Building Knowledge about Wisconsin's Cover Crops

A FARMER CITIZEN SCIENCE RESEARCH PROJECT

FEBRUARY 2022

CCROP Cover Crops Research and Outreach Project

HIGHLIGHTS

- In 2021, 26 farmers in 19 different counties in Wisconsin responded to questions about previous cover cropping experience and sources of information as well as cover cropping practices.
- Biomass samples from these farms reveal that, despite timely cash crop harvest and relatively long cover cropping windows, cover crop biomass production in 2021 slightly trailed our findings in 2020 by 0.3 ton DM/ac, likely as a result of widespread dry conditions.
- 80% of respondents said they'd like to expand the number of fields in which they plant cover crops.
- Most trusted sources of information for nutrient management and cover cropping included farmer-led watershed groups, local Certified Crop Advisors, agronomists, and local Extension and Land Conservation Department staff.
- Top factors influencing cover cropping include reducing input costs for the next cash crop, for example, via nitrogen credits or weed suppression; cost sharing programs; and crop insurance breaks.

We're happy to share results from a second year of a farmer-researcher "citizen science" collaboration to expand knowledge about cover crop use in Wisconsin.

CCROP is a team of university and community researchers and outreach specialists working with farmers to improve water quality and soil health through cover crops and other regenerative farming practices around the state. U.S. farmers are rapidly adopting cover crops. Many parts of Wisconsin saw 5-10% increases in cover crop acreage between 2012 and 2017 (USDA-ARS 2021). Our previous survey work revealed that farmers in Wisconsin need more regionally-specific information about the performance, challenges, and benefits of cover cropping.

This citizen science effort was designed to address that need with the help of farmers from around the state willing to share their cover cropping practices and experiences, and to allow us to collect biomass samples on their farms. Our collaboration aims to identify information gaps, to support farmers in communicating their experiences and practical knowledge with other farmers as well as with researchers, and will help improve decision support tools like SnapPlus.

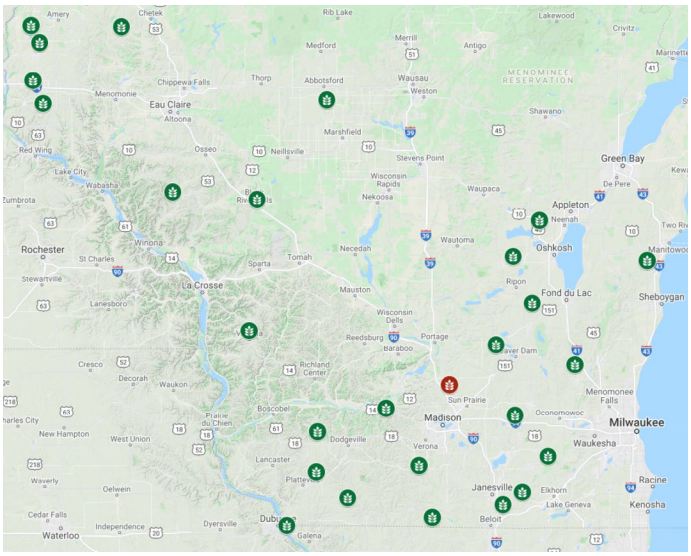


Figure 1.: Field locations for 2021 Cover Crop citizen science project, representing at least one farmer in 19 Wisconsin counties and helping expand the regional range with much-needed data on working with cover crops. UW Arlington Research Station indicated in red.

In 2021, 26 farmers located around Wisconsin (Figure 1), completed an online survey containing questions about previous cover cropping experience, sources of cover crop information, as well as current crop rotations, fertility and tillage treatments, yield, and costs. Farmers also provided us with fall cover crop biomass samples from one field. This data improves our understanding of cover crop performance under a range of management, soil and growing conditions. This information builds on work done in 2020, in which 15 farmers participated in the project (see 2020 report). Five of these original 15 farmers returned to participate in 2021.

