COVER CROPS, WATER QUALITY AND SOIL HEALTH RESEARCH AND OUTREACH
Year 4 Report, August 2021

The aim of this cooperative agreement is **to develop profitable and practical cover crop options for Midwestern dairy, grain and vegetable production systems, including in no-till organic systems and as forages**. This fourth annual report demonstrates the progress our multi-institutional research and outreach teams have made in the five major project areas.

Following are highlights of 2020-2021 research activities by the interdisciplinary team of scientists and outreach specialists at University of Wisconsin-Madison, the UW-Madison Center for Integrated Agricultural Systems (CIAS), the USDA Dairy Forage Research Center (DFRC), and the Michael Fields Agricultural Institute (MFAI). The cooperative agreement funds have been leveraged to initiate new research, expand previous studies, and secure additional research funding to support long-term research and outreach on cover crops, water quality and soil health.

As in previous years, the collaborative met monthly for hour-and-a-half brown-bag lunches, facilitated by Margaret Krome with the Michael Fields Agricultural Institute. Many of those meetings were organized around "Quick Take Presentations," from both within and outside of our network. Invited presenters included, for example, Matt Komiskey, USGS, who spoke on "'Unintended Consequences of a BMP, Cover Crop, Evaluation from Edge-of-field monitoring for the Great Lakes Restoration Initiative Priority Watersheds Program;" UW Department of Geography student Ryan Geygan on remote sensing and cover crop adoption in the Midwest, and members of University of Wisconsin Nutrient and Pest Management Program sharing their on-the-ground experiences of working on cover crops with farmers in all corners of the state.

CCROP team members, with the help of an agroecological modeler hired this year, are working to modify existing agricultural and water quality models to incorporate current and future cover crop research results to help farmers answer questions. The team pursued a number of outreach efforts, which had to be amended in the context of COVID-19. Projects included on farm research trials, a citizen science research project, participatory economic modeling including cover cropping, and multiple virtual presentations and talks on cover cropping to farmers, agricultural educators and students.

Cover Crop planting with highboy (photo credit: Gregg Sanford)

PROJECT AREA 1

Project Area 1. Pursue cover crop research trials in organic and conventional dairy, grain, and vegetable production systems at 3 locations in Wisconsin to evaluate the use of no-till and forage systems, the effect of cover crops on corn yield responses, the use of red clover in forage rotations, species selection, planting date and rate, and updating SnapPlus to more accurately model nutrient losses associated with cover crop systems.

Sustainable intensification and soil health research at the Wisconsin Integrated Cropping Systems Trial (WICST). Co-PDs staff scientist **Gregg Sanford**, PhD (CIAS and Department of Agronomy) and Professor **Randy Jackson** (Department of Agronomy) are working to understand the combined effects of reduced tillage, living cover (e.g. cover crops), and livestock integration on soil health and soil carbon stocks in common Midwestern organic and non-organic cash-grain rotations. The setting for the research is WICST, a large-scale cropping systems experiment established in 1990. Numerous studies published from the trial in the last decade have demonstrated the stabilizing

effect of perennial grasslands on soil carbon as well as the soil health benefits of diverse, integrated crop-livestock rotations. Cash grain cropping systems on the other hand (organic and non-organic) have experienced significant declines in both soil carbon and key soil health metrics over time. The aim of this research is to determine if by manipulating tillage (decrease), living cover (increase), and crop-livestock integration (increase) in cash-grain cropping systems we can capture some of the benefits associated with perennial agriculture systems and simultaneously increase yield, improve soil health, and maintain profitability. Data will also be used to augment the Wisconsin Cover Crops Database (see below).

Collection and curation of a Wisconsin cover crop database to improve regional understanding of cover crop production and derived ecosystem services via SnapPlus, SmartScape, and Agro-IBIS model improvement. Multiple project partners led by UW-Madison Jackson Lab/CIAS staff scientist Gregg Sanford, PhD to improve cover crop data for SnapPlus. Sanford, continues the development of the Wisconsin Cover Crops Database. The aim of the database, which currently covers 67 site-years (~600 observations), is to aggregate all vetted cover crop data collected in the state with the goals of: 1) improving the accuracy of SnapPlus in estimating tolerable soil loss and P index, 2) developing predictive models of cover crop potential and risk throughout the state under specified seasonal parameters (e.g. temperature, precipitation) to provide data for SnapPlus in parts of Wisconsin where cover crop data is not currently available, and 3) creating a farmer-focused tool to estimate potential and risk of cover crop choices based on where in Wisconsin they are farming. This year, members of the project team initiated development of a cover crops module that will serve as a decision support tool for SmartScape, a web-based tool that allows users to build land-use change scenarios and evaluate multiple ecosystem responses including profitability, soil carbon, nutrient loss, and biodiversity.

