American Farmland Trust
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The Massachusetts Coordinated Soil Health Program Survey Report:

Soil Health, Producer Experience, and Barriers to Access in the Commonwealth

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American Farmland Trust

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Contents

Executive Summary

Beginning in 2021, American Farmland Trust (AFT) facilitated programming in partnership with farmers and agricultural organizations as part of the Massachusetts Coordinated Soil Health Program (MACSHP). As part of AFT's effort to advance soil health practices and knowledge in the Commonwealth, a survey tool was developed to better understand barriers to soil health practices in MA and steer the development of future programming based on direct feedback from participating farmers.

From 2021–2024, 328 unique farms completed the MACSHP survey before participating in AFT programming. These farmers were from across the Commonwealth, representing every county, a wide range of enterprises, and the demographic breakdown closely aligned with the 2022 Census of Agriculture. It is important to note, however, that this sample was self-selected. Farmers were interested in participating in MACSHP programming, most were implementing conservation practices on at least a portion of their farm already, and many feel confident in their soil health knowledge.

Upon analysis of this survey data, several key take aways emerged. First, several differences in access to programming were illuminated among farmers who self-identified as BIPOC or women. Notable among these differences were access to support from trained staff in applying for cost share assistance from NRCS and differences in knowledge about availability of programs that provide financial support.

Second, it is clear that outreach needs to be adapted to meet the needs of under-resourced farmers. We recommend a strong focus on partnering with organizations led by BIPOC, women and LGBTQ+ farmers wherever possible. Future programming should support or enhance the work of these organizations, rather than recreate or dilute it.

Third, grants to farmers were overwhelmingly identified as the preferred method of financial support by participating farmers. 75% of participating farmers indicated grants were their preference, with all other options receiving less than 10% of total interest. Cost share programs may be too rigid for the adaptability preferred by some farmers.

Finally, field visits were identified as the preferred way to receive technical assistance. Service providers should continue to prioritize visiting farms and seeing successes and challenges firsthand.

These are all opportunities to improve access to financial and technical support services for farmers in the Commonwealth, addressing self-identified wants and needs, reinforcing Massachusetts' leadership position in the world of soil health.

Introduction

"Simply put, healthy soils are soils capable of supporting healthy ecosystems and the services they provide. This inexorable connection between the soil capabilities and ecosystem functions makes the stewardship of soil resources essential to every citizen of Massachusetts by offering win-win solutions which increase both economic and ecological yields of living landscapes."

- *Massachusetts Healthy Soils Action Plan*

In 2019, Massachusetts became a national leader in advancing soil health practices by becoming the first state to produce a statewide Healthy Soils Action Plan. The action plan was commissioned by the Executive Office of Energy and Environmental Affairs and completed in 2022. A Working Group consisting of representatives of dozens of state and federal agencies, conservation and environmental groups, knowledgeable stakeholders, and scientific advisors participated in multiple planning calls and listening sessions over the course of an 18-month planning process. The report uses the NRCS definition of soil health: "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans" and makes recommendations for improving soil health on all land, regardless of land use, in Massachusetts.

While agriculture accounts for only 4% of land cover in Massachusetts, our Commonwealth's agricultural soil health has an outsized importance for several reasons. First, healthy farmland soils are more productive, are more adaptable to climate change, and therefore support regional food security and farm viability. As the Healthy Soil Action Plan states, "a commitment to farmers and farming that supports resilient landscapes and healthy soils in rural, suburban, and urban communities, may help to strengthen the role of MA agriculture in the regional food economy." Second, there has been a noticeable and growing interest in soil health among farmers in Massachusetts in recent decades, resulting in a practitioner-driven, vanguard movement to advance soil health on farmland. Third, advances made in the agricultural sector can support cross-sectoral learning for healthy soils implementation for other land uses.

For these reasons, the Massachusetts Coordinated Soil Health Program (MACSHP) was designed to accelerate farmer knowledge transfer around healthy soils, advance agricultural service sector knowledge of technical and financial assistance gaps, and coordinate across organizations to improve service delivery to producers.

American Farmland Trust's (AFT) MACSHP began in 2021, with the support of the Massachusetts Department of Agricultural Resources (MDAR). The main purpose of MACSHP was to bring farmers and service providers together to develop and deliver effective soil health programming. Over the past four years, the program included direct financial support to farmers in the form of grants for soil health practice implementation, no-cost soil health testing and interpretation of results, field events highlighting soil health practice implementation, a Soil Health Advisory Committee, and a soil health consultants program, among others.

Between 2021 and early 2024, farmers were required to complete a short survey before engaging with services tied to MACSHP programming. Farmers that applied for grants, attended events, or submitted soil samples all completed the survey. Questions focused on soil health practices implemented by farmers, their associated challenges, and farmer education and technical support needs (the survey in full can be found in Appendix A).

In the report that follows, we take a closer look at survey responses to inform future soil health programming in Massachusetts.

Methods

Before farmers engaged with MACSHP programming at AFT, completing a short survey was required. This survey was developed by AFT's Soil Health Advisory Committee, distributed using Survey Monkey, and was offered in English. The Soil Health Advisory Committee also assisted with outreach. Committee members distributed the survey through farmer list serves, social media, and email.

Between 2021 and 2024, AFT collected 436 responses, though not all of them were from unique farms. Many farms engaged with AFT several times over the lifetime of the MACSHP program, and completed the survey multiple times, before engaging in different programs. To avoid over-representing farms that continuously engaged with AFT, all survey responses except the first response submitted were removed, leaving 328 responses. A farm's first response was selected to analyze the way farmers thought about conservation practices, technical assistance, and financial assistance, before engaging with MACSHP at AFT. This was not necessarily that farm's first time working with AFT as an organization but was the first time they engaged with MACSHP. For several questions, AFT was interested in how a farm's engagement with programs changed over time. AFT was able to compare first and last survey responses that were more than one year apart from 76 farms.

While a demographic breakdown of participating farms generally reflects information from the 2022 Agriculture Census (see page 6-8 for additional details), it is important to note

that this is not a representative sample of agriculture in Massachusetts. Because this survey was required to access programming at AFT, we can assume that participants were already interested in engaging with soil health programming.

Soil samples collected for this project followed Cornell University's sampling protocol and were sent to the Cornell Soil Health Laboratory for analysis, the Comprehensive Assessment of Soil Health (CASH). Soil samples were either collected by the farmer, after receiving instructions from AFT staff, or collected by AFT during a site visit. 268 soil samples were collected and analyzed as a part of the MACSHP program.

All analyses were performed using R Statistical Software (v4.4.2; R Core Team 2024). Figures were generated using the dplyr (v1.1.4, Wickham et al. 2023), forcats (v1.0.0, Wickham 2023), ggplot2 (v3.5.2, Wickham 2025), likert (v2.0.1, Bryer 2025), tidyverse (2.0.0, Wickham et al. 2023) and wordcloud2 (v0.2.1, Lang 2018) packages.

MACSHP Survey Analysis

Demographic Data

A generally diverse group of farmers participated in MACSHP programming at AFT between 2021 and 2024. Tables 1 and 2 describe the demographic breakdowns of these groups based on self-described gender and ethnicity. Where possible, these numbers were compared with the 2022 Census of Agriculture. It is important to note that while the self-reported identities of participants closely align with the 2022 Census of Agriculture data, our sample is not representative of Agriculture in Massachusetts. Farmers voluntarily participated in MACSHP programming and often had a pre-existing or advanced knowledge of soil health practices. The data presented should be considered a snapshot of AFT's farmer network, rather than Massachusetts agriculture as a whole.