We analyzed this statewide data in the context of the long term (30+ years) Wisconsin Cover Crop Database. This database includes cover crop and cropping systems data collected by scientists at the Michael Fields Agricultural Institute and the UW College of Agricultural and Life Science, including multi-decadal observations from the Wisconsin Integrated Cropping Systems Trial (WICST). With trials of conventional, organic, cash grain, dairy forage, perennial bioenergy, and livestock grazing enterprises, WICST is one of the most diverse and longest running cropping systems experiments in the world. This citizen science effort is helping build the database with farmer-sourced cover cropping information from around the state.

RESULTS

Cover Crop Experience and Trusted Sources of Information

In 2021, 26 farmers responded to questions about previous cover cropping experience as well as their cover cropping practices. The 19 Wisconsin counties represented by at least one farmer include: Barron, Dodge (2 farmers), Fond du lac, Grant, Green (2 farmers), Iowa, Jackson, Jefferson (2 farmers), Lafayette (2 farmers), Manitowoc, Marathon, Pierce, Polk, Rock (2 farmers), St Croix (2 farmers), Trempealeau, Vernon, Washington, Winnebago (2 farmers). Levels of cover cropping experience and farm size varied among participants. Cover cropping experience was spread evenly across survey respondents, ranging from 1-3 years to over 10 years. Total cover crop acres planted by each farmer ranged from 10 acres to over 2200 acres, representing from under 10% to 100% of all acres farmed (Figure 2).

We asked farmers about their most trusted sources of information for both nutrient management and cover cropping. For nutrient management recommendations,

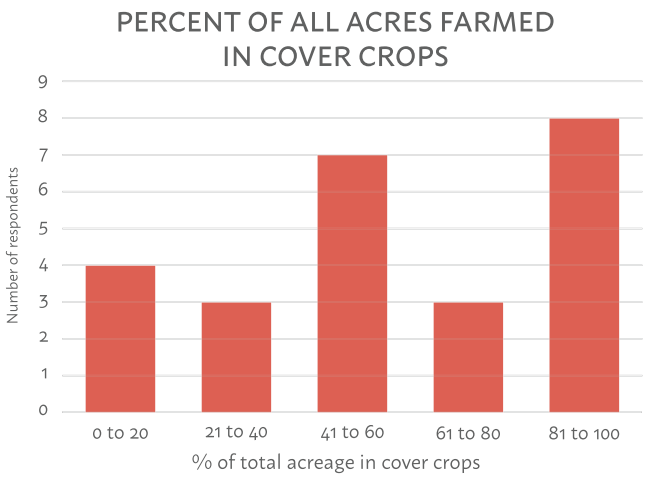


Figure 2. Total acres planted in cover crops by each farmer ranged from from under 10% to 100% of all acres farmed (10 to over 2200 acres).

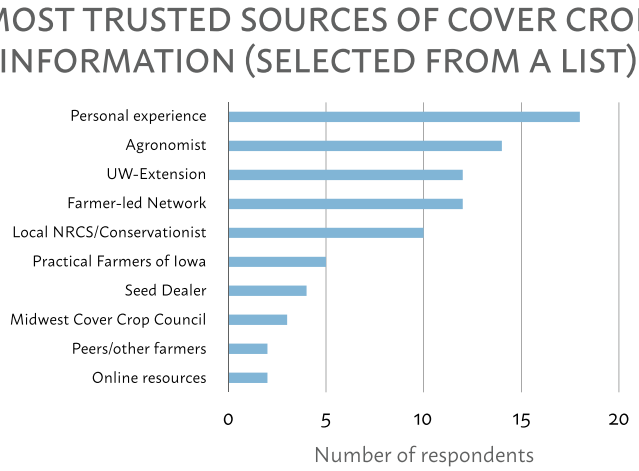


Figure 3: For trusted sources of information about cover cropping most respondents chose "personal experience." Agronomists, UW-Extension and farmer-led networks were other key sources. Written in sources included books, OGRAIN, Michael Fields Agricultural Institute, Wisconsin Discovery Farms, and Iowa Learning Farms.

over 65% of our respondents (18) chose an agronomist or a Certified Crop Advisor. Personal experience was listed by 44%, local cooperatives by 37%, and UW Extension by 22% of our 26 respondents. Other written-in sources included SnapPlus, the DeLong Company, and Granular Agronomy digital tools.