Understanding and predicting cover crop efficacy in the North Central US. Randy Jackson (Agronomy), Claudio Gratton (Entomology), Gregg Sanford (Agronomy), Priscila Pinto (Agronomy), Chris Kucharik (Agronomy & Nelson Institute), Laura Good (Soil Science), Matt Ruark (Soil Science) are leading an effort to improve our capacity to model cover crop performance in the North Central US and enhance our capacity to predict the effects of cover crops on soil health, water quality, and economic viability in the region. For the past 4 years, we have been developing an integrated landscape model called SmartScapeTM (Tayyebi et al. 2016a, Tayyebi et al. 2016b), a web-based decision support tool that allows us to alter land cover (e.g., crop types) and its management (e.g., nutrient inputs) on the landscape and then visualize sustainability outcomes: profit, production, soil carbon, nutrient loss, biodiversity (Meehan et al. 2013). The tool predicts crop growth given specific soil types and slope, as well as location in the landscape such as proximity to water bodies. However, SmartScape is limited by the range of parameters we can manipulate and the 'data under the hood' used to make predictions about future outcomes. The data under the hood of SmartScape comes from ecosystem process models such as Agro-IBIS, a simulation model developed by Kucharik et al. (Kucharik 2003) that mimics C, N, P, and H2O flows within and between agroecosystems (Kucharik and Twine 2007, Twine and Kucharik 2008, Motew et al. 2017, Campbell 2018). However, neither Agro-IBIS nor SmartScape are parameterized for cover crop inclusion into annual grain cropping systems in ways that allow for exploration of interactions among main- and cover-crop species or management. Currently, we are working on incorporating effects of cover crops on soil loss and P-index changes through a simulation of the Wisconsin SnapPlus (Good et al. 2018) nutrient management tool.

Oat and alfalfa companion cropping (photo credit: Gregg Sanford)

By incorporating representation of cover crop phenology and growth parameters into Agro-IBIS, calibrating Agro-IBIS with extant datasets, and linking Agro-IBIS output to SmartScape, we set ourselves up to ask questions about

how various combinations of main crops, cover crops, the environment, and management affect the efficacy and profitability of using cover crops. Moreover, we can then explore the range of these combinations where the model 'works' by collecting validation data that will guide future cover crop experiments. Critically, the ability of SmartScape to allow rapid exploration of scenarios in different parts of the landscape would allow us to identify if, and specifically where, cover cropping systems may be most useful. Finally, by building cover crop effects into the process-based system that underlies Agro-IBIS, we would be able to explore how variability in temperature and precipitation affects the effectiveness of cover crops in mitigating soil erosion, P and N losses. This would make a decision support system able to explore the effects of the expected climate-related shifts in spring and summer rains on the viability of cover crops for soil health management.

Anna Orfanou, an ecosystem modeler, was hired in the summer of 2020 to work with the co-PI team to synthesize the extant datasets described above, expand the capabilities of Agro-IBIS to represent cover crops, and perform model calibration and validation. These key datasets are accessible or in hand and will be compiled, standardized where appropriate (i.e., units of measure), and used to calibrate the outcomes of cover crop functional types within the agroecosystem process model, Agro-IBIS and the landscape decision support tool, SmartScape.

FACILITATING ON-FARM RESEARCH:

This effort aims to provide farmers with a framework to guide and support meaningful research on their organic farms, particularly around the area of cover crops and soil health. Led by **Erin Silva** and **Anne Pfeiffer**, this work was launched in Fall 2020, bringing together stakeholder groups (Farmer-led watershed groups, conservation districts, crop consultants, NRCS staff, Extension staff, demonstration farms) to determine their interest in becoming involved, and their priority research needs. Throughout these conversations, an emphasis on interseeding cover crops on 30 and 60-inch corn and soybeans was determined and plans were executed to establish 21 on-farm trials throughout the state. Pfeiffer will continue to provide support with respect ot data collection, analysis, and reporting throughout the next year, with a meeting of collaborators planned for winter 2022

Linking citizen science to field agronomy at UW-Madison. Many studies point to improved yields and soil/nutrient retention when cover crops are incorporated into annual cropping systems, but the data is inconsistent, especially in Wisconsin and other more northern states. In the summer/fall of 2020 we successfully initiated **"Building Knowledge about Cover Crops: A farmer-research data collection project." Dan Smith** at the Nutrient and Pest Management Program, CIAS staff **Michelle Miller** and **Mrill Ingram**, and **Gregg Sanford** in the Department of Agronomy linked the WICST data collection protocol to a Citizen Science google survey and also organized a biomass collection process for each participating farmer. Some fifteen farmer researchers gathered data on their cover cropping practices and experiences, and welcomed the research team to gather biomass samples, which had to be done following COVID-19 safety restrictions. The research provided cover crop potential and risk in parts of Wisconsin where cover crop data is not currently available. In addition, the survey collected qualitative information on sources of information grower rely on for cover cropping as well as years of experience. MFAI worked with the Wisconsin NRCS to provide incentives for farmer engagement and arrange for reporting that satisfied NRCS requirements.

Roller crimped buckwheat (photo credit: Jim Stute)

Research results were presented in an online Research Brief and distributed to participants along with a personalized report that included the biomass yields for their field. The project is gearing up to launch again for the 2021 growing season, including the launch of new webpages to recruit new participants and keep people informed. We intend to double the number of participants and continue to increase the geographic distribution to include less well represented areas. In addition, we revisited the survey to add a few more questions about structural and system barriers these

farmers observe to cover cropping as well as to make the survey more efficient over all. We are looking forward to continuing this effort in a year not so restricted by a pandemic!