Table 1. Self-described gender of all survey participants. Multiple selections were allowed.

Gender	*# of Responses*	*% of Responses*	*22' Ag Census*
Female	159	48.3%	42.8%
Male	144	43.7%	57.1%
Non-Binary/Third Gender	14	4.3%	ND
Self-Describe	9	2.7%	ND
Prefer Not to Say	9	2.7%	ND

Table 2. Self-described ethnicity of all survey participants. Multiple selections were allowed.

Ethnicity	*# of Responses*	*% of Responses*	*22' Ag Census*
Asian/Pacific Islander	12	3.6%	1.2%
Black	11	3.3%	1.8%
Indigenous	3	0.9%	0.1%
Hispanic or Latino/a/x	10	3%	2.5%
White	280	85.1%	97.2%
Other	7	2.1%	ND
Prefer Not to Say	10	3%	ND
Self-Describe	13	3.9%	ND

Farm and Production Data

Almost half of the farms represented in this survey population are vegetable farms. Small fruit, livestock, and tree production were other common responses (Table 3). Many participating farmers reported using organic farming methods (Table 4), though they are often not certified. The majority of participants also reported having a soil health focused farm operation, defined as "using practices to not only maintain but actively increase soil organic matter and build soil health." The farmers engaging with this survey were already interested in soil health programming, likely contributing to the high number of responses indicating a focus on soil health.

Most participating farms market directly to individual consumers through a farm market, farm stand, or CSA (Table 5). Direct to consumer marketing is a crucial part of small to medium sized farms, especially since most are growing something other than a commodity crop.

MACSHP programming engaged farmers from across the commonwealth, with at least one participant in each county (Table 6). Overall farm sizes ranged from less than 1 acre to 1600 acres, with a mean farm size of 33.83 acres and a median size of 5 acres. Among the 76 participants that took the survey multiple times, mean acreage increased between responses from 15.35 acres to 17.36 acres, but median acres remained constant at 5.

Table 3. Production type of all survey participants. Multiple selections were allowed.

Production Type	*# of Responses*	*% of Responses*
Corn	19	3.3%
Cranberries	7	1.2%
Dairy	23	4.0%
Grain	3	0.5%
Hay	44	7.7%
Livestock	79	13.8%
Small Fruit	67	11.7%
Trees	48	8.4%
Vegetable	270	47.3%
Vine Fruits	10	1.7%

Table 4. Conventional and organic farm practices among all survey participants. Multiple selections were allowed.

Farm Type	*# of Responses*	*% of Responses*
Conventional	67	11.3%
Certified Organic	53	16.2%
Organic, Not Certified	159	48.5%
Soil Health Focused	220	67.1%

Table 5. Distribution/Sales method of all survey participants. Multiple selections were allowed.

Distribution Method	*# of Responses*	*% of Responses*
CSA	156	47.5%
Farm Market/Stand	216	65.9%
Restaurant Sales	71	21.6%
Wholesale	148	45.1%

Table 6. Number of participants by county

County	*# of Responses*	*% of Responses*
Barnstable	8	2.56%
Berkshire	24	7.69%
Bristol	22	7.05%
Dukes	5	1.6%
Essex	27	8.65%
Fraklin	42	13.46%
Hampden	19	6.08%
Hampshire	48	15.38%
Middlesex	41	13.14%
Nantucket	1	.32%
Norfolk	12	3.85%
Plymouth	10	3.21%
Suffolk	6	1.92%
Worcester	47	15.06%

Conservation Practices

The survey asked about three different groups of conservation practices – reduced tillage, cover cropping, and mulching. 217 farms reported implementing all three of these practices in some form, 83 implemented at least 2, 24 implemented 1, and only 4 farms reported using no conservation practices from those listed in the survey.

Hand tillage is prevalent among participating farms: 108 out of 328 reported using hand tillage on at least a portion of their fields. However, it is difficult to know how farms define hand tillage. In previous work with AFT, some farmers refer to BCS tractors as hand tillage, while some only include hand tools like broadforks. Because of this, it is worth considering conservation practice implementation *without* hand tillage included. When we remove hand tillage from the conservation tillage umbrella, 182 farms implement all three conservation practices, 113 implement at least 2, 29 implement 1, and 4 reported no implementation.

Implementation of conservation practices remained consistent across gender (2.59 and 2.5 practices on average for women and men respectively) and ethnicity (2.72 and 2.54 practices on average for BIPOC and white farmers respectively). While adoption of soil health practices in Massachusetts is generally ahead of other states in the country, it is

encouraging to see that among these survey participants there weren't stark differences in adoption of practices along gender or ethnicity lines. What these questions don't cover, however, is the extent to which farmers adopt practices. It is possible that some differences among producers would arise with more granular questions that weren't appropriate for this survey.

Equipment and Tillage

Two hundred and sixty of the participating farmers reported using at least one type of conservation tillage on their farms (reduced till, minimum till, strip till, no till, or hand tillage). Of these 260, 108 reported using hand tillage. Our sample had a median farm size of 5 acres—a feasible scale for hand tillage.

Table 7. Tillage practices reported by all participants. Multiple selections were allowed.

Tillage Type	*# of Responses*	*% of Responses*
Standard	81	24.7%
Reduced	74	22.3%
Minimum	99	30.2%
Strip	34	10.4%
No-till	97	29.6%
Hand	108	32.9%

Cover Crops

Two hundred and eighty-two participating farmers reported using cover crops on at least some portion of their farm, with 161 using a multi-species mix. Composition of cover crop mixes varied widely. Two or three species mixes were common, but some farmers reported using many more. Winter rye, oats, and clover were among the most commonly reported species. However, farmers often specified that they were selecting species to address cash crop needs or to adapt to field conditions. The prevalence of multi-species cover cropping is encouraging, however many participants (n = 108) indicated that they would need financial assistance to help cover the cost of cover crop seeds (Figure 10).