For sources of knowledge about cover cropping, most respondents listed personal experience (Figure 3), perhaps an indication of both the knowledge intensive nature

of cover cropping as well as a relative lack of locally appropriate expertise in many areas of the state, as our previous research has revealed. Respondents also listed knowledge from agronomists and UW Extension as important. Farmer-led groups were high on the list, perhaps not surprising as we included these groups in our recruiting for the survey. Interestingly, peers and other farmers were low on the list, perhaps reflecting that experience with cover cropping remains low among many farmers, and that for many of our participants, farmer-to-farmer communication is happening via the farmer-led networks. Most respondents selected multiple sources. Other sources mentioned include the book, *Managing Cover Crops Profitably*, OGRAIN, and Michael Fields Agricultural Institute.

Motivations, Incentives and Barriers

Participants selected from a list of "motivations" for cover cropping with most respondents selecting improving soil structure, organic matter, water quality, field trafficability, and weed suppression (Table 1). Other factors included nitrogen credits and resilience to weather extremes. About half selected conservation program cost sharing. A third of respondents indicated they use a cover crop for forage.

Table 1. Farmer motivations for cover cropping and barriers to expanding acres (26 respondents)	**# of respondents**
Improve soil structure/water filtration	25
Suppress weeds	23
Increase organic matter/sequester carbon	22
Improve surface and/or groundwater quality	22
Reduce runoff and erosion	22
Increase resilience to weather extremes	18
Improve insect and disease pest management	16
Improve field trafficability	15
Grow nitrogen credits	15
Provide beneficial insect habitat	12
Utilize conservation program cost sharing	12
Forage production	11
Lease requirement	1
Grazing dairy heifers	1
Personal reward	1

We also asked farmers to choose from a list of incentives that might positively influence their decision to plant cover crops. 80% of respondents said they'd like to expand the number of cover cropped fields, with 8 of 26 respondents already planting cover crops on at least 80% of all acres they farm. In selecting from a list of possible positive influences for planting cover crops, almost all of our respondents (25) selected lowering input costs for the next cash crop (via nitrogen credits or weed suppression, for example) and 82% (22) identified the availability of cost sharing programs for cover cropping. 70% (19) of farmer respondents said crop insurance breaks for planting cover crops would make a positive difference. Other positive factors selected included agronomist support in planting cover crops (10 respondents), additional extension or county personnel with cover crop experience (6), and more neighbors planting cover crops (4).

If respondents said they were interested in expanding their cover-cropped acres, they were asked about "main barriers" to expanding cover cropping. "Time" was the main challenge for half of the farmers responding to this question, with several noting that the season is too short following corn and soybeans, that it is difficult to get covers in early enough, and they have a narrow planting window.

In addition, farmers listed the cost of seed as a barrier. Other challenges identified included the need for irrigation to get covers established, too few planes available for aerial seeding, needing guidance technology (GPS) to plant corn into a green standing cover crop, corn residue management concerns, and that a 15 foot no-till drill was too slow.

Soil Fertility and Planting Practices and Cost

Dominant soil type for participant farms in our survey included silty clay loam (11), clay loam (4), sandy loam (3), clay (2), and loam (1). Prior to establishment, farmers performed tillage on 16% (4) of fields to be cover cropped, and applied manure on 16% of fields to be cover cropped. 60% (15) of respondents used a drill to establish their cover crop, four farmers broadcast-seeded with no incorporation, three overseeded using aerial methods, and one used frost-seeding. Manure was applied after cover crop planting on 32% (8) fields. Manure application rates ranged from 2 to 20 tons of box manure and 4,500 and 13,000 gallons of liquid manure.