The farmer researcher data will contribute to our cover crop dataset used to calibrate and validate a state-of-the-art agroecosystem model (Agro-IBIS). Model runs from Agro-IBIS will be used to compare and contrast output from a widely used farm management tool (Snap-Plus). Finally, output from Agro-IBIS and Snap-Plus will feed a landscape decision support tool (SmartScapeTM) to test and explore cover crop efficacy for improving crop yields, soil health, and water quality in the upper Midwest. Results will be used to identify more effective cropping system management and inform new experiments.

Partnerships with underserved groups: Dr. Silva continued her work with the Oneida Nation using interseeded cover crops and cover crop mixes into their production of indigenous white corn, to meet their goals of organic production and building soil health. This work resulted in a successful USDA SARE Farmer-Rancher Grant led by Lea Zeise (Intertribal Agriculture Council). In 2021, this work was expanded to the Menominee Nation and the Ho-Chunk Nation. Michelle Miller, CIAS learned that faculty at University of Minnesota are working with Red Lake, White Earth and Latinx communities on cover crop projects and will be exploring ways to link our work with University of Minnesota efforts.

Red clover growing as an understory cover crop here in winter wheat at WICST (photo credit: Gregg Sanford)

Organic grain rotation trial. Associate Professor Erin Silva (Department of Plant Pathology) continued to oversee an extensive organic grain rotation trial looking at intensifying cover crops and reducing tillage in the organic grain rotation, and its impact on soil health, crop yield, and weed suppression. Specific elements of this experiment include: Cereal grains as a cover crop in organic soybeans (different cereal grain varieties, species, seeding rates, and planting dates); legumes and cereal grains as cover crops in organic corn (different cover crop species alone and in combination and planting dates); a highly diverse (14+ species) cover crop mix as a fallow year; and clovers interseeded into cereal grains.

Assessment of the use of cover crops to reduce tillage in organic systems: Silva and her team analyzed the results of a survey conducted in 2019 documenting farmer experiences with cover crop-based no-till, and barriers to adoption. The results of this work will help inform future research and outreach effort that will facilitate cover crop adoption. These results are being summarized in two peer-review publications as well as one farmer/industry/educator-focused publication.

Summer cover crops for weed suppression, forage production, and cash crop yield maximization in organic rotations – Field trial at Michael Fields Agricultural Institute:

Summer cover cropping aims to provide soil cover for erosion prevention, maintain living roots for improved summer precipitation capture, and suppress weeds during the summer months when a cash crop is not cultivated. Summer cover crops have been proposed especially for systems where fall-planted crops are harvested early in the summer, leaving bare soil ("summer fallow") over the late July through fall period, during which soil is susceptible to wind and water erosion as well as water runoff and nutrient pollution risks. Alternatively, summer cover crops could become an important conservation practice in years where high precipitation precludes spring establishment of cash crops (e.g., 2019) and growers must leave fields fallow. Planting those areas to cover crops would suppress weeds and retain nutrients, providing both agronomic and environmental benefits. Agronomy researchers including **Nicole Tautges at Michael Fields Agricultural Institute** are investigating four warm-season summer cover crop species (grasses: sorghum-sudangrass, teff grass; legumes: sunn hemp, cowpea) in monoculture, biculture, and polyculture, for their potential for weed suppression, forage production, and economic cost/benefit, as summer fallow replacement crops in certified organic production systems. All cover crops were compared to a summer fallow control in which weeds were controlled by mowing (with no forage production). The field trial was initiated in June 2020 with

cover crop planting. The forage cutting of cover crops took place in the last week of August. There was no regrowth of summer covers to allow for a second cutting. The sorghum-sudangrass monoculture and four-way spp. mix were the most suppressive of weeds, and the sorghum-sudangrass monoculture and sorghum-sudangrass + sunn hemp biculture produced the most forage.

In results thus far, weed suppression was greatest in the sorghum x sudangrass monoculture and the sorghum x sudangrass + sunn hemp biculture (in the presence of a high weed seedbank in a historically organically managed field; Figure 1).

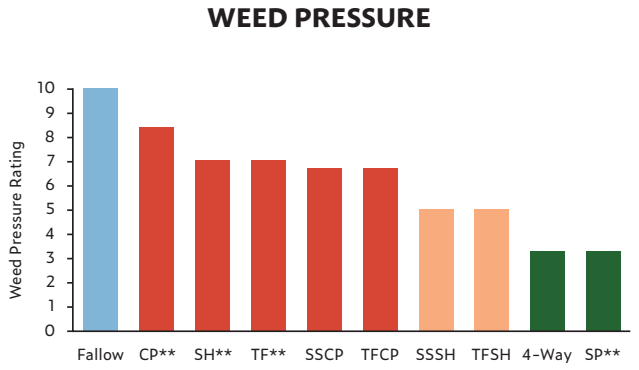

Figure 1. Weed pressure rated 30 days after planting on a 1-10 scale, where 1=0% weed cover and 10=100% weed cover.

** = Monoculture

Forage production was greatest in the sorghum x sudangrass bicultures, where sorghum x sudangrass + sunn hemp and sorghum x sudangrass + cowpea both produced >40 t ha-1 fresh green-chop forage (Figure 2). Sorghum x sudangrass growth in the bicultures benefited from the biological N input from the accompanying legume.

Figure 2. Forage yields on a dry matter basis harvested 60 days after planting.