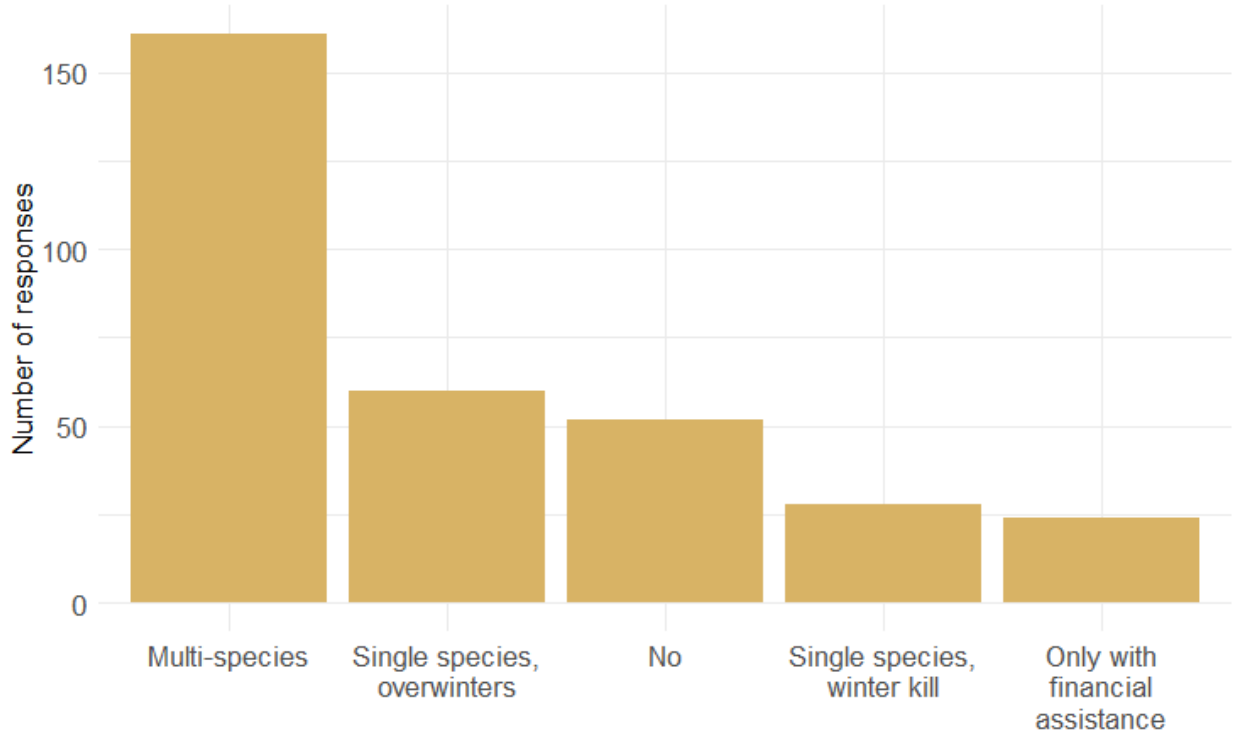


Figure 1. Use of cover crops among survey respondents (n = 325)

Mulching

Two hundred and seventy-three farmers reported using some form of soil carbon amendment on their farm (compost, biological mulch, or manure). Two hundred and eighty-eight farmers reporting mulching on their farm (compost, biological mulch, synthetic mulch, or manure). Covering the soil with either an organic or synthetic mulch can reduce erosion and is an increasingly important method of preserving soil health as Massachusetts and the rest of the Northeast will receive increased precipitation (more, and in larger events) with climate change.

Table 8. Mulching practices reported by all participants. Multiple responses were allowed.

Mulch Type	*# of Responses*	*% of Responses*
Compost	229	69.8%
Purchased In	171	52.1%
Produced on Farm	120	36.6%
Grown in Place	126	38.4%
Tarps	175	53.4%
Bioplastic	32	9.8%
Manure	117	35.7%

Sources of Information and Technical Assistance

In the survey, AFT asked farmers to report where they received both educational information and technical assistance on soil health topics. Education is designed for a general audience (workshops, YouTube videos, etc.) while technical assistance is one on one, individualized support specific to the farm and farmer receiving that assistance.

The majority of farmers reported gathering soil health related information from their peers. Other farmers, podcasts and YouTube, and farmer-led sessions were the three most common soil health education sources selected. Extension, NRCS, agricultural companies, and conservation district workshops were the least commonly reported education sources. It is possible that NOFA workshops were reported more often because of the population that completed the survey – the majority of participants reported using organic practices (whether they were certified organic or not). NOFA was also a critical outreach partner for the lifetime of the survey. Most farmers reported using between two and four sources of information to educate themselves about soil health and soil health practices.

Farmers also reported that when they look for technical assistance for soil health practices, they most often turn to other farmers they know. Other common sources of technical assistance reported were representatives from soil testing labs, personnel from Extension or NRCS, or representatives from agricultural supply companies. Fifty-six respondents (17%) reported that they do not use any technical support. Most farmers reported using one or two sources of technical assistance related to soil health and soil health practices.

Sixty farmers listed other sources of information as a write-in option. Other sources of soil health information reported by respondents include referencing knowledge from family members, and for one person specifically, ancestral indigenous knowledge from family lineage. Respondents also reported using online resources including google, YouTube, the "no till growers" podcast, other farmers' Instagram accounts, and using google scholar to access research papers. Others reported more formalized continuing education, including via a master gardeners' program, college classes – both in person and online, books recommended to them by other farmers, and especially books written by farmers, participating in the Collaborative Regional Alliance for Farmer Training (CRAFT) program, and the New Entry Sustainable Farming program. Workshops and outreach were also referenced as sources of soil health information, including biodynamic conferences and a monthly biodynamic group meeting, extension newsletters, and MDAR and SARE workshops. Specific non-profits mentioned as sources of soil health information include AFT, MOFGA, and CISA. Finally, respondents reported that their own experiences from

working on many farms, observing their own farms, and documenting their experiences on their farms provided soil health information. One responded reported a need for simultaneous Spanish translation for soil health and soil science workshops.

Forty-eight farmers listed other sources of technical assistance as a write-in option. Other sources of technical assistance for soil health practice implementation include online sources including google and YouTube, personal interpretation of soil test results, non-profit staff from organizations including American Farmland Trust, Maine Organic Farmers and Gardeners Association, Berkshire Ag Ventures, NOFA- Massachusetts, and Community Involved in Sustaining Agriculture, extension staff from UMass and UVM, ATTRA staff, books, and peer farmers from the New Entry Sustainable Farming program. Many mentioned that they have reached out to consultants or service providers and never heard back, or are looking for more technical assistance, and have had limited success finding what they need.

Soil testing

Soil testing is a critical type of technical assistance and information available to farmers interested in using soil health practices. Without data from soil tests, it is difficult to know if particular soil health management strategies are having the desired effect or making improvements. In this survey, we asked farmers questions about whether and how often they use soil tests, whether they use assistance interpreting their soil tests, and whether cost is a barrier to accessing soil testing. We found that 82% of respondents do use lab-based soil testing services, and 46% are testing their soil annually. Others who are getting their soil tested are doing so less frequently – one every other year (21%) or one every three years or less (30%). Many, but not quite half of the farmers who responded to this question are using some sort of service to help with interpreting soil test results. The survey did not ask about whether this was the information that generally comes back with soil test results, or something more in depth, like a consultation with a service provider.

Individual soil tests cost between $20 and $150 depending on the type of testing and analysis, and farmers reported that reducing the cost of soil testing or supplying free soil tests would increase the amount of soil testing they would do. Sixty-nine percent of respondents reported that they would use soil tests more often if they were less costly or free, 17% said they would only test more if the tests were free, and 15% reported that free or reduced cost soil tests would not change the frequency with which they test their soil.

Table 9. Do survey respondents use soil tests, do they use services to assist with interpreting soil tests

	Yes	*No*
Do you use lab-based soil testing services?	82.0%	18.0%
Do you use any services to help you interpret your soil test results?	42.0%	58.0%