Cover crop planting costs per acre (using the Wisconsin Custom Rate Guide) were estimated by our respondents to be between $5 an acre to upwards of $30 an acre with an average cost of $20.64/acre. Planting and seed costs can be highly variable depending on cover crop species

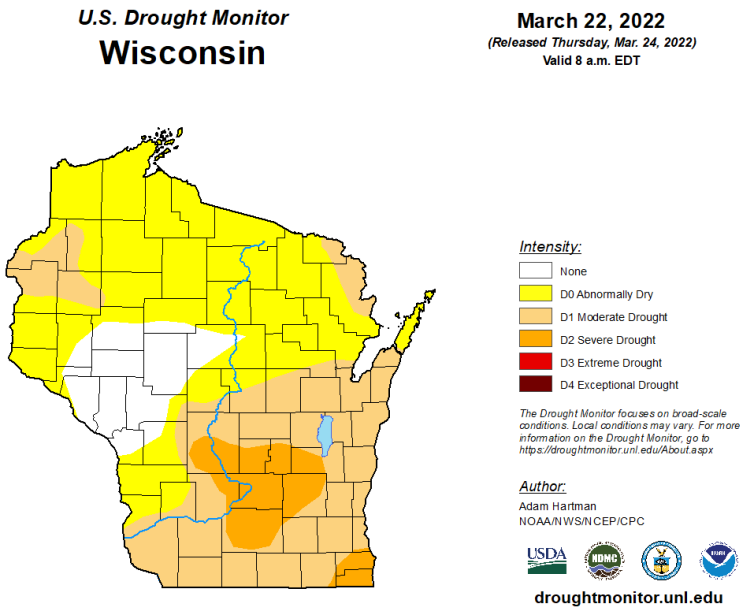
selected (multispecies mixes are much more expensive), equipment availability, and equipment combination used for establishment (tillage + drill vs. no-till drill, etc.).

DISCUSSION

The 2021 growing season provided many challenges. Early spring conditions created a dry planting season that ended in a late May frost in many parts of Wisconsin. Dry conditions prevailed throughout the southern part of the state, causing challenges for weed control strategies and early season crop development. Still, timely rains throughout July and August helped produce average crop yields and opportunities for cover crop establishment following vegetable and small grain crops. Fall conditions allowed for an early harvest in many regions of the state and ample growing degree units for fall cover crop establishment and growth.

Despite timely cash crop harvest and relatively long cover-cropping windows, cover crop biomass production in 2021 trailed our findings in 2020 by 0.3 ton dry matter per acre (DM/ac). Average biomass production was just 1.5 tons DM/ac with a low of 0.03 ton DM/ac for late planted cereal rye following soybeans in St. Croix County (October 10) with 214 growing degree units (GDUs). Growing degree units, also called growing degree days, are an estimate of the amount of time in which a crop will grow based on a minimum (40°F) and maximum (86°F) temperature. Our biomass production high was 2.8 tons DM/ac for an unspecified cover crop drilled on July 26th in Jefferson County (2513 GDUs; see Table 2). The low in 2020 was 0.1 ton DM/ac for a multispecies mix planted on September 22 following corn in Iowa County (453 GDUs), and the high was 3.2 tons DM/ac for a multispecies mix planted following canning peas on July 18 in Sauk County. Not surprisingly, the cover crop window, which is directly related to available growing degree days, has a big impact on cover crop biomass (Figure 4). The longer the window (e.g. following canning crops or small grains), the greater the potential for biomass production. Precipitation is also key, and that was conspicuously lacking in the latter half of 2021 (see map below and Figure 5). The lower-than-expected cover crop biomass was likely related to abnormally dry conditions, particularly in the southern half of the state. Unfortunately, these conditions have worsened over the winter months. If they persist, we can expect exceptionally dry field conditions where dense cover crops have overwintered. Cover crops can help dry out soggy fields in the spring, a benefit that can be a drawback in dry years.

These 2022 results continue to build our historical data set (see Table 3), providing valuable information and additional coverage, especially from SW and NW Wisconsin. Farms surveyed in 2021 predominantly established cover crops following corn (grain (5) and silage (4)), soybeans (5), and wheat (6). This is an interesting difference from 2021 when almost all farms surveyed indicated the cover crop followed wheat. Ten farms planted a multispecies cover crop mixture of annual ryegrass (3/10) and cereal rye (4/10). Commonly, these mixtures contained a grass, brassica, and legume species with the most common species being crimson clover, red clover, oats, forage/field pea, and radish. The most common cover crop planted on surveyed farms in 2022 was cereal rye.