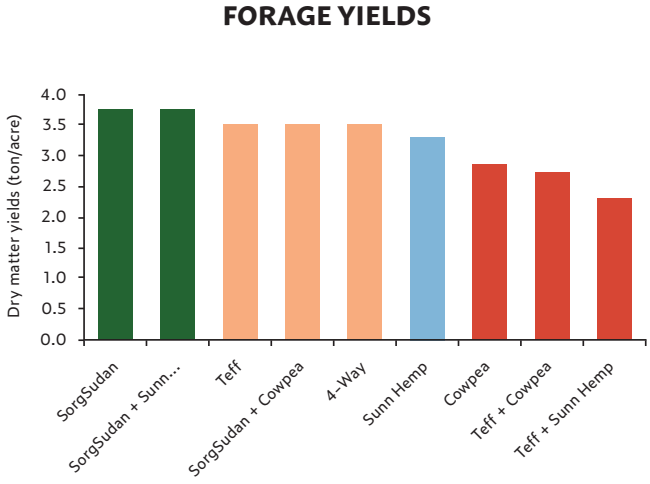

Figure 2. Forage yield on a dry matter basis harvested 60 days after planting.

Economically, seed cost differences among cover crop mixes were small, but all sorghum x sudangrass mono- and bicultures resulted in the greatest forage yield per dollar invested. Early results were communicated to grower and agricultural industry stakeholders via a virtual field day webinar on August 5, 2020, hosted by MFAI, during which we discussed establishment guidelines (e.g., seedbed preparation, seeding rates, seed costs, etc.) and weed suppression observed. During interviews with forage producers for another project, we also discussed results from this study on a one-on-one basis with 10 growers in WI. Full results will be collected and published in 2021 as a grower guide for warm-season cover cropping in WI, including agronomic recommendations for establishment and management, economic costs and benefits, and forage production and quality potential.

Next steps: Rotation effects following summer cover crop treatments will be assessed in 2021 and 2022. However, extreme drought conditions caused spring wheat to fail. We will try again this fall by planting winter wheat and assessing rotation effects by monitoring weed pressure and grain yields in winter wheat in 2022. The summer cover crop trial will be repeated in 2021, planted at the beginning of July. Soil samples from last year's trial were submitted for soil health analyses and forage quality analysis, which is still undergoing analysis. Final results from 2021 will be published in a report for growers posted on the MFAI website.

PROJECT AREA 2

Project Area 2. Prepare initial documentation on cover crop best management practices (BMPs) and the impact on profitability from use of cover crops.

Participatory economic modeling. Cover crops, especially pasture, may provide a valuable alternative feed source for livestock. This year, CCROP funded participatory economic analysis at The University of Wisconsin Center for Dairy Profitability in the Department of Agricultural and Applied Economics. Dr. **Mark Stephenson** and Dr. **Chuck Nicholson** have worked with dairy economists globally to develop a way to model dairy economics. CIAS (Miller and **Sarah Lloyd**) are convening dairy farmers and farm organization representatives to work collaboratively with Stephenson and Nicholson to build out the dairy pricing model based on farmer and organizational interests.

Specific to cover crops and pasture, the model currently uses just two farm types – one that reflects California dairy farms, and the other that reflects farms in other parts of the country, including Wisconsin. The Wisconsin farm type assumes a feeding regime that doesn't include pasture or other cover crops. With CCROP support, Stephenson and Nicholson are developing an additional farm type based on grazing. This farm type will support economic modeling to show how different dairy market policies affect Wisconsin dairy farmers, including those with pasture and cover crops. In addition, to make this application more accessible to individual farmers, Nicholson is working with colleagues in Norway to create an easy-to-use interface for the model. We hope to have the app ready for beta testing at the World Dairy Expo in October 2021.

PROJECT AREA 3

Project Area 3. Plan a regional conference on cropping systems and water quality and two statewide cover crops conferences.

While in-person events were not possible during Fall 2020 and Winter 2021, extensive virtual programming filled this void. In the absence of a regional in person cover crop conference, CCROP team members helped organize several online events. A weekly conservation-oriented webinar series, "**Wisconsin Cover Crop and Conservation Conversations," organized and run by NPM's Jamie Patton** was offered over the lunch hour on three Fridays from March 19 through April 2, 2021. The topic of the March 19 webinar was "Session I - Highlights from Farmer-led Projects Across Wisconsin" and featured lightning-style talks from Dan Smith, Mrill Ingram (CIAS), Chelsea Zegler, Amber O'Brien, Barry Bubolz (NRCS), Matt Brugger (Tilth Agronomy), and Dave Fogerty (farmer). One hundred sixty-one individuals registered for the event and 74 attended the webinar. Talks highlighted the innovative cover crop and conservation work of three DATCP producer-led watershed groups, Biological Farmer Friends, Calumet County Agriculture Stewardship Alliance, and Shell Lake-Yellow River Farmer-led Watershed Council, and two Demonstration Farm Networks, Door-Kewaunee and Upper Fox-Wolf Demonstration Farms. In addition, the results of a statewide citizen science project conducted by the Cover Crop Research and Outreach Project (CCROP) was reviewed. Of those registered for the event (n=161), approximately 35% identified as federal, state, tribal or local agency professionals, 17% as crop consultants or agribusiness professionals, 17% as farm owner/farm managers, 20% as University educators/researchers, and 11% as other or not specified. The registrants represented eight US states and Canada.

