension. Our supporting objectives include to 1) Improve our understanding of agronomic trade-offs associated with legume cover crop integration across working organic farms; 2) Create educational case studies to support decision making about cover crops, with an emphasis on economic outcomes; and 3) Meet farmer demand for education and networking opportunities for HT producers in cold regions.Outcomes include research data from on-farm trials; four farm case studies emphasizing cover crop use, costs, and benefits; a Beginning Organic High Tunnel Vegetable Production course for rural Minnesota growers; and conference workshops and field days. If successful, our project will have far-reaching implications for how farmers manage their HTs for optimizing ecosystem services, system resilience, and long-term sustainability.

## APPROACH

General methods are outlined under each objective. Additional information may be found under \'Products-Activities\'section of this project initiation.Objective 1: Improve our understanding of agronomic trade-offs associated with legume cover crop integration across working organic farms. This overarching objective aims to increase cover crop adoption rates in two northern U.S. regions by first confirming best-bet species and preference with farmers, then distributing cover crop seed to organic farmers in two participation tiers. We will

collect a wide range of data on cover crop performance and soil attributes during and following cover crop production from the on-farm trials. A replicated research station trial (\"mother trial\") will also accompany on-farm trials.Objective 2: Create educational case studies to help farmers and students make decisions about cover crop integration in tunnels with an emphasis on economic outcomes.Co-PD DiGiacomo will collect data and prepare four illustrative case studies to inform educational instruction and improve grower understanding of cover crop production costs and benefits. The case studies will compare and contrastcover crop options. Growerswill be identified for the case studies from the participants from objective one toillustrate a diversity of cover crop strategies and planting windows. Case study content will come from quantitative research results (biomass, soils), newly prepared cover crop production budgets based on grower data, and growers\' qualitative responses to interview questions. The case studies will inform future research and Extension outreach as well as provide curriculum content for cover crop instruction in a variety of educational settings (FFA, technical and community colleges, 4-year Universities).Objective 3: Meet farmer demand for education and networking opportunities for high tunnel producers through development of an annual course emphasizing organic HT management.A multi-format education and networking program will be developed, re-activating previous networks of HT growers while incorporating a new focus on community-building and technical assistance for emerging farmers. Formats will include the following: 1)ABeginning Organic High Tunnel Vegetable Production course developedand deliveredto 20 producers annually for three years through a new collaboration betweenthe University of Minnesota and Central Lakes College (CLC), a comprehensive community and technical college serving about 5,500 students per year in rural Minnesota. 2)In project year three, we will develop a workshop to highlight participant learning gained through the CLC course and transfer important skills to audience participants.

## PUBLICATIONS

**Integrated Control of Cabbage Maggots in Organic Vegetable and Seed Crops** Kristine Buckland, Oregon State University

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# Integrated Control of Cabbage Maggots in Organic Vegetable and Seed Crops

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| **Contract / Grant No.** | 2023-51300-40951 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Kristine Buckland |
| **Performing Institution** | Oregon State University |

## NON-TECHNICAL SUMMARY

Cabbage maggot has been identified as the most challenging pest to control in vegetable cropping systems of the Pacific Northwest (grower survey 2019, Buckland unpublished). This insect pest feeds on root structures, weakening the plant and causing visible damage to root crops, rendering them unmarketable. Cabbage maggot has a wide host range in all Brassicaceae crops, and is most troublesome for damage to root crops such as radish. We will engage research and industry leaders to assess current management techniques and damage estimates with the goal of identifying emerging needs for the further development of organic production of these highly valuable crops. We will collaborate with growers in regions of high production as well as researchers and agronomists to map a pathway forward for future funding projects. Our project will deliver the following outcomes:Identify current cabbage maggot management approaches.Engage stakeholders to describe potential opportunities and constraints: farmers, agronomists, and researchers.Convene a planning workshop to facilitate the development of research priorities for collaborative future research and Extension work.This project is poised to provide essential information for specialty crop markets in vegetable and vegetable seed crops. Information and tools developed in this project will lay a foundation for connections and resources to target research needs within the cropping systems of Brassica crops.

## OBJECTIVES

The goals of this project are:Identify current cabbage maggot management approaches.Engage stakeholders to describe potential opportunities and constraints: farmers, agronomists, and researchers.Convene a planning workshop to facilitate the development of research priorities for collaborative future research and Extension work.

## APPROACH

The project timeline begins 1 Sep 2023 and is completed by 31 Aug 2024.Objective 1: Convene a stakeholder group consisting of farmers, agronomists, researchers, and Extension personnel. Task 1: Gather experts for one-day production planning conference (experienced growers, agronomists, researchers).Identify key Brassica production regions with cabbage maggot losses. Production regions to include Pacific northwest, northeastern US, and upper Midwest.Coordinate with researchers (entomologists or vegetable production areas of expertise) in those regions; they will also know experienced growers and/or agronomists in their region?Task 2: Convene this group in a one-day meeting to address Objectives 2 and 3.Oregon is the home to vegetable and seed production farms of various sizes. This project would work to convene farmers and agronomists of similar crops, along with researchers across the country in a stakeholder group. The diverse nature of this group (farmers, agronomists, researchers) requires a unique event timing specific to key cooperators\' availability. We will poll cooperators for their availability to schedule conference events, offer travel support and will also conduct the meeting in a hybrid meeting format to ensure accessibility to key growers/agronomists/researchers who might not be able to travel because of other constraints.Objective 2: Document current cropping systems of concern, current management strategies, and current damage levels. Task 1: Identify, and describe current crops and crop management practices (field configurations, planting dates, etc.).Prior to conference meeting day, we will identify brassica cropping systems affected, scale of production, and typical field management through participant information gathering using a chart similar to:RegionCropPlant DateHarvest DateIrrigation type & frequencyFertilizationAverage field sizeTask 2: Identify current management strategies for cabbage maggot.Prior to conference meeting day, we will identify the following through participant information gathering:RegionCrop%

Loss to CMControl option% of growers usingEase of implementationCost to implementEffectivenessObjective 3: Identify potential areas for future research and Extension to support integrated management programs with reduced crop loss. The project team, including the Faculty Research Assistant serving as a conference facilitator, will work with conference attendees to elicit ideas, feasibility and highest priority research project ideas as identified in Tasks 1-3.Task 1: List potential areas of new technologiesTask 2: Assess new research ideas for applicability to crops and crop systems identified in Objective 2. Task 3: Prioritize future projects. Objective 4: Engage a broader group of stakeholders in project findings.Task 1: Develop report on conference proceedings in Objectives 2 and 3.The project team, in cooperation with the conference facilitator, will develop a comprehensive document detailing the results of exercise in Objectives 2 and 3.Task 2: Make report and supporting resources available through cabbage maggot portal website. The meeting and priority crops summaries, as well as supporting resources for farmers and buyers will be made available at Oregon State University\'s Cabbage Maggot Portal website (https://agsci.oregonstate.edu/cabbage-maggot).Task 3: Assess the impacts of project. Throughout conference delivery and following the meeting, we will evaluate the success of achieving project objectives. We will assess:1. Number of stakeholders reached at conference delivery2. Number of new crops identified3. Number of research needs identified4. Conference evaluations on quality, inclusivity, and efficacy of towards achieving objectives.At the beginning of the conference, we will present the objectives and tasks for the day as described here. We will ask participants to respond to a quick survey via electronic clicker to assess knowledge levels and industry needs prior to discussion exercises. Following conference delivery, we will administer an exit survey where participants will indicate their experiences and provide feedback on the process and perceived success of the conference content. Finally, following the development of the conference report, we will once again survey (via email electronic survey) the participants to assess the value and accuracy of the developed document and overall project process. Progress 09/01/23 to 02/28/25 Outputs Target Audience:The project has enagaged growers, researchers, and agronomists to identify crops affected by cabbage maggot, the timing of pest damage, and the severity of damage in three crop groups. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?The online conference provided the following opportunities to attendees (researchers, agronomists, and growers): 1. Data summarizing current control methods used in key production areas nation-wide 2. Introduction to four novel control methods for cabbage maggot 3. Connection to key collaborators in this area of research and production 4. Introduction to online resources housed atCabbage Maggot Portal College of Agricultural Sciences How have the results been disseminated to communities of interest?We have disseminated results in three ways: 1. A white paper summary of conference discussions and pre-conference data collection has been uploaded to a webpage at Oregon State University that is maintained as the country\'s most current resource for this insect pest. 2. An Extension publication has been developed and is under review for publication. Extension publications are available online and reach audiences world-wide each year. 3. Continuing education presentations have been delivered directly to producers at 3 regional meetings with 165 attendees. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported Impacts What was accomplished under these goals? The goals of this project are: Goal 1: Identify current cabbage maggot management approaches. A survey was developed for distribution to researchers across the country to capture current management apporaches. Rsponses were collected from four of the key production states with a total of 34 respondants. It shouldbe noted that some of the responses were from industry summaries and some were from individual farms so information gathered likely spans a wider range of experience than individual respondants. Goal 2: Engage stakeholders to describe potential opportunities and constraints: farmers, agronomists, and researchers. The survey was distributed by regional experts through email, direct contact, and grower-group presentations. Through this survey work and individual inputs across production regions, current strategies were explored and documented in a white paper and Extension manuscript (under review). Additional reserach ideas were gathered during the discussions and provided as inputs into the planning conference agenda to include presentations on specific areas of interest (detailed below). Goal 3: Convene a planning workshop to facilitate the development of research priorities for collaborative future research and Extension work. A planning meeting convened via zoom with a total of 15 attendees on Zoom from across the US including NY, WA, OR, and MI with inputs from other regions. Our goal was to provide a roadmap to future research and Extension needs around cabbage maggot control in vegetable and seed crop systems. The program followed the following outline: Introduction and pest overview Current situation: results of surveys and discussion Crops affected Damage assessments Current control options and costs What\'s next? New Ideas to present and discuss: Volatiles\--Dr. Vaughan Walton, OSU Lure and trapping\-\--Dr. Dani Lightle, OFS Barriers, trap cropping, overwintering\--Dr. Kristie Buckland, OSU Discussion and conclusion Following the planning meeting, notes were condensed and combined with expert presentations into a white paper, available online. Further inputs from the conference were combined into an Extension publication that is under review for publication. Publications Type: Other Status: Submitted Year Published: 2025 Citation: Buckland, K.R., A. Rasmussen, D. Lightle, M. Mattson, M. Robinson, C. Dugger, H. Velazquez. 2025. Cabbage Maggot (Delia radicum) in the Pacific Northwest: A Pest of Vegetable and Seed Crop. Submitted to Oregon State University Extension Publications Progress 09/01/23 to 08/31/24 Outputs Target Audience:The project has

enagaged growers, researchers, and agronomists to identify crops affected by cabbage maggot and the timing of pest damage. Changes/Problems:A six month no-costextension was requested and approved due to availability of project team and conference attendees in spring of 2024. This has allowed for additional focus on engaging appropriate stakeholders. What opportunities for training and professional development has the project provided? Nothing Reported How have the results been disseminated to communities of interest? Nothing Reported What do you plan to do during the next reporting period to accomplish the goals?We will continue to gather data in Objectives 1 and 2 of current practices. We will also convene the conference to review the data collected and evaluate the potential of future research ideas. Finally, we will prepare a manuscript for publication summarizing the data collection. We will post conference findings on the Cabbage Maggot Portal and submit the manuscript for publication Impacts What was accomplished under these goals? Pre-conference data collection has begun through worksheets aimed at identifying crops affected, estimated damage, and management strategies (including routine field maintenance practices). Also, five potential new approaches are being identified and detailed for review by conference attendees. These new approaches include management strategies for each life cycle phase of the pest. We are working to engage experts at each method to present the concept to conference attendees for discussion purposes. The conference is currently planned for the last week in September. Publications

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# Enhancing Microbial Safety and Production Efficiency in Organic Poultry Farming: an Interdisciplinary Investigation of Innovative Strategies

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| **Contract / Grant No.** | 2023-51300-40912 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Abhinav Upadhyay |
| **Performing Institution** | University of Connecticut |

## NON-TECHNICAL SUMMARY

Organic poultry farming is an increasingly popular and sustainable method of poultry production that prioritizes animal welfare, environmental protection, and product quality. Despite its potential benefits and rapid growth, organic poultry farming faces several challenges, including disease management, feed availability, efficiency, food safety, and marketing. This multi-regional, multi-institutional, and multidisciplinary proposal aims to develop evidence-based recommendations for improving organic poultry farming practices, focusing on four broad research areas namely (1) microbial safety, (2) gut health and production efficiency (3) product quality, and (4) consumer perception including cost. Project results will be disseminated to scientific groups, the community, organic poultry producers, and stakeholders through conferences, workshops, social media, and webinars. Moreover, instructional material and an online certificate program will be developed to train the next generation of the workforce in organic poultry production and share the findings of the project after the life of the grant. The program staff consists of a combination of young, mid-career, and senior scientists with expertise in poultry production, poultry microbiology, poultry nutrition, poultry economics, poultry processing, product quality, turkey production, food safety, and extension. Taken together, the integrated research, extension, and education activities will improve the sustainability and viability of organic poultry production to meet the food security challenges in the USA and globally.

## OBJECTIVES

The long-term goals of this multi-regional, multi-institutional proposal integrating research, extension, and education is to provide organic poultry producers with innovative, economical, effective and easy to implement strategies for improving the microbial safety, production efficiency, quality, economics and consumer perception in organic poultry farming. The proposal has a total of 11 objectives (6 research, 3 outreach, 2 education). Specific research objectives based on the 4 stakeholder needs are presented below:Stakeholders need 1: Microbial safety of organic poultry and poultry products.Objective 1. Reduce Salmonella and Campylobacter jejuni colonization in organic poultry by in-ovo vaccination of developing embryos.Objective 2. Reduce Salmonella and Campylobacter jejuni in farm and processing environment by application of phytochemical emulsions and encapsulated probiotics.Objective 3. Reduce Salmonella and Campylobacter jejuni colonization in organic poultry by supplementation of drinking water with phytochemical emulsions and encapsulated probiotics.Stakeholders need 2: Gut health and production efficiency in organic poultry.Objective 4. Improve gut health and production efficiency in organic poultry by supplementation of drinking water with phytochemical emulsions and encapsulated probiotics (Lab and field trials).Stakeholders need 3: Product quality and consumer acceptability.Objective 5. Study quality, and consumer acceptability of eggs and broiler carcass obtained from organic poultry supplemented with phytochemical emulsions and encapsulated probiotics.Stakeholders need 4: Consumer perception and cost-benefit analysis.Objective 6. Cost/benefit and consumer perception analysis on the research, extension and education efforts of the project.We will develop a comprehensive outreach program to disseminate the findings of the proposal to avian health professionals, organic poultry farmers and other stakeholders. The project results will be disseminated by a team of young and experienced poultry outreach specialists (4 participating faculty) and stakeholders who have been involved in organic poultry production. The outreach/extension objectives of this proposal are presented below. Please note that the objective numbers are a continuation from research objectives above to maintain continuity and clarity.Objective 7. Disseminate project results to scientific community through conferences, symposia and webinars.Objective 8. Conduct outreach to the

organic poultry community, extension specialists and interested stakeholders through focus group meetings, social media, and workshops.Objective 9. Measure the impact of outreach efforts through surveys and post-program evaluations.Objective 10. Develop instructional materials and incorporate into existing university curriculum.Objective 11. Develop an online certificate program focusing on organic poultry production.

## APPROACH

Obj.1. ReduceSalmonellaandCampylobacter jejunicolonization in organic poultry byin-ovovaccination of developing embryos.A total of 225 fertilized eggs (Cornish cross) will be incubated. On day 18 of incubation, the eBeam-killed-multi-strainor formalin-killed-multi-strainvaccines will be delivered to the embryos as per their groups byin ovoinjection into the amnion. On the day of hatch, the chicks hatched in each treatment group will be placed in individual rearing pens. On day 7, 5 birds from each group will be euthanized, and serum will be collected to measure antibody titer (reflects degree of protection against pathogen). The remaining birds (20 chickens/group) will then be challenged via oral gavage on day 8. After the challenge, 5 birds per group will be euthanized on days 14, 21, and 28for pathogen enumeration in organs.Obj. 2. ReduceSalmonellaandCampylobacter jejunisurvival in farm and processing environment by application of phytochemical emulsions and encapsulated probiotics.The coupons (stainless steel, rubber and PVC plastic) will be individually placed in each well of sterile polystyrene plates followed by addition of 1 ml of specific culture broth medium containingS.Enteritidis orC. jejuni(\~ 6.0 Log CFU). The coupons will be incubated aerobically at 10, or 25°C for 48 h to facilitate biofilm formation. Following incubation, the broth will be removed, and coupons will be gently rinsed with 1 ml PBS in the well. Thereafter, 1 ml of 0, 0.25, 0.5 or 1% of phytochemical (TC, CR, EG, LN) emulsions will be added with a contact time of 1, 5, 10, or 15 min. After phytochemical treatment, the coupons will be tested to enumerate the number of surviving pathogens in the biofilm.Obj. 3. ReduceSalmonellaandCampylobacter jejunicolonization in organic poultry by supplementation of drinking water with phytochemical emulsions and encapsulated probiotics.A total of 240 nineteen-week and 240 forty-week-oldSalmonella-free White leghorn hens will be procured.The birds from each age group will be randomly allocated to probiotic or phytochemical emulsion treatments administeredfor 60 days. On day 14, the birds will be challenged withS.Enteritidis by crop gavage. After 7 days of challenge (day 21 of the trial), eggs will be collected daily from each treatment group and tested for presence or absence of SE until day 60-end of trial. On day 60 of trial, birds from all treatment groups will be euthanized. Cecum, oviduct and liver samples from the birds will be collected for pathogen detection. Similar design will be used to study the effect of phytochemicals and probiotics on pathogen colonization in turkeys and broilers.Obj.4. Improve gut health and production efficiency in organic poultry by supplementation of drinking water with phytochemical emulsions and encapsulated probiotics (Lab and field trials).White Leghorns (34-week-old) will be utilized in the study. There will be 12 replicate hens per treatment, assigned randomly to treatment groups to understand the apparent ileal digestibility (crude protein, amino acids, and metabolizable energy). Birds will be individually housed in PVC coated wire cages. The study will beconducted for 3-week period withad libitumfeed and water. Acid insoluble ash (AIA) (Celite, 2%) added to each diet will be utilized as digestibility marker in feed during the experimental period. Digesta and excreta collection will be performed followed by proximate analysis.Based on the nutrient digestibility study (feeding study I), experimental treatments for on-farm trial will be generated by narrowing down to the top three performing additives.Similar design will be followed at University of Minnesota to perform experiments with Turkeys.Obj.5. Study quality, and consumer acceptability of eggs and broiler carcass obtained from organic poultry supplemented with phytochemical emulsions and encapsulated probiotics. Sensory analysis of meat will be performed by trained sensory panels to assess consumer acceptability and intensity of overall impression, flavor, juiciness and tenderness using 9 point hedonic and 5-point just about right scales. Sensory analysis of eggs will be performed byconsumer triangle tests to determine if consumers can detect a difference between the control eggs and the eggs subjected to the phytochemical or probiotics treatments. The effect of phytochemical emulsion and probiotic supplementation on the chicken meat and egg quality during refrigerated storage will be determined.Obj.6. Cost/benefit and consumer perception analysis on the research, extension and education efforts of the project.There are two sub-objectives associated with this objective. Sub-objective 1 will study the benefits and costs of the strategies. Comparison of the economic benefits and costs will be evaluated using a benefit cost analysis using a standard budgeting technique. This will capture the economic costs of the implements including the intervention, changes in time associated with growth, or other changes in the input side of production. Sub-objective 2 will develop a survey to understand the impact of the project\'s innovative strategies (in-ovovaccination, phytochemical emulsions, probiotics) on producers and consumers.Obj.7. Disseminate project results to scientific community through conferences, symposia and webinars.Extension and outreach activities will be conducted to help organic producers and industry stakeholders make their operations profitable and sustainable. To that end, in the first year, stakeholder advisory panel along with extension co-PDs will be invited to meet with the organic poultry producers across the participating states to discuss appropriate dissemination of results. These discussions will be used to identify areas for improvement and discussed with the

research and education teams to further develop a comprehensive outreach program.Obj.8. Conduct outreach to the organic poultry community, extension specialists and interested stakeholders through focus group meetings, social media, and workshops.The extension team in collaboration with regional partners and stakeholder advisory panel will provide workshops for poultry farmers to disseminate the research findings. Workshops and hands-on activities will be used as tools to facilitate effective learning in participants.Obj.9. Measure the impact of outreach efforts through surveys and post program evaluations.UConn, UKY, and UMN will develop surveys to understand the impact and needs of organic poultry producers on food safety, nutrition and health, animal welfare, and the well-being of birds, human health, and environmental health. Follow-up assessments such as post-program evaluations will be distributed to participants at meetings and other direct contact programs.Obj.10. Develop instructional materials and incorporate into existing university curriculum.The research conducted from obj #1-6, will provide additional material on impact of novel strategies on organic poultry production. The research data will be developed into teachable curriculum and integrated into current Poultry courses taught at the participating institutions.Obj.11. Develop an online certificate program focusing on organic poultry production.Online certificate course:The course will be implemented first at UConn and will be modified for use by other collaborating Universities and/or extension/outreach professionals across the country. This certificate course will be designed on the Blackboard eLearn platform.The certificate course will be equivalent to a 1 credit course for university students with 12-14 hours\' worth of class material. Building Partnerships for Farmer-led Research in Ohio
Douglas Jackson-Smith, Ohio State University

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# Fostering Sustainable Organic Cotton Production in the Us Through Research and Outreach on Organic Regenerative Practices

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| **Contract / Grant No.** | 2023-51300-40849 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Mughu Bagavathiannan |
| **Performing Institution** | Texas A&M University |

## NON-TECHNICAL SUMMARY

There is a critical need for expanding organic cotton area and production in the US due to rapidly increasing consumer demands for organic cotton products and very low domestic supplies. Achieving this will require a coordinated effort among researchers, Extension specialists, and broader industry stakeholders. The long-term goal of this project is to sustainably expand organic cotton production in the US Cotton Belt through the promotion of regenerative production practices. The Specific objectives of this project are: 1. Partner with long-term organic cotton producers to observe agronomic practices, track soil health, conduct economic evaluations, and identify sociological constraints and opportunities; 2. Evaluate agronomic, ecosystem, and economic benefits of locally suitable regenerative practices; 3. Evaluate weed suppressive potential of advanced breeding/already developed cotton lines for utilization in organic production; 4. Expand adoption of organic production practices through collaborative extension and demonstration activities; 5. Provide educational opportunities to train the next generation of research and extension scientists and organic practitioners. These objectives were developed based on extensive discussions with various stakeholders involved in organic cotton production and marketing.Understanding the agronomic, economic, and marketing strategies employed by long-term organic cotton producers is critical in our efforts to increase organic cotton production in the US Cotton Belt. Through field visits and discussions, we were able to establish a 4-year partnership with organic cotton producers managing a total of 63 certified/transitioning organic fields, spanning across New Mexico, Texas, and Tennessee. These fields include transitioning (\<3 yrs) and certified organic operations ranging from 1 to 12 years in duration. These organic cotton producers have agreed to collaborate throughout the duration of the project and are enthusiastic to learn about new management practices, soil health, and carbon marketing opportunities in working with the team. A total of 23 conventional cotton fields in an adjacent locality will also be included as a basis for comparison. Thus, a total of 86 fields will be studied over 4 years.The Objective 1 of the proposed OREI project will directly involve these 86 cotton fields covering approximately 7500 acres in Texas (56 fields), 3000 acres in New Mexico (24 fields), and \~100 acres in Tennessee (6 fields). In Texas, the fields will comprise two equal sets of irrigated and dryland cotton since both are common, whereas in NM and TN all fields are irrigated. In collaboration with these organic cotton farmers, we will study the impact of agronomic production practices followed by each participating farmer on cotton growth, pest incidence (weeds, insect pests, diseases, nematodes), yield, and quality over a period of 4 years (Objective 1a). By connecting with these organic producers and studying their operations, our goal is to identify production practices that have been viable for them and also identify where challenges still exist, and improvements could still be made. These producers may have already overcome major adoption barriers since they have been successfully growing organic cotton over a number of years; however, the sustainability of these practices is unknown, especially from the soil health standpoint. For example, a farmer relying heavily on tillage for weed control may be able to successfully grow the crop short-term, but this practice can severely compromise soil health over the long-term. By closely monitoring soil health indicators (Objective 1b), we will be able to determine which practices are promoting cotton yield without jeopardizing soil health in the long run and which ones need improvements. Our contact farmers have agreed to share the information on input costs and sale prices, which will be used to conduct a partial budget analysis and determine the economic sustainability of their operations. The economic analysis will also include the benefits of soil health promotion measures obtained with regenerative practices such as cover cropping (Objective 1c). These farmers will also be engaged in socioeconomic investigations to understand barriers and opportunities for organic production (Objective 1d). Collaboration with these farmers will also help us understand their operations for thorough scientific investigations of their practices and socio-economic constraints and opportunities.In Objective 2, fully-replicated small-plot experiments will be conducted in certified organic fields in New Mexico, Texas, and

Tennessee over a 4-year period to evaluate specific regenerative management practices currently not in common use by farmers in the region. The experiments in Tennessee are expected to assist with expanding organic cotton research and outreach activities to the Mississippi Delta. In addition to providing locally-relevant research data, these plots will allow for experiential learning of regenerative practices as well as serve as demonstration venues. Additionally, evaluations will be carried out to select cotton varieties with weed-suppressive potential for utilization in organic production (Objective 3).The project will develop and deliver outreach/extension programs to foster continued growth of the organic cotton industry in the US Cotton Belt (Objective 4). The outreach activities also include broader stakeholder engagement for establishing partnerships among various parties involved in organic cotton production, marketing, and consumption. Furthermore, a robust educational activity is planned for training the next generation of scientists and practitioners, utilizing the broad range of field activities planned as part of this project (Objective 5).Overall, this project addresses critical stakeholder-identified needs. It is anticipated that the findings will greatly advance our understanding of organic cotton production practices that are profitable and sustainable. This will eventually promote the implementation of best management practices and help increase the acreage and production of organic cotton in the US. Goals / Objectives The long-term goal of this project is to sustainably increase organic cotton production in the US Cotton Belt through a partnership with organic cotton producers. This will be accomplished via developing the necessary agronomic knowledge on regenerative cotton production practices, facilitating field implementation of such practices through innovative outreach activities, promoting market opportunities by partnering with broader industry stakeholders, and implementing educational programs to train the next generation of researchers, agronomists, growers, and industry stakeholders.The specific objectives of this project are:Partner with long-term organic cotton producers toevaluate the impact of current agronomic practices on cotton growth, pest incidence, soil fertility, yield, and qualityestablish regional soil health and carbon baselines to track outcomes of regenerative production practices that create quantifiable changes in soil health, soil carbon, and greenhouse gas emissionsconduct economic evaluations on various agronomic practices and soil health measures to determine practices that are profitable and sustainableattain a deeper understanding of adoption constraints and opportunities associated with organic cotton production in the US Cotton BeltDevelop locally suitable regenerative practices to advance agronomic, ecosystem, and economic benefits of organic cotton productionEvaluate weed suppressive potential of advanced breeding/already developed cotton lines for utilization in organic productionExpand adoption of organic production practices through collaborative extension and demonstration activitiesProvide educational opportunities to train the next generation of research and extension scientists and organic practitioners Project Methods Objective 1. Assessment of existing organic cotton operationsIn this objective, we will work closely with organic cotton producers identified across NM, TX, and TN. In each state (except TN), the sites will be grouped into 4 treatments (T1-3, CS1-5, CL≥6, T0) based on the duration of organic production: 1) transitioning (T1-3; ≤ 3 yrs), 2) certified short-term (CS1-5; 1 to 5 yrs into certified production), 3) certified long-term (CS\>6; 6 to 12 yrs), and 4) conventional (T0). Thus, we have a total of 14 fields/treatment group in TX (56 fields; 28 each in irrigated and dryland) and 6 per group in NM (24 fields). In TN, there will be three fields each for treatments #2 and #4. At the beginning of the project in Year 1, we will conduct a detailed survey of all 86 fields to understand the soil characteristics and management practices used.In collaboration with these organic cotton farmers, we will study the impact of agronomic production practices followed by each participating farmer on cotton growth, pest incidence (weeds, insect pests, diseases, nematodes), yield, and quality over a period of 4 years (Objective 1a). By connecting with these organic producers and studying their operations, our goal is to identify production practices that have been viable for them and also identify where challenges still exist, and improvements could still be made. These producers may have already overcome major adoption barriers since they have been successfully growing organic cotton over a number of years; however, the sustainability of these practices is unknown, especially from the soil health standpoint. By closely monitoring soil health indicators (Objective 1b), we will be able to determine which practices are promoting cotton yield without jeopardizing soil health in the long run and which ones need improvements. We will conduct a partial budget analysis and determine the economic sustainability of their operations. The economic analysis will also include the benefits of soil health promotion measures obtained with regenerative practices such as cover cropping (Objective 1c). These farmers will also be engaged in socioeconomic investigations to understand barriers and opportunities for organic production (Objective 1d). Collaboration with these farmers will help us understand their operations for thorough scientific investigations of their practices and socio-economic constraints and opportunities.Objective 2. Develop locally suitable regenerative practices to advance agronomic, ecosystem, and economic benefits of organic cotton productionOn-station field experiments will be conducted in four locations (Las Cruces, NM; Lubbock, TX; College Station, TX; Memphis, TN), one site per location, to evaluate various regenerative practices. These four locations represent two major environmental gradients/regions (arid/semi-arid: Las Cruces, Lubbock; and moist: College Station, Memphis). The dryland vs irrigated production will be compared in Lubbock since both systems are common in the region. In NM, College Station-TX and TN, the plots will be irrigated on an as-needed basis. The experiment will be arranged in an RCBD design with five treatments of tillage and novel weed control combinations (i.e. programs), and replicated four times. Soil samples (1 composite sample made of 10 sub-

samples in each plot, 15 cm depth) will be collected at the beginning of the study in Year 1 and again at the end in Year 4, for monitoring changes to the 12 soil health metrics (soil pH, soil EC, cation exchange capacity, extractable phosphorus, phosphatase enzyme activity, extractable potassium, total nitrogen, wet aggregate stability, dry bulk density, soil organic carbon, soil respiration, and microbiome composition).Objective 3. Evaluate weed suppressive potential of advanced breeding/already developed cotton lines for utilization in organic productionTwo released cultivars, CA 4014 and CA 4015 (Maeda et al. 2022) and 20 advanced breeding lines (candidate cultivars) available in Dr. Dever\'s program, along with currently used check cultivar FM 958 (PVP 200100208, PI 619096) will be evaluated to identify those that show potential for weed suppression (total 23 lines). These will include deep-rooting, high-yielding, 18-16-3507, and high-quality okra-leaf 18-06-205. Pedigrees of the strains include germplasm released in previous awards, thrips tolerant CA 4005 and CA 4006 (Wann et al. 2017), abiotic stress resilient CA 4007 (Dever et al. 2020) and 4008 (Dever et al. 2022), and high fiber quality CA 4009 and CA 4010 (Kelly et al. 2021). In the TX High Plains, the field experiments will be conducted in five environments (Halfway, TX: center-pivot irrigated; Lubbock, TX: rainfed and furrow irrigated; and Lamesa, TX: rainfed and pivot irrigated) across two years.Objective 4. Expand adoption of organic production practices through collaborative extension and demonstration activitiesTo develop a successful outreach program, we will engage regional organic cotton producers and member-based and non-profit organizations at the center of knowledge dissemination activities. For outreach activities, we will utilize the collective knowledge and experience of the producers identified in this project in TX, NM, and TN as well as the Co-PDs of the project who have extensive experience with outreach. AgriCenter International, for example, attracts 1.3 million visitors annually. Engaging county extension agents is also an essential component of our outreach efforts. To evaluate and accelerate the sustainable outcomes for organic cotton production, we will work with Field to Market: The Alliance for Sustainable Agriculture to utilize their free Fieldprint Calculator (https://calculator.fieldtomarket.org/). The Organic Center (TOC) and the Organic Trade Association (OTA) will directly assist the project with a host of outreach activities. The combined reach of the two organizations\' social media pages is over 140,000 individuals for Facebook, and over 80,000 followers for Twitter. The newsletters have a combined reach of over 24,000 individuals.Objective 5. Provide educational opportunities to train the next generation of research and extension scientists and organic practitionersTexas A&M University-College Station (1860 land-grant and Hispanic Serving Institution/HIS) will establish an organic cotton summer undergraduate research program in collaboration with Prairie View A&M University (1890 land-grant, Black Serving), Texas A&M University-Kingsville (Hispanic Serving), Texas Tech University (Hispanic Serving), and New Mexico State University (Hispanic Serving), centered on organic cotton production and sustainability. This program will be an eight-week (June and July) paid research, outreach, and leadership program specifically designed with two-weeks of hands-on field experience in one of the organic cotton experimental field locations. We will also support selected undergraduate students from the cohorts to participate in professional meetings and present their findings. Additionally, most of the Co-PDs have formal teaching appointments handling undergraduate and graduate courses. Learnings from this project will be integrated into the teaching curriculum. A total of 35 undergraduate courses and 5 graduate courses will be benefited from across the 7 educational institutions. At the AgriCenter International (TN), the organic research sites will be used in STEM education, which reaches about 10,000 school students annually from across the Mid-South region. Progress 09/01/23 to 08/31/24 Outputs Target Audience:The key target audiences for this project include organic cotton farmers, Texas Organic Cotton Marketing Cooperative (TOCMC), county extension agents, organic cotton ginning mills, organic cotton merchandisers, carbon market providers, USDA-Risk Management Agency (RMA), The Texas Organic Farmers and Gardeners Association (TOFGA), National Center for Appropriate Technology (NCAT), graduate and undergraduate students, as well as the general public interested in learning organic crop production. Changes/Problems:The 2024 field season marked the first year of this project, and as expected, we refined several protocols throughout the process. We anticipate that the 2025 field activities will be more streamlined and efficient. Extreme weather conditions in Memphis (TN) and Las Cruces (NM), occurring shortly after cotton planting, resulted in poor stand establishment, and replanting was not feasible. However, these sites will continue to be part of the project during the 2025 field season. What opportunities for training and professional development has the project provided?During the summer of 2024, an undergraduate intern from Texas A&M University-Kingsville actively participated in field activities at the College Station site. The student gained hands-on experience in experimental design and agronomic data collection related to organic cotton experiments. Additional undergraduate students will be recruited to participate in the project during the upcoming field season. This project also supported professional development opportunities for a diverse group of participants during the reporting period, including two PhD students, one MS student, one postdoctoral research associate, and six undergraduate student workers/interns. These individuals were involved in various aspects of agricultural experimentation, field data collection, non-chemical weed control, and organic agriculture practices. How have the results been disseminated to communities of interest?The research team participated in the Organic Cotton Field Day held in late August 2024 in Lamesa, Texas. We are now preparing to present our findings at upcoming conferences, including the American Society of Agronomy Meeting, the Beltwide Cotton Conferences, and the

Weed Science Society of America Annual Meeting. What do you plan to do during the next reporting period to accomplish the goals?In the next reporting period, the team will continue collaborating with organic cotton producers to collect soil samples for monitoring various soil health metrics, including the analysis of soil microbial diversity. On-station experiments will also continue into the second growing season across all four participating sites. Additionally, we will initiate sociological investigations and engage in relevant outreach and educational activities to further support the project\'s goals. Impacts What was accomplished under these goals? Objective 1. Assessment of existing organic cotton operations During the Spring and Summer of 2024, organic cotton growers in the Texas High Plains were identified and recruited for on-farm research partnerships. These partnerships aim to document current agronomic practices and outcomes. The participating farmers were selected through various platforms and farmer networks, resulting in a group of 55 growers across different categories: transitioning organic (0-3 years), certified short-term organic (3-10 years), and certified long-term organic (\>10 years). Comprehensive data on organic cotton agronomic performance and weed infestation were collected mid-season and prior to harvest. The data are currently being analyzed and will be presented at upcoming professional meetings. Objective 2. Develop locally suitable regenerative practices to advance agronomic, ecosystem, and economic benefits of organic cotton production Replicated on-station field experiments were initiated in Fall 2023 with cover crop planting at four locations: College Station, TX; Lubbock, TX; Las Cruces, NM; and Memphis, TN. In early Summer 2024, an organic cotton variety was planted at each site. The study included five specific organic weed control and conservation tillage treatments, along with a conventional cotton check. The primary goal was to reduce the number of tillage passes while maintaining effective weed control in organic cotton production. The experiments proceeded successfully at the College Station and Lubbock, TX locations. However, adverse weather conditions in Las Cruces, NM, and Memphis, TN, during early summer resulted in poor cotton stand establishment, with insufficient time to replant at those sites. In the two Texas locations, comprehensive agronomic and weed control data were collected throughout the growing season. Objective 3. Evaluate weed suppressive potential of advanced breeding/already developed cotton lines for utilization in organic production Replicated multi-site field experiments were conducted in the Texas High Plains during the summer of 2024 to evaluate the growth and weed-suppression capabilities of advanced organic cotton breeding lines (candidate cultivars) from Dr. Dever\'s program. The experiments were carried out at two locations: Halfway, TX, under overhead irrigation, and Lubbock, TX, as a rainfed system. Agronomic performance and weed densities associated with the various organic cotton lines were systematically monitored and documented throughout the growing season. Objective 4. Expand adoption of organic production practices through collaborative extension and demonstration activities The research team participated in the Organic Cotton Field Day held in late August 2024 in Lamesa, Texas. We are now preparing to present our findings at upcoming conferences, including the American Society of Agronomy Meeting, the Beltwide Cotton Conferences, and the Weed Science Society of America Annual Meeting. Objective 5. Provide educational opportunities to train the next generation of research and extension scientists and organic practitioners During the summer of 2024, an undergraduate intern from Texas A&M University-Kingsville actively participated in field activities at the College Station site. The student gained hands-on experience in experimental design and agronomic data collection related to organic cotton experiments. Additional undergraduate students will be recruited to participate in the project during the upcoming field season. This project also supported professional development opportunities for a diverse group of participants during the reporting period, including two PhD students, one MS student, one postdoctoral research associate, and six undergraduate student workers/interns. These individuals were involved in various aspects of agricultural experimentation, field data collection, non-chemical weed control, and organic agriculture practices. Publications