CCROP CITIZEN SCIENCE DATA 2021

County	Previous Crop	CC Species	Planting		CC Biomass			Precip (in)	GDU[1]	CC Termination
			Method	Date	Date	ton DM/ac	StdErr			
Grant	--	annual ryegrass	broadcast	9/18/2021	11/16/2021	1.3	0.0	5.6	898	plant green
Green		red clover	frost seed	2/20/2021	11/16/2021	2.4	0.3	23.5	5404	plant green
Iowa		multi-species mix	drilled	8/24/2021	11/05/2021	2.5	0.2	8.2	1501	early, herbicide
Jefferson		--	drilled	8/20/2021	11/03/2021	1.2	0.1	7.8	1719	plant green
Lafayette	corn grain	cereal rye, radish	interseed	8/26/2021	11/16/2021	1.2	0.1	5.1	1538	early, crimp
Lafayette		multi-species mix	drill	8/1/2021	--	--	--	--	--	plant green
Rock		cereal rye	interseed	9/13/2021	10/26/2021	0.7	0.0	6.1	963	plant green
Trempealeau		annual ryegrass	--	10/15/2021	12/1/2021	0.7	0.1	2.8	257	plant green
Winnebago		multi-species mix	broadcast	9/17/2021	11/10/2021	1.4	0.4	1.8	922	plant green
Jackson	corn silage	cereal rye	drill	10/5/2021	11/9/2021	2.0	0.4	1.0	451	graze
Manitowoc		barley, winter wheat	broadcast + inc.	9/18/2021	11/10/2021	1.0	0.2	4.4	810	plant green
Washington		cereal rye, oats	drill	8/19/2021	--	--	--	--	--	winterkill
Winnebago		cereal rye	broadcast	9/10/2021	--	--	--	--	--	plant green
Vernon	forage sorghum	multi-species mix	interseed	9/10/2021	11/5/2021	0.9	0.1	2.6	939	plant green
Green	soybeans	cereal rye	drill	10/15/2021	--	--	--	--	--	graze
Marathon		multi-species mix	broadcast	7/13/2021	11/9/2021	1.0	0.1	16.3	2623	plant green
Polk		cereal rye	drill	9/24/2021	11/9/2021	1.3	0.3	3.1	632	plant green
Rock		oats	drill	9/30/2021	10/26/2021	0.8	0.1	5.7	531	winterkill
St. Croix		cereal rye	drill	10/10/2021	11/10/2021	0.0	0.0	0.8	214	plant green
St. Croix	vegetables	multi-species mix	drill	9/15/2021	11/9/2021	1.8	0.2	2.3	796	early, crimp
Barron	winter wheat	multi-species mix	drill	8/14/2021	11/9/2021	2.1	0.3	8.0	1741	plant green
Dodge		multi-species mix	drill	8/14/2021	11/9/2021	1.0	0.1	7.98	1741	plant green
Fond du Lac		multi-species mix	drill	8/17/2021	11/9/2021	0.7	0.0	8.83	1590	winterkill
Jefferson		--	drill	7/26/2021	11/03/2021	2.8	0.1	12.1	2513	plant green
Pierce		multi-species mix	drill	8/17/2021	11/09/2021	1.5	0.1	8.8	1590	winterkill

Table 2. Cover crop management and biomass production throughout Wisconsin during the 2022 growing season.

[1]Growing Degrees Units (base 40°F)

SELECTION FROM CCROP DATABASE: 1991 TO 2019

main crop	*species*	*cover details*			*CC biomass (ton/ac)*				
		seeding method	*seeding time*	*CC termination*	*n*	*average*	*min*	*max*	*StdErr*
corn grain	cereal rye	drill	after corn	following spring	65	0.74	0.01	2.49	0.09
corn grain + stover	cereal rye	broadcast interseed	R4/R5	following spring	10	1.47	0.96	1.93	0.08
corn silage	cereal rye	drill	after corn	following spring	235	2.17	0.10	4.98	0.06
soy beans	cereal rye	broadcast interseed	R6	following spring	10	1.65	1.25	2.29	0.10
	cereal rye	drill	after soybeans	following spring	34	0.40	0.03	2.31	0.11
winter wheat	red clover	broadcast	early spring	fall frost	273	1.50	0.16	3.80	0.04
	red clover				104	1.69	0.04	3.87	0.10
	multispecies mix	drill	early spring	fall frost	24	1.32	0.99	1.76	0.07
	berseem clover & oats				120	1.39	0.00	3.35	0.06
	hairy vetch				22	1.12	0.49	2.43	0.14
	multispecies mix	drill	after wheat	fall frost	12	2.76	1.10	3.92	0.36
	oats				14	1.37	0.55	2.34	0.15
	radish				54	2.61	0.39	5.03	0.16
fallow (no main crop)	sun hemp	drill	early season	fall frost	57	3.67	0.70	16.04	0.46
	sun hemp				41	1.28	0.00	6.51	0.22
	barley				11	2.00	1.14	3.74	0.25
	multispecies mix	drill	mid-season	fall frost	12	3.49	2.31	5.00	0.23
	oats				59	1.22	0.27	3.67	0.08
	radish				11	1.78	0.85	3.54	0.23