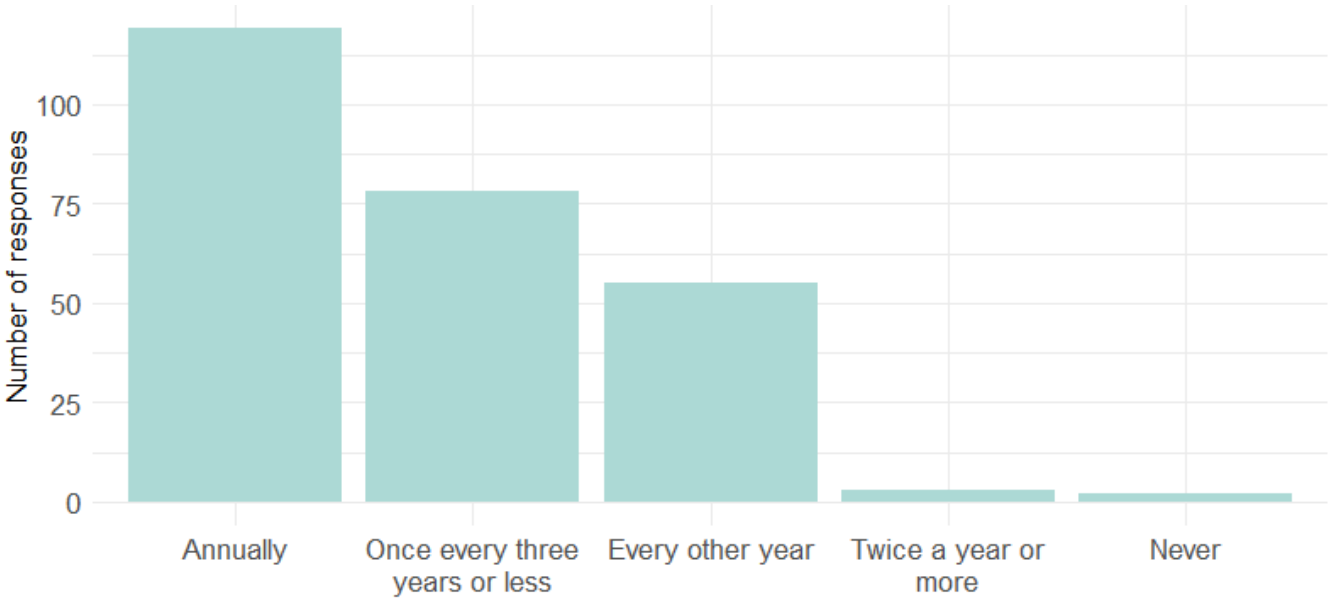


Figure 2. Frequency of soil testing (n = 257)

Desired future educational and technical assistance resources

A wide range of technical support options were identified as a high priority. On-farm follow up and recommendations (58%), equipment recommendations (45%), soil lab result analysis and recommendations (43%) and consultations with experienced farmers (33%) were among the most commonly identified preferences. Technical assistance focused on manure management, and grazing/feed management were ranked among the least helpful for participating farmers. This is likely due to the types of farms that contributed to this survey; only 79 had a livestock component.

Farm visits were, by a wide margin, the most commonly reported preferred method of receiving technical assistance (60%). Email followed as the second (24%), with video calls (8%) and phone calls (7%) close to one another as the least preferred method of technical assistance delivery. Service providers should continue to prioritize field work and work to find ways to bring what has become digital work in the post-COVID era back into the field.

On farm field days were reported as being the most helpful educational format (57%) followed by farmer-led workshops with farmer discussion following (44%). The next three preferred education formats were all reported at a similar frequency: farming conferences with workshops from farmers, researchers, and agriculture companies (38%), recorded webinars (36%), and live webinars (34%). It is interesting to note that the two most requested educational formats are a) live and b) led by a farmer in some capacity. This supports previous research, and other responses in this survey, suggesting that farmers enjoy learning from one another. More traditional forms of farmer outreach (workshops and conferences, and webinars) are still valued by farmer audiences, but are not the most desired forms of educational outreach.

A list of soil-health related topics was offered to respondents to select highest priorities for continuing education. The most selected topics were financial assistance for soil health and how to access that financial assistance (53%) and soil health indicators for farmers (40%). Other highly ranked topics include time saving and efficiency within soil health practices (34%), equipment options for tillage reduction (27%), and general farm systems for tillage reduction (27%). Prioritizing financial information about soil health practices and ensuring that farmers are aware of financial assistance programs is critical. This finding is interesting in the context of responses reported below showing that not all farmers in the survey population are aware of the existing financial assistance programs (through NRCS, MDAR, AFT, and other sources) that already exist.

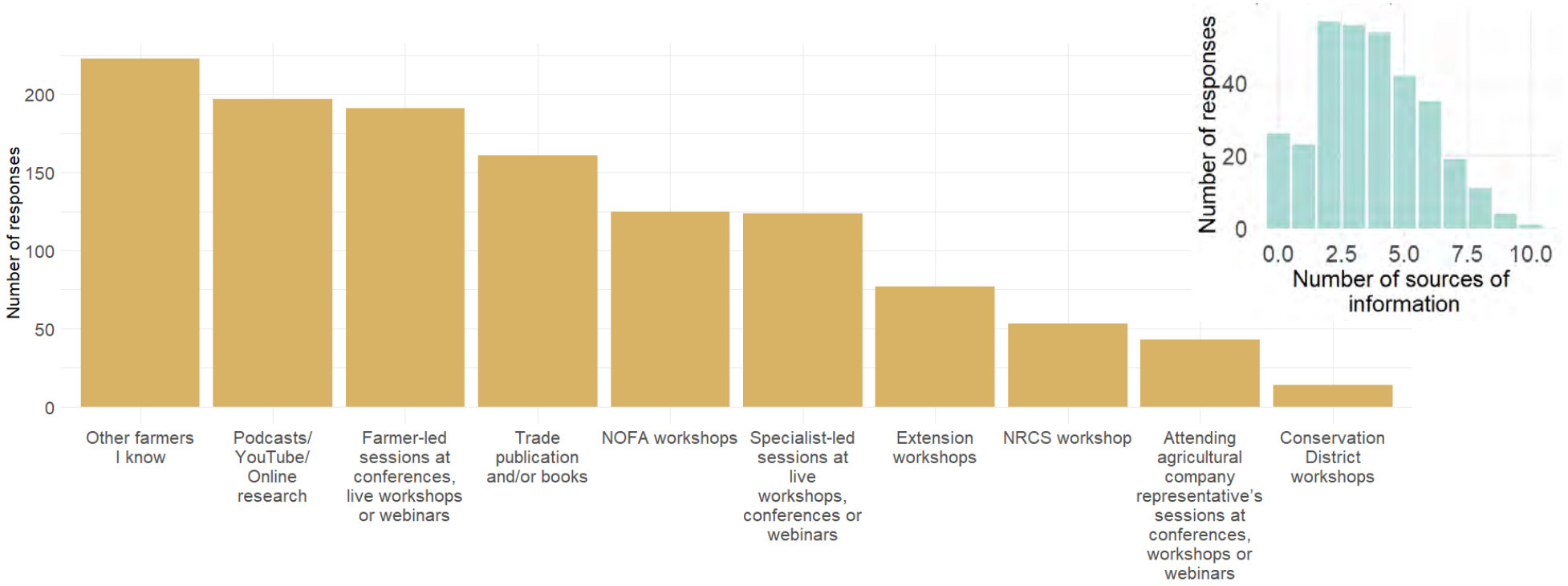


Figure 3. Where survey respondents report finding education and information about soil health, and number of information sources reported.