The topic of the March 26 webinar was "Session II – Engaging Diverse Audiences in Cover Crops, Soil Health, and Conservation Education" and featured lightning-style talks from Dan Smith (NPM), Mrill Ingram (CIAS), Tara Wachowski and Cheyenne Behnke (Manitowoc County Soil and Water Conservation District), Whitney Prestby, Michelle Probst, Wade Moder (Upper Sugar River Watershed Association), Stephanie Egner (Washington County Land Resources Department), and Julie Peterson (Pheasants Forever). One hundred seventy-five individuals registered for the event and 82 attended the webinar. Talks highlighted the innovative outreach practices of two DATCP producer-led watershed groups, Farmers of the Upper Sugar River Watershed and Cedar Creek Farmers, human dimension survey results from all DATCP producer-led watersheds, outreach lessons learned from the Lower Fox River and Door-Kewaunee Demonstration Farm Networks, as well as outreach strategies by land conservation department and non-governmental organization partners. Additionally, the results of a statewide citizen science project conducted by the Cover Crop Research and Outreach Project (CCROP) was reviewed. Demographic information (n=40) was collected through the Zoom platform. Of those registered for the event (n=175), approximately 37% identified as federal, state, tribal or local agency professionals, 13% as crop consultants or agribusiness professionals, 18% as farm owner/farm managers, 21% as University educators/researchers, and 11% as other or not specified. The registrants represented twelve US states and Canada.

Rye germinating in standing corn (photo credit: Gregg Sanford)

The topic of the April 2 webinar was "Session III – Research Highlights on Cover Crops and Conservation from Across the State" and featured lightning-style talks from Nick Arneson, Jason Cavadini, Gregg Sandford and Kevin Shelley (UW-Madison), Kevin Fermanich (UW-Green Bay), Veronica Justen (UW-River Falls), and John Grabber (USDA Dairy Forage Research Center). One hundred ninety-three individuals registered for the event and 52 attended the webinar.

Silva hosted a series of virtual events throughout the fall and winter. The first included weekly Friday workshops, which typically drew about 100 virtual attendees. Several of these workshops focused on cover crop-related topics, including cover crop-based reduced tillage, producing corn on 60" rows, producing cereal grains (which allows for more cover crop opportunities within the rotation), establishing prairie strips,and innovative interseeding techniques. These meetings involved organic farmers, educators, and industry members. Additionally, Silva hosted monthly virtual discussion groups, one of which focused on creating carbon-positive organic systems, of which cover cropping was a primary focus. The goal of these discussion-based meetings was to build the cover crop community and share ideas among practitioners using cover crop-based no-till production. Dr. Silva was also a key partner in the Growing Stronger Collaborative Conference, a virtual event which drew over 1,000 attendees. As part of the track organized by Silva, cover crop related topics were featured, included cover crop-based reduced tillage and managing cover crops for diversity and nitrogen in organic grain systems.

Working with partner organizations and consultants, MFAI has begun coordinating a national investigation into societal benefits of cover crops and related soil health initiatives, including reduction in flooding, avoided damage to infrastructure, and improvement in water quality. Interdisciplinary teams will develop discussion papers for participants in our national virtual meetings and, potentially in-person meetings as part of a National Soil Health Conference in March, 2022.

PROJECT AREA 4

Project Area 4. Produce written and electronic outreach materials on cover crops and the importance of water quality for distribution to farmers, agency personnel and crop consultants.

OGRAIN listserv, website, Compass. Covering a broad range of research and practice including cover cropping, the OGRAIN Project and associated resources continue to complement the CCROP Project with material likely to be of interest to its organic farming audiences throughout the 2020-21 reporting period. The OGRAIN suite of programming includes a listserv that facilitates dialogue and community building among organic farmers and industry; and a website hosting a wealth of cover crop information under the "resources" tab, including Fact Sheets, archived presentations, and videos.The OGRAIN Compass, a joint project with the Silva lab and CIAS John Hendrickson, is a cost of production tool that allows farmers to predict cost and revenue scenarios by entering expenses related to the incorporation of cover crops into their systems, including fuel, seed, and labor costs.

CIAS cover crop website. This newly revamped site at https://cias.wisc.edu/ccrop/ includes links to the Citizen Science project, compass tools, a photo gallery, and publications.

Outreach for Systems Approaches: Agroecology 702, *The Multifunctionality of Agriculture*

CCROP supported graduate level instruction in the Agroecology Masters program at University of Wisconsin-Madison to engage students in systems thinking on agroecological change and build facilitation and process design skills to forge collaborative relationships between the university and farmers, as well as key stakeholders in agricultural systems change. Adding cover crops to a farming system adds complexity to farm management and its effects cascade through the system. Transforming existing agricultural crop and production systems, to include more cover crops, takes a systems approach. This includes building relationships through dialogue and co-learning between university researchers, agency staff, technical advisers, farmers and land owners.

CIAS scientist Dr. **Sarah Lloyd** developed and taught the Spring Agroecology 702 course – The Multifunctionality of Agriculture. The course enrolled sixteen graduate students, representing multiple disciplines in the agricultural sciences from agronomy, soil science, dairy science, horticulture to geography and community & environmental sociology, explored participatory action and community-based research methods, focusing on the socio-technical and environmental aspects of agriculture, food systems, and community-natural resource relationships.