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# Enhancing the Viability of Grass-fed Dairy Production in the U.s.through Comprehensive Research and Extension

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## NON-TECHNICAL SUMMARY

Consumer demand for 100% grass-fed dairy products continues to rise. Dairy producers are seeking information about successful transition and management of grass-based dairy systems that maintain herd health and production, milk quality, and farm economics. Producers also seek information on management practices and strategies that support financial viability. Our specific objectives include enhanced data collection on cost of production, economical soil and forage production and management, animal husbandry and nutrition, and milk nutritional and sensory quality. This project aims to increase the success and viability of grass-fed dairy production operations by conducting research and education programs that address the needs of farmers, stakeholders, and consumers.The information generated from this project will be disseminated through a combination of education and outreach strategies to encourage learning and improvement of grass-fed management practices across a wide range of farms located throughout the U.S. Goals / Objectives Our overarching goal is to build on the knowledge gained through our recent OREI (2018-02802) to address remaining knowledge gaps in practices and strategies at the soil, plant, and animal levels that maximize farm success and viability into the future. While our research provided essential foundational understanding of these systems and their unique challenges, additional needs for both research and education emerged that must be addressed to further production, consumption, and farm viability. Our specific objectives below include enhanced data collection on cost of production, economical soil and forage production and management, animal husbandry and nutrition, and milk nutritional and sensory quality. This project aims to increase the success and viability of grass-fed dairy production operations by conducting research and education programs that address the needs of farmers, stakeholders, and consumers.Project objectives: Our interdisciplinary team, with the guidance from our major stakeholders, aims to enhance grass-fed dairy production through the following objectives:Objective 1: Identify key management strategies that enhance farm viability through expanding economic benchmarking.Objective 2: Understand grazing and youngstock management impacts on internal parasitism risk, animal health and productivity, and markers of ruminal development.Objective 3: Identify soil and forage management strategies that enhance forage productivity and quality and are resource efficient.Objective 4: Understand the nutritional and sensory quality of grass-fed milk to inform market growth and expansion strategies.Objective 5: Strengthen knowledge, skills, and networks among farmers, processors, and technical service providers. Project Methods Objective 1.1-Expand the data collection and participants in the financial benchmarking program: Through this project we aim to expand our financial Benchmark program to include at least 30 grass-fed dairy farms annually over 3 years. Data will be entered into the DairyTRANS workbook that was updated for grass-fed producers through the last project.Objective 2.1- Quantify the impacts of grazing management on gastrointestinal parasite burden in organic grass-fed dairy cattle and identify impact on milk production: In year 2, ten lactating herds will be monitored over the grazing season for gastrointestinal parasite burden and milk production. Fecal Egg Counts (FEC) will be taken at turnout and repeating every 4 weeks. Samples of freshly dropped cattle dung (n=10) will be collected and taken to the laboratory for copromicroscopic diagnosis of GIN infection. Milk production in these herds will be monitored by DHIA report data.Objective 2.2- Investigate impact of grazing management and calf milk feeding (quantity and duration) on youngstock resiliency to gastrointestinal parasites, breeding performance and productivity in first lactation: In years 2-3 of the project, a subset of 10 farms will be selected and fecal samples will be taken from calves for FEC to assess parasitism at first turnout and every 3 weeks over the grazing season. For these farms, ongoing survey data will be collected relating health, reproductive and breeding outcomes, and DHIA reports will be used to follow milk productivity during first lactation.Objective 2.3- Evaluate the interaction of forage quality and milk feeding duration on calf and heifer growth and markers of ruminal development: In years 2-3, a feeding trial will be conducted at the University of New Hampshire. Forty-eight newborn dairy calves will be assigned to the experimental diets in a randomized complete block design with a 2 x 2 factorial arrangement of treatments. All calves will receive 4L of colostrum in

the first 12h of life. On d2 of life, calves will be fed 6L/d milk until d14, followed by 8L/d from d15 to 21, and 10L/d from d22 to 90 (short) or d22 to 180 (longer milk duration). Calves will be blocked by birth date and sex and, within block, randomly assigned to 1 of 4 treatments as follows: 1) low-quality alfalfa-grass hay+ milk for 3 months, 2) low-quality alfalfa-grass hay + milk for 6 months, 3) high-quality alfalfa- grass hay + milk for 3 months, and 4) high-quality alfalfa-grass hay + milk for 6 months. The experiment will continue until heifers and steers reach 9 months of age to fully evaluate the impact of weaning (3 or 6 months) on growth and markers of ruminal development. Measurements will include daily DMI, bi-weekly BW, and skeletal measures along with blood samples for indicators of ruminal development.Objective 3.1- Identify management strategies that enhance forage productivity and quality: The experimental design will be a randomized complete block with four replications and a factorial arrangement of two treatment factors: 1) 3 grass species and 2) N treatment. Total N supplied via applied amendments will be held constant across the treatments except for the control which will have no N, and a second chilean nitrate treatment applied at twice the N rate as the other products. At each harvest, DM yield and forage quality will be measured. Prior to each harvest, 5 soil cores will be collected within each plot to a depth of 30cm and analyzed for nitrate and ammonium.A second experiment will compare the N supply provided to a companion perennial grass from several legume inclusion rates. The experimental design will be a randomized complete block with four replications and a factorial arrangement of three treatment factors: 1) grass species, 2) legume inclusion, and 3) N fertilizer rate. The first factor will include two perennial cool season grass species. The second factor will be inclusion of alfalfa at 0, 25, 50, or 75%. The third factor will be N fertilizer rate of 0, 25, and 50 kg N ha-1 as Chilean nitrate.Objective 3.2- Characterize soil nutrient dynamics on grass-fed dairy farms: Soil fertility status will be surveyed on approximately sixty fields from organic grass-fed dairy farms in VT, NY, OH, and PA to characterize trends related to production. Just prior to first harvest soil samples will be collected from a 5m x 5m area by compositing 10 soil cores. Samples will be collected from the 0 to 15, 15 to 30, and 30 to 60 cm depths and analyzed for pH, carbon, nitrogen, and extractable P and K. Samples from the 0 to 15 cm depth will also be analyzed for buffer pH, organic matter, extractable Ca, Mg, B, Mn, and Zn.Objective 3.3- Evaluate the interaction between forage quality and molasses supplementation level on ruminal fermentation and methane emissions: A four-unit dual-flow continuous culture fermentor system (Dillard et al., 2019) will be inoculated with rumen fluid from dairy cows managed under Penn State Institutional Animal Care and Use Committee protocols. In Year 1, treatments will be in a 2 x 2 factorial arrangement as follows: 1) high-quality herbage plus liquid molasses at 10% of total DM fed; 2) high-quality herbage plus liquid molasses at 5% of total DM fed; 3) low-quality herbage plus liquid molasses at 10% of total DM fed; and 4) low-quality herbage plus liquid molasses at 5% of total DM fed. Fermentors will be operated for four, 10-day periods. Effluent samples will be collected on days 8 to 10 for analyses of DM, ammonia-N, volatile fatty acids, and bacterial protein synthesis. Samples of diet and effluent will be analyzed for DM, organic matter, crude protein, fiber, starch, water soluble carbohydrates, and minerals. Nutrient digestibility and methane output will be quantified per the methods of Dillard et al. (2018).Objective4.1- Expand understanding of grass-fed milk sensory quality\'s relation to farm management and processing: Three lots of processed grass-fed milk will be collected from each of the three major regional processors, every other month, over a three-year period. In addition, we will collect market samples from nine randomly chosen retail outlets in the Northeast each quarter. Lastly, we will collect raw milk samples from randomly selected grass-fed milk farms that supply the three major producers. We expect to assess raw milk samples from at least three farms per regional processor per quarter. Raw milk samples will be pasteurized at UVM. They will then be chilled and presented to the DSA panel blindly in a random order to be evaluated cold, in triplicate using the PAA and QI methods. An aliquot of each sample that is assessed by the UVM DSA panel will be submitted for fatty acid and β-carotene analysis as described below.Objective 4.2 Identify the β-carotene content and fatty acid content and profile in grass-fed milk to assess their applicability as potential biomarkers of authentication of grass-fed milk as well as the nutritional quality of grass-fed milk: We will conduct a study on grass-fed farms to perform an intensive sample collection to robustly determine and quantify the content of fatty acids and β-carotene in grass-fed milk. Over a period of two years, we will collect weekly milk samples at six grass-fed farms and determine the fatty acid content and profile and β- carotene. In addition, other milk types, such as conventional milk and organic non-grass-fed milk, will be collected in parallel and used as a reference. Milk will be analyzed for fatty acid content and profile using established methods (Kraft et al., 2003). Total fatty acid profile will be determined by gas liquid chromatography (GLC) with flame ionization detection in combination with GLC-mass spectrometry in electron ionization mode. β-carotene will be determined via solvent extraction followed by ultra-high performance liquid chromatography-photodiode array detection according to the method by Chauveau-Duriot et al. (2010). Progress 09/01/23 to 08/31/24 Outputs Target Audience:Project outreach goals include reaching and disseminating practical research-based information derived from the project to no fewer than 1000 organic dairy farmers, organic certifiers, technical service providers, and milk buyers across the United States. The expectation is that outreach efforts will ultimately serve to expand and enhance the ability of producers and the related support industry to grow and market high quality grass-fed milk. To reach our target audiences, we will reach out to farmers and other stakeholders with whom we have established relationships through our previous OREI projects and ongoing Extension activities. In addition, press

announcements will be developed in advance of each outreach activity including the on-farm workshops, conferences, and webinars. These will be distributed through traditional media outlets, as well as project partner social media channels including Facebook, Instagram, and Twitter. We will also use popular agriculture communication channels, especially those that attract organic farmers and those who work with them, such as Odairy (an email listserv serving the organic dairy industry with a membership of more than 500 farmers and others) and organic and sustainable agriculture associations. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?One graduate student and one technial received training to develop sensory techniques and basic skillls. This was a 6-part training for a total 18 hours education. Students and technical support learned theDescriptive Sensory Analysis (DSA) how to use the Profile Attribute Analysis (PAA) that could then be used to relate to farm-level variables. How have the results been disseminated to communities of interest?Objective 5.1- Strengthen our national network. In 2024, 452 copies of A Farmer\'s Guide to Grass-fed Dairy Production developed under our last research project were distributed to farmers and partnering organizations across nine states: IA, IL, IN, MA, MD, NY, PA, WI, and WY. In addition, to help advertise our work more widely, the following communications were distributed: Flyer for April 3 event sent to Organic Valley, Maple Hill Creamery, Family Farmstead, NY Grazette newsletter, NOFA-NY, and NODPA (online and March newsletter). Elam Stolzfus (PA farmer) wrote something about the grass-fed guide in Topsoil Magazine and put our phone number with it, prompting farmers to call requesting a copy. August 2024 Flyer for October 31 event sent to Organic Valley, Maple Hill Creamery, Family Farmstead, and mailed to list of farmers who had attended events and signed our mailing list who were within 2.5 hours of the location. Objective 5.2- Building knowledge and skills. The following presentations and events were hosted by project staff: Desrochers, R. and S. Ziegler. Dairy and Beef Sensory Session. Northeast Grazing & Livestock Conference, January 25th-27th, 2024. Amherst, MA.Roy Desrochers and Sara Ziegler attended and provided a 2.5-hour presentation on grass-fed beef and dairy sensory research. They also provided outreach to attendees providing information on the new project and opportunities for farmer participation. Flack, S. and S. Ziegler. Developing the Grass-Fed Organic Milk Market. Prograssive Conference, February 20, 2024. Utica, NY.. Sarah Flack and Sara Ziegler attended and had a table at conference sharing resources and conducting outreach to potential farmer participants. Healthy Soil, Pasture & Forage, April 3, 2024. Fort Plain, NY.Heather Darby, Sarah Flack, and Sara Ziegler hosted an all-day workshop focused on soil health and fertility, grazing and forage management for grass-fed dairy operations. They also provided information on past, current, and upcoming research opportunities through this project. Sensory Basics Workshop at the UVM Ext. NWCS Annual Field Day, July 25, 2024, Alburgh, VT.Roy Desrochers facilitated a 2-hour workshop on the basics of objective sensory analysis with a focus on 100% grass-fed milk, craft beer, local hops, and maple syrup. He also provided outreach to attendees providing information on this research project. Milk Sensory workshop for Family Farmstead farms, August 1, 2024. Worchester, NY.Roy Desrochers, Heather Darby, and Sara Ziegler supported Tom McGrath in an all-day workshop focused on milk sensory evaluation and management at the farm and processor level that can help contribute to the production of high-quality grass-fed dairy products. Sensory Basics Workshop at the UVM CALS Annual Retreat, August 21, 2024, South Burlington, VT. Roy Desrochers facilitated a 1.5-hour workshop on the basics of objective sensory analysis with a focus on 100% grass-fed milk, 100% grass-fed beef, and locally produced honey. He also provided outreach to attendees providing information on this research project as well as active UVM projects with other grass-fed products. Pasture Walk, September 19, 2024, Schenevus, NY. Sarah Flack, Kurt Cotanch, and Sara Ziegler hosted a pasture walk for 100% grassfed dairy farmers interested in discussing and learning more about grazing management to improve pasture forage quality, pasture plant species, plant diversity and soil health. Also discussed was how milk production, quality and flavor can be changed as forage species and quality changes. Introduction to Sensory Science presentation for UVM Science Café, September 21, 2024, Burlington, VT. Roy Desrochers facilitated a 2-hour workshop on the basics of objective sensory analysis with a focus on 100% grass-fed milk and maple syrup to a group of high school students from across Vermont. He also provided outreach to attendees providing information on this research project, as well as other active UVM projects using sensory to help local farmers and producers. Nutrition for the Grass-fed Dairy Cow: How forage quality and management impact milk production and quality, October 31, 2024. Fort Plain, NY. Kurt Cotanch, Sarah Flack, Heather Darby, and Sara Ziegler hosted an all-day workshop focused on dairy cow nutrition and forage quality. They discussed forage quality analysis and how farmers can interpret the test results as well as how forage quality and the resulting nutritional quality and milk production potential are impacted by management factors such as harvest timing and storage. They also discussed creating a forage inventory for the farm to plan out how to feed the various quantities and qualities of forage on the farm through the winter to optimize milk production and milk quality. Sensory Analysis Workshop for the Association of Africans Living (AALV) in Vermont, November 6, 2024, Burlington, VT. Roy Desrochers facilitated a 2-hour workshop on the basics of objective sensory analysis with a focus on 100% grass-fed milk to a group representing the AALV. This is a group of young adults learning about food systems in Vermont including dairy. He also provided outreach to attendees providing information on the this research project as well as other active UVM projects using sensory to help local farmers and producers. The following outreach materialswere developed through this

project in 2024: Northeast Organic Dairy Producers Association Newsletter. November 2023 issue. Managing Soil Fertility and Other Lessons on Grass-fed Dairies.https://nodpa.com/files/2023_11_November_NODPA_News.pdf Graze Magazine. December 2023 issue. Looking at grassfed\'s nutrient challenges. https://www.grazeonline.com/digital-back-issues 2023 Cost of Production on Grass-fed Dairy Farms in the Northeast.https://uvmd10.drup2.uvm.edu/d10-files/documents/2024-12/2023-CostOfProduction-Article.pdf Grass-fed Dairy Production Practices and Farmer Perceptions: Results from a survey of grass-fed dairy producers in the US.https://uvmd10.drup2.uvm.edu/d10-files/documents/2024-12/2024-GF-Survey-Results-Article.pdf A Guide to Assessing Forage Quality for the Dairy.https://uvmd10.drup2.uvm.edu/d10-files/documents/2024-12/A-Guide-to-Assessing-Forage-Quality-for-the-Dairy.pdf What do you plan to do during the next reporting period to accomplish the goals?Objective 1.1- Expand the data collection and participants in the financial benchmarking program. In January-April 2025, financial data will again be collected from 32 grass-fed dairy producers across three states in the Northeast using the Dairy TRANS 20.20 analysis tool during in-person and phone interviews. An summary of the cost of production will be created and shared with the target audience. Objective 1.2- Identifying strategies that support economic viability of grass-fed dairy farms. Publicationsummarizing the findings from these analyses are in process and will be published in 2025. Objective 2.1- Quantifying the impacts of grazing management on gastrointestinal parasite burden in organic grass-fed dairy cattle and identify impact on milk production. This objective is planned to start in Year 2. Initial planning amongst the research team was conducted at an annual team meeting in August, 2024. This objective will be reported on next year. The remaining activities for this objective are not slated to start until 2025. Initial planning discussions were held at the annual team meeting in August 2024. Objective 2.3-Evaluate the interaction of forage quality and milk feeding duration on calf and heifer growth and markers of rumen development. This objective is not slated to start until 2025. Initial planning discussions were held at the annual team meeting in August 2024. Objective 3.1- Identify management strategies that enhance forage productivity and quality. Four trials will be continued in 2025 to investigate forage management strategies that enhance productivity and quality. Forage and soil samples from 2024 are in process of being analyzed in the laboratory for forage quality parameters and when complete will be summarized in a research report in early 2025. Objective 3.2-Characterize soil nutrient dynamics on grass-fed dairy farms. Eight dairy farms provided management data that was entered into the Cornell Whole Farm Mass Nutrient Balance calculator. We will collect more data sets in 2025 and hope to align our cost of production questionnaire more with this data collection so that we can investigate the economic interpretation of these balances as well. In addition, the soil fertility survey was started with the collection of soil cores at 0-15, 15-30, and 30-60cm depths on 22 fields on 6 farms across two states. Farms were selected based on their acreage, stored forage production, and other management factors with the goal of obtaining a spread of management systems that would help elucidate trends in soil fertility and their connection to management practices. On each farm, up to two hay fields and two pastures were sampled. Fields were selected by the farmer through a conversation with technical staff who helped identify sites that were under relatively consistent management from year to year and the farmer possessed decent records for nutrient applications and forage harvests/grazings. In each field, a point was GPS located where a bulk density sample was collected at the three depths. Surrounding that point, a composite sample of 5 cores was collected at the three depths. The maximum depth achieved, if less than 60 cm, was noted along with the number of attempts out of 10 maximum attempts to obtain the 5 cores. Over the winter, participating farmers will be interviewed to obtain fertility and yield record information. The research team will finalize plans for additional sampling to be conducted in 2025. Objective 3.3-Evaluate the interaction between forage quality and molasses supplementation level on ruminal fermentation and methane emissions. This objective is not slated to start until 2025. Initial planning has been conducted. ?Objective 4.1- Expand understanding of grass-fed milk sensory quality\'s relation to farm management and processing. The UVM trained Descriptive Sensory Analysis (DSA) taste panel will complete a second year of sensory to replicate 2024 data collection. We are currently completing the analysis of the full year\'s sensory data, with a focus on: The variation of flavor quality in the market for conventional, organic, and 100% grass-fed milk Differences in flavor quality between the major brands of 100% grass-fed milk. Differences in flavor quality between brands of organic milk. Differences in flavor quality between local conventional milk. Differences in the flavor quality of lots of milk produced at the participating dairies, processors, and identification of processing factors that may cause these differences Differences in the flavor quality of raw milk between farms that supply 100% grass-fed milk, and factors or farming practices that may be responsible, especially for off-flavors Seasonal differences in milk flavor quality that may be reflective of cow diet and eating habits Ultimately, we will be looking to identify factors at the farm, or in processing at the dairy, that affect the flavor quality of milk. Once identified, we will work with farmers, and dairy producers, to adjust practices to produce the highest quality milk possible, leading to increased sales and sustained market success. Objective 4.2-Identify the β-carotene content and fatty acid content and profile in grass-fed milk to assess their applicability as potential biomarkers of authentication of grass-fed milk as well as the nutritional quality of grass-fed milk. In 2025 the team will continue analyzing the remaining samples collected in 2024 on the GC. We will also assess collected data more deeply for potential biomarker applicability and will assess the influence of pasteurization on fatty acid composition in grass-

fed milks. We will also compare fatty acid composition data with the sensory data described in objective 4.1 to investigate potential correlations. Further, a second year of milk samples will be collected and analyzed as in 2024. We will also finalize a methodology for the β-carotene quantification and begin measurements. Finally, a literature review will be completed and published and an abstract submitted to the American Dairy Science Association. Impacts What was accomplished under these goals? Objective 1.1- Expand the data collection and participants in the financial benchmarking program. In January-April 2024, financial data were collected from 32 grass-fed dairy producers across three states in the Northeast using the Dairy TRANS 20.20 analysis tool during in-person and phone interviews. The participating farms managed on average 60 crossbreed cows, 295 acres of crop land, purchased 34.2% of their herd\'s forage needs. Overall, the total cost of production on grass-fed dairy farms in the northeast averaged \$49.63 which was similar to what was found in previous years. Objective 1.2- Identifying strategies that support economic viability of grass-fed dairy farms. Eleven top-performing farms were selected from a group of approximately 49 organic grass-fed dairy farms across the northeast that participated in a cost of production study between 2018-2023. The farms were selected due to their higher levels of profitability defined by their 1) return on assets (ROA) 2) return per unpaid labor hour and 3) cost of production per hundredweight equivalent. The farms were visited in the spring of 2024 and asked a list of 24 questions relating to their management, perspectives, and farming philosophies. In addition, the financial data from 2019-2022 were utilized in statistical analyses to investigate correlations between the cost of production and key production and management factors. The top-performing farms identified feed quality and quantity, genetics, and labor efficiency as the three most important practices impacting their profitability. Similarly, these in addition to facilities and infrastructure were identified as the biggest challenges to maintaining profitability. Objective 2.2- Investigate impact of grazing management and calf milk feeding (quantity and duration) on youngstock resiliency to gastrointestinal parasites, breeding performance, and productivity in first lactation. A national survey was developed and distributed to 509 grass-fed dairy farms nationally in early 2024. The survey included some similar questions as the 2019 survey regarding farm characteristics, farmer demographics, and perceptions, but included more detailed questions regarding youngstock rearing, herd health, and grazing management. One hundred forty-four farmers returned the survey for a response rate of 28.3%. Responses were collected from nine states with most farms located in NY, OH, IN, and PA and most (75%) identified as belonging to a Plain sect community. Average herd size was similar to the previous survey at 48 milking cows, predominantly crossbreeds, milked year-round producing 10,599 lbs milk per cow annually at 4.4% butterfat and 3.4% protein contents. Farms reported producing forage on 4.1 acres per mature cow, however, 72.3% reported they still needed to purchase 36.4% of their herd\'s stored forage needs. In youngstock management the survey identified that calves are fed an average of 1.75 gallons of milk per calf per day for 5.1 months. In addition, breeding age averaged 16.5 months but ranged from 11 to 30 months. Additionally, calf health issues were influenced by calf rearing system with more contact-heavy group systems seeing respiratory diseases for example, more than individual rearing system. While calf mortality was most commonly associated with scours, dystocia, and respiratory disease, 71.5% did not administer any vaccinations to calves. ?Objective 3.1- Identify management strategies that enhance forage productivity and quality. Four trials were initiated in 2024 to investigate forage management strategies that enhance productivity and quality. Firstly, a perennial grass variety trial with 38 varieties of six perennial grass species replicated five times was established in the late summer of 2023. In 2024 this trial was harvested four times assessing yield at each harvest. A representative sample was collected at the first harvest and is currently in process of being analyzed in the laboratory for forage quality parameters. Secondly, a trial investigating legume inclusion rates (0-50%) was established in the late summer of 2023. Plots were also mechanically harvested to assess yield at four cuttings across the season. After each cutting, nitrogen treatment rates (0-50 lbs N/ac) were applied via Chilean nitrate. At the beginning and end of the season soil samples were collected to be analyzed for ammonium and nitrate nitrogen content. Third, a trial investigating fertility amendment efficacy for managing forages organically was established late summer 2023. Plots containing three species of grasses mixed with and without red clover and alfalfa were established. Plots were mechanically harvested four times throughout the season to measure yield. After each harvest plots were treated with Chilean nitrate, liquid dairy manure, poultry manure, or no additional fertility source. At the beginning and end of the season soil samples were collected and analyzed for soil ammonium and nitrate nitrogen content. Objective 3.2- Characterize soil nutrient dynamics on grass-fed dairy farms. Eight dairy farms provided management data that was entered into the Cornell Whole Farm Mass Nutrient Balance calculator. The farms ranged in size, milk production, and management.Most farms fell within feasible ranges for N and P balance per acre but due to low production fell outside feasible for N and P balance per hundredweight. All were considered outside the \"optimal zone\". In terms of K balance, most farms were outside the feasible range per acre and all were outside on a per hundredweight basis. However, farms that made their own forages were inside the feasible range per acre and close to zero. ?Objective 4.1- Expand understanding of grass-fed milk sensory quality\'s relation to farm management and processing. The UVM trained Descriptive Sensory Analysis (DSA) taste panel completed its sensory evaluation on a total of 168 milk samples.The samples that were assessed included: 35 - 100% grass-fed milk samples shipped directly from the manufacturer to UVM, every other month, starting in Feb. 2024.

(February, April, June, August, October, and December.) 30 - raw 100% grass-fed milk samples provided by individual grass-fed farms supplying the processors above. 103 - Market purchased milk samples which included 25 samples each quarter representing grass-fed milk from various processors. The raw milk that was collected each quarter from participating farms was pasteurized using a Kleen-Flo® 2 Gallon Benchtop Pasteurizer prior to tasting. All samples were presented blind and in random order to the trained UVM DSA panel. In addition, all samples were replicated resulting in a total of 336 evaluations by the trained UVM DSA panel. The UVM DSA panel used Profile Attribute Analysis (PAA), a standard modification of the Flavor Profile Method of Sensory Analysis, to assess each sample. Objective 4.2- Identify the β-carotene content and fatty acid content and profile in grass-fed milk to assess their applicability as potential biomarkers of authentication of grass-fed milk as well as the nutritional quality of grass-fed milk. In 2024, the research team separated cream from over 600 milk samples. Over 300 of these samples had lipids extracted and were prepared for gas-liquid chromatography analysis. Two large batch runs on the GC were performed which processed 226 samples which included all market samples, direct-from-manufacturer samples, quarterly individual farm samples, and a subset of the weekly farm samples. Fatty acid composition analysis was started on the samples. This analysis compares the output from the GC to 98 identified fatty acids to identify and quantify the fatty acid profile of each sample. Several initial compositional trends noted differentiating grass-fed and conventional milk samples that may serve as potential grass-fed biomarkers upon further detailed analysis. Publications

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# Using Organic Mushroom Stems as Sustainable Feed Resource for Organic Poultry Production

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| **Contract / Grant No.** | 2023-51300-40853 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Jayant Lohakare |
| **Performing Institution** | Prairie View A&M University (Texas 1890 LGU) |

## NON-TECHNICAL SUMMARY

To promote organic poultry production, we will use edible organic button mushroom stems (MS) as a feed ingredient. The mushroom market size is estimated to be \$50.3 billion and \~300 mushroom farms in the US are producing about 435,000 tons of mushrooms in 2020. Currently, \~8-10% of the MS and damaged mushrooms are discarded in landfills causing environmental pollution. The specific research objectives are to develop a process to produce dried MS as a feed resource for organic poultry production; perform chicken feed trials to evaluate how much dried MS could replace soybean meal (SBM) and impact performance, meat and egg quality, and study effects on health and immunity by doing challenge studies. Approaches: discarded MS will be cleaned using multistage mechanical processing, dehydration and grinding to produce sustainable shelf-stable high value protein feed ingredients. Effects on growth performance, egg production, egg and meat quality in chickens will be determined by feeding diets containing different levels of MS by replacing SBM. By conducting challenge studies against pathogens that cause necrotic enteritis in chickens, we will evaluate the health benefits of feeding MS. The expected outcomes are that the organic dried MS feed ingredient generated will help to maximize poultry production efficiency and reduce the dependence on SBM. This transition will help to increase food security, increase income for farmers and reduce food waste thereby benefiting our environment. Through this integrated collaborative project, we will provide research and educational opportunities to minorities, students, and poultry and organic farmers through extension programs. Goals / Objectives -develop a process to produce dried mushroom stem (DMS) as a feed ingredient.-perform chicken feed trials to evaluate how much DMS could replace soybean mealandimpact meat and egg quality.-identify the benefits of feeding DMS on chicken health by challenge studies usingpathogens.-provide experiential learning opportunities for students and outreach to organicpoultry producers. Project Methods 1\. Develop a process to produce DMS as a feed ingredient. We will collect button mushroom stems from the mushroom farm and subject them to following steps: (1) remove the surface dirt from the mushroom stems using a nylon roller brush; (2) cleaned mushroom stemswill be subjected to steam for a short period of time to disinfect any microbial contaminant and will be freeze-dried; (3) DMS will be milled, stored in an airtight container and evaluated for its composition, nutritional value, and food safety using established lab protocols; and (4) performtechno-economic analysis (TEA) to determine the cost for producing DMS.2. Perform chicken feed trials to evaluate how much DMS could replace SBM and impact meat and egg quality. For this objective, three separate studies will be conducted to utilize DMS as a protein source for poultry to evaluate the effects of DMS in poultry production. (1) study on layer pullets of 10-12 weeks age to study the effects of replacement of SBM with different levels of DMS in the diet on the performance; (2) study on layer hens of 30 weeks age to study the effect of replacement of SBM with different levels of DMS on the egg production performance, egg quality, and grading; and (3) six-week trial study on broilers to evaluate the effects of replacement of SBM with different levels of DMS on the growth performance, gene expression in muscle and fat tissues.3. Identify the benefits of feeding DMS on chicken health by challenge studies using pathogens. We will conduct three studies using roosters and broilers: (1) digestible amino acids and metabolizable energy of DMS will be determined using a rooster assay to use DMS as a feed ingredient for broiler studies; (2) different inclusion rates of DMS to replace SBM will be evaluated in a challenge study with broilers where growth performance, blood chemistry, immunity, intestinal development, salmonella inhibition, and gut microbiome will be measured in Salmonella challenge model; and (3) the effects of DMS on growth, immunity, and gut health will be evaluated in necrotic enteritis broiler challenge model.4. Provide experiential learning opportunities for students and outreach to organic poultry producers. To ensure availability of a well-qualified diverse pool of agricultural workers we(1) involve currently enrolled students in animal, poultry, and biotechnology majors from the three universities in research experiments mentioned above during academic year to increase the number and diversity of livestock industry professionals in the agricultural workforce;and (2) execute extension and outreach activities involving local small and medium-sized farmers providing education about organic mushroom stem harvesting and poultry

production practices. Progress 09/01/23 to 08/31/24 Outputs Target Audience:Students, farmers, and researchers in mushroom production, organic agricultural farmers, and animal and poultry science-related people are targeted at this time. Next year, we will present the results from these studies to agriculture and poultry farmers during Agriculture Field Days at the respective universities, as well as scientists and researchers at academic conferences. Changes/Problems:No problems or changes are necessary. None. What opportunities for training and professional development has the project provided?One research assistant professor at UH, and one graduate student each at UH, PVAMU, and UGA are recruited for this project, and several UG students have learned mushroom collection, handling, and processing. In addition,one postdoctoral associate at PVAMU was involved in washing, cleaning, andprocessingmushroom stems and will conduct research on poultry as planned in this project. How have the results been disseminated to communities of interest?At this time, no data has been disseminated.However, one MS student presented an oral presentation on the mushroom supplementation in chickens to other animal science students, scientists, and researchers at the Association of Research Directors (ARD, 2024) Symposium in Nashville, TN on April 07, 2024. Two workshops were conducted (one at Poultry Center, PVAMU and one at Tyler, Texas) for farmers to learn how to grow mushrooms,collect and prepare mushroom stems, and use them in poultry feed. What do you plan to do during the next reporting period to accomplish the goals?1. Begin formulating poultry feed incorporating DMS, considering the nutritional composition of the samples to ensure balanced nutrition. 2. Fine-tune and finalize the design and begin the development of the cleaning and sanitizing machine. 3. Use DMS powder in the poultry studies at Prairie View A&M University and the University of Georgia for feeding trials. 4. Continue exploring partnerships with mushroom companies to scale-up the production of DMS and make it more widely available to organic poultry producers. 5. Plans are underway to organize training sessions for local farmers using extension agents on these projects from PVAMU and UGA, focusing on sustainable mushroom cultivation practices and the potential use of mushroom stems in poultry feed. These sessions will provide students with opportunities to engage with industry professionals and gain practical knowledge of agricultural practices. 6. We are exploring possibilities for students to participate in farm visits and workshops, allowing them to gain hands-on experience in the agriculture and animal industry sectors. We plan to work with all team members on this project in terms of interpreting the analytical results generated and preparing manuscripts for publication.A review article on mushroom feeding in chickens is in the developing stage, and we hope to get it published before the next reporting period. Impacts What was accomplished under these goals? For major goal 1: Develop a process to produce dried mushroom stems (DMS) as a feed ingredient. Progress: Milestone 1.1 Develop a process to collect and prepare mushroom stems for further processing. The process of upcycling mushroom stems is developed effectively, involving cleaning the mushrooms and cutting the stems from the roots. The process begins by feeding the mushroom stems into a vibrational bowl feeder, which directs them to a custom-designed cutting machine that meets specific requirements. Following the cutting stage, the mushrooms are washed to ensure cleanliness. While commercially available vibrational bowl feeders and washing machines are utilized, the cutting machine is tailored to precise specifications for optimal performance in the upcycling process. The mushroom root trimming machine is designed to trim the roots of mushrooms. The stems are trimmed from the root and can be utilized as chicken feed. The mushroom stems are placed into a vibrational bowl feeder, which aligns and feeds them into the cutting machine developed at University of Houston (UH). The main function of the bowl feeder is to ensure that the mushroom is delivered into the cutting machine in a single line. After exiting the bowl feeder, a linear actuator was employed to move each mushroom forward through the stem cutting machine. Computer vision algorithms will determine whether the mushroom needs adjustment to reorient the stems. After alignment and rotation, if necessary, the blade cuts the mushroom stem, extracting the usable portion for chicken feed while discarding the waste root. This separation is facilitated by swinging arms that turn and place the mushrooms into their respective sorted piles. Milestone 1.2 Develop methods to freeze dry and pulverize DMS into a fine powder for use in chicken feed formulation. We have successfully doubled our freeze-drying capacity by purchasing freeze dryers (two at UH and (1 at PVAMU). This enhancement will allow us to process larger quantities of mushroom stems, supporting the scaling up of our DMS production. We visited mushroom farms to become familiar with the mushroom cultivation process and to educate workers on properly harvesting button mushrooms and caps. The students gained valuable hands-on experience and insights into the mushroom industry. Two sets of samples were prepared to investigate the effect of different cleaning methods on the mushroom stems\' composition: Method 1: The freshly harvested mushroom stems without the dirt were cleaned using soft nylon brushes to remove surface dirt and freeze dried. Method 2: The harvested mushroom stems with the dirt were washed with water to produce dirt-free stems. This method was used to check how many soluble minerals, vitamins, and other compounds get lost during the water washing process. For each cleaning method, both brown and white varieties of button mushrooms were used. The cleaned and washed mushroom stem samples were freeze-dried until the moisture content was reduced to below 5 wt.%, to enhance the shelf-life of mushroom stem. Due to the low moisture content of the freeze-dried mushroom stems, a single milling method was sufficient to pulverize the stems into a fine powder in a few minutes, minimizing energy consumption. Dried mushroom stems were then finely ground into powder to be infused into chicken feed. Milestone 1.3 Determine the chemical composition and

nutritional value of DMS. 1. Amino Acid Profile Analysis: We have completed a comprehensive amino acid profile analysis for both brown and white mushroom stems, comparing brush-cleaned and water-washed samples. All the essential amino acids required by poultry are present in all the samples. White mushroom stems generally showed higher amino acid content compared to brown mushroom stems. Water washing appeared to have a more significant impact on the amino acid content of white mushroom stems compared to brown mushroom stems. 2.Vitamin Analysis: We conducted a detailed vitamin analysis, focusing on B vitamins, vitamin E family, vitamin D family, and vitamin A family in DMS. Notable results include: Vitamin B2 (riboflavin) is present in relatively high concentrations (16.3 to 19.5 mg/kg) across all mushroom stem samples, with levels significantly higher than those found in common chicken feed ingredients such as corn, wheat, and soybean meal. Vitamin D2 levels were significantly higher than Vitamin D3 levels in all samples, potentially offering a valuable plant-based source of this essential nutrient for organic poultry diets. Interestingly, water-washed samples showed higher levels of vitamins across several families, including both water-soluble (B vitamins) and fat-soluble vitamins (E, D, and A), compared to brush-cleaned samples. 3. Heavy Metal Analysis: We performed heavy metal analysis to ensure the safety of DMS as a feed ingredient. Arsenic, cadmium, lead, and mercury were detected in low concentrations across all samples, ranging from 0.1-0.255 ppm, 0.02-0.021 ppm, 0.1 ppm, and 0.01 ppm respectively. These levels are well below the maximum allowable limits for animal feed (2 ppm for arsenic, 1 ppm for cadmium, 5 ppm for lead, and 0.1 ppm for mercury), indicating that the mushroom stems are safe for use in poultry feed. Interestingly, water-washed samples showed slightly higher levels of some heavy metals, particularly arsenic in white mushroom stems (0.125 ppm in brush-cleaned vs. 0.255 ppm in water-washed). Despite these variations, all values remained well within safe limits. For major goal 2, we are collecting enough dried mushroom stems for poultry studies at Prairie View A&M University. Once we have the required amount of DMS material, we will conduct studies on broilers and layers to measure the effects on performance and product quality. For major goal 3, we have sent brown and white dried mushroom stemproduct for rooster assay studies at the University of Georgia at Athens to evaluate the nutritional value of the DMS. After the rooster assay studies, we will send more DMS materials for chicken health and challenge studies at UGA. For major goal 4, Students from the University of Houston have been actively involved in sample preparation and data collection for mushroom stem processing studies. This includes participating in collecting, cleaning, and freeze-drying procedures. While the detailed analyses (amino acid, vitamin, and heavy metal studies) were conducted by external laboratories, students gained valuable experience in sample preparation, data interpretation, and understanding the importance of these analyses in feed development. Students are continuously involved in various aspects of the research project, including literature reviews, data analysis, and assisting in the optimization of processing methods. Along with the students and researchers at the University of Houston, researchers and students at Prairie View A&M University were involved in collection, washing, cleaning, freeze drying, and preparing the samples for poultry studies. The students from the Department of Engineering at UH were actively involved in designing and developing a machine for cutting, cleaning, and washing mushroom stems. DMS samples from brown and white mushrooms are sent to UGA to conduct rooster assay studies. Students are being involved in these animal studies too. Publications Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: K. G. Stamps*, A. A. A. Abdel-Wareth, and J. Lohakare. 2024. The Use of Mushrooms in Poultry Nutrition: Current and Future Prospects. Association of Research Directors Symposium. Nashville, TN. April 06-09, 2024. Presented orally by Ms. Stamps. USDA-NIFA-OREI support was acknowledged.