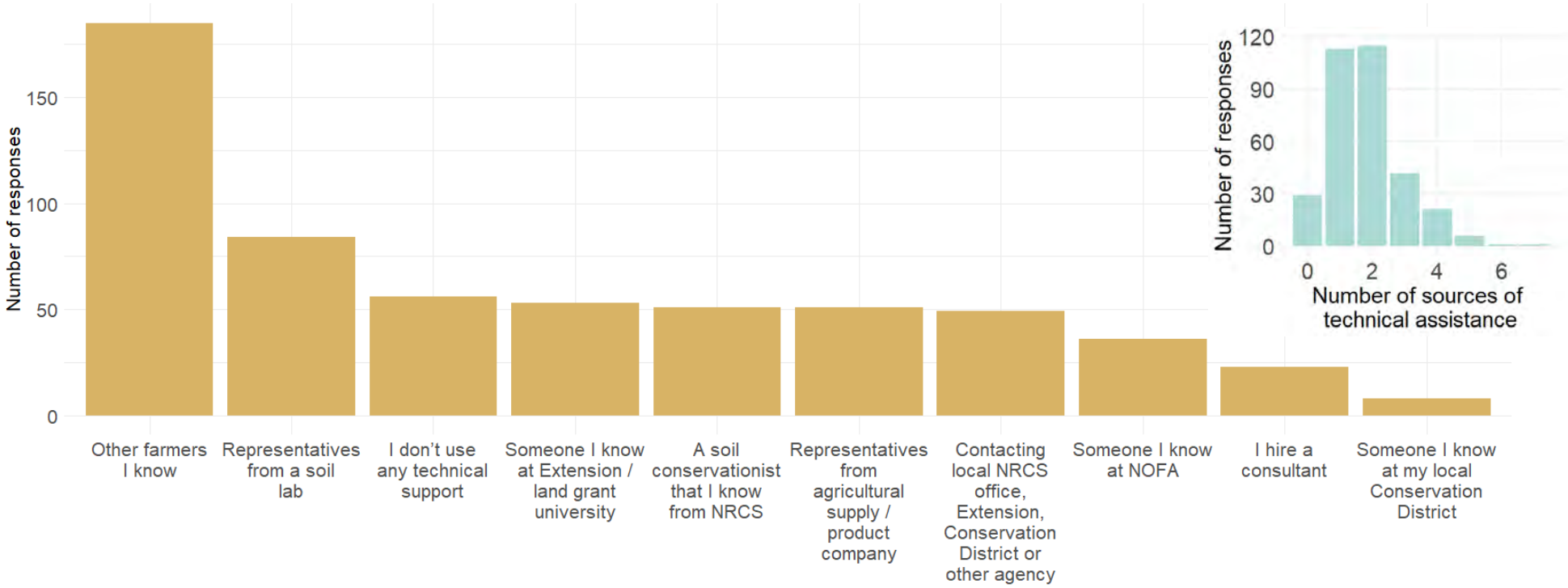


Figure 4. Where survey respondents report seeking technical assistance for soil health, and number of information sources reported.