Special guest speakers at the class included:

Agricultural economist **Chuck Nicholson** provided specialized workshop sessions for the students on participatory modeling methods and how to work with communities to build shared understandings of systems change opportunities.

Students in the course also had a special lecture and discussion time with Dr. **Jess Gilbert**, Emeritus Professor of Community & Environmental Sociology, and author of Planning Democracy: Agrarian Intellectuals and the Intended New Deal, regarding historical policy initiatives from USDA as well as current policy landscapes and methods of working with farmers to improve agricultural and community outcomes.

CCROP collaborators CIAS researcher Dr. **Mrill Ingram** and **Dan Smith**, UW-Madison's Nutrient and Pest Management Program, visited the class to describe CCROP's new citizen science cover crop project as well as an overview of the goals of participatory research and a discussion of some of the barriers to systematically expanding cover crop systems.

Agroecology 702: The Multifunctionality of Agriculture broke new ground in offering a suite of research methods, facilitation approaches, and process design skills that can support a new generation of researchers and professional technicians and administrators working to advance a more sustainable agriculture, including the aims of CCROP.

PROJECT AREA 5

Project Area 5. In partnership with the Wisconsin Cover Crop Workgroup, conduct agriculture educator trainings to increase attention to the importance of water quality and soil security.

Crimping winter rye near Darlington, Wisconsin

Personnel changes at Extension and within the Wisconsin Cover Crop Workgroup along with the impacts of COVID19 have meant that this deliverable is largely on-hold. The Information Provider Survey we ran in 2019 helped provide direction to our team about the type and delivery of educational content that will support agricultural educators. We look forward to engaging with educators virtually, and hopefully in person, in the near future.

MFAI continues to use existing and new farmer-networks (Farmer-led watershed groups, and other southern Wisconsin networks) to disseminate information and experience gained through on- farm, university and extension research. We continue to provide management support and work with the Uplands Watershed Group, whose boundaries have recently expanded. Much of the primary outreach focuses on cover crop importance in this watershed area.

OTHER DELIVERABLES

Peer-reviewed Publications 2020-2021

Bhérer-Breton, P., L. Vereeckee, J. Peigne, and E.M. Silva. 202X.Creating a typology of organic corn and soybean farmers using reduced tillage practices in the upper Midwest of the United States. In prep.

Bruce, D. and E.M. Silva. 202X. Living mulch plasticulture systems for organic zucchini (Cucurbita pepo L.) production In prep.

Bruce, D. and E.M. Silva. 202X. In-row management strategies for cover-crop based reduced tillage organic squash production impact marketable yield and weeding labor time. In prep.

Campbell, TA, Booth EG, Jackson RD, Gratton C, Kucharik CJ. 2021. Agricultural landscape transformation needed to meet water quality goals in the Yahara River watershed of southern Wisconsin. Ecosystems in press

Jackson RD. 2020. Soil nitrate leaching under grazed cool-season grass pasture in the North Central US. Journal of the Science of Food and Agriculture 100: 5307-5312. doi: 10.1002/jsfa.10571

Potter TS, Vereecke L, Lankau RA, Sanford GR, Silva EM, Ruark MD. 2021. Long-term management drives divergence in soil microbial biomass, richness, and composition among upper Midwest, USA cropping systems. Ag. Ecosystems and Environment. In Review

Rui Y, Jackson RD, Cotrufo MF, Sanford GR, Spiesman BJ, Deiss L, Culman SW, Liang C, Ruark MD. Submitted. Regenerating persistent soil carbon via efficient plant-microbial-soil interactions. Nature Communications. In Review

Reynolds J, Bell MM, Grace J, Gratton C, Jackson RD, Keeley K, Mayerfeld D. 2021. A vision for perennial agriculture. Agroecology & Sustainable Food Systems doi: 10.1080/21683565.2021.1918313

Sanford GR, Cates A, von Haden AC, Roley S, Robertson GP, Jackson RD. 2021. Soil carbon dynamics in dedicated bioenergy crops. In Prep

Sanford GR, Jackson RD, Rui Y, Kucharik C. 2021. Land use-land cover gradient demonstrates the importance of perennial grasslands with intact soils for stabilizing soil carbon in the fertile Mollisols of the North Central US. Geoderma. In Review

Sanford GR, Jackson RD, Booth EG, Hedtcke JL, Picasso Risso V. 2021. Perenniality and diversity drive output stability and resilience in a 26-year cropping systems experiment Field Crops Research 263: 108071

Silva, E.M. UW IPM "Badger Bumper Crops" Series – Rolling Crimping Rye.

CONFERENCE PAPERS & PRESENTATIONS 2020-2019

Ingram, M. 2020. "Cover Cropping is a Gateway Drug." Toward a network knowledge model for agricultural transformation. American Association of Geographers annual conference (virtual), April 9, 2021.

Jackson RD. 2020. Can we save family farming with agricultural innovation? Center for Culture, History, and Environment Colloquium. 23 Sep 2020.

Jackson RD. 2020. Can managed grazing improve soil health and water quality in the Driftless Area? Kickapoo Valley Reserve Dialogue Series. 26 Sep 2020.