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# Economic Consequence of Parasite Loads and Selection Opportunities for Parasite Resistance in Organic Dairy Cattle

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| **Contract / Grant No.** | 2023-51300-40857 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Chad DeChow |
| **Performing Institution** | Pennsylvania State University |

## NON-TECHNICAL SUMMARY

Organic production systems provide natural environments that confer animal wellbeing advantages. However, antimicrobial and pesticide restrictions coupled with grazing requirements create challenges related to both internal and external parasites, some of which are also a zoonotic risk. We will collect fecal samples to determine internal parasites and record horn flies and other external parasites on approximately 3,225 organic dairy animals from multiple breeds. This data will facilitate estimation of losses due to compromised animal health, particularly for calves, and subclinical reductions in milk yield. All animals will be genotyped so that we can conduct genomic analyses and identify regions of the genome associated with parasite susceptibility. A citizen science mobile app will also be developed to allow public contribution of parasite data. We will deliver information about parasite control through a wide variety of outreach events and a web platform that will include herd-specific economic selection indexes. This effort directly addresses OREI priorities related to selection of animal breeds and genotypes adapted to organic systems and demonstration of educational tools for Cooperative Extension personnel and other professionals who advise producers on organic practices. The long-term goal of this project is to reduce economic losses from parasites and through development of genomic selection and crossbreeding programs designed specifically for organic production. Goals / Objectives The long-term goal of this project is to enhance the sustainability of organic dairy production by reducing economic losses from parasites and through development of genomic selection and crossbreeding programs designed specifically for organic production. Our supporting outreach objectives will facilitate adoption of genetics tailored organic production by engaging producers in the collection of data and development of selection indexes unique to their management system.The objectives of our project are to1. Quantify the effects endoparasite and ectoparasite load at different life stages on current and future performance.2. Determine breed, crossbreeding, and within-breed genetic effects influence parasite load.3. Develop and deliver project outreach activities to advance knowledge enhancing parasite resistance in organic dairy cattle.4. Engaging producers through an innovative and comprehensive web and mobile app-based outreach program. Project Methods Fecal sampling populationWe aim to collect 5,250 fecal samples during the late summer as parasite exposure is expected to increase over the course of the grazing season. Our sampling plan attempts to balance determining the repeatability of endoparasite levels across grazing seasons and life stage (calf, heifer, cow) with a sufficient sample size for genomic analysis by resampling a portion of animals from the previous year plus new cows. Calves sampled in year 1 will be sampled as heifers in year 2 and as cows in year 3. Calves and heifers that are culled or heifers that have not calved will be replaced with a cohort of the same age in subsequent years. We will aim to sample 500 new lactating cows each year with the remainder representing cows sampled the previous year. If all initially enrolled calves and heifers from year 1 are available in years 2 and 3, we would genotype 3,000 unique animals. However, we estimate that 85% of calves and heifers in years 1 and 2 will be available for sampling the subsequent year resulting in a total of approximately 3,225 unique animals.Ectoparasite evaluation Experimental herds. Herds enrolled in the fecal sampling trial will also be included in evaluation of ectoparasite infestation level using the methods for fly scoring described in the background and preliminary data. Cows and heifers will be visually scored on a scale of 0 (no flies) to 4 (heavy infestation) with pictures taken on a case (moderate to heavy infestation), control (few or no flies) basis. Flies on the side of the cow (primarily horn flies) and face flies will be evaluated separately.Animals will also be observed at least twice annually for other external parasites, including ticks, lice, mange, and ringworm. Animals will be evaluated during fly scoring while on pasture and in winter when many external parasites are more prevalent. Genotyping for other parasites will be conducted on a case, control basis and we estimated 100 case-control pairs for budgeting purposes.Public data contribution. We will develop an application for a citizen science approach where producers can submit pictures of cows with high and low levels of fly infestation. This data will be pooled with the experimental data collected to facilitate expanded genetic evaluations and is detailed more fully in our outreach plan below.Field trial. A field trial will be conducted during

the third and fourth year of the trial at WCROC to demonstrate the effects of selection for horn fly infestation level on fly distribution levels. Genomic PTA for horn fly infestation (described below in genomic analysis section) and breed differences will be used to generate groups of 25 heifers each. One group will include 20 high and 5 low susceptibility heifers, whereas the second group will have the reverse (20 low and 5 high susceptibility). With this design, we aim to address the extent to which the average number of flies per heifer is different between groups versus how numbers of flies are distributed between high and low susceptibility animals within the group. This will help demonstrate the extent to which genetic and breed selection can be used to manage fly infestation levels.Growth and performanceGrowth. Calves enrolled in the study in year 1 will be weighed at birth and then monthly for 3 months after birth. Blood samples will be collected at 48 to 72 hours after birth to determine serum total protein levels using a Brix refractometer. The animals will be weighed again in year 2 (approximately 1 year of age) and year 3 (during first lactation). Heifers will be weighed upon enrollment in the trial during year 1 again in first lactation in year 2.Performance. Herds will be selected that are enrolled in a DHI testing program to determine milk yield, fat and protein yield and concentration, somatic cell count, fertility, and culling. Additionally, we will determine digestive efficiency on a case control basis. Fecal neutral detergent fiber (NDF) and indigestible NDF (iNDF) will be determined as described in our previous work for 50 lactating cows with a high endoparasite load to determine potentially degradable NDF (pdNDF). These will be matched to 50 control cows based on herd, age, breed, and stage of lactation. We will use the same sample for pdNDF determination as used to determine parasite levels. Fecal and feed NDF and iNDF can be used to derive total tract dry matter digestibility and NDF digestibility. However, diet NDF and iNDF are constants in digestibility formulas assuming cows are fed the same diet and the nutrient intake of cows while on pasture can be uncertain depending on fluctuations in pasture quality and intake of pasture. Therefore, pdNDF will be our measure of digestibility for simplicity.Fecal collection. Samples will be collected by inserting a gloved hand in the rectum of cows and heifers and extracting a handful of feces to avoid environmental contamination. For sample collection from calves, we will manually stimulate defecation into a sterile container by inserting a gloved finger into the anus because hand insertion is not feasible due to the size of the rectum.Endoparasite quantification. Parasitic eggs will be separated from feces using the Wisconsin sugar float method. Using our previous procedures, we will microscopically determine fecal egg counts of protozoal oocysts and helminth nematodes, cestodes, and trematodes to the family or genus level. Subsequently, qPCR will determine the relative differences among genus and species for 500 case-control pairs. We elect to use a case-control approach to provide a manageable workload while validating microscopic fecal egg counts. A two-trait analysis with visual and qPCR scores will be conducted as we have previously described for visual and counts of fly levels.We will release nuclear material from the oocytes using a freeze-thaw method to facilitate DNA extraction with ethanol precipitation. The primary GIN genera we will quantify via qPCR include Cooperia, Haemonchus, Trichostrongylus, Nematodirus, Ostertagia and Strongyloides. We will use a multi-plex qPCR approach with primers designed to amplify unique ITS2 rDNA sequences. qPCR will also be used to quantify Cryptosporidium spp. with particular focus on Cryptosporidium parvum and Eimeria sp). The qPCR procedure can only be used to determine the relative proportions of each species as opposed to absolute proportions because there is no internal independent standard reference gene. Relative abundance will then be multiplied by the total fecal egg count to derive quantities of individual parasites.Genotyping: Hair samples will be collected from all animals to facilitate genotyping. Samples will be genotyped for \~42K SNPs at a commercial lab and forwarded to the Council on Dairy Cattle breeding for imputation to the \~79K genotypes used in national genomic analyses and to receive genomic PTA (gPTA) for traits included in the national genetic evaluation system (yield, fertility, survival, type traits, RFI, etc.); imputation will be done with high accuracy since we are working with AI sired cows. By partnering with some farms with whom we have already worked and collected data, we will be able to leverage previously collected family genotypes to expand the accuracy of genomic evaluations for the current study; many of the cows that were previously genotyped will be dams of those cows that will be sampled in the current study (estimated to be \~400).

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# Expanding Resilient Climate and Pest Protection Systems for Diversified Organic Specialty Crop Producers

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| **Contract / Grant No.** | 2023-51300-40855 |
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| **Investigator(s)** | David Gonthier |
| **Performing Institution** | University of Kentuky |

## NON-TECHNICAL SUMMARY

Diversified fruit and vegetable growers are a hallmark of the organic agriculture industry and movement. Diversification opens market opportunities, hedges risks, conserves biodiversity, and grows healthy communities and local economies. At the same time, diversified organic growers must master the production of many specialty crops with a limited set of tools to combat pests, diseases, weeds, and a changing climate. Some of these tools, like OMRI (Organic Materials Review Institute)-listed pesticides perform sub-optimally and fail to reduce damage from pests and diseases. Mounting evidence suggests mesotunnel protection systems limit pests, diseases, and some extreme weather conditions. However, while mesotunnels reduce the use of OMRI-listed pesticides, consumer concerns over plastic use in agriculture may present new social challenges to the adoption of these plastic-based systems. The overall goal of this four-year project is to expand the organic tool kit to overcome biotic and abiotic challenges to specialty crops in the Southeast, Midwest, and Northeast. Field experiments and on-farm trials with brassica (greens, broccoli), cucurbit (melons and squash), and solanaceous crops (eggplant) will optimize the use of mesotunnel protection systems to control biotic and abiotic stressors (Objective 1). Innovative strategies to incorporate mesotunnels into diversified organic fruit and vegetable rotations will aim to maximize the benefits to growers in each region. Data generated from experiments will be used to determine which mesotunnel-crop combinations maximize grower profits (Objective 2). To understand marketing, policy, and adoption barriers, we will assess grower and consumer acceptability of mesotunnels through surveys, interviews, and consumer preference experiments (Objective 3). Growers and industry stakeholders will provide continuous input to guide the project through an Advisory Panel, surveys, listening sessions, and on-farm trials. Finally, a coordinated regional and national outreach program will reach thousands of growers and millions of consumers to highlight the most promising protection systems (Objective 4). Together, these objectives address five OREI goals and will help the organic specialty crop industry to grow resilient to changing climates and consumer demands to insure the sustainability of the organic industry. Goals / Objectives GoalsThe proposed work will aim to increase the sustainability of the organic specialty crop industry in the Midwest, Northeast, and Southeast regions. Specifically, this project will aim toexpand the organic tool kit to overcome production challenges including pests, diseases, weeds, and social acceptability, while also building resilience to climate change related stressors.The long-term goalsof the proposed project are to:(1) Develop strategies for integrating protection systems into diversified organic specialty crop operations to prevent biotic and abiotic stressors.(2) Developprotection systems to prevent biotic and abiotic stressors that maximize cost-effectiveness.(3) Understand the social acceptance of plastic-based protection systems to guide market, policy, and adoption strategies for the organic specialty crop industry.(4) Showcase the success of these protection systems through outreach to growers and consumers to increase the adoption and social acceptance of these practices.ObjectivesFocusing on organic cucurbit (squash and melons), brassica (kale, greens, broccoli), and solanaceous (eggplant) crops, we will assess mesotunnels (plastic-based fine-mesh protection systems) as they relate to the following objectives:1. Optimize the use of mesotunnels to protect organic specialty crops from biotic and abiotic stressors.2. Assess the economic efficiency of mesotunnels systems for organic specialty crops.3. Evaluate grower perceptions of and barriers to mesotunnel systems relative to other organic protection systems and assess consumer preferences for vegetables produced with mesotunnels versus organic pesticides.4. Outreach: Share the advances in new production systems with organic growers, extension professionals, and other stakeholders through a diverse set of outreach initiatives. Project Methods Activity 1.1. Mesotunnel system efficacy for control of pest, disease, and weather extremes. During Years 1-3, we will conduct field trials on certified organic land at the University of Kentucky (UK) Cornell University AgriTech (CUA) and Iowa State University(ISU). To determine the agronomic efficiency of mesotunnel systems for diversified specialty crop growers, each regional team will assess the impact of mesotunnel systems on spring (brassicas), summer (eggplant or muskmelon), and fall crops (brassicas) produced in each region. Three treatments will be deployed

with four replicates per treatment per crop-season:(1) Mesotunnel system(2) OMRI-listed pesticide system (uncovered)(3) Control treatment (uncovered, untreated)Crop pests and diseases will be monitored weekly by visually observing all plant material in quadrats (3 x 3 ft) every 10 feet in the center bed of each plot. Sticky cards will be deployed 1-week after planting for a 7-day period and 1-week before harvest (for 7-days) to monitor insect pest abundance.Abiotic stressors. We will place temperature, humidity, and dew point loggers within each plot and record climate variables continually for the duration of the experiment (Watchdog). Micro-weather stations (Davis) will collect rainfall, solar radiance, and wind speed estimates. Any extreme weather event (e.g., heavy rain episodes, drought, windstorms, hail) during experiments will be noted to determine if mesotunnels improved productivity in the face of a climate challenge.Yield and produce quality. Total, non-marketable, and marketable yield will be recorded from quadrats (3 x 3 ft) of the center bed every 10 feet in the center bed of each plot. Produce will be weighed and graded according to current USDA commercial standards to determine marketable yields and unmarketable yields related to biotic and abiotic related losses.Activity 1.2. Weed management under mesotunels. Weed management treatments will be integrated into experiments to optimize weed control under mesotunnel systems. For each spring, summer, and fall crop studied, we will use plastic mulch on raised plastic beds and we will implement three weed management strategies (n=4 per treatment) for control of weeds within the inter-bed spaces (furrows):(1) Mesotunnel system + Living mulch(2) Mesotunnel system + Landscape fabric(3) Mesotunnel system + BaregroundLiving mulches will consist of teff in Iowa and Kentucky, while New York will utilize an annual rye/clover mixture.Weed and cover crop density will be measured in two randomly placed quadrats (1 x 1 ft) within the inter-bed space at harvest. All plant biomass will be cut at ground height, sorted, and dried to measure the dry biomass of weeds (broadleaf and grass) and cover crops.Data analysis for Activities 1.1-1.2. For each crop species, an analysis of variance for blocked designs will determine how treatments impacted pests, pathogens, abiotic stressors, weeds, or yield. Additionally, multivariate general linear mixed models will be used to determine relationships between biotic and abiotic stressors and marketable yield.Activity 1.3. Building mesotunnel rotational systems. The timing of each experiment in the spring, summer, and fall will allow for the re-utilization of mesotunnel materials for two to three times per year. Utilizing the marketable yield data from each crop experiment, and the selling price of each crop we will standardize yields across the different crop species by calculating revenue. We will use general linear mixed models to assess which crops generate the most revenue from utilizing mesotunnel systems and how increasing the number of uses per year will increase the revenue generated.Activity 2.1. Cost-effectiveness of mesotunnels. Using the experimental trials performed in Activity 1.1, we will perform a partial budget analysis and develop enterprise budgets to compare costs across labor, supplies, pest/disease control application, fuel, and machinery depreciation and compare these costs to economic efficiencies including marketable yield, profit, average cost ratio, and relative cost-efficiency ratio.Activity 2.2. Cost-effectiveness of weed management strategies. Using the weed management treatments from Activity 1.2, we will compare the profitability and cost effectiveness of weed management strategies under mesotunnel systems. Following economic approaches described in Activity 2.1, we will compare the economic efficiencies of the different weed management strategies.Activity 2.3. Cost-effectiveness of mesotunnel rotational systems. Using the combined results of all experiments in Activity 1.3, we will compare economic efficiency of these diversified systems as described above in Activity 2.1.Activity 3.1. Understanding grower\'s perceptions of barriers and incentives for adopting mesotunnel systems. In Year 1, we will develop a baseline survey instrument to measure growers\' local knowledge of systems, perceptions of pests, disease, and weather risks, and current decision support strategies to manage these risks. Growers that will receive outreach material or participate in on-farm trials will be selected for this survey. In Year 4, an end-of-project assessment will document changes in grower knowledge and adoption behavior as well as to determine what drove these changes.Activity 3.2. Nation-wide survey of perceptions of organic pest, pathogen, weed and climate protection practices. A national level survey will be developed to assess the perceptions of organic growers related to the effectiveness of: (i) OMRI-listed insecticides and fungicides, (ii) row covers and mesotunnel systems, and (iii) other alternatives. We will also collect information on the strategies that growers use to mitigate extreme weather events. Questions will include growers that have used technologies such as mesotunnels or row covers, growers that have heard of these technologies but have not used them, and growers that have never heard of these technologies. The universe of organic growers will be amassed through extension contact lists as well as through Organic-, Fruit-, and Vegetable-Growers Associations.Data Analysis. We will use a variety of quantitative methods to analyze the survey data and assess the future likelihood of adopting mesotunnels and other associated production technologies, including Technology Acceptance, Diffusion of Innovation Theory, factor analysis and Structural Equation Modeling, and Discrete Choice Models.Activity 3.3. Framed laboratory experiment of consumers\' acceptability of and preferences for organic vegetables produced in mesotunnels and other plasticulture production systems. In Years 2 and 3, we propose to use framed laboratory experiments to elicit consumers\' willingness-to-pay (WTP) for organic and local vegetables produced using mesotunnel production systems. We will employ Becker-DeGroot-Marschak (BDM) auctions that have been used extensively to elicit maximum truthful consumer WTP for food attributes. University students and general public consumers will be recruited through the Cornell University Experimental Economics Research Laboratory. They

will be presented with four organic vegetable varieties to perform sensory evaluation of muskmelon (1) produced in mesotunnel systems from NY trials in obj.1, (2) locally produced without row covers, (3) non-locally produced in IA mesotunnel trials, (4) and non-locally produced without row covers. Each option will be accompanied by pictures of production scenes, and how plastics are used in these production systems. Following the affective test method, the consumer participants will observe the appearance, taste the four muskmelon varieties, and then be asked to place sealed bids for a pound of each variety in the auction. Analysis will reveal consumer\'s willingness to pay for local-ness of organic vegetables and isolate the potential impacts of the use of mesotunnels in consumer valuation. Progress 09/01/23 to 08/31/24 Outputs Target Audience:There are three target audiences for this project: Organic produce growers, consumers, and industry leaders across the supply chain. The organic grower\'s audience is focused in the Northeast, Midwest, and Southeast regions of the U.S. Efforts to inform this audience focus on face-to-face and online outreach activities, including on-farm demonstration trials, in-person presentations at grower meetings, a project website, virtual field days (videos), and short social media posts. In year 1, teams focused on building a project website and network building via social media platforms in addition to in-person presentations at growers\' meetings and on-farm collaborations. Through a national-level outreach campaign led by The Organic Center (TOC) that utilizes social media outlets, in partnership with Organic Voices, to expose consumers and industry to the efficacy of protective row covers for not only organic farmers but also for backyard gardens and homesteads. In the first year of this project, TOC focused on the produce industry and consumers as their primary target audience. TOC created a micro-website for the project to engage industry and consumers. The outreach activities\' main messaging goals this year were to engage the industry with the project launch and to update the public on experimental progress. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?Kathleen Fiske, Post Doctoral Scholar, Department of Entomology, UK: Project team coordination, field research and outreach coordination, mentoring of graduate and undergraduate research assistants, developing educational content Elaine Losekamp, MS student, Department of Entomology, UK: Field research experience, mentoring of undergraduate research assistants, developing outreach educational content Alexis Gauger, PhD student, Department of Entomology, UK: Field research experience, mentoring of undergraduate research assistants, developing outreach educational content Mario Reyes, PhD student, Department of Entomology, UK: Field research experience Simon Aaronson, Undergraduate researcher, Department of Entomology, UK: field research experience, developing educational content Yuuki Cherian, Undergraduate researcher, Department of Entomology, UK: Field research experience, developing educational content Kylie Ryan, Undergraduate researcher, Department of Entomology, UK: Field research experience, developing educational content Turner Siddens, Undergraduate researcher, Department of Entomology, UK: Field research experience Smriti Chaudhary, MS student, Department of Horticulture, ISU: Field research experience, mentoring of undergraduate research assistants Ariana DeCleyre, Undergraduate researcher, Department of Horticulture, ISU: Field research experience Joe Hollis, PhD student, Department of Sociology and Criminal Justice, ISU: Development of National survey Ivy Lawson, Undergraduate researcher, Department of Horticulture, ISU: Field research experience Quang (Peter) Ngo, Undergraduate researcher, Department of Horticulture, ISU: Field research experience Akshaya Thinakaran, MS student, Department of Horticulture, ISU: Field research experience, mentoring of undergraduate research assistants Raymond Wilmes, Undergraduate researcher, Department of Horticulture, ISU: Field research experience Kaitlin Diggins, PhD student, Department of Plant Pathology and Plant-Microbe Biology, Cornell University: Field research experience, mentoring of undergraduate research assistants Sean Murphy, Research Associate, Department of Plant Pathology and Plant-Microbe Biology, Cornell University: Supervisor for field research Yu Ping Chang, PhD student,Cornell University: Development of the economic cost data gathering Qualtrics survey How have the results been disseminated to communities of interest?To reach the target audiences of organic growers, consumers, and industry leaders across the supply chain, online and in-person dissemination was initiated. In-person dissemination to organic growers was focused in the three focal regions of Northeast, Midwest, and Southeast. Thirteen face-to-face presentations were given at grower\'s meetings. Two presentations were given at industry-facing conferences focused on the sustainable use and recycling of agricultural plastics. Three presentations were presented to academic audiences in departmental seminars or conferences. Three presentations were presented to governmental agencies through governmental visits or conferences. Additionally, two on-farm trials with participating growers were undertaken in year 1. For online dissemination efforts, two websites and two social media accounts were launched to house and highlight the project findings and outreach materials. A press release announced the project\'s initiation. While the project has only just begun to release video content, aschedule of video releases has been created for year 2. What do you plan to do during the next reporting period to accomplish the goals?OBJECTIVE 1. Each state team will proceed with protective row cover experiments in the spring, summer, and/or fall to study pest protection, weed management, and climate protection as described in the proposal. Analysis of year 1 (2024) data will be summarized into reports for outreach materials, manuscripts, and graduate student theses. OBJECTIVE 2. The economic analysis of year 1 (2024) data will be completed before the start of the year 2 field season. The economic data will be collected for year 2 experiments and analysis will begin. OBJECTIVE 3. The national organic grower\'s survey will be

distributed to growers, analyzed, and summarized into a report. In the summer of year 2 (2025), a consumer field experiment will be conducted in Lexington, KY, at farmer\'s markets to assess consumer perceptions and willingness to pay for vegetables produced with plastic-based row covers. In conjunction with on-farm collaborations with growers, a before and after survey will be conducted to assess organic growers\' willingness to adopt protective row covers. OBJECTIVE 4. Outreach activities and efforts surrounding the synthesis of year 1 results will continue. The results of each year 1 experiment will be translated into video, infographics, and short reports for the online grower, consumer, and industry audiences. Online outreach will be disseminated via social media accounts, the Crops Under Cover! Website, and The Organic Center project micro-website. Students and faculty will report results at grower\'s and academic meetings, workshops, and field days across the three states. On-farm collaborations with growers will be conducted across all three states. In Kentucky, 10-20 grower collaborators will participate in two workshops in the spring of 2025, and a before-after survey will document the grower\'s perceptions of and willingness to adopt these practices. An advisory panel meeting will take place in January of 2025 to report year 1 results and seek direction for years 2-4. Impacts What was accomplished under these goals? OBJECTIVE 1: Kentucky. Experiments tested the efficacy of protective row covers for pest, weed, and climate management in spring-bok choy, summer-eggplant, and fall-napa cabbage (all plots 30ft long, triple rows, N=4 per treatment). Pest control experiments compared two fine-mesh row cover treatments, controls, and organic insecticide treatments. In spring-bok choy, row covers (85g) + org. insecticides increased marketable yield compared to row covers alone, org. insecticides, and control treatments. In summer-eggplant, row covers (85g, tunnel-ends opened at flowering) had higher marketable yield than control, org. insecticides, and row covers (entirely removed at flowering). In fall-napa cabbage, row covers (both 85g & 25g) increased marketable yield relative to control, while org. insecticides did not differ from the other treatments. Weed management experiments compared living mulch (teff or perennial ryegrass), bare-ground control, and landscape fabric within the furrows between plasticulture raised beds (all covered with row covers 85g). There was no difference in weed biomass or marketable yield between treatments in the spring-bok choy or fall-napa cabbage experiments. However, in summer-eggplant, weed biomass was lowest with landscape fabric, intermediate with teff-living mulch, and highest with bare-ground. Marketable yield was higher with landscape fabric compared to the teff-living mulch. Climate protection was monitored by comparing uncovered controls to row cover treatments, however results are still pending. Summer pilot studies were carried out to explore alternative vegetable crops that may benefit from fine-mesh row covers (all plots 30ft long, triple rows, N=1 per treatment; except for green beans \30ft long, single row, N=4 per treatment\). Fine-mesh row covers increased marketable yield in patty pan summer squash, slicing cucumbers, watermelon, and brussels sprouts compared to controls. However, fine-mesh row covers did not impact yield in red bell peppers, basil, and green beans. Iowa. Experiments tested pest, weed, and climate management in spring-broccoli, summer-eggplant, and fall-napa cabbage (all plots 30ft long, triple rows, N=4 per treatment). Pest control experiments compared fine-mesh (85g) row cover, organic insecticides, and control treatments. In spring-broccoli, pest damage was higher in the control compared to the row cover and org. insecticide. Marketable yield of round heads was not different across treatments. However, fine-mesh (85g) row covers had more hollow, but marketable heads than org. insecticide treatment. In summer-eggplant, row covers (85g) had lower unmarketable yield compared to org. insecticide and controls. However, there was no difference between marketable yield between treatments. The fall-napa cabbage experiment is still on going. Weed management experiments compared living mulch (teff or annual ryegrass+crimson clover), bare-ground, and landscape fabric treatments within the furrows between plasticulture-raised beds, all under 85g row covers. In spring-broccoli, there was no difference in marketable yield of round heads between treatments. However, the landscape fabric had significantly greater hollow, but marketable heads compared to the bare-ground control and annual ryegrass+crimson clover. In summer-eggplant, marketable yield was higher in the landscape fabric than in the bare-ground and teff-living mulch. Climate variables were monitored, but results are still pending. New York. Experiments combined pest, weed, and climate management in summer-muskmelon and fall-mini red cabbage (30ft long, triple row, N=4 per treatment). Pest management treatments were applied as fine-mesh (85g) row cover, org. insecticides, or control. Weed management treatments were applied in the furrow between plasticulture-raised beds as annual ryegrass-living mulch or landscape fabric. The experimental design compared (A) ryegrass+row cover; (B) ryegrass+uncovered; (C) landscape fabric+row cover; (D) landscape fabric+uncovered; (E) org. pesticides+landscape fabric+row cover; and (F) org. pesticides+landscape fabric+uncovered. In summer-muskmelon, the dry weight of the ryegrass cover crop biomass was higher in uncovered compared to row cover treatments. However, more than 99% of all aboveground biomass was weeds. Uncovered treatments D and F had higher numbers of striped cucumber beetles compared to row cover treatments A and C. Treatment B had lower Alternaria leaf spot severity (AUDPC) compared to all other treatments. Treatment F and C had more unmarketable fruits compared to other treatments. Treatment E had more marketable fruits compared to all other treatments.The fall - mini red cabbage experiment is still ongoing. Climate variables were monitored, but results are still pending. OBJECTIVE 2: Economic assessment of pest and weed management. For all Obj. 1 experiments, each state team tracked labor, materials, machinery, and input costs related to field preparation, pest and weed management, and harvest activities. Yield and produce price

point was also collected. A Qualtrics survey was designed and field-tested to gather all production costs. The survey and data collection process was refined and field-tested with KY and NY data. Profitability estimates for each treatment in each experiment are currently being analyzed. OBJECTIVE 3: Social acceptance of plastic-based protection systems. A national survey questionnaire was developed to understand organic grower use and perception of row covers and other plastic uses in organic production. This process included surveying all research team members for topics and questions, collaborating with the ISU\'s Center for Survey Research to compile a sampling framework for organic fruit and vegetable growers across 10 states, designing survey dissemination protocol, and IRB submission and approval. The survey will be administered in Januaryof 2025. Consumer perceptions of plastic-based protection systems. A consumer field experiment was designed to study consumer perceptions and willingness to pay for organic vegetables produced with plastic-based protection systems. This field-based study solicits real customers of farmer\'s markets and their preferences for cucumbers grown using plastic-based row cover technologies versus conventionally grown cucumbers. Participants will be randomly assigned to treatment groups with varying levels of information, presented with a price level, and assessed for their willingness to purchase produce. The experiment will take place in the summer of 2025 at farmers markets in Lexington, Kentucky, and aims to recruit at least 500-600 respondents. OBJECTIVE 4: Outreach. An organic grower-facing outreach strategy was developed, including the launch of the \'Crops Under Cover!\' (https://cropsundercover.ca.uky.edu/) website, social media accounts, short project videos, and in-person presentations at grower\'s meetings. The Organic Center (TOC) offered professional development opportunities to all research team members that included training in developing effective social media content, posts, and publication strategies and helped design the research project logo and branding. TOC also developed a consumer-facing website: https://www.organic-center.org/site/enhancing-efficacy-protective-netting-climate-and-pest-resilience and social media posts. See outreach products described under Products and Other Products. Publications Type: Websites Status: Published Year Published: 2024 Citation: Organic farmer outreach website Crops Under Cover! (https://cropsundercover.ca.uky.edu/). University of Kentucky. Launched July 10, 2024. Type: Websites Status: Published Year Published: 2024 Citation: Organic consumer, farmer, and industry outreach website. https://www.organic-center.org/site/enhancing-efficacy-protective-netting-climate-and-pest-resilience. The Organic Center. Launched June 27, 2024. 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Feasibility of mesotunnels for cucurbit production. 43rd Annual LI Agricultural Forum, Riverhead, NY. January 11, 2024. Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Chaudhary, S. and Nair, A. Eggplant Insect and Weed Study. AgDiscovery. Horticulture Research Station, Ames, IA. July 16, 2024. Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Chaudhary, S. and Nair, A. Eggplant Insect and Weed Study. Costa Rica Study Abroad Group. Horticulture Research Station, Ames, IA. July 25, 2024. Type: Other Status: Published Year Published: 2024 Citation: Fiske, K. Addressing the trade-offs of pest protective row covers for integrated pest management in vegetable production. Department of Entomology, University of Kentucky. Departmental seminar. March 28, 2024. Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Dentzman, K. Life is Plastic, its (sometimes) fantastic: A consideration for the socio-economic costs and benefits of agricultural plastics from a growers perspective. Annual Agriculture Food and Human Values conference, Syracuse, NY. June 6, 2024 Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Chaudhary, S. and Nair, A. Eggplants in Mesotunnels. GPSS Symposium. Bessey Hall, Iowa State University. March 18, 2024. Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Chaudhary, S. and Nair, A. Eggplants in Mesotunnels. ISU Fruits and Vegetable Field Day. Horticulture Research Station, Ames, IA.

August 6, 2024. Type: Conference Papers and Presentations Status: Published Year Published: 2023 Citation: Chaudhary, S. and Nair, A. Pest Management Using Insect Netting in Organic Vegetable Productions Systems. Iowa Specialty Producers Conference. FFA Enrichment Center, Akeny, IA. December 8-9, 2023. Type: Conference Papers and Presentations Status: Published Year Published: 2023 Citation: Thinakaran, A. and Nair, A. Effects of Mesotunnels on Pest and Disease Management in Brassica Species. Great Lakes EXPO. Grand Rapids, MI. Poster. December 4-6, 2023. Type: Conference Papers and Presentations Status: Published Year Published: 2023 Citation: Thinakaran, A. and Nair, A. Effects of Meostunnels on Pest and Disease Management in Brassica Species. Iowa Specialty Producers Conference. Akeny, IA. Poster. December 8-9, 2023. Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Diggins, K., Damann, K., Murphy, S. P., and Pethybridge, S. J. 2024. Enhancing organic acorn squash resilience with mesotunnel production systems. Squash bug (Anasa tristis). Proc. APS Annual Meeting, Memphis, TN. P-310. Presentation. 2024. Type: Other Status: Other Year Published: 2024 Citation: Gonthier, D.J. Building resilience to pests and climate with protective row covers. Kentucky Congress Aid Policy Tour. University of Kentucky. Presentation. April 24, 2024. Type: Other Status: Other Year Published: 2024 Citation: Gonthier, D.J. Building resilience to pests and climate with protective row covers. USDA-NIFA Tour. University of Kentucky. Presentation. April 24, 2024. Type: Other Status: Other Year Published: 2024 Citation: Diggins, K., and Pethybridge, S. J. NY field trial plants mesotunnel research. USDA-NIFA OREI Project Advisory Meeting. Virtual presentation. January 11, 2024.

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# Planning for an Upper Midwest Organic Gluten-free Grain Value Chain: Economic, Field, and Stakeholder Data Aggregation

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| **Contract / Grant No.** | 2023-51300-40959 |
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| **Performing Institution** | Michael Fields Agricultural Institute |

## NON-TECHNICAL SUMMARY

A small but growing segment of the Midwest region\'s important organic grain production industry focuses on food-grade grains-higher value grain crops intended for direct human consumption, oftentimes distributed through local processors and manufacturers. The production of food-grade grains for local communities has promoted well-being, rural development and economic growth, and contributed to demand for organic grains. Thus far, food-grade grain production has been dominated by wheat and corn, but oats and buckwheat are grown by farmers in rotation because of their agronomic and environmental benefits; however, a current lack of markets, resources, and processing infrastructure prevents growers from selling these crops at profitable prices. Food-grade grains have not received much attention from public research or extension agencies as they are considered \"minor\" crops; however, our grower-focused nonprofit organizations have received increasing inquiries from farmers regarding resource development to improve information availability for these crops. Preliminary stakeholder discussions have revealed a need for more economic cost/return production data, agronomic management recommendations, crop variety availability and development, processing and end-user capacity, and regional network development. Given the dearth of foundational information related to these crops, we have developed a Planning Project proposal to build the foundation to strategically design a larger project that generates recommendations from fundamental economic and agronomic and crop research, to value chain and market development. During this planning project, we will perform analyses of existing economic information to develop preliminary cost and return estimates for oat and buckwheat production on small and midsize farms in the Midwestat the farm level, as well as adoption by local/regional food businesses. We will address the lack of resources for organic growers in decision making around oat and buckwheat variety selection for food grade specifically, especially for buckwheat, where virtually no variety development has been performed in the region for culinary buckwheat applications. To connect actors throughout the local/regional supply chain to begin network development and create common purpose around identifying opportunites and challenges, we will convene at least six focus groups with seed industry experts, plant breeders, growers, grain cleaners, millers, distillers, chefs, and other end users. Focus group priority setting around field research and supply chain development needs will be used to develop research and economic objectives for an OREI Implementation Proposal. We will also convene a team of regional or transregional collaborators from different supply chain sectors to participate in developing aTier I or II OREI Implementation Proposal to be submitted in the FY2025 funding cycle. In the near term, this project will generate a variety trial report, a cost/returns economic factsheet, and a multimedia report on focus group learnings, to be shared via the web with Midwest grain chain stakeholders.

## OBJECTIVES

Economic Potential: Review and synthesize USDA database cost/return data and conduct interviews with key oat and buckwheat industry actors to begin generating reliable economic data.Agronomic Variety Trials for Oats and Buckwheat: Generate one year of baseline data on vigor, grain quality characteristics (e.g., test weight, groat %, etc.) and yield, by conducting variety trials with readily accessible oat and buckwheat varieties evaluated in an organic system.Stakeholder Network Development: Hold focus groups with growers, processors, end users, and other value chain stakeholders to understand barriers and establish social networks and connections that facilitate the development of markets and supply chains for organic oats and buckwheat; identify agronomic research, education, and outreach priorities; and understand end user interests and needs for regional oat and buckwheat sourcing.Collaboratively develop an Implementation proposal with stakeholders, reflecting the long

term goals of creating a resilient and equitable value chain for Midwest organic buckwheat and oats based on findings fromthe above objectives.