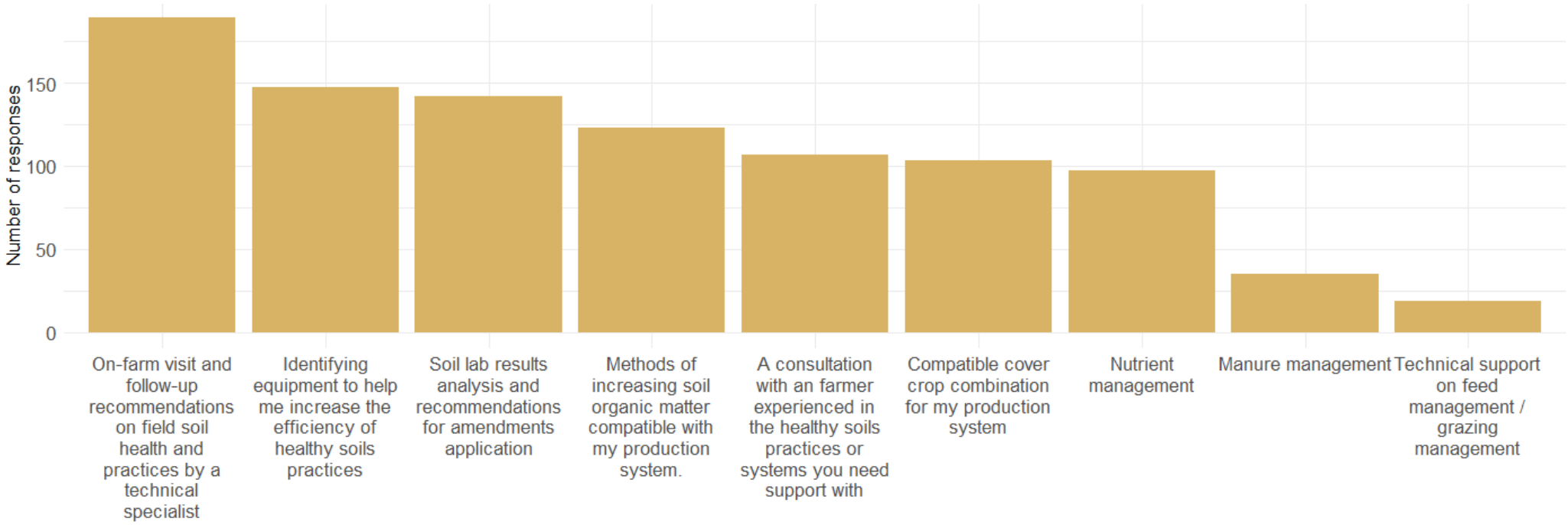


Figure 5. Most helpful form of technical support

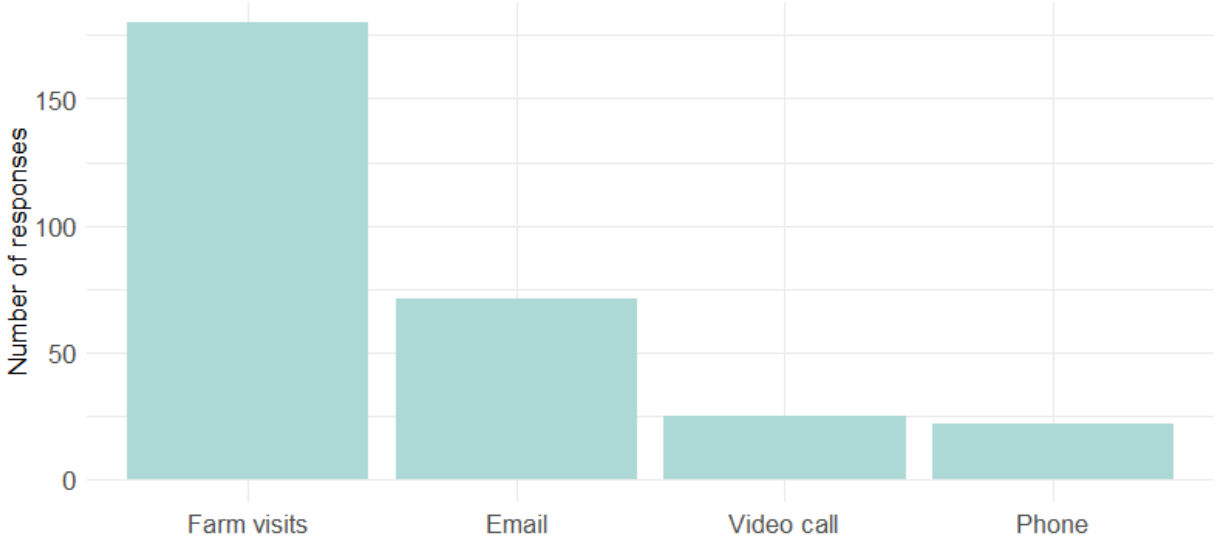


Figure 6. Most desirable format for technical assistance

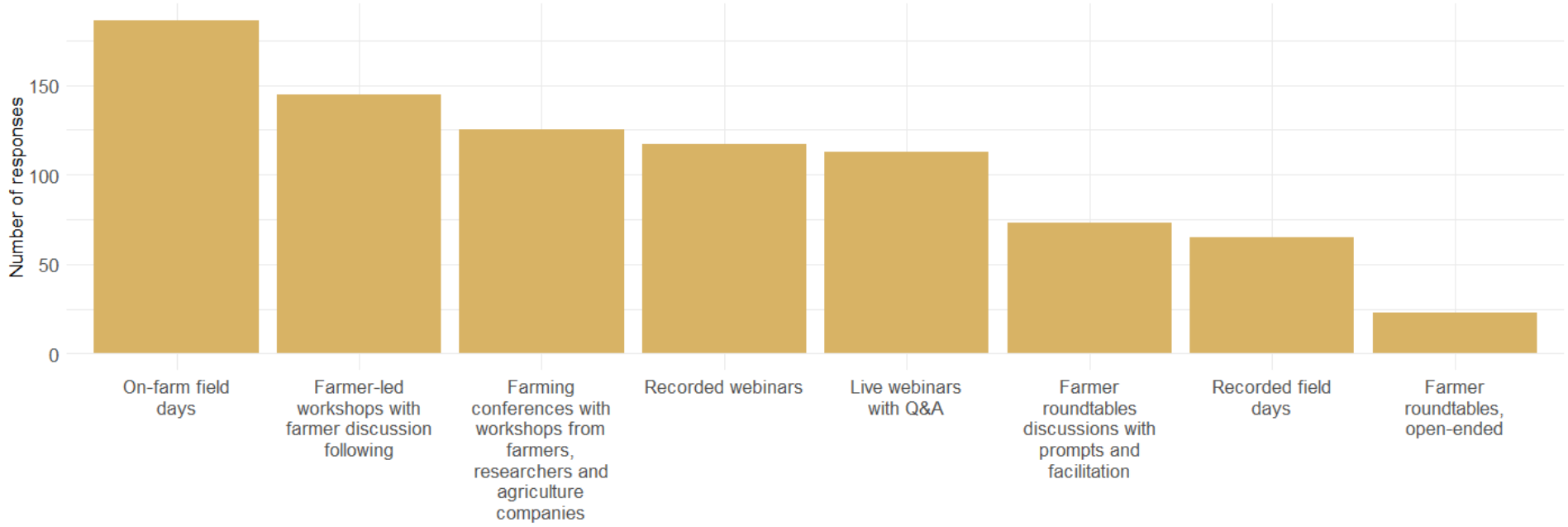


Figure 7. Most desirable format for educational programming

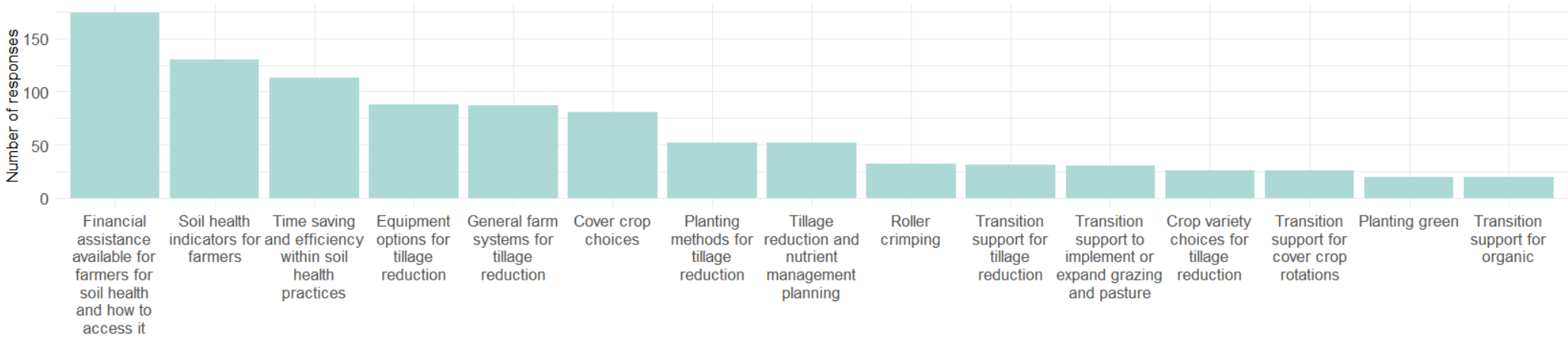


Figure 8. Ranked soil health topics of interest to survey respondents

Engagement with Financial Assistance Programs

While most farmers know about NRCS programming, less than a third of survey respondents currently participate in national conservation programming. In this survey, farmers were asked about the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and Agricultural Management Assistance program (AMA). Thirty-five percent of respondents reported that they either currently have or have had an NRCS contract in one of these programs. BIPOC, women, and non-binary farmers reported an unfamiliarity with NRCS programming more often than their white male counterparts. BIPOC (27.6%), women (20.5%) and non-binary farmers (27.3%) all reported not knowing about one or more of these NRCS programs.

Table 10. Engagement with NRCS programming by demographic (EQIP, CSP, AMA)

	I don't know what one or more of these are	*No*	*No, but I have had one previously*	*Yes*
BIPOC	27.6%	48.3%	13.8%	10.3%
Prefer not to say	20.0%	30.0%	50.0%	0.0%
White	15.0%	49.9%	13.1%	22.5%
Female	20.8%	50.3%	14.1%	14.8%
Male	11.5%	46%	12.9%	29.5%
Non-binary	27.3%	62.5%	0.0%	0.0%
Prefer not to say	0.0%	0.0%	25%	12.5%

The majority of farmers seeking financial assistance have either reached out to or have been contacted by NRCS or their conservation district. However, 57% of BIPOC farmers, 37.2% of white farmers, 45.7% of female farmers, 29% of male farmers, and 81.8% of non-binary farmers reported that they didn't know that they could receive assistance applying for services. This data shows that among our survey population, white and male farmers are more likely to know that NRCS can provide assistance applying to programs than BIPOC, women, and non-binary farmers. NRCS and conservation district outreach leading to assistance was also reported more frequently by white farmers, 13.2% compared to 6.7% among BIPOC farmers, and by male farmers (16.8% of male farmers, 8.6% of female farmers, and 0% of non-binary farmers).

When asked specifically about an MDAR grant for no-till equipment, we found that 87% of respondents had never applied for this MDAR grant, 11% had successfully applied, and 2% had applied unsuccessfully. Twenty-two men (15.7% of men responding) and 8 women (5.4%) received the MDAR no-till grant. Only one BIPOC respondent received the grant, as compared to 29 white survey respondents.