Jackson, Randy, Claudio Gratton, and Rebecca Power. Exploring the Collaborative Landscape Design process with Grassland 2.0. Savanna Institute Perennial Farm Gathering, 08 December 2020. 58 participants. (Y)

Jackson RD. 2021. Grassland 2.0. Joint Wisconsin Department of Natural Resources-Department of Agriculture, Trade & Consumer Protection, Jan 2021 (Y)

Jackson RD, LeZaks D, Heisler Wodill D. 2021. Pennsylvania Sustainable Agriculture (PASA) - Get 'em out on grass! Grassland 2.0 panel, 1 Feb 2021 (Y)

Jackson RD. 2021. We're all grassland ecologists! Department of Agronomy Research Colloquium. University of Wisconsin-Madison, 18 Feb 2021 (Y)

Jackson RD. 2021. Soil carbon and yield stability tradeoffs over 30 years of long-term cropping systems research. University of Minnesota Applied Plant Sciences seminar, 22 Feb 2021 (Y)

Jackson RD, Sanford GR, Ruark MR, Cates AM, Becker A, Rui Y, LeZaks D. 2021. Can we stabilize soil carbon with regenerative agriculture? Growing Stronger annual conference, 25 Feb 2021 (Y)

Jackson RD. 2021. Restoring prairie and people to agriculture. Environmental Law & Policy Center's (ELPC) 6th Annual Great Lakes Science-Policy Confluence Conference, Impacts of Concentrated Animal Feeding Operations on the Great Lakes, 8 Apr 2021 (Y)

Jackson RD. 2021. Grassland 2.0 soils research. G-team meeting, 20 Apr 2021 (Y)

Jackson RD. 2021. Soil C in ag soils. NRCS Soil Health meeting, 7 Jun 2021 (Y)

Jackson RD. 2021. Can we design and promote agriculture that cares for people? UCOWR conference, 8 Jun 202

Jackson, RD. Grasslands 2.0 Call to Action - Transforming Livestock Agriculture from Grain to Grass. Grassworks Grazing Conference - 2020. 24 January 2020

Jackson RD. 2020. Grassland 2.0. Columbia-Dodge-Sauk Counties Annual Grazing Conference, Portage, WI 3 Mar 2020.

Silva, E.M and B. Luck. 2021. Cover crop-based reduced tillage for organic soybeans and corn. Organic Association of Kentucky Annual Conference (virtual event). January 28.

Silva, E.M. and D. Bruce. 2021. Cover crop-based reduced tillage for organic cucurbit production. Mid-Atlantic Vegetable Conference (virtual event). February 9.

Silva, E.M. 2021. Using the roller-crimper for soybean and corn production. Dodge County Farmer Group (virtual event). February 10.

Silva, E.M. L. Vereecke, B. Luck, and J. Drwery. 2021. Cover crop-based reduced tillage for organic soybeans and

corn. OGRAIN Virtual Learning Series (virtual event). February 12.

Silva, E.M. 2021. Cover crop-based reduced tillage for organic soybeans and corn. Ohio Ecological Food and Farming Association Annual Conference (virtual event). February 13.

Silva, E.M. 2021. Using the roller-crimper for soybean and corn production. Innovative Farmers of Ontario Annual Conference (virtual event). February 18.

Silva, E.M. and L. Vereecke. 2021. Cover crop-based reduced tillage for organic soybeans and corn. CETAB Annual Conference (virtual event). February 17.

Silva, E.M. and R. Clark. 2021. Cover crop-based reduced tillage for organic soybeans and corn. Growing Stronger Collaborative Conference (virtual event). February 27.

Silva, E.M. Using the roller-crimper for soybean and corn production. National No-Till Summit (virtual event). March 17.

Silva, E.M. Using the roller-crimper for soybean and corn production. Badger Crop Connect (virtual event). May 26.

FUNDED PROJECTS ON RELATED RESEARCH IN PROCESS - $36,815,930

- Jackson, RD. 2021-23. Grassland 2.0 Learning Hubs - place-based Collaborative Landscape Design for a more sustainable agriculture, Anonymous Foundation Gift. $650,000
- Jackson, RD 2020-24. Managed grazing effects on soil C in southern Wisconsin. Individual Hatch. $180,000
- Peterson H, Jackson RD. 2021-23. Onto greener pastures-effects of grazing cover crops on soil health and profitability, USDA-SARE. $375,000
- Silva, E.M. 2020-2024. Taking tillage out of organic grain production (with Cornell University)(USDA NIFA OREI). $2,000,000
- Silva, E.M. and D. Smith 2020-2023. Identifying and expanding integrated disease management resources to include organic grains in support of organic and transitional North Central farms (with Purdue University) USDA-SARE. $150,000.
- Jackson RD, Gratton C 2021-25. Land use and land cover effects on water quality of the Lower Wisconsin River Basin. $180,000
- Wallace J, Jackson RD, Ruark M, Sanford GR. 2021-27. Dairy Soil & Water Regeneration Project, Foundation for Food and Agriculture Research. $22,000,000
- Herald, Vanessa (CIAS), and Hartman, Alyssa. 2020-2023. Grains to Institutions: Expanding Value Chains and Cultivating Resources for Upper Midwest Grain Growers. $410,464
- Jackson, RD 2019-21. Grazing effects on water quality in the Driftless Area. Nuzum Fund-Kickapoo Valley Reforestation $76,000
- Jackson RD, Gratton C, Bell MM, Kucharik C, Ruark M, Barham B, Power R, Jordan N, Rissman A. 2019-2023. Grassland 2.0-An agroecological transformation plan for perennial grassland agriculture, USDA-NIFA. $10,000,000
- Jackson RD, Sanford GR 2018-2021. Sustainable intensification to improve soil health and productivity of conventional and organic grain agroecosystems of the North Central US, USDA-NIFA. $500,000