## APPROACH

For Objective 1, we will assess the availability of information about costs of production and returns at the farm level and at the post-farm level for organic oats and buckwheat, through a review of secondary sources and interviews with relevant agencies and stakeholders. This information will provide an initial assessment of the value proposition for farmers and inform the need for additional data collection in the full OREI Implementation Proposal. We will also develop initial estimates of the costs and returns of dedicated value chains for oats and buckwheat using available secondary sources and interviews with key informants, and describe the key information gaps in understanding the value proposition for oats and buckwheat for farmers and the post-farm value chain that would be relevant for the development of a follow-on OREI Implementation Proposal.A graduate student, under the supervision of Dr. Nicholson, will review secondary data sources, collate, and write summary sheets with the outcome of this database review.For Objective 2, we willconduct a variety trial in two sites with at least six currently available oat and buckwheat varieties, each with four replicates. Variety trial plot dimensions will be 10 x 20 ft. and will be conducted on MFAI\'s two certified organic farms in WI. Varieties will be evaluated by measuring early-season vigor and competitiveness with weeds in the first six weeks of growth by conducting stand counts, height measurements, rating canopy cover, and weed counts. Grain yields will be measured with a small plot combine and grain samples will be bagged individually for each plot. Grain will be assessed for quality parameters such as test weight, groat percentage, and beta glucan levels for oat, and for protein content and bran:germ ratio for buckwheat.For Objective 3, we will conductat least six virtual focus groups with distinct categories of stakeholders including farmers \1 for small-scale (\<300 acres) and 1 for mid-size (\>300-1,000 acres) farmers\, oat and buckwheat processors (e.g., cleaners, millers, etc.), buyers/end-users (e.g., bakers, food manufacturers, etc.), crop breeders and seed industry experts, and secondary market experts. We will also hold in-person roundtable/listening sessions at two organic conferences that welcome all of the above groups to holistically discuss oat and buckwheat value chains in winter 2024. Recruitment of participants for these focus groups and roundtables has already been underway.For Objective 4, through the focus groups and other project activities, co-PIs will work to assemble a team of breeders, researchers, technical assistance providers, and other necessary personnel to build a comprehensive and effective OREI Implementation Proposal in an effort to develop a framework that will support the creation of an equitable and resilient oat and buckwheat value chain in the Midwest. Development of an Organic Agriculture Curriculum Yuzhi Li, University of Minnesota

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# Influence of Orchard Grazing on Soil Health and Pest Control While Mitigating Food Safety Risks

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| **Contract / Grant No.** | 2023-51300-40948 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Alda De Andrade E Pires |
| **Performing Institution** | University of California, Davis |

## NON-TECHNICAL SUMMARY

Grazing sheep or other animals to convert cover crops to manure infield has a number of practical benefits such as negating labor and costs associated with manure transport, reducing pests, and increasing soil fertility and soil health. Given these benefits, there has been increased interest in the use of cover crops and livestock grazing in nut orchards (almonds, walnuts and pistachios). However, grazing livestock are natural reservoirs for foodborne pathogens, and diet type can increase foodborne pathogen shedding in manure and affect their survival in the soil. While many growers consider livestock grazing of cover-crops on orchards as a way to enhance soil health and environmental benefits, recent concerns about microbial food safety are limiting expansion of this practice because livestock grazing may introduce pathogens into soil with a potential for transfer to nuts. Therefore, we are proposing a multi-regional integrated research-extension approach to fully assess the benefits of livestock integration via cover-crop grazing on bacterial population dynamics, soil health, pest control and economic outcomes to enhance the value of cover crops while limiting food safety risks in organic orchards in two distinct agroecological regions in California. The overall goal of this proposal is to improve the microbial food safety and productivity of organic nuts while maintaining the value of integration of livestock and cover crops in nut production while limiting food safety risks and environmental impacts, and promoting sustainability and biodiversity. Goals / Objectives Our long-term goal is to facilitate adoption of organicintegrated crop-livestock systems (ICLS) practices within nut and fruit agriculture throughout the United States, by leveraging the research outputs described in this proposal to create a decision analysis tools encompassing food safety risk, economic cost/benefit, soil enhancement, water conservation, and pest management. These tools would be employed by a diverse range of stakeholders (growers, educators, policymakers, certifiers) to implement and regulate these systems in an evidence-based, economical, and sustainable fashion.The overall objective of this proposal is to develop on-farm research plots in which livestock are integrated into perennial nut crop systems in major production zones to quantify the impacts of sheep grazing of cover crops in organic orchards on soil ecosystems, suppression of common pests of high economic importance, food safety risks, and socioeconomic metrics. Our specific objectives are to measure effects of integrated crop-livestock systems (ICLS) on 1) N availability and soil health (Activity 1); 2) presence and persistence of navel orangeworm (Activity 2); 3) determination of the optimal time-interval between grazing and nut harvesting as a function of environmental & soil parameters to reduce foodborne contamination (Activity 3); 4) determination of the economic costs and benefits of grazing sheep in organic tree nut orchards (Activity 4); and 5) development of an outreach program to guide the implementation of ICL systems in nut production (Activity 5). Project Methods Field sites: We will establish field research trials in mature commercial almond, walnut and pistachio orchards located in the Sacramento Valley (SV) and the San Joaquin Valley (SJV) (n=6 trials). Experimental design and management: Four treatments will be established in a randomized split block design with three replicates. Winter cover as main plot treatments and grazing as subplots will be implemented to tease out impacts of cover crop and grazing in isolation or combined. Treatment at the main plot level will consist of 1) planted cover crop (CC) or 2) spontaneous resident vegetation (RV). Grazing treatments will consist of (3) one high density short duration grazing event to terminate cover (G) or 4) ungrazed vegetation (NG), established on subplots by fencing. Plots will be established across the orchard alley on both sides of three tree rows (6 middles). Tree berms will be managed according to grower practices and NG winter covers will be terminated at the time of grazing by mowing. A similar cover crop mix adequate for grazing and to these production zones will be planted at all orchards. Activity 1: Above-ground vegetation biomass and litter quality will be measured before grazing or mowing. Total C and N content of dried above ground plant samples will be measured. Composite soil samples will be taken and analyzed for: Total C and N , POM, pH, CEC, soil inorganic N pools, dissolved Organic C and N pools, Microbial biomass C and N, and Potential Mineralized Nitrogen.Soil samples will be taken in the alleyways at the interface between tree roots and the orchard middles at termination and four weeks following termination to capture shifts in soil health chemical and physical metrics

relevant for assessing salinity (EC), compaction (bulk density) and water capture (infiltration rates). Activity 2: Each year in late October and March, all plots at all orchard sites will be surveyed to determine the abundance of remnant nuts prior to ground cover development and sheep grazing activity and post grazing. Each year in early November, cohorts of remnant nuts infested with navel orangeworm will be placed into the various experimental plots. Each year around March 1 a series of egg traps will be placed into the experimental plots to measure egg deposition by first flight navel orangeworm females. Activity 3: A repeated cross-sectional sampling scheme will be conducted in almond, walnut and pistachios orchards (3 nut types X 2 regions X 3 years),following the treatment : 1) planted cover crop (CC), 2) spontaneous resident vegetation (RV) \main plots\ and 3) high density grazing (G) and ungrazed vegetation (NG) (planted cover crop (CC), spontaneous resident vegetation (NG) \subplots\. Each orchard will be sampled six times following the growing cycle. Soil, fecal, air and leaf samples will be collected and tested for E. coli O157:H7, non-O157 STEC, Salmonella and indicators of fecal contamination. Further molecular analysis ( WGS of isolates and microbiota analysis) will be conducted from a subset of the samples. Environmental factors, treatment and orchard effect will be analysed using multilevel logistic regression models. A decision- making tool using Bayesian Belief Networs. Activity 4: To quantify associated economic costs and benefits, we will begin by conducting three Cost and Returns Studies for organic almond, pistachio and walnut orchards. Once the cost and returns studies are completed for each crop, we will develop an interactive decision tool that incorporates partial budget analysis methods to analyze a producer\'s decision of whether to incorporate animal grazing into their organic tree nut production system. Acomprehensive online and in-person (mixed model) outreach program will be developed to provide training for organic producers adopting crop-livestock integration, and industry leaders who seek to purchase from sustainable suppliers. Progress 09/01/23 to 08/31/24 Outputs Target Audience:The target audiences reached include various stakeholders in organic nut production, including organic growers, researchers, extension specialists, extension agents, policy makers, experts and industry working/ planning to work with integration of livestock in organic nut production systems. They were reached as part of Advisory Board Annual Meeting, workshops and informal education activities (field days, one -to-one meetings with farmers), and grower meetings. To reach our target audience the Organic Center disseminated a press release to publicize the planned research which was picked up and shared in the California Ag Network media channel (see link in the media listing below). The Organic Center also developed a micro-website where a description of the project, updates, and information has been posted. We also launched and maintained a social media campaign surrounding the research, primarily via The Organic Center, but also through our various UC ANR, UC Davis and UC Riverside accounts.The combined reach of our organizations\' social media pages is over 36,000 individuals for Facebook, over 4,800 followers for Instagram, 4,200 Twitter and nearly 1,000 followers on LinkedIn. 1) CA Wool Growers Association, Annual Membership Meeting, August 8, 2024, Paso Robles CA.; 2) 3rd Annual Regenerative Almond Field Day, February 22, 2024. Burroughs Family Farms, Denair; 3) Integrating livestock in organic orchard production in California, Plant and Soil conference, February 2024, Fresno CA; 4) Outcomes and Challenges: Integrating livestock in organic orchard production in California, Agronomy Society of America Meeting, Organic agriculture workshop, Saint Louis, November 2023. Changes/Problems:In the first year, we had some delays with personnel hiring therefore the field trials were postponed one year. The new dates for the field trials are the growing seasons of 2024-2025; 2025-2026 and 2026-2027. The potential grower participants have a cover crop established (ranging from 2 years to \> 5 years), therefore one of the treatments (residual vegetation) was removed from the study design. Therefore, to compensate the sample size in the overall study, we increased number of enrolled sites and total of replicates/ samples per farm. Measures of soil health and nutrient cycling have been revised to two time points (before and after 14d after grazing) to accommodate this change and coincide better with other frequent sampling events for foodborne pathogens and mummy nuts. Given these changes in the experimental design, the insect sampling component of this project has been slightly modified. Cohorts of remnant \"mummy\" nuts infested with navel orangeworm (Lepidoptera: Pyralidae: Amyelois transitella) will still be evaluated before and after grazing, both to observe changes in their abundance as well as survival of overwintering navel orangeworm. Spring monitoring of navel orangeworm egg deposition will no longer be included as a measure of pest control, since the ground covers and grazing will take place prior to this period, and as such we do not expect these practices to have any influence on this pest activity. Previously, spring egg deposition was used as a measure of pest control since participating growers were keeping their ground covers in place late into the spring period, but that is not really reflective of standard agronomic practice in this cropping system. Dr. Goodrich left her position at UC Davis and transitioned to a faculty position at University of Illinois, Urbana-Champaign in August of 2024. She has requested a subaward from UC Davis totaling \$74,492. Dr. Goodrich no longer has cost study staff to assist her and the graduate student with the cost benefit analysis, so she has requested her own summer salary funds in lieu of staff salary funding. What opportunities for training and professional development has the project provided?The project provides support for two post-doctoral researchers and undergraduate students, thus helping to build capacity for future professionals in soil health, agroecology, epidemiology and food safety. Dr. Pires, Gaudin and Wilson mentored one post-doctoral researcher each. Dr Pires also mentored 1 undergraduate student at UC Davis. How have the results been disseminated to

communities of interest?The field trials haven\'t started, so no results to share with the communities of interest. What do you plan to do during the next reporting period to accomplish the goals?We will establish field trials in certified mature commercial almond (3), walnut (3) and pistachio (1) orchards located in the Sacramento Valley and the San Joaquin Valley. Two main treatments will be studied: 1) cover crops and grazing and 2) cover crops and not grazing. Cover crop re-seeding is expected in 2024 Fall, and grazing starting in the Spring of 2025. The field trial(s) sampling for soil health, microbiology and pest control will start in the 2024 fall or 2025 spring (depending on grazing events frequency). We will continue with the planned outreach program (website updates, participation in conferences and grower-based meetings; and advisory board meeting). Impacts What was accomplished under these goals? Growers located in Sacramento Valley and San Joaquim Valley were contacted and invited to participate in the field trials. 3 growers were visited in person to discuss the project and 5 growers (3 Almond orchards, 1 Pistachio and 3 Walnut sites) have been invited to participate. Initial study design is being discussed with the growers (Activities 1-3). The farm sites were selected to represent different growing climates (including soil type and weather patterns), irrigation practices, planted cover crop, and grazing practices. A short survey of their farming practices was conducted prior to the enrollment. Baseline microbiological testing of soil, and fecal samples will start in the fall of 2024 (Activity 3). Optimization of microbiological testing for generic E. coli and foodborne pathogens was conducted in soil, leaves and fecal material (Activity 3). An advisory board meeting was conducted with the participation of representatives of the nut commodities (almond, walnut, and pistachio), no-profit organizations (organic and food safety), consultants, extension farmer advisors and specialist growers. The project was announced through a press release and several media interactions to stakeholders, industry, grower groups and consumers. We developed (hosted by The Organic Center) a dedicated public-facing website for the project (Activity 5). Publications Type: Conference Papers and Presentations Status: Accepted Year Published: 2024 Citation: Cheong S*, Carolyn-Khayd*, Pires A#. Evaluating the presence of foodborne pathogens of crop-integrated crop-livestock in CA orchards (Abst. \# 305). 17th International Symposium on Veterinary Epidemiology and Economics, 2024 ISVEE, November 11-15, 2024, Sydney, Australia. Poster presentation (accepted). Type: Websites Status: Published Year Published: 2024 Citation: Website: <https://www.organic-center.org/site/influence-orchard-grazing-soil-health-food-safety-and-pest-control>.

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# Improving Organic Vegetable Profitability by Identifying Cost-effective Technologies That Optimize Production and Whole-farm Planning in the Southeast: a Planning Grant

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| **Contract / Grant No.** | 2023-51300-40949 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Aaron Turner |
| **Performing Institution** | Clemson University |

## NON-TECHNICAL SUMMARY

The long-term goalof this research is to support the regional adoption of production strategies and precision technologies that improve economic and environmental sustainability of vegetable production in the southeast. The adoption of precision technology over the past couple of decades represents a profound technological transition. However, many of these technologies have seen the highest adoption rates among large row-crop operations, and information regarding their use in specialty crop production (let alone organic vegetable production) is very limited. However, some of these technologies (i.e. sensors for site specific decision making, precision pest management, and automation) could positively impact organic production and farm profitability by increasing yield and/or reducing cost, which would help to overcome the costs of adopting such technologies. Combined with a whole-farm approach to crop mix planning and profitability analysis, technology adoption and investment can be evaluated. Theshort-term goalof this planning proposal is to form a team and collect preliminary data necessary to develop a well-informed full OREI proposal focusing on organic vegetable(Cucurbits and brassicas) and sweet corn production in the Southeast. To achieve this goal, one of our primary focuses will be to fill a knowledge gap with survey data to guide the development of the full OREI proposal. This survey data will be used to identify the optimal crop mix that maximizes profit, and combined with industry and producer participation, will be utilized to identify the most promising production strategies and precision technologies that have the potential to improve and expand organic production in both near (\<5 years) and long term (5+ years). This project will explore these needs and build a team of researchers, producers, and industry for a full OREI submission. Goals / Objectives The short-term goal of this planning proposal is to form a team and collect preliminary data necessary to develop a well-informed full OREI proposal focusing on organic vegetables (Cucurbits and brassicas) and sweet corn production in the Southeast. The long-term goal of this research is to support the regional adoption of production strategies and precision technologies that improve economic and environmental sustainability of vegetable production in the southeast.In order to facilitate the development of a full OREI proposal, this planning grant aims to:Objective 1: Identify current production practices, planning strategies, and production systems:Objective 1a: Identify the most common crop mix, yearly rotations, and production practices using a pilot survey that will guide the development of the full integrated proposal which will utilize a systems approach to improve profitability.Objective 1b: Identify producer\'s perceived and actual barriers to transition from conventional to organic production or to expand certified-organic acreage. This will be used to guide the education activities covered by the full integrated proposal.Objective 2: Evaluate the producer and industry perspectives on technologies with the potential to improve and expand organic production.Objective 2a: Identify the current state of agricultural technology use along with technologies producers are considering adopting near term (in both conventional and organic production).Objective 2b: Engage in discussions with industry to identify promising emerging technologies (e.g., robotic weeding, digital scouting, and remote sensing) that have the potential to enhance and expand organic production, as well as identify barriers to adoption.Objective 3: Build integrated team for the full grant submission, and disseminate survey results:Objective 3a: Identify organic producers in the Southeastern region willing to conduct on-farm trials.Objective 3b: Identify other researchers in the region with relevant expertise to collaborate on the full proposal.Objective 3c: Organize a focus group and proposal planning meeting with all researchers involved and those interested in working on the full OREI proposal application. Objective 3d: Develop extension material summarizing survey results (Objective 1a and Objective 2) Project Methods To achieve Objective 1 & 2, the team will design and distribute surveys to produce growers in the Southeast via email, at extension meetings and through Qualtrics. The survey will be analyzed to identify trends, barriers to transition to organic or expand existing organic acreage, and opportunities for future research and intervention. Producers will be asked to

identify current cropping rotations, crop mix and diversification, marketing channels, and other production system related questions.To accomplish Objective 2, the survey described above will include questions to specifically identify agricultural technologies currently in use, barriers to adoption of new agricultural technologies as well as producers\' perceptions of promising technologies. These questions will primarily focus on digital (or precision technologies), but information about other technologies used in production (ex. biodegradable plastic mulch) will also be evaluated in a more limited manner. The technologies evaluated will be classified broadly into the non-exclusive groups below, and additional information about the facet of production they are used in will also be collected as appropriate (pest management, crop scouting, nutrient management, farm management, etc.). Direct sensing technologies (ex. IoT sensing, soil moisture, weather stations)Remote sensing technologies (ex. unmanned arial systems, satellite imagery)Automation (ex. guidance, robotic weeding)Decision support (ex. soil mapping, irrigation scheduling, artificial intelligence)Information support (web-based applications, record keeping, farm management)To support recruitment and stakeholder engagement (Objective 3), astakeholder focus group will be held early in the project. We anticipate having all PDs and at least 10 producers at this meeting to discuss survey results, and the development of a full OREI proposal. The team will also conductnetworking at the Southeast regional Fruit & Vegetable Conference to recruit additional regional researchers for the full proposal, andaplanning meeting for the development of a full OREI proposal will be heldin Spring 2024. Progress 09/01/23 to 02/28/25 Outputs Target Audience: Organic vegetable producers Extension agents Academic community Agricultural technology companies Changes/Problems:One of the primary goals of this planning project was to assemble a team and develop a full OREI proposal. The team successfully collected preliminary data, engaged stakeholders, and completed a full draft of the proposal. However, the intended call for proposals was withdrawn for review prior to the submission deadline. As a result, the proposal could not be submitted as planned. The team remains prepared to revise and submit the proposal once the program is reissued or an alternative funding mechanism becomes available. What opportunities for training and professional development has the project provided? One graduate student was trained in survey design and data analysis in conjunction with this project. The graduate student, along with several members of the project team, attended the trade show and educational sessions at both the 2023 & 2024 Southeast Regional Fruit & Vegetable Conference in Savannah GA. One project team member attended the 2025 Southern Agricultural Economics Association Annual Meeting in Irving, Texas How have the results been disseminated to communities of interest?The following is a summary of major outreach activities utilized to disseminate the results of this work. Results were also informally shared with stakeholders while developing the full proposal team. A journal article based on the survey results related to how these producers utilize insurance as a risk management tool was accepted for publication in the Journal of Agribusiness. A poster summarizing survey respondents\' perception of and perceived barriers to technology adoption was presented at the 2024 Clemson University Center for Agricultural Technology\'s Ag. Tech. spotlight. Clemson University Center for Agricultural Technology co-organized an agricultural technology and business forum that included panels related to vegetable production and agricultural connectivity An oral presentation covering the results of objective 2 is scheduled for the 2025 American Society of Agricultural and Biological Engineers Annual International Meeting. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported Impacts What was accomplished under these goals? Impact statement: This planning project provided new insights into how vegetable producers in the Southeastern U.S manage production and perceive agricultural technologies. Through a survey with 131 growers, we gained new insight into their production decision making, their attitudes towards precision agriculture, and their perceived barriers to both adopting new technologies and organic production. Specifically, this research addresses questions related to how Southeastern vegetable growers perceive precision agriculture and their levels of interest in specific types of technologies. We obtained data on farm characteristics, organic practices, general perceptions of technology, perceptions of specific technologies, and barriers and benefits to adoption. We also advanced the current understanding of how vegetable producers engage with USDA risk management programs. Project outcomes were shared through a peer-reviewed journal article and two conference presentations. This work also supported networking between researchers, technology companies, and growers; along with the development of a draft full OREI proposal. Findings from this work can help develop grower-relevant research questions and outreach materials. In the long term, this can help reduce barriers to adoption of organic practices/certification and technologies such as precision agriculture; improve farm efficiency; and support more sustainable organic vegetable production in the Southeast. Objective 1: Identify current production practices, planning strategies, and production systems: Activities/Data collected: One of the major activities and accomplishments of this planning grant was the development and distribution of the survey that was used to answer the question posed in objective 1 & 2. This was distributed through Qualtrics resulting in 131 southeastern vegetable producers responses, where 22% certified organic producers. The survey was distributed by Qualtrics in January-February 2024 and targeted producers of brassicas, cucurbits and sweet corn in the Southeastern U.S. The survey area was defined as Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina. The survey consisted of questions about farm characteristics, organic status and history, production practices, rotation, crop mix, technology used, perception, risk, financial, and demographic questions. Summary and discussion: Surveyed growers were highly

diversified, with the most common response indicating production of 6 to 10 different crops. When asked about obstacles that prevented producers from using organic practices, the most selected response was lack of information regarding the transition process, followed by cost of transition, and then by lack of available markets. For current organic producers the most frequent obstacle they faced when transitioning was lack of available markets. We also evaluated the use of risk management programs in production planning. Risk management program experience was summarized based on self-reported use of the following: Specialty Crop Insurance, Whole Farm Revenue Protection, and Non-Insured Crop Disaster Assistance. The analysis suggests that program experience varies based on farm characteristics and producer socio-demographics. We find that self-reported risk is associated with adopting one program but a lower probability of adopting two products. Outcomes: Data from the survey on 131 southern U.S. vegetable growers. One peer reviewed journal article accepted for publication in the journal or Agribusiness. Objective 2: Evaluate the producer and industry perspectives on technologies with the potential to improve and expand organic production Activities/data collected: The primary data collection associated with this objective was through the same survey described above. Specific to this objective, growers were asked plans to adopt 26 different technologies that were then grouped into 6 groups by their general function. Questions about their perceived barriers to adoption, benefits, and what factors would influence their likelihood of adoption were also included. Additionally formal and informal discussions with industry were used to help identify focus areas for the full proposal. Summary and discussion: Related to perceptions of precision agricultural (PA) technology, respondents rated their agreement (from strongly disagree to strongly agree). The statements with more than 50% agreement are as follows: \"My farming operation lacks strong, reliable internet\" (54%), \"PA makes my job easier\" (57%), \"PA results in yield benefits\" (66%), \"The cost of PA is too high\" (61%), and \"Early adoption of PA is risky\" (72%). When asked about the biggest barriers to PA adoption, most frequently selected response was that PA technologies were too expensive, or they were not convinced of the return on investment (\~43%). This generally agreed with their response to a question related to what factors influence their decisions to adopt a new technology where detailed budget information was the largest deciding factor (\~40%). 64% of respondents viewed yield improvement as the biggest potential benefit to PA adoption. Respondents were asked about technologies they currently use or intend to adopt within the next five years. When grouped by type and ranked from most to least frequently selected, the categories were: water management, input management, decision support, data collection, automation, and guidance. Outcomes: Survey results related to technology adoption were presented at a university-level agricultural technology event (CU-CAT agricultural Technology Spotlight) in 2025 and are scheduled for presentation at the American Society of Agricultural and Biological Engineers (ASABE) annual meeting in July, 2025. Objective 3:Build integrated team for the full grant submission, and disseminate survey results: Activities/data collection: Four individual interviews of certified organic producers were conducted. Information on the project was presented in a technical session related to technology use in fruit and vegetable production at the 2023 SE Fruit and Vegetable Conference. The project supported team networking with vegetable and precision ag stakeholders at the 2023-2024 SE Fruit and Vegetable Conference in Savannah, GA; and at the 2025 Southern Agricultural Economics Association Annual Meeting in Irving, Texas. The research team held a planning/writing meeting in February 2025 at Clemson University with researchers from different locations. Summary and discussion: Several of the key priorities observed in the interviews were related to weed/pest management and opportunities to reduce inputs, labor-saving technologies and increase yield. The adoption motivators from the interviews were labor efficiency, chemical reduction, sustainability, peer influence and print & online sources. Barriers to adoption were: cost, complexity, compatibility, reliability, and philosophical reservations. Outcomes/accomplishments: Data on individual interviews (n=4). Research objectives, researchers, industry collaborators, and cooperating famers were identified and a draft full proposal to the OREI was developed with the short term goals of: 1) evaluating the technical performance and economic feasibility of two emerging weeding technologies; 2) developing decision-support tools to facilitate better decision making regarding harvest scheduling; and 3) developing tools and resources to better enable organic producers to evaluate investment decisions. It is awaiting submission once the call for proposals becomes available. Publications Type: Other Status: Awaiting Publication Year Published: 2025 Citation: Thayer, A.W., Silva, F.D., Turner, A.P., Willis, D.B. 2025. Risk Management Program Adoption Among Vegetable Producers in the Southeastern United States: Do extreme events and previous losses matter? Journal of Agribusiness. 41(1). In-Press. Type: Conference Papers and Presentations Status: Other Year Published: 2025 Citation: Wayt, V., Turner, A.P., Silva, F.D., Thayer, A. Kirk, K.R, 2025. Southeastern Vegetable Producers Possess Positive View of Precision Agriculture Technology. ASABE Annual International Meeting, Toronto, CA. July 13-16 Progress 09/01/23 to 08/31/24 Outputs Target Audience: Organic vegetable producers Extenstion agents Academic community Agricultural technology companies Changes/Problems:One of the main goals of this planning proposal was to develop a full OREI proposal, but the timeline for the last submission combined with a slight delay in distributing oursurvey did not match well with the funding cycle for FY 24.We requested and received a no-cost extension on this project to meet the submission deadline for the FY 2025 RFA. What opportunities for training and professional development has the project provided?One graduate student was trained in survey

design and data analysis in conjunction with this project. The graduate student, along with several members of the project team, attended the trade show and educational sessions at the Southeast Regional Fruit & Vegetable Conference in January. How have the results been disseminated to communities of interest? A journal article based on the survey results related to how these producers utilize insurance as a risk management tool was submitted to Agricultural Finance Review. A poster summarizing survey respondents\' perception of and perceived barriers to technology adoption is scheduled at an upcoming event focused on agricultural technology. CU-CAT co-organized an gricultural technology and business forum that included panels related to vegetable production and agricultural connectivity What do you plan to do during the next reporting period to accomplish the goals?Related to objectives 1 and 2, the main tasks for the next reporting period are the continued analysis of survey data and dissemination of results. Most remaining activities are associated with objective 3, which focuses on developing a full OREI proposal. We requested and received a no-cost extension on this project to meet the submission deadline for the FY 2025 RFA. The majority of the remaining tasks involve developing the full proposal, including team formation (producers, industry, and other researchers), a planning meeting, and proposal development. Impacts What was accomplished under these goals? Objective 1 & 2: One of the major accomplishments from year one was the development and distribution of the survey that is being used to answer the question posed in objective 1 & 2. This was distributed through Qualtrics and has a response of 131 southeastern vegetable producers. Data analysis is still on-going, especially related to objective 1, but some preliminary takeaways are: Biggest barrier to adoption was related to technology being too expensive or they were not convinced of the return on investment. By far the biggest perceived benefit was yield improvement. When asked which technologies they currently use or are considering adopting, those related to water or input management were most common. Additionally, analysis showed risk management program experience was associated with self-reported willingness to take production risks, reported yield losses, as well as other variables describing the producer and the operation. Objective 3: Most efforts here were related to networking at the 2024 Southeast regional Fruit & Vegetable Conference in Savanah, GA. The 5 members affiliated with the projectgroup were in attendance and met with several SC producers and other researchers. Additionally, information on the project was presented in one of the technical sessions related to technology use in fruit and vegetable production. Initial discussions with producers and industry generally showed interest around soil moisture sensing, automation, and image analysis. Publications Type: Journal Articles Status: Submitted Year Published: 2024 Citation: Thayer, A.W., Silva, F.D., Turner, A.P., Willis, D.B. 2024. Risk Management Program Adoption Among Vegetable Producers in the Southeastern United States: Do extreme events and previous losses matter? Agricultural Finance Review. Submitted. Type: Conference Papers and Presentations Status: Accepted Year Published: 2024 Citation: Wayt, V., Turner, A.P., Kirk, K.R, 2024.Perceptions and precived barriers to precison technologys among SE Vegetable Producers. Clemson University Ag. Tech Spotlight. Clemson, South Carolina, Sept 17.

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# Seizing on the Potential to Breed for Intercrops: Definition of Breeding Goals

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| **Contract / Grant No.** | 2023-51300-40958 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Kellly R. Robbins |
| **Performing Institution** | Cornell University |

## NON-TECHNICAL SUMMARY

Historically, breeding crops to improve their performance in intercrops has been an intractable problem. Recent technological developments in plant breeding, specifically, genomic selection methods, crop growth models, and high throughput image capture using drones, however, will allow progress. Though intercrops have been shown to perform better than monocrops in multiple ways, we have only a poor understanding of the most important aspects of intercrops are for farmers. Before embarking on breeding for intercrops, we will use this planning grant to consult with farmers to build our understanding of their needs and thus define breeding goals that they will embrace.To accomplish this information gathering, we will first develop a set of contacts with farmer organizations, cooperative extension agents, and farmer stakeholders. These contacts will be people who are interested in intercropping and in defining appropriate research and breeding directions for intercrops. We will interact with key farmer stakeholders to define a survey likely to capture the breadth of farmer needs. We will administer that survey and analyze responses. We will deepen the understanding derived from the survey through focus groups. We will leverage this understanding to define the objectives of grant proposals seeking to fund breeding for intercropping to benefit farm diversity and ecological intensification. Goals / Objectives Objective 1:We will connect with cooperative extension and with farmer organizations (see support letters) to identify farmers interested in intercropping. Participants will also be identified through the USDA Organic Integrity Database, listservs, and conferences. We will first reach out to key stakeholders viewed as community leaders. These stakeholders will play a critical role both in formulating survey questions and, with consent, as \"survey champions\" to promote the completion and return of the survey among farmers in their communities. We will not limit the survey to organic farmers, though we anticipate that a majority of participants will be organic or transitional.At this early time in the grant, we will also lay the groundwork for focus groups. Scheduling to dovetail with winter meetings and seeking permission to present at those meetings happens well in advance. We recognize that several of us have not been members of the organic community. The burden will be on us to show that we care about its philosophy and social relationships. We will be asking farmers for help through sharing observations derived from their work. We will seek to deserve that help.In the collaborative network that we want to create, we hope to attend to its racial equity. As much as in any other area, seeking racial equity will require cultural humility. Our current collaborative includes one Filipino and two Latinx members. We are otherwise all of white European descent. Efforts at racial equity need racially diverse leadership (Penniman, 2018), which we do not have. Nevertheless, as we engage in understanding farmer needs, we will seek both equitable processes and outcomes (Brzozowski et al., 2022). A number of farmer organizations and cooperative extension agencies have policy statements and resources for equity and inclusion (e.g., https://marbleseed.org/about/racial-equity; https://staff.cce.cornell.edu/board-toolbox/dei). In planning, we will consult with these resources.Objective 2:The survey will be developed iteratively in consultation with key stakeholders. Topics will include farmer demographics, current acreage, current intercropping practices, anticipated benefits in several areas (e.g., overall marketable production, non-marketable organic matter production, weed pressure, disease and pest prevalence, soil fertility and health, seed sourcing, logistical challenges, perceived training needs, and other topics identified by key stakeholders). The survey instrument will be designed and distributed using the Tailored Design Method (Dillman et al., 2014). The survey will be piloted with a group of non-key-stakeholder farmers then distributed via paper mail and email. Each participant will receive multiple contacts. We will prime survey respondents to consider possible breeding targets by opening the survey with a paragraph on genetic variability and its use to tailor adaptation and performance. In collating responses, we will highlight constraints that might be mitigated by breeding. Many constraints might be more effectively addressed by management or engineering interventions. For the focus groups, we will seek to set up contrasts between approaches to better rank them.One or more focus groups will be conducted with farmers at regional organic farming conferences, such as the Marbleseed Organic Farming Conference in St. Croix, WI. We will coordinate the travel with farmer organizations to leverage

their winter meetings so that in-person focus groups can be held without additional farmer travel. Questions will focus on key topics identified through a preliminary analysis of the survey data. Focus groups will be planned and facilitated according to the best practices. Each focus group will include up to twelve participants and will last between one and two hours. Focus groups will be led by a facilitator and an assistant; the facilitator will introduce the goals of the study, obtain consent from participants, ask open-ended questions, and draw out participants as needed. The assistant will take notes. Focus groups will be recorded for future transcription and analysis.Objective 3:Researchers will meet virtually for a project initiation meeting in September 2023. Thereafter, the group will meet bimonthly to progress toward defining goals and writing a larger proposal. Broadly, the agendas for these meetings will be: 1. Project initiation and Networking (Sept). Re-iterate purpose of planning grant. Identify a keynote speaker on collaborations with the organic farming community. We will brainstorm organizations and distribution lists to approach and divide tasks according to Co-PDs with the best connections. 2. Survey Prep (Nov). We will invite key stakeholders. Co-PDs will bring in survey topic area and question suggestions. All suggestions will be consolidated into the first survey draft. 3. Preliminary survey results (Jan). It will still be early in the survey, but we will need some initial idea of survey outcomes to begin planning the larger proposal. We will define objectives and decide if we need other researchers given farmer needs. 4. Planning and writing tasks (Mar). This meeting will occur in the shadow of the likely deadline for the 2024 OREI RFA. We will plan final tasks prior to grant submission. 5. Field Day and post grant proposal planning (Jun). We will hold an in-person meeting and field day event in Ithaca, NY. Final results of the stakeholder survey and focus groups will be synthesized and presented at the meeting. The meeting will allow more long-term objective setting and planning to target multiple funding sources including the NIFA CGP-FAS RFA. Project Methods Some survey questions will be quantitative in nature (e.g., relative rankings of different priorities). Others will be qualitative and require some interpretation (e.g., open-ended questions in the survey). Much of the focus group discussion will be of the latter sort, requiring determination of categories of topics and coding. We are fortunate to have on staff a Communications Specialist with experience in conducting exchanges with farmers and performing data compiling. We will interpret results along the dimensions of the particular species farmers are interested in, the reasons for those species, and the functions and ecosystem services farmers need intercrops to fulfill. We will use questionnaire approaches that emphasize possible tradeoffs between different traits or functions \e.g., conjoint analysis with pairwise alternatives (Byrne et al., 2012; Balogun et al., 2022)\ to clarify their relative values among farmers. Progress 09/01/23 to 08/31/24 Outputs Target Audience:We surveyed organic field crop farmers on their practices and purposes when they plant intercrops. The results from this survey are being used to design crop breeding research to develop varieties that better meet the needs of farmers using intercropping. Thus, the first audience served by the project are plant breeders who need to know breeding goals to focus on in this area. The second audience are farmers who use intercropping and who will, when research makes progress, receive varieties that are better suited to their needs. Farmers surveyed (310 respondents) resided primarily in northern states ranging from New York to Montana. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?Emily Fratz worked on developing and administering the survey. She also has compiled its results. She also conducted two focus groups. She is now a Ph.D. candidate at Cornell University. Leah Treffer assisted in conducting the two focus groups. She is also a Ph.D. candidate at Cornell University. How have the results been disseminated to communities of interest?At the present time the summary of the survey has only been distributed to collaborators who are working on a grant together. This summary includes only main results from each survey question. We plan on analyzing a few select interactions between questions (for example, are there intercropping functions that go together more or less frequently with crop species than might be expected by chance). Once that is done, we will seek to publish the survey results as a peer-reviewed manuscript. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported Impacts What was accomplished under these goals? Survey Instrument Development To develop the survey and the focus group instrument we consulted with: Elizabeth Dyck - Organic Growers\' Research and Information-Sharing Network Krysti Mikkonen - Northern Plains Sustainable Agriculture Society Lydia English and Sarah Carlsen - Practical Farmers of Iowa Bethany Wallis and Samuel Rose - Northeast Organic Farming Association of New York Luke Gianforte - Gianforte Farm, Cazenovia, NY Klaas Martens - Klaas and Mary-Howell Martens Farm, Penn Yan, NY Carmen Fernholtz - A-Frame Farm, Madison, MN Survey and Focus Group Administration The survey included a total of 22 questions on a range of topics including respondent demographics, characterization of the farm operation, intercrops planted, intercropping management practices, and intercropping breeding goals. The survey was distributed using the USDA Agricultural Marketing Service (AMS) Organic Integrity Database (https://organic.ams.usda.gov/integrity), which includes all USDA Certified Organic farmers in the US. The survey was distributed to farmers based in the US who listed one of the predefined field crops as a crop produced on their farm. Field crops were defined as: corn, soy, wheat, oat, alfalfa, rye, barley, clover, pea, and triticale. The survey was emailed to 1,721 email addresses and mailed to 1,000 street addresses between Feb. and Apr. 2024. Focus groups were carried out at the OGRAIN conference in Madison, WI in January 2024 and at the Marbleseed conference in Lacrosse, WI in February 2024. Results of these efforts have been tabulated. We plan on publishing the results some time in 2025. Plant Breeding