Table 3. Cover crop management and biomass production in southern Wisconsin for the 28 years between 1991 to 2019.

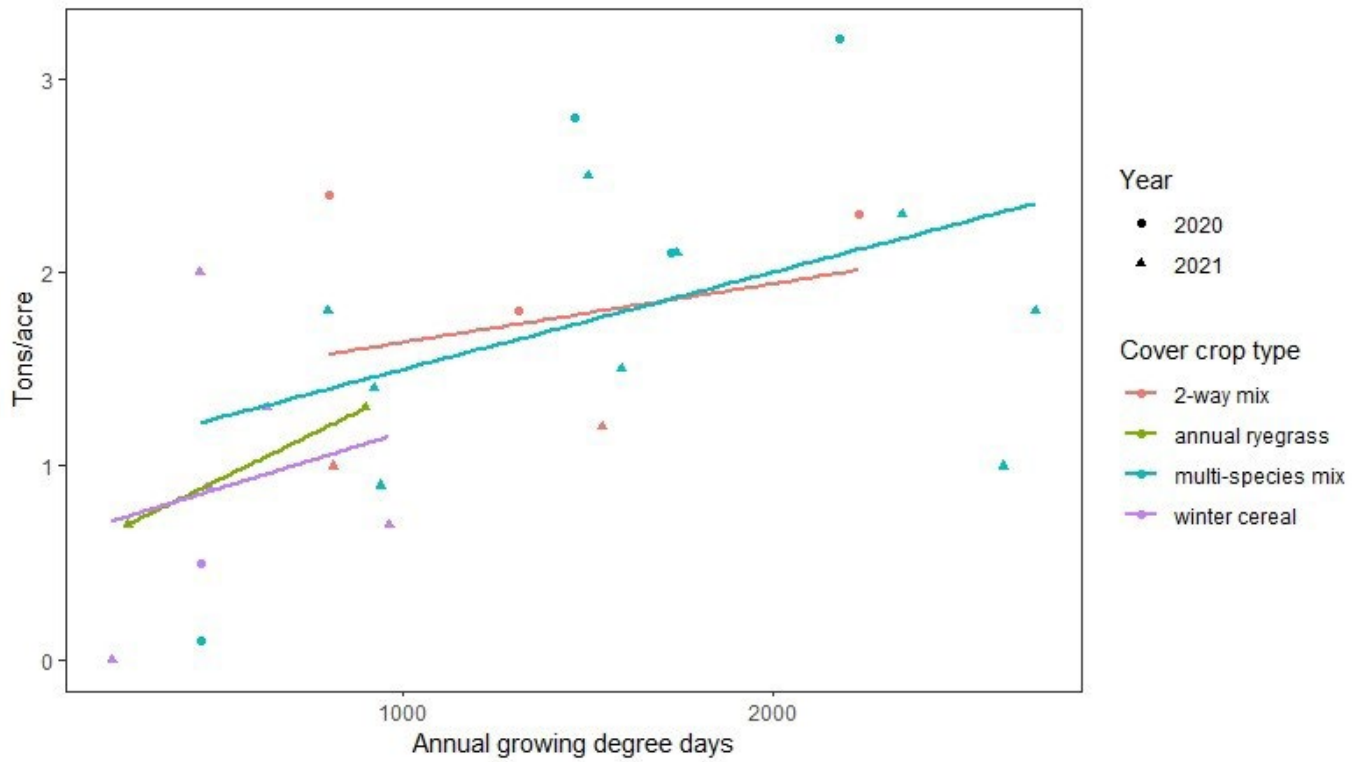


Fig 4. Cover crop biomass by cover crop type as a function of growing degree units (base 40°F). Note the general positive response but also the extreme variability in the data. As we continue to expand on-farm data collection, we can expect better estimates with less variability.