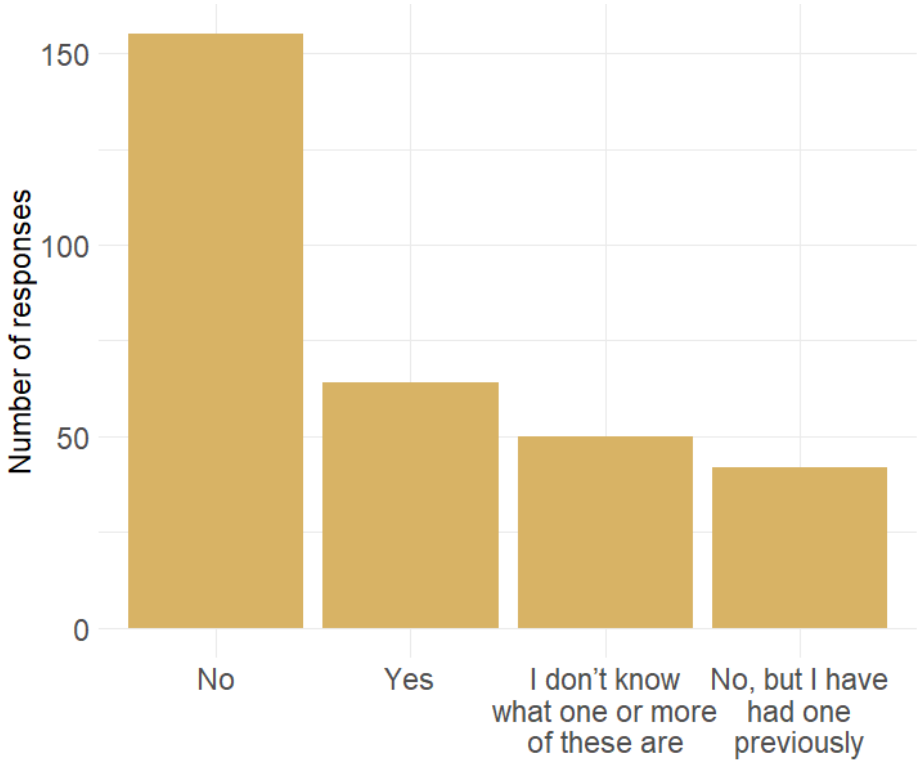
Beyond NRCS and MDAR, we asked respondents whether they had engaged with other forms of "financial incentives" for soil health practices. Most survey respondents were not familiar with options for financial incentives or assistance outside of NRCS or MDAR. Interestingly, farmers interested in applying for soil health minigrants at AFT were required to complete this survey and the total number of applicants for this program exceeds the number of farmers who answered "Yes" or "No, but I'm aware of other places where I could apply." There are a number of possible explanations for this including the wording of this question (Q25) and its potential answers, and farmer perceptions.

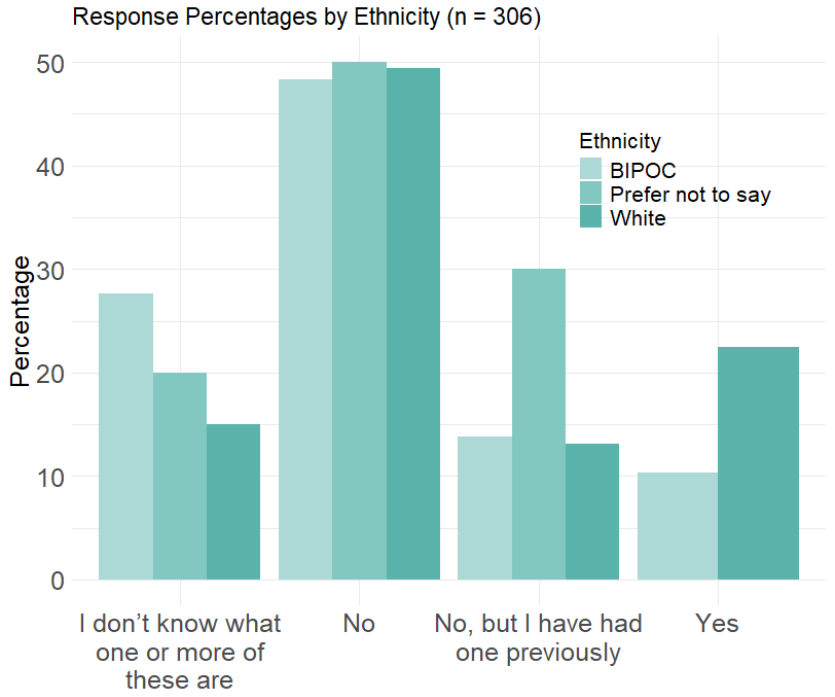
Question 25 asked specifically about "financial incentives for soil health practices," but included "financial incentives or assistance" as a possible answer. Including financial incentives, but not assistance, in the question may have limited farmers' thinking to programs like the cost-share provided by NRCS. Many of the grants and funding opportunities offered by organizations outside of NRCS and MDAR are structured differently and may not have come to mind when answering this question. It is also possible that minigrants offered by AFT were small enough that farmers consider them differently than other types of pay for practice programs.

Desired future financial assistance

Finally, we asked respondents to reflect on desired future financial assistance. We first asked what type of financial assistance would be most helpful to them. The overwhelming response was that grants would be most helpful (75%), with all other responses receiving less than 10% of total interest. The time required to apply for grants, accessibility of applications (language, length, submission method), and other factors should all be considered when designing grant programs.

We then asked respondents to reflect on what they would do with a grant award between $5,000 and $10,000 to spend on meeting their soil health goals. These answers were open-ended and were categorized by AFT staff. The most frequent responses were that they would use the funds for cover crop seed (n = 103), compost (n = 81), amendments (n=42), no till equipment (n=39), and soil testing (n=33). A full list of responses are visually represented in the word cloud in Figure 10. In the context of earlier questions about conservation practices implemented on participating farms, these results show that more resources are needed even among farms already implementing conservation practices. Several existing financial assistance programs require some form of new implementation to qualify for funding. In cases where farmers are still adapting their systems to recently implemented conservation practices, accessing financial assistance may require additional complexity that they are not ready for. It is important for other funding sources to exist to fill in the gaps for farmers that find themselves in this position.





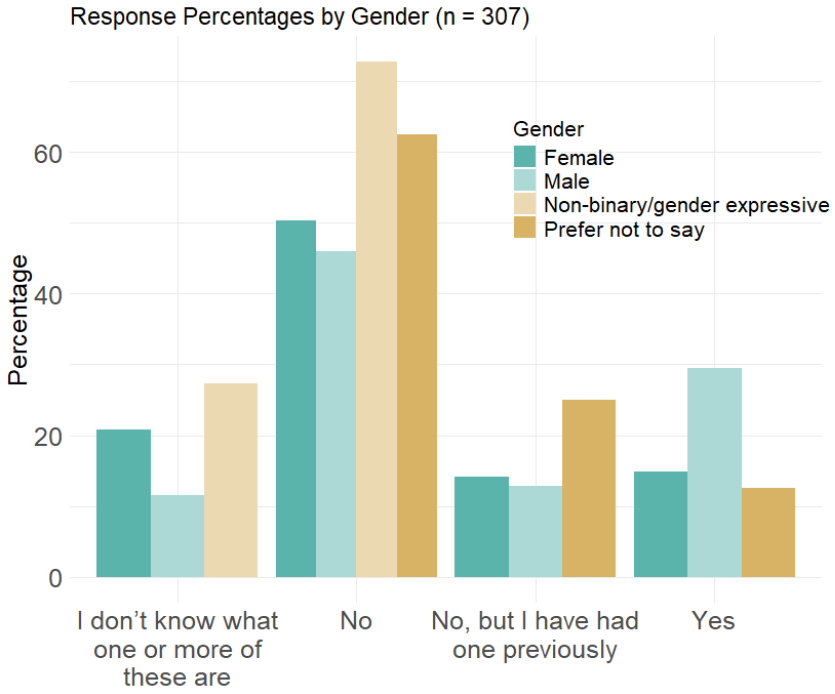


Figure 9. (Above) Do survey respondents have a NRCS Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), or Agricultural Management Assistance Program (AMA) contract (n = 311). (Right) NRCS program engagement by self-reported ethnicity and gender.