Organization There were three primary take home messages from the survey around which we are organizing to do plant breeding research: i) Oat is important in intercropping. Of the top six intercropping combinations reported by farmers, oat was a component of three. ii) Oat is listed in combination with multiple other species. Thus, if we breed oat for intercropping, we need to find out if it is a good partner in multiple different combinations. Thus, we need to research \"interspecific general mixing ability\" of the oats we develop: If we develop oat varieties that perform well in intercropping with pea, will they also perform well as nurse crops for alfalfa and clover? iii) Farmers grow intercrops for purposes other than cash yield. The function of \"cash crop yield\" was only the fifth most important function that farmers mentioned. Soil health is the first. We need to research variety and intercrop impacts on components of soil health. We have developed a collaborative of six oat breeders, two legume cover crop breeders and two cropping systems agronomists to propose research to tackle these problems. Publications

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# Developing Risk-assessment, Educational, and Communication Tools to Lower Food Safety Barriers for Organic Specialty Crop Growers

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| **Contract / Grant No.** | 2023-51300-40950 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Patrick Baur |
| **Performing Institution** | University of Rhode Island |

## NON-TECHNICAL SUMMARY

Organic growers can face unique challenges in trying to meet both National Organic Program standards and food safety requirements. According to the NASS 2019 Organic Survey, regulatory problems were the greatest production challenge for growers, and our 2022 national needs assessment study, funded by an OREI planning grant (#2021-51300-34893), identified food safety as a policy and marketing constraint on the expansion of organic specialty crop agriculture. Specifically, complying with food safety requirements poses both operational and administrative barriers for organic growers. Operational barriers impact farm production decisions and practices. Administrative barriers impact a farm\'s policy compliance and market access. Both barriers can hinder organic growers seeking to grow their operations as well as growers considering making the transition to organic certification, and we propose concrete approaches to lower these barriers. First, by developing a practical, user-friendly risk-assessment and decision-making tool for organic soil amendments. Second, by developing, demonstrating, and evaluating a suite of extension and outreach materials aimed at bringing all organic produce stakeholders\--including organic growers, farm advisors, and organic and food safety auditors and certifiers, and buyers\--to a common understanding of the unique food safety risks and farm management strategies specific to organic agriculture of fruit and vegetable crops covered by the Produce Safety Rule. Our long-term goal is to reduce both the operational and administrative barriers to compliance with multiple regulations by equipping organic growers and industry stakeholders with evidence-based tools and training to comply simultaneously with organic agriculture and food safety best practices and requirements. Goals / Objectives Long-term Goal: reduce operational and administrative barriers to compliance with multiple regulations by equipping organic growers and stakeholders with evidence-based tools and training to meet both NOP standards and food safety requirements.Goal/Objective 1. Lower operational food safety barriers for organic growers by developing a practical, user-friendly risk-assessment and decision-making tool for organic soil amendments. We will comprehensively synthesize and translate food safety evidence on organic soil amendments into practical, user-friendly risk-assessment and decision-making tools for growers to assist them in selecting and managing organic soil amendments. There is a wide range of organic soil amendments available to growers, and significant challenges on both the administrative side (e.g., finding a reliable and up-to-date supplier, managing the necessary records) and the operational side (e.g., differentiating risk profiles and validated treatment methods among different amendment types). The deliverable will be practical guidance, in the form of a publicly-accessible decision dashboard that can be customized to meet the specific needs of organic growers operating under different cropping systems and in different regions.Goal/Objective 2. Lower administrative food safety barriers for organic growers by developing, demonstrating, and evaluating a suite of extension and outreach materials aimed at bringing all organic produce stakeholders\--including organic growers, farm advisors, and organic and food safety auditors and certifiers, and buyers\--to a common understanding of the unique food safety risks and farm management strategies specific to organic agriculture of fruit and vegetable crops covered by the Produce Safety Rule. The deliverables will include region-specific training programs, train-the-trainer modules on how to teach the decision dashboard and disseminate effective organic food safety management and communication strategies, online training modules, and multimedia communication tools that will be piloted, demonstrated, evaluated, and made publicly available for nationwide use. Project Methods Activity 1: Project managementTask 1.1. Initiate Project and Convene Research Team and Advisory Committee.Activity 2: Risk assessment and decision dashboard for organic soil amendmentsTask 2.1. Synthesize current available evidence on food safety risks associated with organic soil amendments from scientific literature, unpublished data, and private sector data.This task will be conducted using multiple approaches in order to summarize available data. First a systematic review of peer-review publications will be conducted to present a broad overview of the evidence

(quantitative and/or qualitative) and represent this evidence by mapping or charting the data. Second, an exhaustive review of unpublished (in-peer review) scientific data will be summarized to complement the systematic review extracted data.Task 2.2. Survey labs serving each region to assess methodological consistency and compatibility of testing data.We will survey regional laboratories providing testing services to growers. A list of labs will be compiled by a comprehensive online search for active microbial soil testing laboratories (in the US). Laboratories will be invited to participate in an online survey.Task 2.3. Survey and assessment of types of organic soil amendments currently available on the market and used by organic growers in our study regions.We will conduct a survey using a mixed-mode approach (survey and in-person interviews) targeting companies that produce biological soil amendments in addition to compost. We will complement this study with information on which organic soil amendments growers are using, collected in the farm advisor survey (Task 3.1).Task 2.4. Quantitative risk assessment using Bayesian belief networks (BBN) & scenario trees (ST).The quantitative risk assessment will be based on two approaches (BBN and ST) and will evaluate diverse scenarios based on soil amendment type, soil amendment application method, crop type, soil characteristics, region. Additional scenarios and input values may be collected and will be incorporated into the models based on findings from tasks 2.1, 2.2, and 2.3.Bayesian Belief Networks (BBN) will be used to calculate the probability of the presence/absence of foodborne pathogens under diverse epidemiological scenarios given the data collected in the scoping review as well as the two surveys for lab, manufacturer and growers (Tasks 2.1-2.3). The model will allow us to evaluate conditional dependencies between the different variables using directed acyclic graphs (DAG).Scenario Tree Modeling will be used to evaluate organic soil amendment uses and management scenarios and the potential cost-benefits of different management strategies to reduce the presence of foodborne pathogens. Scenario tree modeling is a valuable approach in evaluating risk for different \"what if\" scenarios and supporting complex decisions. Outputs of the model will allow us to compare multiple scenarios and identify the ones with the best cost-benefit adapted to each grower production characteristics.Task 2.5. Using a systems approach to predict the pathway of foodborne pathogens in the pre-harvest produce environments.A mathematical system model will be developed to understand the pathway of E. coli O157:H7 and Salmonella in organic production of specialty crops. We will incorporate novel variables such as the role of farm practices, soil amendments management, environmental, and meteorological factors.Task 2.6. Develop a user-friendly dashboard to integrate methods and results of the risk assessment and prediction models (Task 2.4 and 2.5).The risk assessment and prediction models developed and their respective results will be integrated into the Soil Amendment Risk Tool, an interactive, user-friendly, web-based and analytical platform using R and Shiny (shiny.rstudio.com). We will develop a user manual, demo videos, and other tutorials to guide users, in addition to live trainings, and we will also train farm advisors in use of the tool to further support their grower clients (see Task 4.1 and Task 5.1).Activity 3: Needs assessment among farm advisors, extension, auditors/certifiers, and buyersTask 3.1. Survey of farm advisors and extension professionals.To triangulate with what is already known about grower perspectives and experiences, we will conduct a national survey of farm advisors and extension professionals serving the organic fruit and vegetable agriculture sector. We will also ask respondents to provide any local/regional guidance documents or training materials to feed into policy and extension analysis (i.e., gathering the facts, see Task 3.3).Task 3.2. Key informant interviews with auditors, certifiers, and buyers.To gather further critical perspectives on the state of organic and pre-harvest food safety integration, we will conduct semi-structured interviews with key informants in each region, including: organic certifiers, food safety certifiers, and regional produce buyers (wholesale suppliers, food hubs, grocery chains).Task 3.3. Analysis of survey data, interview data, and policy and extension analysis.We will use statistical (e.g., SAS) and CAQDA (e.g., Atlas.ti) software tools to conduct quantitative and qualitative analysis of survey and interview data to identify priority areas for sharing evidence-based information, integrating guidance for growers, and targeting training/outreach efforts.Activity 4: Design outreach programs and training modulesTask 4.1. Develop region-specific training programs for growers and auditors/certifiers, and train-the-trainer modules (TTT) for advisors and extension professionals to execute the training programs.The Research Team will work closely with Organic Agronomy Training Service (OATS) who will lead the development of the regional training programs and train-the-trainer (TTT) education course. The goal of the regional training programs is to provide growers, food safety and organic auditors/certifiers, and other ag professionals guidance on: 1) how to use the soil amendment risk assessment tool; 2) whole farm food safety management strategies; 3) organic practices that can cause tension points with food safety regulations; 4) strategies to overcome operational and administrative barriers for growers; 5) evaluate effectiveness of regional training programs in meeting these goals.Task 4.2. Build an online training module tailored to auditors and certifiers.To reach auditors and certifiers beyond these field days, PSA will also work with our certifier partners (CCOF, Oregon Tilth, PCO) to build an online training module tailored to auditors and certifiers to share the results of the OREI research.Task 4.3. Multimedia tools to help organic growers communicate food safety practices to buyers.We will develop slide decks, fact sheets, and/or short videos tailored to help growers more effectively communicate their integrated organic and food safety practices to buyers in an evidence-based manner.Activity 5: Extension & OutreachTask 5.1. Host regional training workshops with growers and other agricultural professionals.Each of the six contracted, regional outreach organizations will

execute the regional training workshops (Task 4.1). A total of 10 workshops will be hosted nationally, with all major regions of the US represented.Task 5.2. Host 2 webinars with organic/food safety certifiers/auditors to share slide set module.The Research Team will host two 1-hr webinars targeted toward organic auditors/certifiers and food safety auditors/certifies, respectively to share project results, demonstrate the Soil Amendment Risk Tool, and preview the online training module produced in Task 4.2.Task 5.3. Public Outreach.The Organic Center will manage project publicization by disseminating a press release, grower group announcements, and a social media campaign. All co-PDs and partners institutions can amplify these communications through their own social media. Progress 09/01/23 to 08/31/24 Outputs Target Audience:Individuals, groups, market segments, or communities As part of Activity 1, a 2-day in-person planning meeting was convened that included the core project team. (Full team) As part of Activity 2, 2 listening sessions were conducted with stakeholders of the fresh produce industry, fertilizer industry, and regulatory agencies to discuss project goals, methods and our pilot dashboard. (UC Davis) As part of Activity 3, 8 listening sessions and 22 interviews have been conducted with farm advisors and extension professionals, state department of agriculture personnel, organic farm and input certifiers, grower advocates, produce growers and handlers, retailers and organic input suppliers. As part of listening sessions and interviews, participants were introduced to the project and the proposed deliverables were described. Participants were asked to offer feedback as potential end users for the proposed soil amendment risk assessment tool and participants in the training and outreach program. Some of the listening sessions were conducted at Organic Week in Washington, DC where we also networked with wider members of the organic community. (URI and TOC) For the beginning stages of Activity 4, the target audiences were the produce industry and consumers. Our main messaging goal was to engage industry with the project launch and to update the public on experimental progress through the activities cited as part of Activity 3 and a project website. (TOC) Racial and ethnic minorities and those who are socially, economically, or educationally disadvantaged. As part of Activity 3, three of the team members attended the Texas Hispanic Farmers and Ranchers conference and Food Summit to seek feedback from Hispanic growers and better understand their unique needs in relation to project goals. Feedback was solicited via a booth with information about the project and proposed deliverables and conversations with team members. (URI and TOC) Formal classroom instruction, laboratory instruction, or practicum experiences; development of curriculum or innovative teaching methodologies; internships; workshops; experiential learning opportunities; extension and outreach. In addition to research conducted to meet project goals, target audiences were reached through formal classroom instruction, laboratory instruction, and research instruction for students at the University of Georgia. Changes/Problems:URI For Activity 3, we added a task on listening sessions to the data collection as a way to gain early feedback, particularly for input to Activity 2 to address questions raised during the 2-year team planning meeting conducted in January 2024. UC Davis There was a delay in the hiring process at UC Davis, which led to a delay in starting the project. Quantitative data on pathogen prevalence on vegetable crops has been challenging to obtain, therefore, the Bayesian Belief Network analysis has been delayed. Different approaches on collecting qualitative data via expert opinion (Delphi method), focus groups and other approaches are being considered to further complement the information regarding the causal pathway of crop contamination. UGA The primary challenge we faced was finding and training the appropriate graduate students in machine learning skills and building computationally intensive models. Developing a robust system model requires a specialized skill set in data science, particularly machine learning techniques, which are essential for analyzing complex datasets and predicting pathogen behavior in produce fields. We addressed this challenge by seeking graduate students with a background in data science or related fields and providing targeted training to bridge any knowledge gaps. Additionally, we will collaborate with experts in machine learning to guide model development and ensure its accuracy and effectiveness. What opportunities for training and professional development has the project provided? Professional development of URI postdoctoral research fellow and URI PhD student through mentorship, project management activities, and conference participation. The postdoctoral fellow also successfully completed a Produce Safety Alliance food safety training hosted by URI extension. Professional development of UC Davis project scientists and PhD students (2) through mentorship, project management activities, conference participation. A UC Davis PhD student was awarded a 2024 \'Compost Research University Scholarship\', funded by the Compost Research & Education Foundation https://compostfoundation.org/Research/University-Scholarships All events mentioned above offered opportunities for professional development for the Organic Center team members involved in this project. How have the results been disseminated to communities of interest?NA - the project has not yet produced results, as data are still being collected and analyzed. What do you plan to do during the next reporting period to accomplish the goals?External Evaluator\'s Assessment (Dr. Sheely, External Evaluator) Overall, this project is moving forward in a satisfactory manner to achieve the stated goal/objectives as described in the original project proposal and as articulated above in the \"Issue or Problem\" section of this report. The accomplishments described in this progress report are an accurate description of the activities conducted and the progress made by the project team. Activity-specific comments are below: Activity 1: Project management The project is well managed by the Project Director, Dr. Patrick Baur, and his Co-Project Directors. URI Post-Doctoral fellow, Dr. Jaime Barrett, is effective in carrying out her responsibilities, including facilitating/leading project team

meetings as necessary. A second Advisory Board meeting will occur shortly and should yield useful feedback from that group. The January, 2024 launch meeting for the project team was well organized, critical for team building, and effective in developing a shared understanding of the various elements of the project and each team member\'s role in carrying them out. Activity 2: Risk assessment and decision dashboard for organic soil amendments The considerable work related to Activity 2 is well underway and is expected to continue throughout the next reporting period. Supplemental qualitative data and alternative approaches will be used to address difficulties encountered in acquiring quantitative data. *Please note the interesting, timely outcome reported under Activity 2, Task 2.5. Activity 3: Needs assessment among farm advisors, extension, auditors/certifiers, and buyers Significant effort has been made to prepare for an upcoming survey of farm advisors and extension professionals. Numerous interviews and listening sessions were conducted to better understand challenges related to food safety and organic production practices. These activities will provide a strong foundation for Activities 4 and 5, which will occur in subsequent years. Planned Next Steps by Activity Activity 2 2.1 Synthesize current available evidence on food safety risks associated with organic soil amendments from scientific literature, unpublished data, and private sector data. Continuing literature review and summarizing of current available data 2.2 Survey labs serving each region to assess methodological consistency and compatibility of testing data. Conduct a survey of the current available diagnostic tests for soils amendments on detection of foodborne pathogens provided by commercial laboratories 2.3 Survey and assessment of types of organic soil amendments currently available on the market and used by organic growers in our study regions. Conduct a survey targeting the soil amendment manufacturers Analysis of information obtained from tasks 2.1-2.3 using the BBN methodology. 2.4 Quantitative risk assessment using Bayesian belief networks (BBN) & scenario trees (ST). Continue the development of pathway specific models for integration in the risk assessment dashboard 2.5. Use a systems approach to predict the pathway of foodborne pathogens in the pre-harvest produce environments. We will focus on developing a comprehensive system model that integrates our completed studies on the survival of pathogens in produce fields. This model will incorporate the findings from our research, as well as data from existing literature and contributions from our collaborators at UC Davis and other partners involved in the OREI project. By combining these diverse data sources, we aim to enhance our systems-based approach to accurately model the pathways of pathogens within produce fields. Our efforts will include refining model parameters to account for various environmental factors such as weather conditions, soil composition, and agricultural practices that influence pathogen behavior. This approach will allow us to simulate different scenarios and identify key risk factors, offering a predictive tool for growers and regulators to implement science-based interventions. Additionally, we will work on validating the model through collaboration with field experts and testing against real-world data to ensure its reliability and applicability. By the end of this period, we aim to have a robust model that can support decision-making processes to improve produce safety and reduce contamination risks, ultimately contributing to the long-term goals of the OREI project. 2.6 Develop a user-friendly dashboard to integrate methods and results of the risk assessment and prediction models. Finalize the compilation of parameters for the risk assessment model Activity 3 3.1 Survey of farm advisor and extension professionals The survey has been configured and distributed to team members and board members for comment. It is currently in the process of beta testing with a subset of the compiled recruitment list. The final survey will be released to the full recruitment list (N \> 2000) in Fall 2024 after sufficient beta responses have been collected and final adjustments are made as needed. 3.2 Key informant interviews with auditors, certifiers and buyers The interview groups have expanded to include grower representatives or advocates, farm advisors and extension professionals, state department of agriculture personnel and organic soil amendment suppliers. 22 interviews have been conducted. Once the existing interviews have been analyzed, we will determine if additional interviews are needed. If needed, we will perform a second round of recruitment and interviews. In the second round we will focus on clarification and confirmation of existing data and capturing stakeholder groups with low representation. 3.3 Analysis of survey data, interview data and policy and extension analysis Analysis of listening sessions and interviews has been initiated and is expected to continue for the next several months. Survey is expected to be released in Fall 2024 and survey data are expected to be analyzed after the open period or when response rates indicate that no one else is likely to take it. We will be conducting an extensive policy and extension materials search and creating a repository of resources in anticipation of document analysis to identify any relevant policy differences across states and key extension content for later outreach efforts. Activity 4 and 5 TOC\'s new manager of science programs will take over administrative and everyday tasks associated with project Activities 4 and 5. 4.0 Design outreach programs and training modules Working with subawardees, the Produce Safety Alliance (PSA) at Cornell University and the Organic Agronomy Training Services (OATS), we will begin the development of region-specific training programs for growers and auditors/certifiers, and train-the-trainer modules (TTT) for advisors and extension professionals to execute the training programs. We will also begin to build an online training module tailored to auditors and certifiers. Relevant TOC staff will continue to build relationships with potential partners for the in-person workshops and outreach plan. We will engage with the Transition to Organic Partnership Program (TOPP) regional leads to explore collaboration and potential workshop execution. 5.0 Extension & Outreach We will continue communication efforts including maintaining the website, updating the website with progress reports

provided by the project team, and publicizing research phase announcements, and requests for stakeholder input. The Organic Center will continue to engage industry members as needed and will attend regular planning meetings to stay informed on the progress of the research and contribute as needed. Impacts What was accomplished under these goals? Issue or problem To help organic specialty crop growers overcome operational and administrative barriers to complying with both food safety and organic certification requirements by offering science based tools and training. To improve communication across the different stakeholder groups involved in organic specialty crop production on both the regulatory side and throughout the supply chain. Activity 1: Project management Task 1.1. Initiate Project and Convene Research Team and Advisory Committee. Convened a 3 day meeting with the research team to clarify goals and activities for the first 2 years of the project. Planning meeting took place on the University of Georgia campus in Griffin, GA on January 8-10, 2024. Convened the initial advisory board meeting with team and board members Advisory board meeting took place online via Zoom on March 27, 2024. Activity 2: Risk assessment and decision dashboard for organic soil amendments Tasks 2.1: Synthesize current available evidence on food safety risks associated with organic soil amendments from scientific literature, unpublished data, and private sector data. UC Davis conducted a literature review on wildlife, adjacent land use and soil amendments. Two hundred and twenty (n=220) publications (including scientific papers, whitepapers, reports, and guidelines from fresh produce associations) were gathered and reviewed. Papers were organized using tags pertaining to the following categories: wildlife, adjacent land use, soil amendments, climate/weather, livestock proximity, water, soil, airborne contamination, vectors, risk perception, mitigation, handling, BSAAO, manure, compost, and organic. Key information that was considered important for later parameterization was collected in an Excel spreadsheet. This information in each tab varied depending on factors that may influence the risk of fresh produce contamination. Task 2.2. Survey labs serving each region to assess methodological consistency and compatibility of testing data. Expected to start in year 2 Task 2.3. Survey and assessment of types of organic soil amendments currently available on the market and used by organic growers in our study regions. UC Davis is compiling a summary of the current commercially available soil amendments of animal origin for organic farmers. Included in the summary is characterization of the soil amendments (feedstocks, food safety testing, ingredients and intended use (on-going). Task 2.4. Quantitative risk assessment using Bayesian belief networks (BBN) & scenario trees (ST). UC Davis conducted a review of the literature on soil amendments use and survival of pathogenic E. coli in organic produce. They also developed pathways, and \'what if scenarios\' for evaluating the use of biological soil amendments of animal origin: soil amendments included raw manure, compost, and heat-treated poultry pellets. UC Davis is compiling and summarizing the current published data (literature review) and unpublished data available on the soil amendments of animal origin available to organic farmers. Task 2.5. Using a systems approach to predict the pathway of foodborne pathogens in the pre-harvest produce environments. UGA is conducting experiments to estimate the pathways of pathogens in produce fields to enhance food safety. They have published two manuscripts detailing the survival of E. coli in produce fields, emphasizing the significant influence of weather parameters on pathogen persistence. Their research findings have provided insights into the relationships between environmental factors and microbial risks, guiding improved management practices. The initial findings of this project were timely as several foodborne outbreaks associated with root crops such as onions raised questions about the survival of foodborne pathogens in soil and their contributing factors. The initial findings from our models were shared with growers and regulatory agencies at the annual IAFP conferences. The findings have the potential to impact produce safety protocols and have provided growers and regulators with information on weather conditions that exacerbate contamination risk. Our findings have and will continue to fortify risk based recommendations for safer agricultural practices and public health protection. Task 2.6. Develop a user-friendly dashboard to integrate methods and results of the risk assessment and prediction models). UC Davis developed a framework for the demo dashboard based on the input from stakeholders, the research team and other collaborators. UC Davis is integrating environmental and landscape characteristics data for the risk assessment dashboard. UC Davis will use the compilation of input parameters from task 2.1 in the modeling framework. Activity 3: Needs assessment among farm advisors, extension, auditors/certifiers, and buyers Task 3.1 Survey of farm advisor and extension professionals URI compiled a recruitment list of farm advisors and extension personnel across the 50 states with over 2000 names and email addresses. The survey was written and formatted and distributed to team and board members for comment. It is currently in the beta testing stage with a subset (N=100) of the recruitment list. Task 3.2 Key informant interviews with auditors, certifiers and buyers URI has conducted a total of 22 interviews with a combination of farm advisor and extension professionals, state department of agriculture personnel, organic produce and input certifiers, grower advocates, produce growers and handlers, retailers and organic input suppliers. In addition 8 listening sessions were conducted with the same stakeholder groups. Between interviews and listening sessions URI team members have talked to over 50 stakeholders about the project and proposed deliverables and the challenges and priorities at the intersection of food safety and organic certification. Task 3.3 Analysis of survey data, interview data and policy and extension analysis URI is analyzing the data collected. Listening sessions have been transcribed and coded (i.e. text was categorized by topic or theme); analysis is on-going. All other forms of data are still being collected. Activity 4:

Design outreach programs and training modules Expected to start in year 2 Activity 5: Extension & Outreach Expected to start in year 3 Who or what will be most immediately helped by your work, and how? All stakeholder groups involved in organic specialty crop production will benefit from improved communication through development of the soil amendment risk assessment tool and training and outreach program. Those groups in close contact with growers and/or soil amendments will also benefit from the development of a data-based risk assessment tool that can serve in both a decision support and educational capacity. Publications

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# Developing Multi-use Naked Barley for Organic Farming Systems Iii

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| **Contract / Grant No.** | 2023-51300-40964 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Brigid Meints |
| **Performing Institution** | Oregon State University |

## NON-TECHNICAL SUMMARY

Organic growers need new crops, markets, and rotation options supported by varieties that are developed specifically for organic conditions. Our long-term goal is to provide organic gardeners, growers, processors, and consumers with an alternative crop, food, and raw material that will be economically rewarding and sustainable. Currently, organic barley end-uses and markets are stratified due the presence of an adhering hull and grain β-glucan content. We are characterizing and breeding naked barley with modest levels of β-glucan to create varieties suitable for brewing, feed use, and that will meet FDA guidelines for soluble fiber in human diets. Development, assessment, and breeding of multi-use naked barley will be conducted under organic conditions in five states (OR, CA, MN, WI, & NY) using four classes of germplasm: a naked barley blend targeted to K-12 students and home gardeners, a large diversity panel to apply genetic data to improve barley for organic systems, a modified nested association mapping panel developed as a breeding population targeting traits important for organic systems, and multi-regional trials to identify advanced varieties for release. We will evaluate agronomic and multi-use quality traits and resistance to biotic and abiotic stresses. Workshops will educate stakeholders on best management practices and processing procedures. Our outreach efforts will familiarize students, gardeners, growers, processors, and consumers with the benefits of naked barley varieties and provide guidance for capitalizing on the advantages these varieties can offer through case studies highlighting bakers, chefs, maltsters, and brewers. Goals / Objectives The long-term goals of this multi-region, integrative project are to: (1) provide organic growers, processors, and consumers with a new crop, food, and raw material alternative that will be economically rewarding and sustainable (2) identify and release high-yielding, high-quality, flavorful and nutritious multi-use naked barley varieties for organic systems based on a regional variety testing program anchored in Oregon, California, Wisconsin, Minnesota, and New York; (3) continue to characterize traits that were identified in the first two cycles of this project as being especially critical for organic production on a large, genetically diverse panel of naked barley germplasm; (4) use a modified nested association mapping (NAM) population to breed for traits important for organic production and regionally relevant to the different areas represented in this project and to maximize the efficiency of selection via integration of phenotypic and genotypic data (5) engage K-12 students and home gardeners in plant breeding and organic grain and food production through the dissemination and study of an organically grown naked barley composite population; (6) engage growers, culinary end-users, maltsters, and brewers in pilot experiments to explore how naked barley performs on farms and in production facilities; and (7) educate the public on the uses and production value of naked barley using a number of dissemination techniques. Project Methods Project 1: Oregon Naked Barley BlendEach breeding program will collaborate with a local school to develop lesson plans using the ONBB to teach students about barley breeding, genetics, agronomy, and nutrition. Depending on the school facilities, the ONBB will be grown in a school garden or in pots in collaboration with the breeding program. Students will collect data on the ONBB throughout the barley growing season. In addition, teachers will post descriptions and images of ongoing activities at the project website. At each school, outreach, plant breeding, and graduate student personnel will be available for visits throughout the season.Project 2: Regional TrialIn order to focus on regional breeding and selection based on the results of the G×E studies performed in previous cycles of this project, two separate fall and spring-planted regional trials of twenty entries each will be designed and tested in representative mega-environments (ME); ME1 includes OR & CA and ME2 includes MN, WI, & NY. These trials will be composed of existing varieties, advanced lines, lines from the modified NAM population, and two covered checks (1 general and 1 local). In each state, trials will be conducted on-farm or on-station. At each location, a three replicate Randomized Complete Block will be used. Standard yield trial protocols (e.g. plot size, seeding rate, seeding date) will be used at each location. Soil tests will be conducted at each location and organic fertilizer(s) applied as appropriate.Each variety will be evaluated for agronomic traits including: heading date, plant height, lodging, brackling, grain yield, test weight, and plump/thin grains. These traits will be measured using standard units at all

locations, following the procedures implemented by the USDA-NIFA Barley and Triticeae CAP projects. Fall trials will be evaluated for winter survival. At each location, cooperators will evaluate locally-occurring diseases using standardized rating scales. Typically, these disease/location combinations are (OSU: scald, stripe rust, leaf rust; UC-Davis: leaf rust, stripe rust, BYDV, CYDV; UMN and UW-Madison: Fusarium Head Blight, powdery mildew, stem rust, spot blotch, bacterial leaf streak, net blotch, leaf rust; Cornell: Fusarium Head Blight, powdery mildew, scald).At maturity, treatments will be harvested using a small plot combine and grain yield, test weight, and threshability will be evaluated.Project 3: Diversity PanelThe full diversity panel consists of 384 naked entries from the OSU, WSU, UMN, Virginia Tech, UC Davis, University of Saskatchewan, James Hutton Institute (Scotland), and CSIC (Spain) breeding programs as well as commercially available lines and landraces from the NSGC. The panel includes winter, facultative, and spring growth habits, different seed coat colors, waxy and non-waxy starch, and lines with mostly unknown end-use properties.Using a protocol developed by Grewal et al. (2008a), the diversity panel will be assessed for resistance to loose smut. Briefly, a solution of water and loose smut spores will be injected into florets via a hypodermic needle prior to anthesis. Mature seeds will be planted in the greenhouse and at flowering the level of resistance to smut will be visually assessed as the number of smut heads formed. Initial trials have been conducted to validate protocols. These data will allow us to validate known resistance QTLs and potentially discover novel ones through GWAS. Additionally, the level of resistance is unknown for most lines in the diversity panel. Identifying resistant lines will allow us to select those as parents for future breeding work or help select potential varieties for release for organic production.Project 4: Modified NAM populationIn Year 1, we will advance the NAM population to the F4 and F5 generations by single seed descent in the greenhouse to produce 375 inbred lines. In the F5 generation, we will harvest plant tissue from individual plants for DNA isolation and genotyping by sequencing (GBS). GBS libraries will be developed in-house with a set of 384-barcodes using a slightly modified method from Poland et al. (2012). Sequencing will be done at the UC Davis Genome Center using an Illumina NextSeq 500, which produces an average of 500M reads. Bioinformatics will be done using the TASSEL5 GBS pipeline (www.maizegenetics.net/tassel) with alignment to the most current barley genome (Morex V3).In Year 2, we will evaluate the threshed seed from the head rows for threshability, seed size, and seed weight. Using the seed produced from head rows, we will plant two fall-planted preliminary yield trials, one winter survival trial,and two spring-planted PYTs with a single replication for each entry and repeated checks consisting of the NAM parents and a local check.In Year 3, we will evaluate the full NAM population (n=375) in an additional fall-planted (OSU) and spring-planted (MN) trial as described for year two adding to the data set for genetic mapping and developing GS models. Selected lines (n=50) from the PYTs will be evaluated in 2YT trials in fall-planted locations (OR, MN, WI, NY, CA) and spring planted locations (OR, MN, WI, NY, CA). In addition, each breeding program will advance crosses made in year 2 to the F1 and F2 generations.In Year 4, selected lines from the 2PYT trials will be entered into the spring (SRT) and fall (FRT) trial (see Project 2). In addition, each breeding program will advance crosses made in year 2 to the F3 generation where they will be genotyped. Genomic selection models generated from the NAM population will be used to select F3 plants that will be advanced to the F4 generation in the greenhouse and then to F4:5 head rows in the field.The modified NAM population will generate a rich data set with which to investigate key questions about effectively handling genetic diversity for organic systems.Project 5: Quality and Market AssessmentSmall increase blocks will be planted in each of the five statesin conjunction with the regional trials. Released varieties/germplasm and landraceswill be selected out of the regional trials and diversity panel to be grown out in these blocks. Grain harvested from the increase blocks will be used for end-use quality analysis, product development, sensory trials, and protocol development. Additionally, small commercial scale production will be initiated with interested farmers. Seed will be provided to farmers, as well as a \$500 trialing stipend. Grain harvested from these increases will belong to the farmer, who will be encouraged to sell to local maltsters, food processors, bakers, chefs, or direct-to-consumer.To engage more deeply with chefs and other culinary professionals who are interested in naked barley, this proposal will partner with 30 restaurants (10 in the Pacific Northwest, 10 in the Midwest, and 10 in the Northeast) to host naked barley \"pop-ups\", in which each restaurant will be mailed a bag of naked barley (whole grain, flour, and/or flakes) and support materials to include a naked barley-based item or items on the restaurant menus. Project team members will provide the restaurants with marketing materials and resources to engage consumers around naked barley, and a pre- and post-survey template to gather information about how consumers perceive naked barley before and after the \"pop-up\". We will also survey the chefs engaged in this project to understand their knowledge and interest in using naked barley in their restaurants before and after the \"pop-up\". Following this process, collaborators will publish a resource which will be hosted on the eOrganic website about how to create a restaurant \"pop-up\". Additionally, 5-10 participants will be invited to contribute to an in-depth set of case studies detailing their experience cooking or baking with barley, the positives and challenges, and consumer perceptions. Progress 09/01/23 to 08/31/24 Outputs Target Audience:Public outreach efforts for naked organic barley included speaking at organic agriculture and grain-related conferences, workshops, and events. Such events have allowed us to engage a diverse audience about the potential use of naked organic barley. Producers/growers End-users Grain retailers and wholesalers Processors Millers Brewers Distillers Maltsters Animal feed suppliers and feed mills Chefs

Bakers Students K-12 students Undergrad and graduate students Urban agriculture students Academic and industry researchers Organic organizations General Public Instagram viewers (1109 followers, 159 posts on \@nakedbarley) Consumers and farmers-market shoppers Business owners Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?Attendance at conferences where grant participants have discussed their work with organic naked barley has allowed for development of professional networks and regular input regarding the breeding goals for naked organic barley. Discussion of ideas and challenges at these conferences and events has provided training in how the goals and execution of the project should go forward. The graduate students have had many opportunities for professional development and training. They have learned many technical skills regarding experimental design, field work, plant pathology, disease resistance, data analysis, food science, weed management practices, public speaking, as well as a good sense of what working in academia is like. Attendance at meetings, field days and other activities have provided many opportunities to learn new ideas and points of view. Field related activities also provide the chance to learn many hands-on skills including field and plot management. Also, graduate students funded by this grant learned technical and academic skills to which they would not have otherwise been exposed. Gopika Gopinathan and Siim Sepp (Plant Breeding graduate students) and Sydney Baumgardner (Food Science graduate student) have had the opportunity to develop data analysis, presentation, and writing skills. They have had the opportunity to learn and work with different genomic methods in plant breeding including GWAS and genomic selection. Additionally, from interactions at field days or conferences, they have begun to develop valuable networks with researchers and farmers. Through presenting research proposals and results at various functions, they have improved their speaking ability and have been members of professional scientific societies including the National Association of Plant Breeders, Craft Maltsters Guild, and the Crop Science Society of America. Brigid Meints has had the opportunity to mentor all the graduate students funded by this grant. This project has provided her with training in project management, organizing events, malting, disease inoculation, and new data analysis techniques. Additionally, attendance and presenting at the OREI PD meetings have given her exposure to other experts in the field to learn from and instigate collaborations. How have the results been disseminated to communities of interest?Details of the project have been disseminated through email, personal correspondence and communication, conferences, social media, and websites. UW-Madison, Cornell, UC Davis, OSU, and UMN all hosted in-person field days with hundreds of participants, including farmers, processors, organic industry representatives, students, other researchers, and the general public. At field day events, chefs and bakers prepared barley dishes for participants to taste. The Culinary Breeding Network and Glynwood organized the 2023 Variety Showcase, which brought in hundreds of attendees. Andrew Ross and Sydney Baumgardner made barley tortilla chips, Jordyn Bunting made a barley and bean succotash, and a New York baker, Nora Allen, made pumpkin and apple galettes with a barley flour crust. All the dishes were served while educating the general public about naked barley. Social media postings on Instagram allow researchers to share project updates and photos with thousands of followers between \@nakedbarley, \@culinarybreedingnetwork, \@eorganicofficial, and \@glynwoodorg. Each of the breeding programs have uploaded phenotypic data from the regional trials and diversity panels to the T3 (Triticeae Toolbox: https://triticeaetoolbox.org/barley/) database. These data can be accessed by other breeding programs and researchers. What do you plan to do during the next reporting period to accomplish the goals?Scholarship Submit publications to eOrganic and scientific journals about projects: Weed competitive ability in naked barley Brewing trials Malting research Smut and FHB inoculation studies Nixtamalization of naked barley Education Work with teachers at the local schools to implement previously developed lesson plans. Work with teachers at the local schools to find ways to involve students in the naked barley project. Outreach Continue to educate our target audience through workshops and conferences- either in-person or virtual (Variety Showcase, MarbleSeed, Organic Seed Growers Conference, Organicology Craft Malt Conference, North American Barley Researchers Workshop). Gather and provide information on research and opportunities for growers, processors, bakers, and brewers to gain access to naked barley. Conduct expanded outreach to professionals in the craft beverage and culinary sectors. Host field days and other outreach events to increase community involvement and awareness. Research Advance the NAM population to further assess naked barley germplasm and gather more data on traits determined to be important for its production. Conduct loose smut inoculation trials on the diversity panel in the greenhouse at OSU. Conduct covered smut inoculation trial on a subset of the NAM breeding population. Conduct controlled PHS and dormancy screening for the NAM breeding population Conduct brewing trials with the OSU Fermentation Science program. Consider variety release of MS10S4111-01, Purple Prince, and other advanced germplasm. Impacts What was accomplished under these goals? In the first year of this project, participants grew out a new set of advanced naked barley breeding to assess for inclusion in the regional trials, completed the final cycle of speed breeding in the greenhouse for the NAM, and then put those lines out in the field for the first time. This involved growing \~1500 naked barley lines (\~100 fixed lines including released varieties and advanced breeding lines, and \~1400 mid-generation breeding lines in 61 families for the NAM) in certified organic trials across the country. Advanced lines were characterized for agronomic traits, food and malt quality traits, weed competitive ability, and resistance to abiotic and biotic stressors. Mid-generation material was screened for growth habit, row type, color,

and vigor. Hundreds of growers, processors, and consumers have been provided with trial results and information about naked organic barley at conferences, field days, through personal communication, website postings, and social media. Goal 1: The value of naked barley as a new potential crop was described to stakeholders through a variety of mechanisms. Brigid Meints compiled and presented data on the naked malting and brewing trials to several hundred stakeholders at three different events, including an eOrganic webinar that is available on YouTube. Andrew Ross and MS student Sydney began working on a nixtamalization and tortilla making study with four varieties of naked barley in order to understand the functionality and nutrition of a novel product made with naked barley that could be of interest to the public. This study will continue and the results will be published when finished. Siim Sepp presented Cornell small grains research at Empire State Barley and Malt Summit 2023 on 12th Dec 2023, informing local maltsters, farmers and brewers about the naked barley breeding and research in NY. Goal 2: For the 2023-24 growing season, we grew out a new set of advanced experimental breeding lines and released varieties in the fall and spring to assess for inclusion in the regional trials. For the fall trial, 40 advanced naked barley lines were tested in double-rows at 8 sites in five states: Oregon, Minnesota, Wisconsin, California, and New York. For the spring trial, 30 naked barley entries were tested at 6 sites in the same five states. Genotypes were assessed for grain yield, test weight, plant height, heading date, disease resistance, winter survivability and weed competitive ability. From each of the fall and spring trials, 18 entries were selected to be grown in replicated trials at all locations starting with the 2024-25 growing season until the end of this project. At UW-Madison, speed breeding and early harvest experiment was conducted on naked barley lines, results are being prepared for publication. Goal 3: At OSU, inoculation studies for covered smut (incited by Ustilago hordei) were completed on the diversity panel and race typing is underway. Data is being analyzed and prepared for publication. Inoculation studies for loose smut (incited by Ustilago nuda) are underway on the panel. At UW-Madison, in spring 2024 covered smut screening in naked barley lines was conducted in speed breeding conditions, data analysis is underway. In fall 2024, covered smut screening with a larger number of plants is being conducted in normal greenhouse conditions for protocol development. Goal 4: Development of the modified NAM population continued. The final cycle of speed breeding was completed in the greenhouse at UMN and UW-Madison. This resulted in a population of 1371 mid-generation breeding lines from 61 families. The seed from the greenhouse advance was threshed and planted in single rows under organic conditions in Corvallis in May 2024 to make selections and increase seed. Notes were taken on emergence, row type, head color, and vigor. The population was selected down to 430 entries, harvested and threshed. The best 400 entries will be increased in Davis and used for experiments with covered smut in Madison and pre-harvest sprouting in Ithaca in 2025.The parents of the NAM population were pre-screened for PHS resistance in New York 2024, in preparation of the NAM large-scale screening for the upcoming year. Goal 5: Brigid Meints presented to a group of teachers interested in agriculture in the classroom who were interested in in-person classroom visits in the upcoming school year. The Oregon Naked Barley Blend has been distributed to teachers and dozens of pounds of the blend have been distributed to interested home gardeners around the country for planting and selection. Efforts began to set up a platform for the blend on SeedLinked to track distribution and hear how recipients are engaging with the blend. Additionally, Meints began working with the Oregon Farm to School network and Oregon Ag in the Classroom to plan for further distribution of the blend in classrooms in 2025 and 2026. Goal 6: Brigid Meints and the Artisan Grains Collaborative worked together to conduct a virtual baking test with 14 bakers in the Upper Midwest. Bakers were provided with organic naked barley flour and flakes, which they used to prepare cookies and a sourdough porridge bread. They were instructed to document their process and then everyone came together to discuss their experience. This pilot experience had a very positive response- both in terms of the virtual test itself, as well as the naked barley. These tests will be repeated in other regions in future years. Goal 7: Details of the project have been disseminated through email, personal correspondence and communication, in-person field days, social media, conferences, and websites. The eOrganic website is updated to reflect progress of the project and contains bulletins, publications, webinars, and social media accounts. Brigid Meints presented about the naked malting and brewing workshop in an eOrganic webinar, at the International Women\'s Craft Fermentation Summit, and at the Craft Malt Conference. Meints presented about the structure of the diversity panel and her research on covered smut at the Barley Mutant Conference in Kurashiki, Japan. Meints also gave a flash presentation and presented a poster at the OREI PD Meeting in Orlando, FL. Participants at OSU, UMN, UW-Madison, Cornell, and UC Davis all hosted field days and interacted with hundreds of growers and other stakeholders at these events. All project participants participated in the Variety Showcase held at Glynwood in Cold Spring, NY in October 2023. Andrew Ross and Sydney Baumgardner made barley tortilla chips, Jordyn Bunting made a barley and bean succotash, and a New York baker, Nora Allen, made pumpkin and apple galettes with a barley flour crust. All the dishes were served while educating the general public about naked barley.