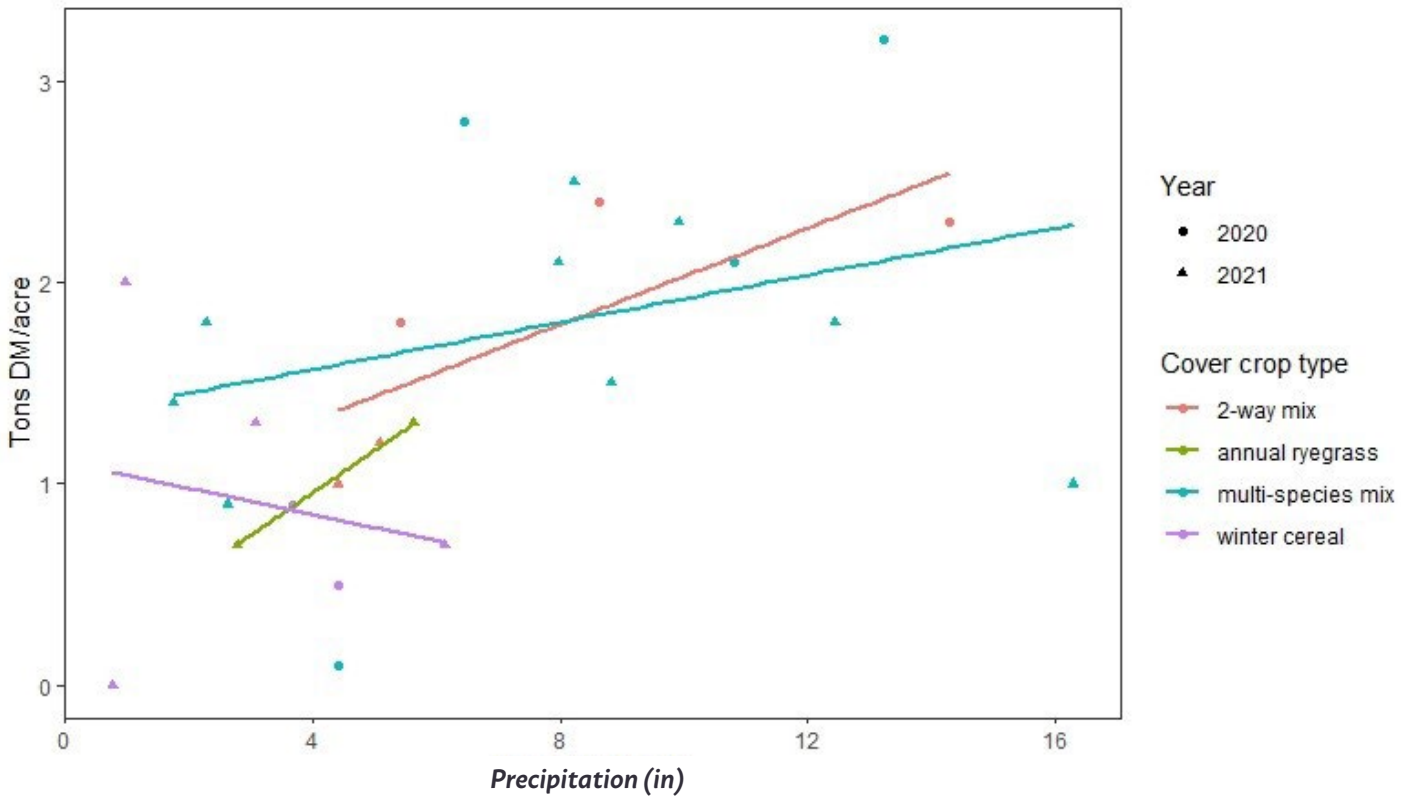


Fig 5. Cover crop biomass by cover crop type as a function of precipitation (in). Note the general positive response but also the extreme variability in the data. As we continue to expand on-farm data collection, we can expect better estimates with less variability.