In 2019, CIAS with the support of UW-Madison College of Agricultural and Life Sciences (CALS), CIAS chose three, two-year research projects that further CIAS's mission of developing diverse and sustainable agricultural and food systems utilizing multidisciplinary approaches. These research projects align with CCROP in that they investigate aspects of diversifying cropping systems and perennializing the landscape for people working in small- to medium-sized food and agricultural enterprises. The projects were selected by a group of CIAS faculty associates, Citizens Advisory Council members, and staff. . The top scoring projects rated highly in terms of alignment with CIAS, scientific approach, project benefits, opportunity for training research assistants, and ability to create synergies and future collaborations between academic departments and CIAS. In all, CALS funded $294,466 worth of aligned research. The projects started in June 2020 and will continue through August 2022.

Developing high-quality cereals for organic and perennial systems in the Upper Midwest is researching options for farmers to incorporate high value food grade cereal grains—winter wheat and perennial intermediate wheatgrass (Kernza)—into organic crop rotations. Research will include crop field evaluations on experimental stations and on farms, and grain food quality testing with chefs and bakers. This will result in advancing the best performing lines as cultivars for the Upper Midwest. Valentin Picasso Risso in

Agronomy leads this project. He will be working with Lucia Gutierrez, Agronomy; Julie Dawson, Horticulture; and Research Assistant Pablo Garcia, Agronomy. Additional collaborators include Lisa Kissing Kucek, USDA Dairy Forage Research Center; Damon Smith, Plant Pathology; and Nick Smith, Food Science. $98,300

Soil health and managed grazing investigates management practices that graziers can implement to improve soil health, productivity, and ecosystem services. Researchers will measure soil health using four indicators on samples collected in 100 fields across Wisconsin during two growing seasons. They will also collect farm-specific management information, assess legume and grass cover, and measure greenhouse gas emissions. Researchers will then analyze the relative importance of soil characteristics and management choices on soil health values. This is a first step in benchmarking soil health in Wisconsin pastures. Matt Ruark of Soil Science is leading this project, working with Randy Jackson, Agronomy; Michel Wattiaux, Animal and Dairy Sciences and CIAS; Jacob Grace, CIAS; and Research Assistant Abby Augarten of the UW-Madison Agroecology Program. $98,508

Evaluation of stockpiling pastures to extend the fall grazing season analyzes grass species, fertilizer rates and economics of pastures set aside (stockpiled) as feed for late fall into winter. Researchers will compare intakes and gains on different forages by grazing dairy heifers. They will also measure methane emissions. Information generated by this project will further the base of knowledge about the use of stockpiling in the Upper Midwest. Matt Akins of Animal and Dairy Sciences is leading this project. Additional researchers working on this project are Michel Wattiaux, Animal and Dairy Sciences; Erin Silva, Plant Pathology; Valentin Picasso Risso, Agronomy; Tom Kriegl, Emeritus, Center for Dairy Profitability; Jason Cavadini, UW Marshfield Agricultural Research Station; and Research Assistant Kate Wells, Animal and Dairy Science. $97,658

PRESS COVERAGE

Booth E, Kucharik C, Jackson RD. 2019. Nitrate contamination in groundwater and drinking water, Nelson Issue Brief 1: 1-4.

Grooms, L. April 8, 2020. “Cover-Crop-Insurance Discounts Considered.” Agriview.

Jackson, N. March April 12, 2021. “Cover crops efforts seek answers to farmers’ questions.” The Country Today.

Jackson R, Sanford G, Ruark M, Cates A, Becker A, Rui Y, LeZaks D. 2021. Researchers use 30-year cropping systems experiment to evaluate if farm fields can serve as carbon sinks. Organic Broadcaster. Edited by Audrey Alwell. Published online 23 Mar 2021.

Jackson RD, Laura K Paine, Claudio Gratton, Bradford L Barham, Gregg R Sanford, Eric Booth, Pamela Porter, Michael Bell, Jacob Grace, Alan Turnquist, Bert Paris, David LeZaks, Richard L Cates, Jr, Dennis Keeney, Curt Meine, Stephen R Carpenter, Laura L Jackson, Jason Cavadini, W Carter Johnson, Paul Daigle, William D Kolodziej, Julie E Doll, Rob Anex, Paul Johnson, Tom Kriegl. 18 March 2020. A vision for agriculture. Aeon.

Nardi A, Grace J, Paine L. 17 Mar 2021. Farmers, researchers form Grassland 2.0 to expand beneficial grassland agriculture. Organic Broadcaster. Edited by Audrey Alwell. Published online

Paine L, Jackson RD. 2021. Positioning agriculture for resilience in a post-pandemic Wisconsin. WisPolitics op-ed

Silva, E. UW NPM “Badger Bumper Crops” Series – Rolling Crimping Rye. June 2021. In this “Bumper Crops” episode, an overview of the techniques and benefits of roller crimping rye are discussed by Extension Specialists Erin Silva, Organic Production, and Damon Smith, Field Crops Pathology, University of Wisconsin-Madison.