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# Developing Research and Extension Collaborations to Support Climate Adaptation by Midwest Organic Vegetable Producers

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|---|---|
| **Contract / Grant No.** | 2023-51300-40952 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Ruth Genger |
| **Performing Institution** | University of Wisconsin |

## NON-TECHNICAL SUMMARY

Organic vegetable growers are uniquely susceptible to the projected impacts of climate change. Across the Upper Midwest, models predict higher annual temperatures with shorter, warmer winters, more hot days (over 95° F) and extended hot spells. Projections also show increased winter, spring and fall precipitation, greater frequency of extreme rainfall events and more dry spells during the summer. These changes can mean shifting planting and harvest windows, more dangerous conditions for outdoor field work, an increased need for irrigation or artificial drainage, increased insect and disease pressure, and reduced produce quality and marketability. The emphasis on soil health and systems diversity in organic agriculture is likely to provide some inherent resilience. However, most organic vegetable growers manage a diverse crop portfolio, leading to frequent and intensive tillage, undermining resilience to unpredictable precipitation. Organic vegetable growers need support to develop effective tools and strategies for climate resilience.Adapting our regional food system to the effects of climate change is an inherently complex problem, involving a wide network of stakeholders including growers, Extension professionals, researchers, regulatory agencies, grower organizations, private companies, and nonprofits. Many groups are still assessing stakeholder needs and defining their roles in this work. The critical next step is to weave these various networks together to facilitate regional coordination. Managing the impacts of complex issues like climate change cannot be achieved solely through traditional research and extension approaches. Instead, these goals must be achieved through creating and applying agroecological knowledge throughout webs of partnerships in which the ways of knowing and experiences of growers, scientists, organizations, industry leaders, and public officials are upheld and utilized. By drawing on principles from social network analysis and \"network weaving\", we hope to share knowledge and work together productively to facilitate more effective groups and collaborations, ultimately better identifying the research and extension needs related to climate resilience for Midwest organic vegetable farms.Through this planning proposal, we aim to: define climate resilience-related research priorities for Midwest organic vegetable growers; focus and strengthen efforts of individuals, organizations, and existing groups engaged in climate resilience outreach and education; learn from one another about best practices for climate adaptation outreach and building research networks with meaningful grower participation; and coordinate our efforts to use funding resources and expertise more effectively.We will coordinate a series of structured meetings to assess research, extension and outreach needs and efforts across the Midwest region on climate adaptation for organic vegetable producers, identifying priorities for future collaborative work. Based on findings from surveys, polls and facilitated discussions coordinated around these meetings, we will develop and publish two peer-reviewed papers outlining research, education and extension priorities to support organic growers in developing climate resilient diversified food production systems. Finally, we will develop and submit an Integrated Project proposal to the USDA NIFA OREI program in 2024 to pursue the research, education and extension priorities that emerge from this planning project. Goals / Objectives The long-term goal of this proposal is to support Midwest organic vegetable growers\' adaptation to a rapidly changing climate. We aim to do this through a \"network weaving\" engagement process to define research and outreach priorities for this audience, allowing us to write a well-coordinated full proposal to OREI in 2024.Our objectives are to:Coordinate a series of structured meetings to assess research, extension and outreach needs and efforts across the Midwest region on climate adaptation for organic vegetable producers, identifying priorities for future collaborative work;Develop and publish two peer-reviewed papers outlining research, education and extension priorities to support organic growers in developing climate resilient diversified food production systems; and,Develop and submit an Integrated Project proposal to the USDA NIFA OREI program in 2024 addressing research and extension priorities identified in OREI program objectives 1, 6 and 7. Project Methods Methods for this planning project are primarily techniques for facilitating discussions among a diverse group of participants to ensure that all voices are represented. By using inclusive methods, we expect to draw together perspectives from people with a wide range of experiences in organic vegetable production. This is an essential foundation to

ensure relevance of future research and extension activities with Midwest vegetable growers.Methods include:social network survey to map target participant groups, key communications channels, and educational resources;Open Space discussion to allow participants to explore emergent themes from lightning talks; modified \'data jam\' approach to collaboratively summarize our coordinated and participatory agroecological approaches to extension and outreach efforts;world cafe discussion to identify existing efforts, gaps, and priorities related to climate resilience research for organic vegetable growers;polling tools like Menti-meter to gather feedback about research priorities and outreach processes;post-meeting surveys to assess participant perceptions of meeting outcomes and priorities.Data collected using survey and polling tools will be summarized using descriptivestatistics in a program such as R. Progress 09/01/23 to 08/31/24 Outputs Target Audience: This project serves organic vegetable producers in the Midwest United States; agriculture professionals who serve their educational needs, including Extension and non-profit staff; and researchers who focus on organic vegetable production systems. The project team and audience are located in the Midwest, and focused on production systems, educational needs, and research needs specific to this region, yet the consultative and network weaving approach taken by this project can be applied across multiple regions. Network building specific to this project began when Wisconsin organic vegetable producers met with Extension educator Claire Strader and researcher Rue Genger to discuss concerns about extreme weather events in 2018, leading to a 2019 climate resilience forum held at the Organic Vegetable Production Conference in Madison WI. This group has built a producer community of practice centered on peer learning and collaborative research into reduced tillage methods for organic vegetable production. Many of these producers sell directly to consumers and retailers in local and regional markets and thus are critical to stable regional food systems. Group members share production practices and research trial outcomes through online and in-person presentations. Concurrently, the Risk to Resilience program in Minnesota, co-led by the University of Minnesota Extension and the Land Stewardship Project, has supported 20 specialty crop farms in developing detailed climate resilience plans with goals, specific practices, timelines for implementation, and plans for evaluation. These producer networks have been important for consultation on project activities as well as promotion and implementation of project events. Extension and producer education professionals in Wisconsin, Minnesota, Iowa, Michigan, Illinois, North Dakota, and South Dakota with interests in climate adaptation for organic vegetable growers have been served by this project. Similarly, Midwest-based researchers active or interested in climate adaptation for organic vegetable growers have benefited from the project\'s activities. This project has connected researchers and extension professionals from a wide range of Federal, State, University, and non-profit organizations, and has developed a framework for on-going collaboration. The project\'s consultative activities have extended our network across disciplines relevant to agroecosystem health, identified gaps in knowledge and expertise, and identified priorities for future research. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?Event attendees heard presentations on climate science, climate adaptation strategies for organic vegetable production, and climate adaptation outreach and education efforts for organic vegetable producers. By convening organic producers, educators, and researchers and providing structured opportunities to discuss strategies, needs, and practices, we enabled these professionals to engage in peer-to-peer learning and to find commonalities and opportunities for collaboration in their future work. How have the results been disseminated to communities of interest?Outcomes from each meeting were summarized and distributed to participants via email. A publication on the first event (focused on needs of producer educators) has been accepted by the Journal of Extension and is awaiting publication, and a second publication (focused on research needs) is in preparation. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported Impacts What was accomplished under these goals? We convened a networking and needs assessment process for extension and grower education professionals from across the Upper Midwest. We invited educators, researchers, and staff from 1862 LGUs and non-profit organizations serving organic vegetable growers in Minnesota, Wisconsin, Michigan, Illinois, Iowa, South Dakota and North Dakota, staff from the USDA Midwest Climate Hub, and representatives from five Tribal Extension, government, or inter-Tribal coalitions engaged with specialty crop growers. Our team developed and distributed a needs assessment and social network analysis survey which was completed by twenty-two people. We then hosted a follow-up retreat in Cloquet, attended by 20 of those individuals. At the event, participants heard presentations on ongoing climate adaptation outreach and education efforts for organic vegetable producers, reflected on survey results together, and summarized priorities and takeaways through World Cafe discussions. The project was deemed \"not human research\" by the University of Minnesota Institutional Review Board (study #00020130). Outcomes of the process indicated that a networked, collaborative approach is critical for supporting organic vegetable growers in adapting to climate change across the Upper Midwest. We learned that most grower educators are seeking to adapt tools and resources for their audiences but are also underutilizing existing resources dedicated to climate resilience for growers in the Midwest. Funding is a key limitation to doing this work, and channeling funds directly to producers is necessary for timely climate adaptation. Training and resources on effective climate communication is needed. More work is needed to bring underserved communities into the existing network of grower educators serving organic vegetable growers. Developing programs and tools specifically for these

audiences is critical, and those programs must be language-accessible and culturally appropriate. Networks of grower educators must also address larger food system barriers to climate resilience in addition to working directly with farmers. Our team convened a session at the 2024 Marbleseed Organic University (OU) on the topic \"Climate adaptation for Midwest organic vegetable growers: grower experience, current research and future priorities\". This event brought together organic farmers and organic agriculture professionals from across the Midwest region. We also recruited attendees from Midwest farmer-serving organizations with a focus on food justice, equity, and environmental stewardship, as well as Tribal food and agriculture affiliates. Eighty-eight attendees pre-registered for the session and attendance was approximately 80-90 people. Attendees heard presentations on climate science and research on production strategies for organic vegetables and on managing climate-related health risks in agricultural work. Through surveys and small group discussion, the following research needs were prioritized: Water management; Resilient crop varieties and species; Pest management; Worker health and labor concerns; BIPOC inclusion; Soil health; Season extension. Attendees identified resource limitations - particularly capital outlay - as obstacles to implementing climate adaptation recommendations and pointed to a need for accessible educational resources delivered through strong positive relationships with producer educators, and for more consultative and collaborative approaches to research into climate adaptation to ensure recommendations are adapted to on-farm needs. Value-Added Grains for Local and Regional Food Systems Mark Earl Sorrels, Cornell University

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# Discovery of Natural Products as Sprout Inhibitors for Organic Potato and Development of Methods for Their Application

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| **Contract / Grant No.** | 2023-51300-40852 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Valtcho Jeliazkov |
| **Performing Institution** | Oregon State University |

## NON-TECHNICAL SUMMARY

The project will identify essential oil (EO) blends for suppression of premature tuber sprouting in potato storage and will develop microencapsulation methods for delivery of the best products. The hypothesis is that synthetic growth suppressants such as chlorpropham (CIPC) can be replaced with microencapsulated EO blends and fractions. The goal is to develop several potato sprout- suppression products for organic potatoes and also methods for their encapsulation and application. The objectives are: (1) Discovery and development of blends from EO that exhibited sprout suppression in our previous studies; (2) Microencapsulation of the most effective EO blends with biodegradable polymeric carriers; (3) Test microencapsulated EO blends in laboratory, semi-commercial and commercial settings, (4) Potato tuber chemistry and hormonal balance as a function of microencapsulated EO blends application; (5) Evaluate safety of the new EO- based products using a high throughput platform, (6) Communicate the results. Incorporate the information into online classes. The project objectives match FY 2022 Purpose and Priorities, specifically Priority 3: \"..evaluate, develop, and improve allowable post-harvest handling, processing, and food safety practices to reduce toxins \..., while increasing shelf-life, quality, and other economically important characteristics\" and Priority 5: \"Explore technologies that meet the requirements of the National Organic Program (NOP) and protect soil, water, and other natural resources\", and Priority 8: \"Develop .. curriculum for organic agriculture\". The project will address limitations in organic potato storage and sprout control. The results will facilitate the development of new potato sprout suppressors or inhibitors, improve the quality of potatoes, reduce environmental impact, improve access of the US potatoes to additional markets, and contribute to improved human health. Goals / Objectives The goal is to develop safe potato sprout suppression/inhibitor product(s) for organic potato and methods for their microencapsulation and application. The project will address serious limitations in organic potato storage. The results will facilitate the development of new potato sprout suppressors or inhibitors, improve potato quality, reduce environmental impact, and contribute to improved human health. The project is based on discussions with potato growers, and will have a positive effect on expanding certified organic potato production, enhance access to additional markets and consumer groups, and increase the competitiveness of the U.S. potato industry.The following objectives will be addressed in the 2023-27 seasons:Objective 1: Discovery and development of blends from essential oils (EO) that exhibited sprout suppression in our previous studies. Bioassay-guided fractionation.Objective 2: Microencapsulation of the best EO blends with biodegradable polymeric carriers;Objective 3: Testing microencapsulated EO blends in laboratory, semi-commercial and commercial settings,Objective 4: Potato tuber chemistry and hormonal balance as a function of non- and microencapsulated EO blends and microemulsions application;Objective 5: Evaluate the safety of the new EO- based products using a high throughput screening platformObjective 6: Communicate the results to the potato industry, scientists, extension, students, and general public. Incorporate the information into online undergraduate and graduate certificates in Organic Agriculture to reach out to students across the nation and abroad. Project Methods Methods:Objective 1: Discovery and development of blends from Essential Oils (EO) that exhibited sprout suppression in our previous studies; bioassay-guided fractionation.The EO fractions and blends will be assessed again at the best concentration ranges.A selected group of the most effective EO blends, EO fractions, and pure compounds for suppressing sprouting from the previous groups of experiments will be evaluated at different concentrationsObjective 2: Microencapsulation of the best EO blends with biodegradable polymeric carriers and microemulsions.Our first approach lies in encapsulating oils within spherical and hollow chitosan biodegradable beads, which will be generated using the spray drying technique. We intend to generate spherical and hollow EO-loaded chitosan beads with different sizes and polymeric outer thickness and investigate the release of EO blends on potatoes.Our second strategy for encapsulating EO and controlling their release lies in using microemulsions.We propose developing microemulsion formulations with the identified EOs stabilized with nonionic surfactants in an aqueous medium. The proposed work consists of;(1) To develop the phase diagram(2) To study the effect of

different surfactants on the phase diagram and select the optimal surfactant system.Experimental set-up. Construction of ternary Phase Diagrams. The phase diagram is constructed to identify the formulation components\' molar ratio that provides the highest solubility and stability for the compound of interest. In other words, this diagram will be used to optimize different conditions with the goal to find the optimum concentrations (ratio) between the components to generate the best microemulsions.Objective 3: Testing microencapsulated EO blends in laboratory, semi-commercial and commercial settings. Several relevant laboratories, semi commercial, and commercial-type trials will follow the development of microencapsulation technology, to facilitate the development of application methods.Objective 4: Potato tuber chemistry and hormonal balance as a function of microencapsulated EO blends application; The mechanisms of EO effect on tuber meristems will be elucidated using a combination of targeted and untargeted metabolomics using an orbitrap quadrupole LS-MS approach. We will test to hypothesis that EOs disrupt sprouting via ABA and other phytohormone interactions and physical damage to meristems. The combination effect of disrupting sprouting via hormone-related crosstalk and physical damage (\'burning\') meristems will be investigated. Targeted metabolomic analysis of meristems will include various plant hormones, sugars and derivatives, as well as other compounds chosen by the team. Microcopy will include SEM, epifluorescence microscopy as well as confocal.Objective 5: Evaluate the safety of selected whole oils, EO blends and fractions and the new EO- based products using a high throughput screening platform.Zebrafish (Danio rerio): The zebrafish embryo is a powerful and relevant in vivo model for assessing chemical safety.General Approach. Rapid in vivo analysis. High throughput analysis will be applied to evaluate the toxicity of whole EO, EO-fractions and microencapsulated EO blends. Our multi-dimensional embryonic zebrafish system platform will provide unbiased and comprehensive biological response profiles for EOs. Methods: EO exposures. Embryonic zebrafish will be exposed to 7 concentrations + control for each EO-based product.Statistical analysis. All statistical analysis will be performed using custom code developed as the zfish R package through an intuitive GUI. The analysis options in zfish include both traditional statistical methods.Objective 6 of the project focuses on extension and education. The goal is to communicate the project\'s results to various stakeholders, including the potato industry, scientists, extension agents, students, and the general public. Dr. Jeliazkov, an expert in potato sprout control, will lead these efforts, with the participation of all project participants and collaborators to meet Objective 5 on extension and education.The project aims to disseminate its findings through several channels, including:Two concise factsheets.A recorded webinar for eOrganic.An article published on eOrganic.A dedicated project website.Presentations at growers\' meetings and field days.Articles published in scientific journals.Integration of new knowledge into two Online Certificates on Organic Farming offered at OSU.To provide timely information to growers, a factsheet will be developed at the end of the first year, presenting preliminary data. Another factsheet will be created near the project\'s completion, incorporating the finalized field data. Additionally, project participants will deliver presentations at the annual OR Potato Growers meetings and potato field days.Through these comprehensive efforts, the project aims to effectively communicate its findings, engage relevant stakeholders, and contribute to the dissemination of knowledge in the field of potato production and sprout control.The results will be included in teaching materials for OSU in-person and online courses. Teaching module on essential oils efficacy, safety and mode of action for potato sprout control in certified organic systems will be developed and included in OSU existing courses offered V.D. Jeliazkov:• AGRI 420/520 Introduction to Organic Food Production• SOIL/CROP 430/530 Organic Soil and Crop ManagementThese courses are Ecampus (online), and reach out to students and professionals across the US and internationally https://ecampus.oregonstate.edu/online-degrees/graduate/organic-agriculture/. Also, the module will be made available to instructors in the Online Undergraduate Certificate in Organic Systems (https://ecampus.oregonstate.edu/online-degrees/undergraduate/certificates/ organic-farming-systems/ ) and in the OSU Sustainability Double Degree Program. A short video and multimedia on the utilization of essential oils as sprout inhibitors in the potato will be developed utilizing the facilities of OSU Ecampus (the online section of OSU) to be used by the OR specialty growers and for students. Progress 09/01/23 to 08/31/24 Outputs Target Audience:We actively engaged with potato growers by delivering a presentation at the Hermiston Farm Fair in December 2023, which reached an audience of approximately 110 participants. Additionally, my graduate students and I presented our research findings at prestigious international conferences, attracting a diverse audience that included professionals, extension agents, and researchers from around the globe. These events provided valuable platforms for disseminating our work, facilitating meaningful discussions, and fostering collaborations within the broader agricultural community. Such interactions have significantly enhanced the impact, visibility, and relevance of our research. Conference Presentations Jeliazkov, V.D. 2023. Essential oils for potato sprout control. Hermiston Farm Fair, December 2023, Hermiston, Oregon. Event details Scientific Journal Publications.The student names are indicated with an asterisk. Alzarqaa*, A., T. Astatkie, C.L. Cantrell, V.D. Zheljazkov. 2024. Efficacy of essential oils in suppressing potato sprouting. Industrial Crops and Products, 222, Part 1. https://doi.org/10.1016/j.indcrop.2024.119561 Mukhlid*, H., C.L. Cantrell, V.D. Zheljazkov. 2024. Do essential oils suppress potato sprout growth? Industrial Crops and Products 219, 119081 https://doi.org/10.1016/j.indcrop.2024.119081 Changes/Problems:We do not anticipate any major challenges. What opportunities for training and professional development has the project provided?The project provided

graduate students and participants with a comprehensive understanding of potato sprout control through hands-on research and practical application. Graduate students gained valuable experience in data analysis and the preparation of manuscripts for publication, honing their technical expertise alongside essential skills in scientific writing, critical thinking, and effective communication. These activities equipped students to present their findings to diverse audiences and navigate the challenges of professional research environments. By fostering these competencies, the project significantly enhanced their preparedness for future careers in academia and industry. How have the results been disseminated to communities of interest?As indicated earlier, we worked actively to disseminate the initial results from this study. The project director presented at the Hermiston Farm Fair in December, 2023. Jeliazkov, V.D. 2023. Essentail oils for potato sprout control. Hermiston Farm Fair, Dec 2023, in Hermiston, Oregon. https://www.owgl.org/events/2023/the-50th-hermiston-farm-fair-seminars? Additionally, we are currently working to compile some of the preliminary results in a manuscript for a scientific journal. What do you plan to do during the next reporting period to accomplish the goals?During the next reporting period, we plan to implement activities aligned with each project objective to ensure continued progress toward our goals: Objective 1 - Discovery and Development of Essential Oil (EO) Blends: We will conduct bioassay-guided fractionation to identify and refine EO blends with enhanced sprout suppression capabilities based on our previous studies. This process will include chemical profiling and compound identification to pinpoint active components. Objective 2 - Microencapsulation: Efforts will focus on optimizing the microencapsulation of the most effective EO blends using biodegradable polymeric carriers. This includes developing stable formulations and evaluating their suitability for sprout suppression. Objective 3 - Testing in Various Settings: We will advance testing of microencapsulated EO blends in laboratory, semi-commercial, and commercial environments. Controlled experiments will assess their efficacy under different storage conditions and variable parameters. Objective 4 - Potato Tuber Chemistry and Hormonal Balance: We will continue analyzing potato tissue samples using HPLC/MS to monitor plant hormones, glucose, and abscisic acid levels. These analyses will evaluate the biochemical effects of EO and microencapsulated EO blends on potato quality and sprout suppression. Objective 5 - Safety Evaluation: Using a high-throughput screening platform, we will evaluate the safety and environmental compatibility of the newly developed EO-based products, ensuring they meet industry standards and regulatory requirements. Objective 6 - Communication and Outreach: We will present key findings at grower meetings, such as the Hermiston Farm Fair, and share initial results at scientific conferences to engage stakeholders and researchers. Additionally, we will incorporate findings into online undergraduate and graduate certificates in Organic Agriculture, broadening the reach of our educational initiatives to students nationwide and internationally. Manuscripts summarizing project findings will also be prepared for submission to peer-reviewed journals. Impacts What was accomplished under these goals? We have initiated and conducted several experiments to achieve the objectives of this study. Our research identified several essential oil blends that outperformed clove (Syzygium aromaticum) essential oil, which is the standard for potato sprout control in certified organic production and storage. Additionally, we have made significant progress in the microencapsulation of individual essential oils and essential oil blends. We successfully developed emulsions of these blends using biodegradable polymeric carriers and conducted further experiments to evaluate their effectiveness in potato sprout control. Through these trials, we identified treatments that demonstrated high efficacy in suppressing potato sprouting. Consequently, we initiated an invention disclosure through the Oregon State University inventor portal. While we are continuing to refine this process, the disclosure has yet to be submitted to the OSU Intellectual Property Office for initial review and feedback. To support this work, we hired a graduate student who is actively conducting experiments and contributing to the achievement of the study\'s objectives. Publications Type: Peer Reviewed Journal Articles Status: Published Year Published: 2024 Citation: Alzarqaa, A., T. Astatkie, C.L. Cantrell, V.D. Zheljazkov. 2024. Efficacy of essential oils in suppressing potato sprouting. Industrial Crops and Products, 222, Part 1 https://doi.org/10.1016/j.indcrop.2024.119561 Type: Peer Reviewed Journal Articles Status: Published Year Published: 2024 Citation: Mukhlid, H., C.L. Cantrell, V.D. Zheljazkov. 2024. Do essential oils suppress potato sprout growth? Industrial Crops and Products 219, 119081 <https://doi.org/10.1016/j.indcrop.2024.119081>.

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# Develop Yeast-based, Immune Inducing Biocontrols of Fire Blight with Improved Efficacy and Minimized Fruit Russeting

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| **Contract / Grant No.** | 2023-51300-40727 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Quan Zeng |
| **Performing Institution** | University of Connecticut |

## NON-TECHNICAL SUMMARY

Fire blight, caused by the bacterium Erwinia amylovora, is top on the list of the most concerned diseases of apple and pear by organic growers. Among all organic approved control measures of fire blight, Blossom Protect, a biological control with a yeast-like fungus Aureobasidium pullulans as the active ingredient, is the most effective and widely used material. Integrated disease management protocols centered around Blossom Protect have been developed and widely adopted by organic growers in the Pacific Northwest. However, applying Blossom Protect under humid conditions can cause of fruit russeting, a disorder of fruit skin that reduce the value of fresh market crops, therefore cannot be adopted by growers in the east.We hypothesize that there are other yeasts from apple and pear flowers that can effectively suppress fire blight similar to A. pullulans in Blossom Protect, without causing significant russeting. Prior to this research, we determined that A. pullulans in Blossom Protect induces plant defense response which is the mechanism for its disease suppression. In this project, we aim to perform an extensive search of flower/fruit colonizing yeasts for their ability to 1. induce plant defense, 2. suppress fire blight, and 3. cause russeting. Isolates with desirable fire blight suppression efficacy with minimal russeting will be selected for a multi-year, multi-location field trial. Extension and education activities include disseminating research findings to growers, educating fruit consumers about the cause of fruit russeting and other skin disorders, and training the next generation organic growers in the Northeast through undergraduate education. Goals / Objectives Isolate yeast-like fungi from apple and pear flowers collected from different cultivars and at different geographical locations.Screen the yeast culture collection for their potential to induce plant defense response and to cause fruit russeting.Test the fire blight biocontrol efficacy and fruit safety of selected yeasts in field trials.Disseminate research findings, increase the marketability of organic fruits, and prepare future organic growers through extension and education Project Methods Objective 1.Isolate yeast-like fungi from apple and pear flowers and fruits collected from different cultivars and at different locations.1.1 Sample collectionApple and pear flowers at full bloom and 2-5 week-old immature fruits will be collected for yeast isolation. Flower and fruit samples will be collected from 25 different apple cultivars and 5 pear cultivars at 4 locations (CT, NY, NH, and OR). Additional sampling will be performed in experimental orchardsat Oregon State University (OR), participating farms in CT, NH, and NY with 5 cultivars sampled at each site. All the farms listed are either certified organic or in the process of being transitioned into organic.1.2 Isolation of microorganism within plant cuticleCuticle portion of the collected flower hypanthium and immature fruits will be dissected with a sterile razor blade, placed in Eppendorf tubes containing 0.5 ml of sterile potassium phosphate buffer (pH 7.0), vortexed for 10 seconds and placed in a water bath sonicator for 3 minutes to release the attached microorganisms present on the surface and internal in the cuticle.Buffer with cuticle microbes will be serial diluted and plated on three different media for yeast isolation: Potato Dextrose Agar (PDA), Yeast extract-Peptone-Dextrose (YPD), and Sabouraud Agar (SA). Chloramphenicol, streptomycin sulfate, and tetracycline will be supplemented into the media at the concentration of 50 µg/liter to suppress bacterial growth. Plates will be incubated at 28 °C for 48-96 hours.1.3 Establish culture collection and identificationAfter the microbial colonies develop, 15 yeast-like fungal colonies representing various morphology and growth characteristics from each biological sample will be selected, purified by streaking on a fresh media, and preserved in 20% glycerol in a -80 °C freezer. Filamentous fungi will not be included in this study. The selected yeast strains will be further identified by amplifying and sequencing the fungal ITS1 gene. Relevant information of the culture collection, including colony morphology and growth characteristics, ITS sequences, and strain identification will be documented in a strain database and managed as described in the data management plan.Objective 2. Screen the yeast culture collection for their potential to induce plant defense response and to cause fruit russeting.2.1 Screen the yeast collection for their ability to induce plant defense response.Yeast strains obtained from Objective 1 will be cultured on the corresponding media.The mycelium on agar surface will be collected and resuspended in sterile water, adjusted to OD600=0.1(cell optical density), and spray-inoculated onto apple flowers on the day of petal open, with two

flower clusters (a total of 12 individual flowers as biological replicates) per yeast isolate. Water treatment, Blossom Protect treatment, and acibenzolar-S-methyl treatment (a chemical inducer of SAR) will be used as controls (Johnson et al. 2016).Three days post yeast treatment, hypanthium portion of the yeast-treated flowers will be dissected from the rest of the flower parts (sepal, filament, style, and the base of ovary) for RNA isolation. RNA will be isolated using RNeasy Plant Mini Kit (Qiagen), and used as input in a quantitative reverse transcription PCR (qRT-PCR) analysis. Expression ofPR2(plant defense gene) andTublin(a gene the expression of which is consistent, used as an internal control) will be measured, using aDDCtmethod. Statistical analyses will be performed using the one-way analysis of variance (ANOVA) model in the \'stats\' package in R. The screening will be performed in a high-throughput manner using 96-well plates.2.2 Screen the yeast collection for their ability to cause fruit russetingWe will perform russeting evaluation using the in orchard attached fruit assay as developed in our preliminary study (Fig. 8A). The russeting evaluation will be performed on \'Golden smoothie\' apple, a cultivar highly susceptible to russeting, located at the Connecticut Agricultural Experiment Station Lockwood Farm (Hamden, CT). Flowers will be treated with Oxidate 5.0 (1.0% v/v) to clean off the indigenous yeasts.In vitrocultures of yeasts will be spray-inoculated to the flowers / fruitlets twice, once at full bloom and again one week after petal fall. Water treatment and Blossom Protect treatment will be used as controls. 20 biological replicates will be included in each treatment. Russeting will be evaluated one week prior to harvest.The in orchard russeting assay is limited by the availability of growing fruits during the growing season. To mitigate this limitation, we will also perform a cutinase production assay on Czapek-Dox medium (Dickman et al. 1986) in the laboratory. Cutinase degrades cutin, the major component of plant cuticle, therefore, yeasts that produce cutinase are more likely to cause russeting than yeasts that don\'t.Objective 3. Test the fire blight biocontrol efficacy and fruit safety of selected yeasts in the field.We expect to identify 6-10 yeast isolate that induce a plant defense response without causing significant russeting from Objective 2. In Objective 3, we will further test whether these yeast isolates can effectively and consistently suppress fire blight, and evaluate the fruit finish through a two-year field trial. The field experiment will be conducted on three apple cultivars with different susceptibility to fire blight and russeting: \'Golden Smoothie\': moderately tolerant to fire blight and highly susceptible to russeting; \'Gala\': highly susceptible to fire blight and tolerant to russeting; and \'Red Delicious\": tolerant to both fire blight and russeting. These trees are located at two locations, 1. Lockwood farm at the Connecticut Agricultural Experiment Station, Hamden, CT, and 2. Griswold Research Center, Griswold, CT. Both locations are currently under transition to organic production. This experiment will be repeated for three years.Objective 4. Disseminate research findings, increase the marketability of organic fruits, and prepare future organic growers through extension and educationActivity 1.We will disseminate the research findings (Objective 1-3) through a multi-channel approach. We aim to target apple and pear growers, both the existing organic growers and conventional growers that have interests in transitioning into organic. We will also reach out to agricultural companies that develop and market biological controls, such as Certis Biologicals, Corteva Agriscience, Dora Agri, Bayer Crop Science et al., which may be interested in collaborating as industry partners for future commercialization of the discovered yeasts. Activity 2.We will educate the general public and fruit consumers about fruit finish cosmetic problems.Disseminate knowledge through social media.We will produce 10-20 short videos introducing 1. Benefits of organic fruits, 2. Different types of fruit cosmetic issues, including common ones caused by diseases, pests, and nutrient deficiency, and stresses.These short videos will be posted on Youtube Channel \"Each an Organic Apple A Day\".Disseminate knowledge at local grocery stores, farmer\'s markets, public schools (K-12).We will produce flyers introducing the common types of fruit finish issues. We will partner with local grocery stores (Big Y, Stop and Shop), and farmer\'s markets to disseminate such flyers to promote the acceptance of fruit with minor cosmetic problems.Activity 3.We will provide guest lectures to undergraduate students on topics of organic fruit production and pest management in the Northeast.We will integrate the organic production in the existing curriculum of fruit production courses at two universities in the northeast, University of Connecticut and University of Massachusetts-Amherst. Progress 09/01/23 to 08/31/24 Outputs Target Audience:Scientists, researchers in agriculture, plant pathology, microbiology, microbial ecology. Apple and pear growers, extension agents and professionals. Agricultural biotech comanies, developers of biological controls. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?This grant allows to train four graduate students from University of Connecticut. Among them, three are PhD students and one master student. Three of the fourstudents were female, three out of four were from underrepresented communities. A mentoring plan was generated and a scientific committee comprising multiple PhD level advisors were in place. Plant Health Fellows (undergrad interns funded by USDA-Education and Workforce Development Program) were also trained concurrently through this program. How have the results been disseminated to communities of interest?PIs will present the findings at the International Congress of Plant Pathogenic Bacteria (ICPPB) and Biocontrol conference in Blacksburg VA in July 2024, Plant Health 2024 (APS annual meeting) in July 2024. Grower education through grower meetings (Connecitcut, Maine, New Hampshire, and New England Vegetable and Fruit Conference) and webinars are also scheduled to happen. What do you plan to do during the next reporting period to accomplish the goals?1. Using the established screening method, we will screen the yeast culture collection for any PR inducer functions. 2.