FARMER OBSERVATIONS

Participating farmers shared takeaway observations from their cover cropping experiences, especially in relation to nutrient management. The comments provide useful context and insights into the needs of Wisconsin farmers implementing cover crops into their crop rotation. We will use this information as we develop our survey and outreach for 2022. Comments included:

- I prefer to plant alfalfa after wheat, this limits my choices
- Attempt to base aerial seeding timing on crop maturity and weather more than a date.
- Will plant earlier next year
- Since just starting with cover crops, I'm really appreciating the weed suppression that they can offer. Also, for the first time this year we planted corn into a green, standing cover crops mix. It planted well, but I learned that GPS is a must for wide scale implementation of that. It was hard to see anything. The crop fell behind at first compared to the other conventional fields, but in the end caught up ok around harvest. Time is still the limiting factor for planting more cover crops.
- This cover crop was my best ever (from someone with over 10 years of experience).
- Do not re-arrange soil. Plant a diverse mix of crops and covers.
- Some will winter kill, others will not. Nitrogen fixation and weed suppression are easy benefits to acquire.
- Cover crops are the key to nutrient management. Living roots are going to hold and sequester nutrients and give them back to the cash crop
- Don't skimp on seed
- Retention of nutrients within the root zone and using legumes to produce nitrogen are the largest benefits. The yield results are real and easily documented.
- We really need more research and data to support cover especially economic returns.

We also asked what questions farmers would like more information on and learned:

- Wheat in the rotation allows for more options in planting covers. Wheat may not pay as well as corn or soy....is the opportunity cost worth the benefit of multi species covers?
- We use a 6 ft rototiller which is not listed above. We flail chop cover crops at various heights. Will UW-Extension be developing user-friendly charts that list the best time to flail chop or kill cover cover crops for maximum N sourcing? Will more small farm strip-tillage equipment become available in the near future?
- Has in-row zone herbicide application of cover crops at the time of planting been studied? Could this technique may assist with a living mulch practice or aid in delaying cover crop termination?
- How can we better assess nitrogen contributions of cover crops and calculate mid-season sidedressing needs of vegetable crops? Can Snaplus offer better inputs for more cover crops and vegetables? How can we estimate rate of nitrogen release from cover crops to better assess when to sidedress vegetable crops? What is the best time to do soil tests if we are using cover crops?

NEXT STEPS

We are launching plans to expand this citizen science effort for a third year and would like to increase our number of participants. Several participants mentioned that receiving biomass yield data was a stronger incentive than the cash

honorarium to participate in this effort. We aim to develop a simple dashboard that will allow all participants to obtain their personal biomass data, and also to compare that information with other farmers in their area and around the state. We are also hoping to increase our analysis to include information about forage quality for grazing purposes, and eventually to extend to information about carbon sequestration and soil health.

ADDITIONAL RESOURCES

Farmers can also find useful information on soil health and cover crops among UW's Nutrient and Pest Management program many publications, including:

- *Legume nitrogen credits*: Nutrient Management Fast Facts
- *Herbicides and cover crops:* Herbicide Rotation Restrictions for Cover and Forage Cropping Systems
- *Cover Crop Species:* Cover Crop Selection Card for Northern Wisconsin & Cover Crop Selection Card for Southern Wisconsin

We are gearing up to continue this work in 2022! If you are interested in participating in our group of farmer researchers, and receiving support to do so, or if you have general feedback on cover cropping in Wisconsin, email Daniel H Smith at dhsmith@wisc.edu, or call 608-219-5170. You can also sign up online.

Visit our website to learn more about CCROP. Report authors include Mrill Ingram, Gregg Sanford, and Daniel H Smith. Layout and design by Jill Groendyk. In addition to the sponsors below, we are grateful for support from Wisconsin USDA's Natural Resource Conservation Service.

Sign up for the 2022 season!

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NPM Nutrient and Pest Management Program

CIAS CENTER for INTEGRATED AGRICULTURAL SYSTEMS

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