Candidates that display ideal immune inducing functions will be further tested in the orchard for biocontrol activities against fire blight. 3. Canididates with proven biocontrol functions will be further studied for the molecular mechanism for the immune induction in plant. Impacts What was accomplished under these goals? 1. A culture collection containing 1348 yeasts were isolated from flowers from Malus species. This effort includes collection of flowers of 23 different apple, crab apple, and pear varieties from two states (Connecticut and Oregon), in two years (2023 and 2024). Only the hypanthium portion of the flowers, which is the most sugar rich high osmolaric parts, was collected. The collected tissues were washed by sterile PBS, sonicated to remove the yeasts, and plated onto PDA, YPD plates containing tripple antibiotics. The yeast colonies were purified, and stored at -80C in 96 well format (in 15% glycerol solution). Electronic documentation of the yeast colony morphology, isolation location and year was established. 2. We developed an 96 well plate method for screening for yeasts that can induce PR gene expression. This mehtods use an Arabidopsis line carrying the PR1-GUS reporter system. THis allows fast screening of the yeast culcutre collection using blue colorization as an indicator for any ones that induce PR1 expression in Arabidopsis. Optimization of this method, including adjustment of plant growth media, incubation conditions, and inoculation concentrations were made. This method is ready to be used in screening the yeast culture collections. 3. We are also in the process of developing a PEG mediated transformation protocol to randomly mutate yeasts candidate that has biocontrol activities. Protoplast preperation ofyeast cellswere optimized and initial transformation was successful in introducing T-DNA mutagenesis into yeast cells. We are further confirming the efficiency and copy numbers of the insertion currently. Publications Type: Journal Articles Status: Accepted Year Published: 2024 Citation: Zeng, Q., Emeriewen, O.F., Rezzonico, F., Sundin, G.W. Peil, A. (2024) Burning questions for fire blight research. II. Critical next steps in disease management and in host resistance breeding of apple and pear. Journal of Plant Pathology. Type: Journal Articles Status: Published Year Published: 2024 Citation: Wang, N., Sundin, G.W., De La Fuente, L., Cubero, J., Tatineni, S., Brewer, M.T., Zeng, Q., Bock, C.H., Cunniffe, N.J., Wang, C., Candresse, T., Chappell, T., Coleman, J.J., Munkvold, G. (2024) Key Challenges in Plant Pathology in the Next Decade. https://doi.org/10.1094/PHYTO-04-24-0137-KC Type: Journal Articles Status: Published Year Published: 2024 Citation: Rezzonico, F., Emeriewen, O.F., Zeng, Q., Peil, A., Smits, T.H.M., and Sundin, G.W. (2024) Burning questions for fire blight research: I. Genomics and evolution of Erwinia amylovora and analyses of host-pathogen interactions. Journal of Plant Pathology. https://link.springer.com/article/10.1007/s42161-023-01581-0 Type: Journal Articles Status: Published Year Published: 2024 Citation: Hassani, M.A., Cui, Z., LaReau, J., Hutley, .R., Steven, B., and Zeng, Q. (2024) Co-culturing with members of flower microbiome caused transcriptional shifts of the fire blight pathogen Erwinia amylovora and influenced disease. Mbio https://doi.org/10.1128/mbio.00213-24 Type: Journal Articles Status: Published Year Published: 2024 Citation: Gr&#65533;nwald, N. J., Altendorf, K., Bock, C., Chang, J.H., De Souza, A.A., Del Ponte, E., Du Toit, L., Dorrance, A., Dung, J., Gent, D., Goss, E., Lowe-Power, T., Madden, L., Martin, F., McDowell, J., Moyer, M., Naegele, R.P., Potnis, N., Quesada-Ocampo, L.M., Sundin, G., Thiessen, L., Vinatzer, B.A., and Zeng, Q. (2024) Ensuring reproducibility in plant pathology. Phytopathology https://doi.org/10.1094/PHYTO-12-23-0483-IA Type: Journal Articles Status: Published Year Published: 2024 Citation: Zeng, Q., Slack, S., and Hassani, A. (2024) Pathogen spotlight on Erwinia amylovora - Recent advances in genomics, resistance breeding, and disease management. Phytopathology 113 (12), 2140-2142 Type: Journal Articles Status: Published Year Published: 2023 Citation: Sun, W., Gong, P., Zhao, Y., Ming, L., Zeng, Q. and Liu, F. (2023) Outbreak of Fire Blight in China. Phytopathology. 113 (12), 2143-2151 Type: Journal Articles Status: Published Year Published: 2023 Citation: Sundin, G., Peng, J., Brown, L., Zeng, Q., F&#65533;rster, H., and Adaskaveg, J. E. (2023) A novel IncX plasmid mediates high-level oxytetracycline and streptomycin resistance in Erwinia amylovora from commercial pear orchards in California. Phytopathology 113 (12), 2165-2173 Type: Journal Articles Status: Published Year Published: 2023 Citation: Gdanetz, K., Dobbins, M. R., Villani, S. M., Outwater, C. A., Slack, S. M., Nesbitt, D., Svircev, A. M., Lauwers, E. M., Zeng, Q., Cox, K. D., and Sundin, G. W. (2023) Multisite field evaluation of bacteriophages for fire blight management: incorporation of 2 UVR protectants, and impact on the apple flower microbiome. Phytopathology 114:1028-1038. Type: Journal Articles Status: Published Year Published: 2023 Citation: Kunz, S. Zeng, Q., and Johnson, K. B. (2023) History, efficacy, orchard ecology, and mode of action of Aureobasidium pullulans, the microbial agent in Blossom Protect, for suppression of apple fire blight. Journal of Plant Pathology. <https://doi.org/10.1007/s42161-023-01448-4>.

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# Advancing Organics in Kentucky: Adopting Practices, Increasing Resilience, and Strengthening Systems

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| **Contract / Grant No.** | 2023-51300-40728 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Brooke Gentile |
| **Performing Institution** | Organic Association of Kentucky |

## NON-TECHNICAL SUMMARY

The Organic Association of Kentucky\'s (OAK) overarchinggoalof the 2024ConferenceAdvancing Organics In Kentucky: Adopting Practices, Increasing Resilience and Strengthening Systemsis to promote organic production as a changemaking system backed by research and on-farm evidence. The conference will engage an estimated 450 farmers, researcher and agricultureal professionals.The three day organic farmingconference will be rooted in the idea that increasing the understanding, adoption and continual improvement of organic solutions as mainstream practices will make organic farming systems productive, profitable and accessible in Kentucky and across the region.Broadly speaking, there is a critical need for investment in organic agriculture education,training and resrouce sharingin Kentucky and the Southeast region. Dominant narratives in education, technical assistance and research in regional agriculture continue to default to conventional farming systems, constricting access to organic knowledge and systems based decision-making modles that could improve the productivity, profitability and resilience of farms. OAK\'sconference will bolster the capacity of regional farmers aligned with organic standards to transition operations to organic certification, improve and scale current organic production, access current and emerging markets opportunities, identify production and market challenges to growth and connect farmers who can serve as peer mentors to other farmers to advance the organic industry in the region.The project activities will include in-person pre-conference workshops as well as conference sessionsacross four tracks, allowing participants to choose programming relevant to their farms or careers.Roundtable discussions will be integrated into conference programming to capture feedback from producers on bottlenecks, challenges and desired research.In-person networkingwill facilitate farmer-to-farmer mentoring and increase connectivity between producers, researchers, cooperative extension and agricultural practitioners.Presenters will be encouraged to incorporate demonstrations and adult learning strategies best practices to ensure content is relatable, engages positive emotions, offers choice, shares mental models and supports opportunities for application.Collaborating researchers will package findings of the conference\'s farmer roundtable and subsequent surveys of farmer segments into awhite paper and potential publication, providing a synthisis onproduction bottlenecks and barriers and will be used to make recommendations to researchers and farmer-support organizations.Project impacts will include improved knowledge about organic farming practices and new technologies and tools to implement on farms resulting in theadoption og management skills toimproved plant,soiland animal health. Additionally, participants will have an increased fwareness of and connection to the broader network of organic stakeholders in the region. Long-term impacts include changes to farming conditions that include increased farm productivity,resilience and revenuefromusing organic practices. Goals / Objectives The long-term goal of the 2024 OAK Conference Advancing Organics In Kentucky: Adopting Practices, Increasing Resilience and Strengthening Systems is to promote organic production as a changemaking system backed by research and on-farm evidence. The conference will be rooted in the idea that increasing the understanding, adoption and continual improvement of organic solutions as mainstream practices will make organic farming systems productive, profitable and accessible in Kentucky.The supporting outreach objectives include: 1) Providing an inclusive community-learning experience for 450 participants that builds the knowledge, connection and human capital of organic and organically-minded farmers, researchers, agricultural professionals and other stakeholders in the region, providing low cost and ample opportunities for scholarship for attendees, offering Continuing Education Units/Credits for agricultural professionals; 2) Connecting Kentucky and other Southeastern farmers with technical advisors and researchers who will share organic production content, tools, techniques and resources that farmers can use through sessions, workshops, hands on demonstrations and the Trade Show; 3) Advancing organic agriculture in the region beyond the event through farmer roundtables and analysis of participant survey data and input that will shape future programming and;4) Developing and sharing a white paper communicating farmer-identified production challenges, research needs and barriers to expanding organics in the region. Project Methods METHODS - Efforts: Face-to-face, in-person sessions and pre-

conference workshops are feasible in the conference space chosen, where four programs can be implemented concurrently - three in conference rooms and one track in various on-farm facilities. Four tracks allow participants to choose programming relevant to their farms or careers. Roundtable discussion will be integrated into conference programming to capture feedback from producers on bottlenecks, challenges and desired research and policies. In-person networking will facilitate farmer-to-farmer mentoring and increase connectivity between producers, researchers, cooperative extension and agricultural practitioners. Presenters will be encouraged to incorporate adult learning strategies from Sustainable Agriculture Research and Education\'s (SARE) best practices to ensure content is relatable, engages positive emotions, offers choice, shares mental models and supports opportunities for application. OAK will also invite agricultural organizations offering services and expertise to exhibit throughout the conference so that participants can connect in real-time.METHODS - How Outputs will be Evaluated:OAK will employ a variety of methods to evaluate the success of the conference. First, data collection will begin with registration, capturing demographic data, occupation and farming details, primary production challenges, etc. Data will be stored in OAK\'s customer relationship management (CRM) software and downloaded for analysis in Excel. Some data will inform session planning and facilitation. Second, OAK will design session-specific and whole-conference surveys. Third, collaborating researchers will package findings of the conference\'s farmer roundtable and subsequent surveys of farmer segments into a white paper and potential publication. Surveying human subjects may require Institutional Review Board approvaland we anticipate an expedited process. The white paper will synthesize input on production bottlenecks and barriers and will be used to make recommendations to researchers and farmer-support organizations. The findings will also identify opportunities and challenges in organic systems formarket actors, researchers and technical assistance providers.? Progress 09/01/23 to 08/31/24 Outputs Target Audience:The 2024 Organic Association of Kentucky (OAK) Conference targeted a diverse audience, including farmers, agricultural professionals, researchers practicing organic methods, and individuals interested in organic and sustainable agriculture across Kentucky and the southeastern U.S. The conference responded to farmer stakeholders\' needs for opportunities to network, share strategies for overcoming production challenges, and explore new techniques and resources in organic agriculture. It also provided a platform to connect with industry leaders, researchers, and the broader community of organic agriculture stakeholders in the region. Programming was designed to address the educational needs of both beginning farmers (10 years or less of experience) and advanced farmers. Detailed engagement from specific farmer stakeholder groups is included below. OAK invited stakeholder feedback well in advance of the event, collecting input on conference topics, priority speakers, and workshop ideas. Attendees from previous conferences, field days, and listening sessions shared their thoughts on educational topics and research priorities. Additionally, six months before the event, OAK issued an open call for session proposals through its website and monthly newsletter. The conference featured an in-person format open to researchers, farmers, and other stakeholders. Sessions were recorded and made available to attendees immediately after the event, with public access to the recordings released in the Summer and Fall of 2024. Promotion efforts spanned Kentucky and extended to farms, educational networks in eight neighboring states, and key partners throughout the southeast region. OAK farmer members, organic industry partners, researchers, extension agents, government representatives, and other agricultural stakeholders collaborated to shape the conference\'s vision and agenda. These groups also actively participated in the conference and benefited from the shared content and programming. Over three days, the conference welcomed 392 attendees. The event sold out, reaching the venue\'s capacity limit. Thanks to NIFA-OREI support through this project, OAK hosted a successful conference and was able to secure additional funding to offer reduced registration fees and provide 125 full scholarships. Details on the target stakeholder participants include: Attendees originated from a total of 14 states, with the majority (89%) being from Kentucky and 4% from the southeast region outside of Kentucky. Farmers constituted 70% of event attendees Farmers (Beginning to 10 years or less): 30% Farmers (Experienced - more than 10 years): 26% Farmers (Aspiring farmers - not currently farming): 14% Students: 2% Black, Indigenous, People of ; font-variant-numeric: normal; font-variant-east-asian: normal; font-variant-alternates: normal; font-variant-position: normal; vertical-align: baseline; white-space: pre;\" aria-level=\"1\"\> Agricultural professional / extension: 23% Research: 10% Farmer Participants reported: 74% diversified produce production 4% broad acreage row crop production of corn, soy, small grains 22% livestock Overall Farmers reported 29% manage certified organic operations 49% use organic practices but are not certified 9% use conventional practices 12% active transition to organic 1% did not specify Farmers and researchers worked together during program planning to ensure the conference content was relevant and impactful. In 2024, this collaboration shaped sessions and presentations focused on key topics, including strategies for improving soil health, reducing dependency on plastics, examining the connection between the soil microbiome and human health, expanding the cultivation of perennial crops for emerging markets, and advancing organic grain production challenges and research and technical assistance needs. These themes fostered dynamic discussions about regional challenges and opportunities related to production practices, market demands, and research priorities. Farmers were particularly interested in approaches that minimized reliance on external inputs, enhanced production efficiencies, and built whole-farm resilience. Overall and across all commodities, conversations highlighted a need for more durable and expansive

certified organic market development. Many noted that consumer desire for \"local\" is still stronger than \"certified organic.\" Participant conversation indicated a desire for guidance on diversifying product offerings to improve market access and profitability. The annual conference played a vital role in delivering information to strengthen the region\'s foundational knowledge of organic production. It served as a platform for sharing insights and identifying the support and solutions needed to address emerging challenges and opportunities in organic agriculture. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?The project delivered sessions and networking opportunities, connecting farmers with technical advisors and researchers who shared sustainable production content and resources farmers can put to use in the field. In total, the Conference delivered 32 sessions, convening 392 farmers and agricultural professionals for a combined 3 days of learning and networking. 91% of attendees said they learned something new they would put to use on their farm to advance their operation in the coming year. 83% of attendees also reported a high likelihood of sharing information learned with their peers, indicating that the information was valuable and worth sharing and reinforcing the peer-to-peer community of support. Additionally, 92 agricultural professionals accessed the event to learn about organic practices and access professional development opportunities in organic and sustainable production. Professional development opportunities were further accessed by 22 participants who chose to claim Continuing Education Units (CEUs). CEUs were available to agricultural professionals through Extension (KERS) and the Kentucky Department of Agriculture (Agricultural Pesticide Applicator Certification CEU). How have the results been disseminated to communities of interest?The results of the 2024 Conference were disseminated to the Kentucky agriculture network through email, newsletters, and social media. The session recordings are available on OAK\'s Conference webpage:https://www.oak-ky.org/conference-2024-recordings. Soon after the conference was complete OAK shared a program impact summary with collaborators, speakers, sponsors, industry partners, and attendees. OAK recorded all the sessions with the assistance of a project partner, Kentucky State University, providing an expanded opportunity for participation for those who were not available to join in person. Session recordings were made available to all those registered in the spring of 2024 and then to the public at large starting June 2024 with new installments of content added monthly through September 2024. Content dissemination through OAK\'s communications network reached 4,350 stakeholders, with session recordings having been viewed over 1,600 times. ? What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported Impacts What was accomplished under these goals? The 2024 OAK Conference brought together farmers, researchers, and agricultural professionals to enhance their understanding of organic farming practices. The conference focused on improving farm productivity, resilience, and the relevance of research and technical assistance. By fostering networking and knowledge-sharing among stakeholders, this project built on past successes to support continued progress in adopting practices focused on plant and soil health. It also encouraged the use of new approaches to decision-making, addressing production challenges, boosting farm profitability, advancing regional conservation initiatives, and exploring regional market constraints. Ultimately, the identified research and resource needs will drive long-term outcomes and further promote the adoption of organic farming practices. O1 Providing an inclusive community-learning experience O1 Major Activities Coordinated Conference Offered low-cost registration and 125 scholarships Provided Continuing Education Units (CEUs) for professional development O1 Data #2 Demographics 392 attendees 125 scholarships Farmers: beginning 30%, experienced 26%, aspiring 14% BIPOC: 18% Extension: 23% Research: 10% 29% certified organic operations 49% organic practices not certified 9% conventional practices 12% active transition to organic O1 Discussion #3 The conference engaged 392 attendees, which was fewer than expected, but more participants registered for pre-conference workshops, increasing overall session attendance compared to the previous year. Scholarships and the conference\'s affordability removed financial barriers to participation. Session recordings were made publicly available after the event, enhancing accessibility for non-attendees. 70% of participants were farmers, with 30% being beginning farmers, 26% experienced, and 14% aspiring, indicating the content was relevant to a range of experience levels. 18% of attendees identified as Black, Indigenous, or People of Color, reflecting the event\'s inclusivity. Among farmer participants, 29% managed certified organic farms, 49% used organic practices without certification, 9% used conventional methods, and 12% were in active organic transition, highlighting strong interest in organic farming. O1 Outcomes #4 93% of participants reported that the content accessed through the Conference was \"good\" or \"excellent,\" 91% of respondents reported that they plan to use something they learned, and 83% reported they would likely share content with a peer, indicating a broad reach. CEUs were claimed by 22 individuals for professional development, the vast majority from higher education and extension institutions. O2 - Connect farmers with TA, Research and Resources O2 Major Activities #1 Coordinated Conference Provided opportunities for stakeholders to connect Promote sessions for organic grain survey, agroforestry survey and resource panel O2 Data #2 See conference agenda, sessions and speaker details in the Conference Print Program Offered 32 sessions 65 experts connected with farmers O2 Discussion #3 The Conference connected farmers with technical advisors, researchers, and other experts who shared sustainable production content and resources. See the Conference Program for details on the 32 sessions offered. Panels, keynotes, farm tours, demonstrations, and community discussions proved accessible and

engaging, increasing connectivity among interdisciplinary stakeholder groups. O2 Outcomes #4 Conference evaluations showed that 91% of attendees were \"definitely\" or \"most likely\" to apply what they learned to their farms. Sessions provided practical guidance on topics like grazing management, agroforestry, crop planning, and cover cropping. The project also identified and developed additional technical tools to support farmers. USDA representatives and grant recipients showcased funded research and highlighted opportunities through USDA programs, including upcoming funding for equipment and infrastructure. O3 Advancing organic agriculture post-event O4 Major Activities #1 Two roundtable discussions Organic grain survey and agroforestry survey promoted Stakeholder input on production and marketing needs gathered across all commodities O4 Data #2 Organic Small Grains Survey 25 responses: 92% cited soil health as a primary motivation Farmers ranked grain quality as a minor obstacle to marketing, but organic market size, demand and consumer awareness were ranked as more pressing issues Agroforestry Survey 96 responses from farmers: 15% experienced, 65% beginning and 16% aspiring Marketing challenges are a barrier to expanding agroforestry businesses with 54% citing buyer transparency need; 33% need aggregation and distribution; 30% need marketing and business planning. 47% need better access to planting stock and 42% require access to capital for processing equipment. Overall participant feedback defined the need for resources and decision-making tools including: an inputs resource guide, organic recordkeeping tools, vegetable crop planning templates, soil test analysis template. O4 Discussion #3 Organic Small Grains Survey: A University of Kentucky partner surveyed current and aspiring organic grain farmers in Kentucky and led a conference session. Challenges identified throughout the production cycle included weeds, animal damage, and issues with harvest and post-harvest equipment. Marketing emerged as a significant concern. Future research should focus on market development and assistance and production technical assistance. Agroforestry Survey: This baseline assessment of agroforestry producer needs was part of a collaborative planning effort across central Appalachia led by Virginia Tech. Priority needs identified involve production, inputs, processing, market development, and access to wholesale buyers, including developing connections for farmers with national and global organic value chains for woodland medicinals. O4 Outcomes #4 This project highlighted sessions and surveys led by partners and opportunities to provide direct stakeholder feedback. Findings from surveys will be shared by partners to inform future projects. The tools developed by OAK staff are available for use. Through continued conversations and considering that investment in organic research in the southeast region has historically been lower than in other regions, there is a high need for more research leadership and organic farmer participation across the region to bolster available technical assistance and grow durable organic market access. O4 - White paper O4 Major Activities #1 Collecting stakeholder insights with registration and post-event survey Recording of sessions and notetaking during conference sessions and roundtable discussions O4 Data #2 Production and business challenges, research needs (see details above in O3) O4 Discussion #3 The goal of the white paper will be to provide an assessment of the state of organics in Kentucky with unique insights to communicate farmer-identified production challenges, research needs, and barriers to expanding organics in the region, setting the stage for changes in conditions for the region. Participants highlighted several key challenges: low farm profitability, consumer demand failing to deliver premium pricing, insufficient capital for infrastructure improvements, unreliable or costly labor, and limited access to certified organic processors for livestock and value-added products. Beginning farmers specifically noted difficulties in business management, record-keeping, crop planning, and addressing pest and disease issues. O4 Outcomes #4 Partners at the University of Kentucky are collaborating on a forthcoming manuscript that will provide an overview of the state of organics in Kentucky. The paper will incorporate insights gleaned from the 2024 OAK Conference sessions and stakeholder feedback. The partners plan to submit it to the Journal of Agriculture, Food Systems, and Community Development. Publications

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# Climate-smart Organic Sorghum Partnership for Grain and Silage Production

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| **Contract / Grant No.** | 2023-51300-40854 |
| **Grant Year** | 2023 |
| **Investigator(s)** | William L. Rooney |
| **Performing Institution** | Texas A&M University |

## NON-TECHNICAL SUMMARY

Sorghum is a drought-tolerant, non-GMO crop used for food and feed production around the world.The U.S. is the world\'s largest sorghum producer, with a staggering 7.31 million acres planted in2021. Despite this, the acreage dedicated to organic sorghum in the U.S. is extremely limited. Thisproposal is motivated by urgent demands from stakeholders to develop drought and pest-tolerantsorghum cultivars suitable for organic production. Other important issues such as the availability ofirrigation water, soil deterioration in certified organic lands, and the desire to diversify farmenterprises have highlighted the necessity for this project. Our four-year project engagesresearchers in major sorghum-producing states (Texas, Oklahoma, and Kansas) and potential states,such as South Carolina and California, to address significant gaps. The long-term goal of thisproject is to identify high-performing grain and forage sorghum varieties under organicmanagement, and successfully integrate sorghum into existing organic cropping systems wheresorghum is a significant commodity or has the potential to be a novel inclusion. Our project willdeliver new organic sorghum varieties, innovative management practices, and insights into theeconomic, market, and climate-smart potential of sorghum-based organic crop rotations. We willfoster a community of individuals equipped with the knowledge and skills necessary to succeed inthe growing organic agricultural industry through our education approach. Our efforts to advancethe science of organic sorghum production and outreach will not only benefit growers, includingHispanic growers but also contribute to a more sustainable and resilient organic cropping system. Goals / Objectives The goal of this project is to identify high-performing grain and forage sorghum varieties under organic management, and successfully integrate sorghum into existing organic cropping systems to expand grain and silage production in regions where sorghum is a significant commodity or has the potential to be a novel inclusion. To achieve this, we believe that it is crucial to conduct extensive research and outreach that delves into suitable cultivars, effective management practices, the benefits of improved soil health, production economics, and market opportunities. Our interdisciplinary team includes researchers from seven institutions across five states, including Texas A&M University, Kansas State University, Oklahoma State University, Clemson University, the University of Texas Rio Grande Valley, Prairie View A&M University, and the University of California. The specific objectives of this project are based on our interactions with stakeholders (discussed previously).The specific objectives of the project include:1. Improve sorghum hybrids for adaptation to organic production conditions.Identify sorghum parental lines with high levels of genetic resistance to biotic stress to common sorghum diseases and insects. Specific target traits include resistance or tolerance to anthracnose, grain weathering, and the sorghum aphid.Screen sorghum parental lines and hybrids for abiotic stress tolerances including but not limited to water stress (primarily post-flowering), and nutrient deficiency (low N). Evaluate forage and grain sorghum hybrids for productivity in organic production systems and assess if performance is correlated with conventional systems in sorghum growing regions with varying climates ranging from subtropical to semi-arid.2.Identify and release hybrids for organic grain and silage sorghum production (Leads: Rooney, Boyles, Perumal, and Atim).Development of genomic prediction to select sorghum genetics that are optimized for organic cropping systems.Develop agronomic management practices and tools for organic grain and silage production aimed at improving soil fertility, soil organic matter, soil health, and weed control.Investigate integrated cover cropping, manure, and tillage management practices for sorghum grain and silage production.Evaluate soil health and multifunctionality in organic sorghum production systems.Investigate the potential climate-smart benefits of organic sorghum.Develop precision weed management practices and tactics for organic sorghum systems.3. Assess the economic benefits of organic sorghum and its marketing potential as a combined climate-smart and organic commodity.Conduct an economic feasibility study of organic sorghum production as a rotational crop.Determine current and potential marketing opportunities and constraints for the expansion of organic sorghum production.4. Develop and implement educational programs promoting organic sorghum production.Establish a collaborative undergraduate research program on organic sorghum in partnership with

land grant and minority institutions, growers, and industries.Equip students with team-oriented and leadership skills to help them engage with the wider private-public sector opportunities in the agricultural industry.Create educational materials in Spanish that support Hispanic growers in successfully transitioning to and producing organic sorghum.Develop experiential and transformative openly accessible digital curricula for farmers and Extension professionals and perform impact assessments to determine increases in knowledge, information use, and resulting outcomes.5. Develop farmer-oriented extension programs to assist established and transitioning producers to expand acreage, increase production, and avail new carbon credit opportunities.Develop extension programs to facilitate the dissemination of organic sorghum production strategies based on scientific research to sorghum producers.Organize annual \"Women in Ag\" workshops tailored to support female students, farmers, and entrepreneurs.Develop innovative extension programs that effectively communicate emerging opportunities in climate-smart agriculture and carbon credit market to organic sorghum producers. Project Methods For objective 1, existing sorghum germplasm will be evaluated to identify lines best suited for organic production. The traits of emphasis will include but are not limited to disease and pest resistance, abiotic stress tolerance as well as agronomic adaptation. Sorghum lines for both forage and grain will be screened and the best lines will be used to produce hybrids for evaluation.In objective 2, we will establishlarge-scale organic systems experiments at four locations that cover the major sorghum-producing states of Texas, Oklahoma, and Kansas. Additionally, we will conduct smaller-scale demonstrations in collaboration with certified organic sorghum growers.We will collect data from the above field experiments to assess soil health and soil multifunctionality.To determine baseline carbon status, we will collect soil samples from 0-30 cm depth from a minimum of 10 certified growers\' organic fields without sorghum in each study region where agronomic experiments will be conducted. Finally, we will explore a number of organic strategies to manage weed problems which include allelopathy and precision weed management with image analysis.In objective 3,our project will gather experimental data and insights from organic growers to develop customized enterprise crop budgets for organic sorghum as a rotational crop. The economic feasibility analysis will assess the two primary uses of organic sorghum: grain and silage.Enterprise crop budgets will be utilized to determine the probability of economic success of organic sorghum (i.e., chances of obtaining a positive net return) using Monte Carlo simulation techniques. This will factor in inherent production and market risks, such as input and product prices, transportation costs, labor, and other relevant production costs, including newly developed organic management practices.In objective 4, our project will provide training opportunities for undergraduate students to equip them with the skills, knowledge, and experience necessary to succeed in both academic and non-academic careers. Each year, we will recruit seven undergraduate research scholars across the entire project and engage them in undergraduate research and leadership development programs. To address the lack of educational materials in Spanish, our project will publish all educational materials, including written articles and videos, in both English and Spanish.In objective 5, demonstrations of new sorghum varieties and field days will be conducted in organic farmers\' fields in the third and fourth years of the project. The results of this organic sorghum project will be presented at outreach programs held throughout Texas, Oklahoma, and Kansas. We will also use electronic media to distribute and showcase our results to a national and international audience. Progress 09/01/23 to 08/31/24 Outputs Target Audience:The project targeted a diverse range of stakeholders within the organic agriculture sector to maximize the impact and relevance of its research and outreach activities. Producers were engaged through outreach initiatives such as field days, newsletters, and direct communication, providing them with practical insights into organic farming practices. Researchers benefited from the dissemination of findings at major conferences, including the American Society of Agronomy annual meeting in San Antonio, TX, as well as several regional conferences. Post-doctoral research associates, graduate students, and undergraduate students gained hands-on experience in leading field experiments, data collection, and data analysis activities. Classroom lectures further extended the project\'s educational reach to a broader student audience. The general public isengaged through radio talks, raising awareness about organic agriculture practices. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?The project has provided numerous professional development opportunities. Two graduate research assistants were hired - one lead the agronomy field experiment at College Station, TX, and to coordinate the work across all locations and another to lead the breeding research work and coordinate it. Additional graduate students are funded at Kansas State and Clemson to conduct additional research related to this project. To date, the TAMU agronomy student presented the first-year project results at the American Society of Agronomy annual meeting in San Antonio, TX. Two undergraduate students also received training in field experiment implementation and data collection. At the Bushland location, two postdoctoral research associates and two undergraduate student workers worked in the project during the growing season. The two undergraduate students received training in field experiment implementation, weeds management and fertilization, and data collection. How have the results been disseminated to communities of interest?The results have been disseminated through conference presentations, field days, and various outreach activities. Findings from the College Station location were presented at the American Society of Agronomy annual meeting in San Antonio, TX. Mr. Whitney actively engaged with organic producers through multiple channels, including newsletters, field day presentations, and direct communication. These efforts have helped to share

project outcomes with stakeholders, foster discussions about sustainable agricultural practices, and encourage the adoption of research findings by the farming community. What do you plan to do during the next reporting period to accomplish the goals?We will continue the activities as proposed in the project. Impacts What was accomplished under these goals? The project generated extensive data from the field experiments, encompassing both soil and plant parameters. Key plant data collected include measurements such as plant height, weed biomass, and grain yield. These results are systematically organized and stored in a dedicated database, which serves as a central repository for project findings. This database is maintained through Texas A&M\'s Teams service, ensuring easy accessibility and efficient collaboration among researchers and stakeholders. For Plant Breeding, two sets of projects were initiated. The first tests were for the evaluation of existing sorghum hybrids and their suitability in organic systems. A set of 20 sorghum hybrids, previously tested in conventional systems were grown in three locations (Florence SC, College Station TX and Kearney CA) in a conventional and an organic production system. At this report, the TX trials have been harvested; the others will be harvested in October. Initial observations indicated that, as expected, yields will be higher in conventional production and that both abiotic and biotic stresses reduce yields in organic system. The second project is focused on selection for organic production environments. For this project, a set of F2 breeding populations were grown in four different environments under both conventional and organic production systems. The environments were Florence SC, College Station TX, Hays KS and Kearney CA. In each environment, the populations were grown in both conventional and organic management. At maturity, desirable genotypes were selected in each population for breeding advancement. These lines will be grown in Year 2 and further selected. The objective of this work is to determine the relative need for specific selection in organic environments improves productivity in such environment and to assess the relative selection efficiency in the diverse testing environments. For Agronomy, field experiments were established at all project locations to investigate two crop rotations: forage sorghum-maize with and without cover crops, and grain sorghum-cotton with and without cover crops. The experiments began with the planting of cash crops in 2024 at all locations. At the College Station location, grain sorghum yielded an average of 3,560 kg ha?¹, while forage sorghum produced 28.9 metric tons ha?¹ of aboveground dry biomass. Maize yielded 2,165 kg ha?¹. Following the harvest of cash crops in Fall 2024, cover crops consisting of Austrian winter pea and oats (in a 70:30 ratio) were planted. At Bushland, field plots were established in late May. Grain sorghum and forage sorghum were well established with good stands, but some plots of cotton and corn faced poor stand issues, necessitating replanting in early July. Weed control posed a significant challenge but was managed through manual weeding and mowing. Late-season moisture supported cotton maturity, although harvest was delayed until early December. Grain sorghum yields ranged from 1,524 to 3,048 kg ha?¹, while forage silage yields ranged from 23 to 54 tons/ac (at 65% moisture). Cover crops (Austrian winter pea and oats in a 70:30 ratio) were planted after cotton harvest in mid-December 2024. The field experiment at Keyes, OK, was set up on a commercial certified organic farm and successfully established in its first year. Both grain and forage sorghum achieved good stands at 55,000 seeds/ac. Above-average seasonal rains in the region supported early crop establishment, reducing the need for irrigation. However, these rains also promoted weed germination and hindered cultivation due to prolonged wet soil conditions. Weed pressure surpassed the growth of grain sorghum plants. Grain sorghum yielded 590 kg ha?¹, while sorghum silage yielded 13 metric tons ha?¹. A portion of the sorghum silage was allowed to complete its lifecycle, producing 2,321 kg ha?¹ in grain. Soil samples were collected for initial moisture and baseline soil properties at planting across all locations. Post-harvest soil sampling has been completed at College Station and Bushland, while at Keyes, sampling is scheduled for early 2025. State Organic Extension Specialist Mr. Whitney participated in several outreach events, reaching approximately 1,550 people through field days and presentations. A radio talk show expanded the audience significantly, reaching an estimated 20,000 listeners. Further outreach and educational activities are planned for Year 2 of the project. Publications Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Campbell, N., Rajan, N., & Rooney, W. L. (2024) Investigating Organic Management Practices for Sustainable Cultivation of Grain and Forage Sorghum, Maize, and Cotton \Abstract\. ASA, CSSA, SSSA International Annual Meeting, San Antonio, TX. <https://scisoc.confex.com/scisoc/2024am/meetingapp.cgi/Paper/159781>.

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# Onion-iq (improve Quality): Improving Quality, Resilience, Soil Health and Food Safety in Organic Onion in the Southeastern and Southwestern U.s

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|---|---|
| **Contract / Grant No.** | 2023-51300-40913 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Bhabesh Dutta |
| **Performing Institution** | University of Georgia |

## NON-TECHNICAL SUMMARY

Soil-borne bacterial pathogens are the significant critical limiting factors for sustainable organic onion production in the southern US. Most conventional and organic management practices for pathogen control are either ineffective or have not been rigorously evaluated for these issues. Hence, the University of Georgia and the Texas A&M University will coordinate an integrated multi-regional effort to improve the quality of organically-grown onions by managing soil-borne bacterial diseases (sour skin and slippery skin) through the optimization of nitrogen fertilization and the use of cultural practices (bio-fumigation and soil solarization). We will develop research-based tools to improve soil fertility, soil health, and food safety in organic onions grown in the southeastern and southwestern U.S. Using an integrated approach, we will optimize organic nitrogen-fertilization scheduling in organic onions that will increase productivity, improve soil health (decrease in pathogenic bacterial populations and increase in beneficial microflora), and improve food safety. We will integrate bio-fumigation and soil-solarization with nitrogen fertilization strategies, soil-biome \both micro and macro (insect natural enemies and predators) assessments, and evaluations of plant-parasitic and beneficial nematodes, weeds and soil-borne bacterial diseases that will improve quality of organic onion production. We will integrate economic assessments, extension and education efforts into each objective that will further strengthen our project. This project meets the legislatively mandated OREI focus areas of \"developing and evaluating systems-based integrated management programs to address diseases, nematodes, and weeds related problems for organically grown crops in southern US\" and \"Conduct on-farm crop, research and development that emphasize innovation for organic farms\". Goals / Objectives Objectives: Five-broad and integrated objectives will aim at addressing critical needs for organic onion growers in the southeastern and southwestern U.S.Objective 1:Evaluate cultural practices that reduce soil-borne bacterial pathogens and weeds and increase/sustain growth of beneficial microflora, and predators and natural enemies (20% effort).Objective 2:Evaluate and optimize N-fertilization programs in organic onions that will increase productivity and reduce N loss and improve food safety (20% effort).Objective 3: Integrate activities from objectives 1 and 2 to improve soil health (decrease in sour skin and slippery skin; evaluation of soil-microbiome and predators and natural enemies) and improve food safety (30% effort).Objective 4:Conduct economic analysis (10% effort). Objective 5: Conduct, outreach activities and enhance organic education opportunities (20% effort). Project Methods Objective 1. Evaluate cultural practices that reduce soil-borne bacterial pathogens and weeds (digital scouting for weeds and diseases) and increase/sustain growth of beneficial microflora, and predators and natural enemies (20% effort).(i) Assessing robustness of a qPCR assay that differentiate onion-disease-associated vs. saprophytic Burkholderia spp.in soil:(ii) Evaluate cultural practices. We propose to monitor the effects of cultural practices in separate field trials in GA and TX (solarization duration treatments and biofumigant-crop treatments) on the populations of onion-disease-associated Burkholderia spp. in soil. (ii a) Soil-solarization: We will work with organic onion producers from GA and TX to assess if soil solarization can effectively reduce populations of onion-disease-associated Burkholderia spp. in soil. A total of four field trials in organic certified fields (two in each state) over a period of two years (Y1 and Y2) in GA and TX will be conducted.Experimental design: We will evaluate the effectiveness of a 60-day duration of solarization in reducing both bacterial pathogens in soil, thereby reducing sour skin and slippery skin incidence/severity in onion bulbs (pre- and post-harvest).(ii b) Biofumigation: We will assess if biofumigation with two known biofumigant Brassica species, namely Sinapis alba (white mustard) and Brassica juncea (brown mustard) can effectively reduce B. cepacia and B. gladioli pv. alliicola in soil.Experimental design: We will evaluate three cultivars that will include a cultivar each from B. juncea (cv. Kodiak) and S. alba (cv. Ida Gold) and a blend of S.albaandB. juncea (cv. Caliente 199) for their biofumigation abilities to reduce both bacterial pathogens in soil compared with a no treatment control plot and thereby reducing sour skin and slippery skin incidence/severity in onion bulbs (pre- and

post-harvest). Hence, we will utilize a randomized complete block design with four replicates/plots. Each field trial will consist of plots with dimension (50 ft × 6 ft) with 6 ft to 10 ft borders on all sides. Each brassica cover crop for biofumigation purposes will be grown and maintained according to the UGA and TAMU Cooperative Extension Recommendations. At flower initiation, these crops will be flail mowed and immediately rototilled in the soil. Prior to mowing, brief over-head irrigation will be employed. Immediately after incorporation, a transparent 30µM-thick, low density polyethylene mulch will be laid in strips using a tractor.Objective 2: We will focus on evaluating and optimizing N-fertilization programs in organic onion that increase productivity, improve soil health, and improve food safety (20% effort). Evaluation of two organic fertilizer sources (PL, and COF) and assessment of cool season N-release patterns.Field sites: There will be four organic certified field sites two will be in GA: Tifton, Athens and two will be in TX (TAMU): Overton, College Station. The project will conduct studies over two consecutive years (Y1 and Y2), providing a total of 4 sites for each year under varied conditions of climate and soil in the southeastern and southwestern US. The field study will evaluate N release from two organic fertilizer sources (PL, and COF) as a function of temporal application patterns. The PL will be locally available broiler litter and the COF will be a Nature Safe 10-2-8.factorial design and 4 replications of each combination plus a non-amended control (36 plots total) (Right). Plots will be 20-ft long (on-raised beds), containing 4 rows each of onions, separated by 10-ft alleys for adjacent plots within the same row.(i) Nutrient assessments: Preplant and at-harvest samples will be collected for routine and micronutrient soil tests for all 4 sites each year (2 TX and 2 GA). Soil samples will be collected at the 0-15 cm and 15-30 cm depths by hand sample probe. Routine soil analyses will be conducted on all samples as well as, SOM (loss on ignition) total C and N (combustion), active C as PMO×C (49), NO3-N and NH4-N (50). Organic fertilizers will be analyzed for total nutrient content (acid digestion and ICP-AES), total C and N, NO3-N and NH4-N soluble carbohydrates, cellulose/hemicellulose, and lignin to provide supporting data for prediction of N mineralization.Influence of organic N-fertilizer sources on food safety; Salmonella Newport survival in soils. BSL2 level-growth -chamber assessment: Food safety aspect in this proposal will be conducted only in GA under controlled BSL2 facility at the Center for Food Safety, UGA, Griffin. This aspect will be led by Co-PIs Dunn and Kumar. The survival of Salmonella enterica serovar Newport (onion outbreak isolate) will be evaluated in soil obtained from organic onion cultivation fields. The soil (100g portions) will be seeded with Salmonella Newport (approx. 2 and 5 log CFU/g). Soil will be amended with raw and treated amendments of poultry origin (used by organic growers). Traceability of the Salmonella strains will be facilitated by developing resistance to ampicillin and streptomycin (100 µg/ml) as described earlier (53). Survival will be evaluated over a duration of 120 days (10-day intervals) using culture-based enumeration on selective media and enrichment-based presence/or absence tests to assess if population declined below the limit of detection. Non-amended soils will be used as a comparative control. Objective 3: Integration of organic production practices (organic N sources, biofumigation, and solarization) on onion-disease-associated Burkholderia spp., crop quality, food safety, nutrient cycling, and the soil microbiome (30% effort).Experimental design: In Y3 and Y4, integrated field trials will be conducted, one in each of the two locations (GA and TX). Three main treatments will be used: biofumigation, solarization, and non-treated control. Within each main treatment, four fertility sub-treatments will be applied: F1). poultry litter (PL) applied at the beginning of the disease-reducing techniques (at planting of mustard for biofumigation, at tarping for the solarization, and to the soil in the non-treated control); F2). PL applied at onion planting, F3) commercial organic fertilizer (COF; Nature Safe 10-2-8 organic mix) applied at onion planting; and F4). non-fertilized control. PL and COF will be applied at a rate equivalent to 200 lbs N/acre.Objective 4: Analyze the economic feasibility of the proposed integrated production approaches for organic onion in Southern U.S. (10% effort) (Greg Colson; Economist).In Y1, a survey will evaluate economic losses due to sour skin and slippery skin in organic onion growers and packers across the southeastern and southwestern U.S. The survey will also gather information on management, variety selection, fertility and irrigation regimes, and organic pest and disease programs in their region. Project team members and stakeholder advisory panel (SAP) will analyze the results. Economic analysis will be calculated annually (Y1 and Y2 assessments of individual components, and Y3 and Y4 assessments of integrated components).Objective 5: Extension, outreach and education (20%): We will extend our information at local and regional meetings focusing on organic onion production, and disease management after the first year of trials in GA and TX. Based on our experience with Extension and outreach (seven Extension specialists on the team, including PD and several Co-PIs), we are confident of identifying numerous opportunities to present information in a face-to-face format and also reach a large contingent of vegetable growers. The event that will capture a large cohort of vegetable growers is the SE Regional Fruit and Vegetable Conference (annually in Savannah, GA) and the GA Organics Conference (annually in Georgia). Progress 09/01/23 to 08/31/24 Outputs Target Audience:Primary audience of the project is the organic onion producers in the southern United States. This includes organic onion producers, packers, shippers, agronomists, crop consultants, farm managers, field workers, seed companies, and dealers; and onion storage and shipping/transport personnel and companies.Primary audience of the project is the organic onion producers in the southern United States. This includes organic onion producers, packers, shippers, agronomists, crop consultants, farm managers, field workers, seed companies, and dealers; and onion storage and shipping/transport personnel and companies.Primary audience of the project is the organic onion producers

in the southern United States. This includes organic onion producers, packers, shippers, agronomists, crop consultants, farm managers, field workers, seed companies, and dealers; and onion storage and shipping/transport personnel and companies. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?CO-PIs Kvitko, Isakeit, Mowrer trained their graduate students in experimental design and helped them in establishing field trials. Co-PI Kumar\'s graduate student was trained in basic culturing and detection methods for Salmonella. The student was trained on the analysis of growth curve data to calculate lag phase duration, growth rate, maximum cell growth. Student was trained on electroporation and methodology to evaluate plasmid stability in both growth medium and environmental matrices The graduate student presented this data at three conferences- AOAC, ASM and IAFP. How have the results been disseminated to communities of interest?PD-Dutta and Co-PD Coolong extended some of the initial outcomes of the project at various conferences including Southeast Fruit and Vegetable Conference, Annual Meeting of American Phytopathological Society and American Society of Horticultural Sciences. Co-PD Coolong and Co-PI Cassity-Duffey presented information on mustard performance and biofumigation practices in organic systems at two winter cover crop programs (Feb. 16, Gulf Shores Alabama and March 15, Griffin GA) with approximately 100 attendees. What do you plan to do during the next reporting period to accomplish the goals?We plan to finish our on-going field trials related to objectives in Georgia and Texas. Data obtained will be analyzed and presented at various meetings and conferences. In the meantime our stakeholder advisory panel will be meeting on Jan 9, 2025 to provide their assessments on our Year 1 trials. Impacts What was accomplished under these goals? To develop a qPCR assay to quantify Burkholderia TTG in onion field soils, we first designed a primer and probe set that would amplify within the TTG region for all common genotypes under TaqMan conditions. We assembled a collection of Burkholderia spp. type and field strains to verify their TTG status. From this group we selected three strains, LMG 1222 (B. cepacia, a TTG+ type strain), 20GA0385 (B. gladioli pv alliicola, a TTG+ well-studied GA field strain) and LMG 10929 (B. vietnamensis, a TTG- type strain) as controls for assay development. Genomic DNA was isolated from HortHill Farm, UGA, Tifton field soils with no history of onion cultivation spiked with standardized concentrations of control inocula using Qiagen\'s DNEasy PowerSoil Pro kit. The two TTG+ strains showed titratable quantities via qPCR, and the TTG- strain showed amplification on par with un-spiked soil. Since DNA isolation from soils tend to carry over inhibitors (soilborne chemicals which impede amplification), we incorporated the use of a competitive internal positive control (CIPC) to measure shifts in amplification due to soil quality. The CIPC will allow us to mathematically correct under-estimations of TTG quantities due to PCR inhibition. The CIPC is a synthetic, short double-stranded DNA fragment of Green Fluorescent Protein DNA flanked with recognition sites for the TTG forward and reverse primers. The TaqMan probe for the CIPC is specific to GFP and labelled with a different fluorophore than the TTG probe. Thus, we can multiplex detection of both TTG and CIPC in the same PCR reaction. We are currently optimizing these two probes and the reaction to ensure they do not interfere with each other\'s detection. We also are currently testing a variety of onion and non-onion field soils against a standardized dilution series of bacterial gDNA to quantify TTG+ Burkholderia within each field. This qPCR assay will next be used to track changes in TTG+ Burkholderia populations in fields undergoing elimination treatments (fumigation and solarization) in support of this project. Co-PI Mowrer in Texas has established solarization trial at College Station, Texas. Soil is mapped as a Chazos loamy fine sand. Activities under this objective include tillage to remove weeds, loosen soil, and smooth field for plastic installation. Field has been squared and plots laid out and labelled according to plant. Nematode soil sampling were performed. Soil sampling for nutrients, weed seed bank, and DNA were performed. Overhead irrigation has been installed. Inoculation with onion bulbs is pending as is installation of the plastic. Starting in September, 2023 Co-PD Coolong evaluated eight mustard varieties for suitability for biofumigation in replicated plots. Plots were 150-ft long each so that termination and incorporation could better simulate biofumigation processes. Because of the tight production window and high temperatures during the cover crop growing period (Aug-Oct) we needed to identify a mustard variety that could germinate, grow, mature and produce significant biomass in the early fall in Georgia. We identified Pacific Gold as the variety with the best combination of maturity index, biomass, sulfur accumulation (as a surrogate for glucosinolate concentrations). The trial repeated in Spring 2024 with similar results. Organic biofumigation trials are currently underway in Fall 2024 using the selected mustard. Co-PI Mowrer in Texas conducted a soil incubation study on three soils to assess the effect of reagent grade allyl isothiocyanate and two mustard meals at multiple rates on the mineralization and nitrification of organic N from organic fertilizer. Data shows clear inhibition of both mineralization and nitrification and that this inhibition is dependent upon soil texture. Trials are underway in Fall 2024 to evaluate PL and COF in organic production systems in Georgia. Greenhouse trials are in progress to evaluate poultry manure mineralization at Texas A&M AgriLife Research, Overton TX. The goal is to establish N availability timeframe for both 3 and 5 ton/ha PM. We evaluated and standardized methodologies to extract, identify, and quantify plant-parasitic nematodes and free-living nematodes. Preliminary soil samples were collected from fields naturally infested with nematodes. Soil sampling involved collecting 8-10-inch-deep soil cores from 10-15 sampling points to generate each composite sample. The samples were then transported and stored at 4°C until processing. Nematodes were then extracted from each soil samples using the centrifugal

sucrose floatation method. Plant-parasitic nematodes were then identified and enumerated to genus level, based on morphological features, under the microscope. We were also able to identify the free-living nematode to their trophic level. Additionally, we have evaluated several free-living nematode identification keys and found that the web-based \"Interactive Diagnostic Key to Plant Parasitic, Free-living and Predaceous Nematodes\" developed by the University of Nebraska Nematology Team can be utilized to identify free-living nematodes to their family or genus level. Thus far, we collected pre- fumigation and pre-solarization soil samples from each of the trial plots. Nematodes were extracted from these samples and currently being processed following the procedures described above.Utilizing taxonomic keys is time consuming and tedious for processing large number of samples. Hence, we are working on a functional group identification scheme and also preparing a workflow to metabarcoding soil DNA samples and DNA extracted from nematodes isolated soil to compare and use for free living nematode identification.To accomplish this, we first reviewed the literature on metabarcoding primers currently in practice for nematode eDNA work, and optimized them in the lab during May-July 2024. The primers are amplifying common entomopathogenic nematode (EPNs) species. The next step is creating mock communities in soil extractions, and isolating DNA from these standardized soil extractions. We will use a combination of EPN species, free-living, and plant pathogenic species in these nanocosm tests. Following results, we will conduct a controlled set of positive controls for many different species of common nematodes. Co-PI Schmidt has also worked with a variety of arthropod primers, and in the last sequencing runs has observed a few primer sets that are capable of amplifying both microbial (bacterial and fungal) DNA. These will be applied to soil samples and a set of arthropod specific primers will be used to detect changes in soil arthropod communities in relation to biofumigation, using eDNA as an indication of activity of soil arthropods in relation to treatments. The work to characterize Burkholderia species in plots under solarization and biofumigation has already started. We are in the process of extracting microbial genomic DNA from pre-planting/pre-treatment samples. The characterization of the Bulkholderia species will be carried out with amplicon sequencing targeting the recA gene. The California onion outbreak strain was obtained and characterized for its growth rate through comparative studies with cattle isolate of S. Newport. Plasmid (pGFPuv) stability was evaluated in this strain both with and without the presence of selective pressure (ampicillin) in growth medium. Further, the plasmid stability and survival of the strain in soil was evaluated through comparative survival studies with a cattle isolate of S. Newport. The soil used for this experimental study was from an onion farm. Publications Type: Journal Articles Status: Published Year Published: 2024 Citation: Paudel, S., Zhao, M., Dutta, B., and Kvitko, B. 2024. Thiosulfinate tolerance gene clusters are common features of Burkholderia onion pathogens. Molecular Plant Microbe Interactions 37: 507-519. Type: Journal Articles Status: Awaiting Publication Year Published: 2024 Citation: Paudel, S., B. Dutta, and B. Kvitko. 2024. Onion?Pathogenic Burkholderia Species: Role and Regulation of Characterized Virulence Determinants. Plant Pathology Type: Conference Papers and Presentations Status: Published Year Published: 2024 Citation: Neupane P., Somenahally A., Gentry T., Aguilar C. 2024. Evaluating disease suppression and soil health properties under organic practices for vegetable production. ASA, CSSA and SSSA International Annual Meetings, Nov 10-12, 2024. San Antonio, TX. SOD: Solutions for Organic farm Diseases: suppressing soilborne pathogens in vegetable high tunnels Sharifa Crandell, Pennsylvania State University

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# Building Partnerships for Farmer-led Research in Ohio

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|---|---|
| **Contract / Grant No.** | 2023-51300-40856 |
| **Grant Amount** | $49828 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Jackson-Smith, D. |
| **Performing Institution** | Ohio State University |

## NON-TECHNICAL SUMMARY

Collaborative on-farm research is a critical component of advancing productivity, profitability, and resilience in the organic sector. Our project will partner with organic producers and leverage existing personnel, resources, and knowledge at three institutions (The Ohio State University, Central State University, and the Ohio Ecological Farm & Food Association) to expand farmer-led organic research in Ohio. We propose a series of research workshops and engagement activities to develop an Ohio Organic Farmer-Researcher Network. We will implement five workshops that bring organic farmers together with institutional educators, extension, and researchers to co-develop specific organic research project ideas. Workshops will be held at existing farmer events and will focus on transforming on-farm problems or ideas into viable researchable projects. The culminating event will bring together potential partners and resources to develop an Ohio organic research agenda to guide future work and grant applications. Our leadership team will facilitate monthly virtual meetings and follow up activities by organizing additional events, sharing research planning tools and information, and creating working groups to advance specific research projects that address identified needs. The project will provide funds to defray the costs of participation by organic producers and compensate farmers who lead future research project development. In this way, we will advance the OREI goals of facilitating the development and improvement of organic agriculture production and fostering advanced on-farm research and development which is farmer-led. In addition, our project will build the trust and common vision needed to advance collaborative research for organic agriculture in Ohio.

## OBJECTIVES

Identify research needs and co-develop plans and partnerships to address identified needs.Collaborate with farmers, researchers, and educators to explore future ideas, share experiences with on-farm research, and respond to needs identified during in-person workshops.Build trust, a common vision, and concrete plans for a sustainable, collaborative, on-farm Ohio Organic Farmer Researcher Network.Develop and submit new grant proposals to support Ohio Organic Farmer Researcher Network activities, collaborative on-farm research projects, and peer-to-peer networking events focused on organic farm management.

## APPROACH

We will design and implementfive in-person events to engage a wider group of farmers in workshops and community building. These workshops will identify research priorities, organize on-farm research projects, and build authentic and respectful partnerships and shared understandings between farmers and Ohio\'s public and private research and education institutions. Workshops will coincide with existing farmer events and include follow-up activities to encourage continued discussion. To further reduce barriers to farmer participation, we will offer \$100 stipends to offset participant travel costs and lost work time. We will also support the meeting and host organizations by contributing to on-site food costs, space, promotional, and facilitation needs, in exchange for their partnership. Personal invitations from Ohio Organic Farmer Researcher Network farmer leaders will also be critical to event promotion, as well as including our network farmer leaders as workshop facilitators, monthly meeting speakers, and working group leaders. This grant proposal will allow us to support this higher level of farmer participation with compensation for their time. Workshop venues will be selected to encourage participation by historically underserved farmers, and by Plain community members who constitute a majority of Ohio\'s organic growers and are less able to attend virtual meetings.Our workshops will allow farmers to identify

shared research questions grounded in production issues with support from farmer leaders, educators, and researchers. These events will encourage farmer ownership of organic research topics, ensure authentic exchanges of knowledge, and increase the relevance and impact of future collaborative research and education programs. Time permitting, our workshops will incorporate educational presentations, panel presentations with question-and-answer periods, and small group breakout sessions with report back periods. These activities allow interaction between all attendees as well as more personal interaction focused on specific topics and tasks within small groups. Small group facilitators from our network leadership will help keep conversations on track, ensure all voices are heard, take notes, and report areas of main interest and possible follow-up to the whole group. With the limited time available for these workshops, our main workshop objectives will be to 1) introduce research process; 2) share experiences with on-farm research; 3) develop and share viable research questions; 4) begin to elaborate methods and approaches to address these questions. Our network and project co-coordinators will encourage further development of workshop ideas through follow-up activities.To support the in-person workshops, we will continue our monthly virtual meeting series. Meetings will be used to hear from past recipients of on-farm research grants to share experiences with research and network building, resources, and relevant knowledge.Feedback from workshop surveys and input from monthly meeting participants will be used to adjust and improve our methods and approaches throughout the project to improve results.Our project will culminate in an all-hands meeting at the 2024 OEFFA Annual Conference where we will share outcomes from the regional workshops, collaboratively set an organic research agenda, and discuss opportunities for new institutional investments and funding to support continued and coordinated on-farm research and infrastructure for a permanent Ohio Organic Farmer Researcher Network.

## PROGRESS

***09/01/23 to 08/31/24***

Outputs Target Audience:Farmer operators, agricultural scientists and extension faculty, private sector consultants, policy makers and commodity groups. Changes/Problems:Distributing participation stipends to our farmer workshop attendees has proven difficult. Both universities require vendor paperwork which includes personally identifiable information, and many farmers have not bothered to fill out these 2-5-page forms for the relatively small payout amount. We have collected them onsite, but this is not best practice due to the PII requested on the forms. Attempts to use gift cards have met with obstacles at both universities. Lack of financial support for network staff time has also been a challenge. The grant did not provide much salary support for the organizing team, and most of the OOFRN project has been supported through in-kind allocation of time from faculty and staff at the three partner organizations. While this has worked well for the first year or two, and our organizations are supportive of the project, we have realized that it will be difficult to expand the OOFRN further without a more sustained and official investment in staff time from all three of our partner organizations. The good news is, our efforts have pulled in numerous other staff and faculty as workshops and meeting presenters, workshop facilitators, and technical assistance. We are hopeful that this second year of funding may deliver enough grant projects and partnerships to justify a request for stronger and more sustained staff support commitments from one or more of our organizations. We are also planning to include more staff support compensation in future proposals to grow and extend the OOFRN. What opportunities for training and professional development has the project provided?Our network provided multiple opportunities for in-person and virtual professional development for students, educators, and farmers. Two graduate students were trained as small group facilitators and were provided an opportunity to meet and learn from farm participants. Our network has also helped many newly hired extension educators and researchers meet farmers, engage in farmer-led and participatory on-farm research discussions, and brainstorm collaborative and interdisciplinary research projects. More significantly, more than 100 farmers received training in the scientific process, research approaches, and grant writing through our programming. How have the results been disseminated to communities of interest?We developed an electronic newsletter based on feedback from our network members, which shares information about upcoming presentations and links to recordings of past presentations, upcoming grant deadlines, research opportunities, and workshops or other events of interest. We expanded our network mailing list from 87 initial names and email addresses to 195 by the end of September 2024. Articles about the network have appeared online at our three institutions and Johnnie Speicher, our co-facilitator at OEFFA, developed a flier about our network for distribution at OEFFA and other events. Co-facilitator Denise Natoli Brooks made a presentation about our network at a Central State - Ohio State Universities research networking/exchange event. She also developed a presentation about our approach for the 2024 National BUGs (Black Farmers & Urban Gardeners) Conference in Columbus, Ohio, and has had one-on-one discussions with regional and national SARE leadership about our network. Our network has also been mentioned by at least two Ohio State researchers as a place to build farmer relationships for collaborative research and several have been inspired or used our network as a model for their own collaborative efforts or proposal. What do you plan to do during the next reporting period to

accomplish the goals?We requested a one-year no-cost extension to continue our work and implement emerging ideas about how best to distribute incentive payments to participating farmers. We hosted two more workshops this fall and have plans to do another in February 2025. While these initial on-farm research brainstorming workshops have been successful, our farmers have told us in planning meetings that it is difficult for them to put forth the time and effort needed to follow-up with farmers and other network partners to formalize ideas into concrete research proposals. As a result, our main focus during this second year will be to help launch and support a handful of active on-farm research working groups on focused topics. These working groups will make use of the best ideas from our workshops, planning meetings, and monthly network discussions. We are reallocating some of our participant stipends to support farmers who are willing to take a leading role in these emergent focused working groups. We also learned that we need to find more sustainable and extensive funding to compensate network staff to support the emerging on-farm research projects and extend the impact of our growing OOFRN network. This could include proposals to foundations, USDA NC-SARE and OREI or ORG programs.

## IMPACT

What was accomplished under these goals? Workshops. Our team hosted 3 successful DIY Research workshops between September 2023 through August 2024 and had scheduled 2 additional workshops for the fall of 2025. For each event we were able to draw in facilitators from our organizations who were new to the workshop process. Attendance varied from 14 to 61 with a good mix of farmers, educators, and professional researchers. After each event, we reviewed evaluations and facilitator experiences to learn what should be retained or improved. Materials and presentations were modified to meet time and facility constraints, audience, and to respond to feedback. We learned that 2 hours was the bare minimum of time required to make this work, and that most of that time should be devoted to small group work. We also felt the events were better if the conference attendees already had something in common, as opposed to the pilot workshop we had done at the OEFFA Conference in February 2023. Before the grant period ended in September, our team had confirmed plans to hold additional workshops at the Ohio Southern Forest Farming Conference (9/29/2024), the Ohio State Beekeepers Association Meeting (10/25/2024), and had began conversations about an OEFFA Conference event in 2025. Workshops completed during first year: Black Farming Conference 9/30/2023 34 pre-registered, 26 attendees Small group topics: Pest Issues, Marketing, Farm Diversification, Soil Health, Land Access Ohio State Organic Grains Conference 1/3/2024 61 pre-registered, 55 attendees Small group topics: Weeds, Marketing and Sales, Cover Crop N Contributions, Soil Health, and Diversified Rotations OEFFA Conference 2/15/2024 14 pre-registered for this event 18 attended Small group topics: companion planting, cover crops, Cover Crop N contributions, variety trial, variety breeding Virtual Ohio Organic Farmer-Researcher Network (OOFRN) Meetings. Our team hosted monthly virtual meetings during the first-year grant period with attendance varying between 5 and 26 people. Four farmer presenters were compensated for sharing their research experience. Farmer-led topics included powdery mildew trials, pasture management tools for rotational grazing, organic no-till corn trials, and strategies for addressing in-row weeds in organic field corn. Four meetings focused on guided conversations with network participants to review and discuss the network\'s goals, strategies, and specific projects. Additional meetings discussed strategies for using and assessing biostimulant products; the mechanics and logistics of variety trials; and basic information and Q&A with a major grant program leader. Recordings of these meetings are posted to our website and have had 377 views. Quarterly Network Leadership Meetings. These were scheduled to be part of our monthly meeting routine so that we didn\'t have to set a separate date. Over the course of the year we built a good group of regular attendees, despite the difficulty of weather and time constraints that plagues farm industry meetings. Direct feedback led us to offer a small \$100 stipend to farmers who participated in the quarterly leadership meetings to allow them to prioritize attending and in making them feel like their time was valued. Build network. We were able to gain regular participation from a diverse and growing group of farmers, as well as researchers and educators in our partner organizations. By the end of the year, we had numerous examples of new partnerships and relationships forming between the farmers, researchers, and educators who had been participating. We have decided to shift energy from introductory/early planning workshops to provide more support for specific emerging clusters of farmers and researchers who are developing and implementing their on-farm research ideas. Proposals. We did meet our grant objective of developing multiple grant proposals or proposal teams to generate resources to support intensive farmer-led, on-farm organic research. Four of our DIY workshop ideas were submitted as grant proposals to the Ohio State on-farm collaborative Warner Grant program (https://amp.osu.edu/research/funding-opportunities-warner-grants-sustainable-agriculture).These focused on participatory produce breeding and trials, flame cultivation, perennial cover crops systems for organic transition, and the use of manually vs. remotely-vented high tunnels for spinach production. Three of the proposals received funding. In addition, ideas generated at one of our workshops led to

the development and submission of a major proposal to the USDA OREI program (which was not funded, but will be resubmitted this year). The farmer who originally proposed the idea was a substantial partner in the OREI planning and writing process.

## PUBLICATIONS

Type: Conference Papers and Presentations Status: Accepted Year Published: 2024 Citation: Can I Get A Little Help??? Writing SARE Grants. Presentation at Black Farmers and Urban Growers Conference, Columbus Ohio, June 29, 2024. Lead: Denise Natoli Brooks; Co-presenters: Liz Brownlee, NC SARE and Michelle Wallace, CSU Extension/SARE State Coordinator. Type: Conference Papers and Presentations Status: Accepted Year Published: 2024 Citation: Curious Mind? The Ohio Organic Farmer Researcher Network. Invited presentation to Central State University-Ohio State University Showcase Research Partnership Meeting presentation, Columbus, OH, May 2, 2024. Denise Natoli Brooks lead, Douglas Jackson-Smith, co-presenter. **Fostering Sustainable Organic Cotton Production in the US through Research and Outreach on Organic Regenerative Practices** Mughu Bagavathiannan, Texas A&M University

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# Development of an Organic Agriculture Curriculum

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|---|---|
| **Contract / Grant No.** | 2023-51300-40911 |
| **Grant Amount** | $750000 |
| **Grant Year** | 2023 |
| **Investigator(s)** | Li, Y. |
| **Performing Institution** | University of Minnesota |

## NON-TECHNICAL SUMMARY

The rapid growth of organic production has been accompanied by development of new organic agriculture curricula at land-grant universities. However, most existing curricula do not include organic animal production, which along with educating the next generation is essential to sustaining organic agriculture. Overarching goals of this project are to: 1) Sustain and support the expansion of organic agriculture by building competent professionals and workforce, 2) Enhance organic educational programs at land-grant universities, 3) Promote leadership and career success among underrepresented students in organic agriculture. Our goals will be achieved by 1) Developing a series of courses and modules to provide students with fundamental knowledge and hands-on exposure to organic animal production, 2) Developing internship programs to provide extended experiences and to hone students\' problem-solving skills, 3) Developing directed study programs to deepen students\' knowledge of organic production, and 4) Providing leadership and career development opportunities for underrepresented students in organic agriculture and related areas. In this project, we will develop two core courses and several modules inorganic animal production. All courses and modules will consist of both lectures and lab (hands-on) activities. The lecture session will aim to increase students\' understanding of fundamental knowledge and principles in organic animal production; and the hands-on activities will help students apply what is learned in the classroom to field settings. Additionally,we will design an internship program and a directed study program to provide students real world experience in organic animal production and hone students\' problem-solving skills. Furthermore, we will focus on underrepresented students and help them to achieve their career goals through connecting themwith tribal partners working in the area of food sovereignty.Courses,modules, and programs will be offered across two campuses of the University of Minnesota. Organic certified facilities (dairy, swine, poultry, and student garden) at the University of Minnesota will be used for students\' hands-on activities. Project outcomes will be delivered through publications, presentations, and online posting. In alignment with Priorities of 8, 1, 6, and 9 of the OREI program, this project addresses the absence of educational programs in organic animal production at land-grant universities, the scarcity of opportunities for students to engage in organic animal production in real-world situations, and the shortage of competent professionals and workforce in organic agriculture.

## OBJECTIVES

The overarching goals of this project are to 1). Sustain and support the expansion of organic agriculture by providing competent professionals and workforce, 2). Enhance organic educational programs at land-grant universities, and 3). Promote leadership and career success of (especially but not limited to) underrepresented students in organic agriculture.By developing a comprehensive curriculum focusing on organic animal production and integrating the curriculum into existing majors across departments and campuses at the University of Minnesota, we strive to meet the urgent demand for competent professionals and workforce with fundamental knowledge, skills, and experiences to support organic animal production. The goals will be achieved through the following objectives: 1. Develop a series of courses and modules for undergraduate and graduate students in order to provide students with fundamental knowledge and principles, and hands-on exposure to organic animal production.2. Develop internship opportunities to provide real world experience and hone students\' problem-solving skills, with particular emphasis on a systems approach to addressing challenges in organic animal production by working with organic farmers and potential employers in organic agriculture and food systems. 3. Develop directed study programs to deepen students\' knowledge of organic animal production in the context of ongoing research programs with faculty and organic farmers.4. Provide organic agriculture-targeted leadership and career development opportunities for students, including underrepresented students; facilitate student

interactions with employers in organic agriculture systems; and work with students to develop individual career plans that will enable them to become competent professionals and workers to sustain and support the expansion of organic agriculture.

## APPROACH

To achieve Objective 1, we will develop two core courses (Introduction to Organic Animal Production, and Organic Animal Production Systems and Management). Both courses will consist of both lectures and lab (hands-on) activities. The lecture session will aim to increase students\' understanding of fundamental knowledge and principles in organic animal production; and the hands-on activities will help students apply what is learned in the classroom to field settings. The first course will be designed for undergraduate students, and the second course will be for graduate and advanced undergraduate students. Both courses will emphasize multi-disciplinary and systems thinking, practical and experiential learning, and skill building. The hands-on activities for the first course will include development of Livestock Organic System Plans and business plans, preparing paperwork for annual inspection, case studies, farm visits, and interaction with organic farmers and stakeholders. The hands-on activities for the second course will include individual projects, case studies, hands-on experiences at the organic dairy and organic swine facilities at the WCROC, and the student organic poultry farm on St Paul campus, farm visits, and interactions with organic farmers and their stakeholders at field days.Additionally, lectures and hands-on activities related to three species (organic dairy, swine, and poultry) will be modified and made stand-alone modules to be plugged into existing courses to increase the number of students engaged in the curriculum. In addition to the three animal species-specific modules, we will develop other comprehensive modules with emphasis on integrated organic production systems, and social and environmental impacts of organic animal production. All these modules will be designed to increase students\' awareness and understanding of concepts and principles in specific areas related to each module. Each module will also consist of both lecture session and lab or field activities. The lecture session will cover fundamental concepts and provide examples. The hands-on activities will include visiting organic animal facilities at WCROC and St. Paul campus, virtual or in-person tours of commercial organic animal farms and processing facilities, and communication with organic farmers and their stakeholders at field days.To achieve Objective 2, we will design an internship program to help students apply knowledge and principles to organic animal production. We will develop an individual internship agenda for each student to achieve the following goals: to gain work experience in organic animal production and associated areas in a real-world setting, to enhance problem-solving skills by applying fundamental knowledge and principles learned in the classroom to identify and solve problems in organic animal production, to meet the students\' learning objectives and personal growth goals, and to provide guidance and networking opportunities to help students achieve their career goals. At the conclusion of the internship, students will present final project papers to reflect what they have learned, whether they have achieved their learning objectives, how the internship experiences have helped them understand and apply knowledge and principles to the real-world and influence their career goals.For Objective 3, we will provide directed studies for students who wish to dive into a specific area in organic animal production, organic food systems, or integrated organic crop-livestock systems. We will pre-evaluate the student\'s learning objectives and career goals before custom-designing a directed study for each student. Students in directed studies will have more opportunities to work on commercial organic farms and interact more frequently with organic farmers and stakeholders than student interns. At the conclusion of the program, students will present a final project report to reflect what they have learned, whether they have achieved their learning objectives, how the directed study experiences have helped them understand and apply knowledge and principles to the real-world and influence their career goals.Objective 4 will be achieved through collaborations among the project team, the Native American Student Services (NASS) staff, and Career Development Center (CDC) of UMN. We will include Native individuals\' and communities\' work in organic agriculture in the curriculum. We will also connect Native students with tribal partners working in the area of food sovereignty. All students who enroll in the proposed curriculum will have opportunities to meet with the project team and staff from CDC to discuss and refine their career goals and to develop strategies for meeting the goals. Additionally, students will be connected with organic farmers, stakeholders, and potential employers on individual basis to learn about what expectations and needs there are for competent leaders, professionals, and workforce in organic animal production and related areas. Students will meet with the project team and staff from CDC and (as appropriate) NASS on a regular basis to check progress they have made in leadership and career development.

## PROGRESS

***09/01/23 to 08/31/24***

Outputs Target Audience:The main target audience of this project is undergraduate and graduate students who are interested in agriculture, food systems, and sustainability. Additional audiences include instructors at universities, agricultural professionals, extension specialists, and organic farmers who can use the curriculum developed through this project in their educational programs. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?The project provided training opportunities for the intern and directed-study students to gain experience in organic animal production and research. These experiences contribute to the students\' career goals. The directed-study student is applying knowledge and experience gained through this program to improve productivity and efficiency on his small-scale, multispecies farm. He became very interested in organic agriculture and has the potential to become a leader in organic production in the future. For the two intern students, one is interested in sustainable agricultural production. The program provided her opportunities to examine organic agriculture through the lens of sustainability (e.g., net greenhouse gas emissions). The other intern student\'s career goal is to become a holistic large animal veterinarian. The experience she gained through this program helped her understand the benefits and challenges in herd health in organic production. We believe that all three students will contribute to the future of organic agriculture in their own ways. How have the results been disseminated to communities of interest?The project was introduced at the College Assembly on April 21, 2024, and listed on the University website (Experts@Minnesota). Additionally, administrators from the Vice President Office of the University of Minnesota met with the project team twice to discuss how to publicize this project in order to benefit students across campuses. As a result, we reached out to the Crookston campus for potential participation in the project. Furthermore, project progress has been shared with the stakeholder advisory committee. What do you plan to do during the next reporting period to accomplish the goals?To accomplish the project goals during the next reporting period we will: Offer Course One and make the adjustments based on students\' feedback (Objective 1). Finalize Course Two content and offer the course (Objective 1). Continue to develop and finalize stand-alone modules (Objective 1). Offer two modules in Fall 2024 and five modules in Spring 2025 (Objective 1). Refine and continue to offer the internship and directed study programs (Objectives 2 and 3). Refine and continue to provide opportunities for leadership and career development in organic agriculture to students, including underrepresented students (Objective 4). Disseminate project outcomes.

## IMPACT

What was accomplished under these goals? During the first year of the project, we focused on developing the courses and modules related to organic animal production for undergraduate and graduate students. Meanwhile we offered the intern and directed study programs to undergraduate students. The project team met monthly with the stakeholder advisory committee for input and to discuss progress on syllabi and course content. The main accomplishments related to each objective of the project over the reporting period are listed below: Objective 1: We developed syllabi of two courses (Course One, 3cr): Introduction to Organic Animal Production; (Course Two, 3cr): Organic Animal Production Systems). Goals, objectives, and expected outcomes of each course are addressed in the syllabi. The outline of the course content, the topic of each class, and course schedule were designed for each course, with teaching responsibilities assigned to each instructor. Both syllabi were reviewed and approved by the Department of Animal Science Undergraduate Curriculum committee. Currently, the team members involved in each course are working collectively on finalizing the course content, identifying reading materials for students, planning hands-on activities, and designing quizzes, student projects and final exams. We plan to offer the Introduction to Organic Animal Production course (Course One) in the fall semester of 2024, and the Organic Animal Production Systems course (Course Two) in the spring semester of 2025 after students complete the introductory course. In addition to the two courses, we have been developing the content of nine modules. Among the nine modules, two will be offered in Fall 2024, five in Spring 2025, and two in Fall 2025. All courses and modules aim to increase students\' understanding of fundamental knowledge and principles in organic animal production, to provide the hands-on activities to help students apply what is learned in the classroom to field settings and emphasize multidisciplinary and systems thinking and skill building. Objectives 2 and 3: We recruited and trained two interns and one directed study student during the summer of 2024. Based on students\' interests, their career goals, and the goals of this project, we developed individualized internship and directed study agendas for each student. The agenda emphasizes the theme of \'learning by doing\' and focuses on applying knowledge and principles to the real-world. All three students were provided hands-on opportunities at either university organic facilities (organic dairy and swine facilities at WCROC) or a commercial organic farm (Prairie Horizon Farm, Benson, MN). Students documented their experiences and conducted self-reflection on a weekly basis. Besides obtaining experience in organic animal production and food systems, each student was required to conduct a case study related to their interest in alignment with the project goals. The project team met with the students on a weekly basis to provide feedback and guidance on their individual projects. At the

conclusion of the summer, the students submitted final project papers and gave presentations at the WCROC to reflect what they learned, how and whether they achieved their learning objectives, and how the internship/directed study experiences contributed to their career goals. Objective 4: All internship and directed study students involved in this project over the past reporting period are considered underrepresented students, including one African American, one Native American, and one Asian student. The project team helped the students develop and refine their career plans and tailored their hands-on activities and on-farm experiences towards their career goals. The students were also provided with opportunities to participate in organic research projects at the WCROC, field days at the WCROC and on commercial organic farms, and visits to organic commercial farms. These opportunities helped students understand the breadth of organic agriculture, meet and interact with organic farmers, and establish professional networks and connections with potential employers.

## PUBLICATIONS

**Influence of Orchard Grazing on Soil Health and Pest Control While Mitigating Food Safety Risks** Alda De Andrade E Pires, University of California, Davis

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