Figure 10. Word cloud of responses to the question: "If small grants of $5,000-10,000 were available to farmers to support healthy soils practices adoption, what would you spend it on that would best help you meet your soil health goals?" Larger font size indicates a greater number of answers.

Figure 11. Have survey respondents received support from NRCS or their Conservation District to apply for technical and/or financial assistance (n = 294)

Table 11. NRCS contact with respondents

	No, I have not been contacted by NRCS or a conservation district to invite me to apply for services	*Yes, I have been contacted by NRCS or a conservation district to invite me to apply for services*
BiPOC	87.1%	12.9%
Prefer not to say	50%	50%
White	62.1%	37.9%
Female	70.1%	29.9%
Male	56.9%	43.1%
Non-binary	90.9%	9.1%
Prefer not to say	50%	50%

Table 12. Have respondents applied for an MDAR grant for no-till equipment

	No	*Yes, and it was awarded*	*Yes, and it was not awarded*
BiPOC	96.7%	3.3%	0.0%
Prefer not to say	70%	30%	0.0%
White	86.8%	10.9%	2.3%
Female	91.9%	5.4%	2.7%
Male	82.9%	15.7%	1.4%
Non-binary	100%	0.0%	0.0%
Prefer not to say	62.5%	37.5%	0.0%

Table 13. Outreach to and from NRCS and Conservation Districts, specifically for assistance applying to services

	I didn't know I could get assistance applying for services.	*I contacted NRCS/CD but I did not hear back and/or get the help I needed.*	*I receive services from NRCS/CD but I don't need any help applying.*	*Someone from NRCS/CD contacted me but I did not follow through with an application.*	*I reached out to NRCS/CD and they helped me apply for services.*	*I was contacted by NRCS/CD and invited to apply for services and they assisted me in applying for services.*
BIPOC	56.7%	6.7%	3.3 %	10%	16.7%	6.7%
Prefer not to say	44.4%	11.1%	0.0%	22.2%	11.1%	11.1%
White	37.2%	6.8%	4.8%	5.6%	32.4%	13.2%
Female	45.7%	10.7%	2.1%	5%	27.9%	8.6%
Male	29%	3.8%	6.9%	8.4%	35.1%	16.8%
Non-binary	81.8%	9.1%	0.0%	0.0%	9.1%	0.0%
Prefer not to say	0.0%	0.0%	0.0%	12.5%	25%	12.5%

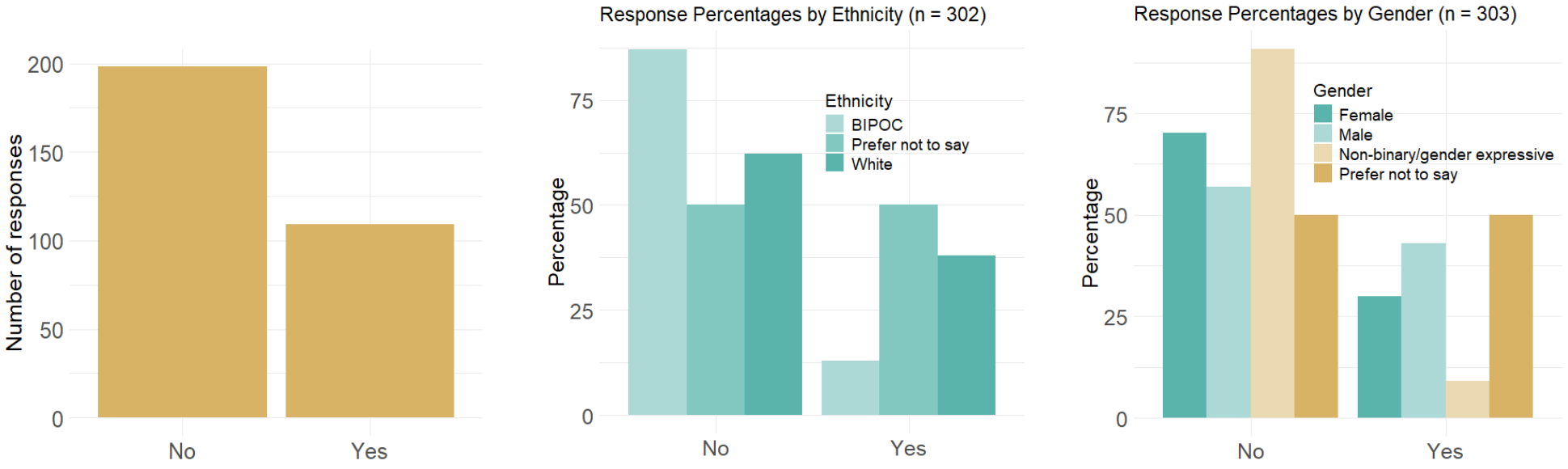


Figure 12. Have survey respondents been contacted by NRCS or their Conservation District to apply for services (left) and results by self-reported ethnicity (center) and gender (right).

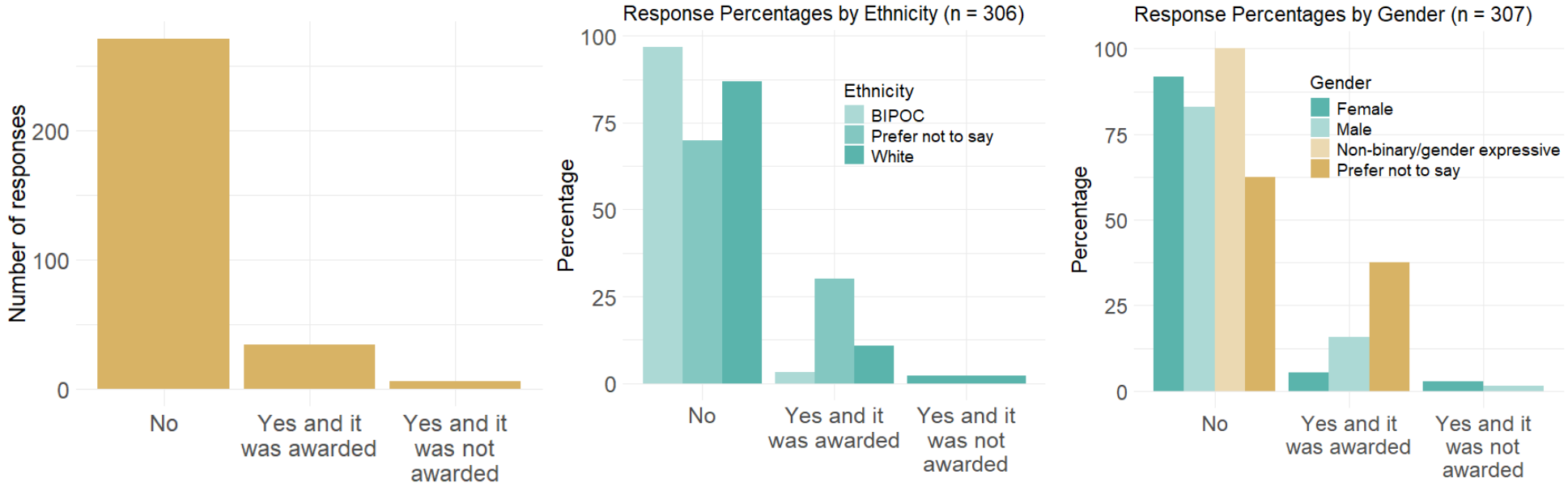


Figure 12. Have survey respondents applied for an MDAR grant for no till equipment (left) and results by self-reported ethnicity (center) and gender (right).

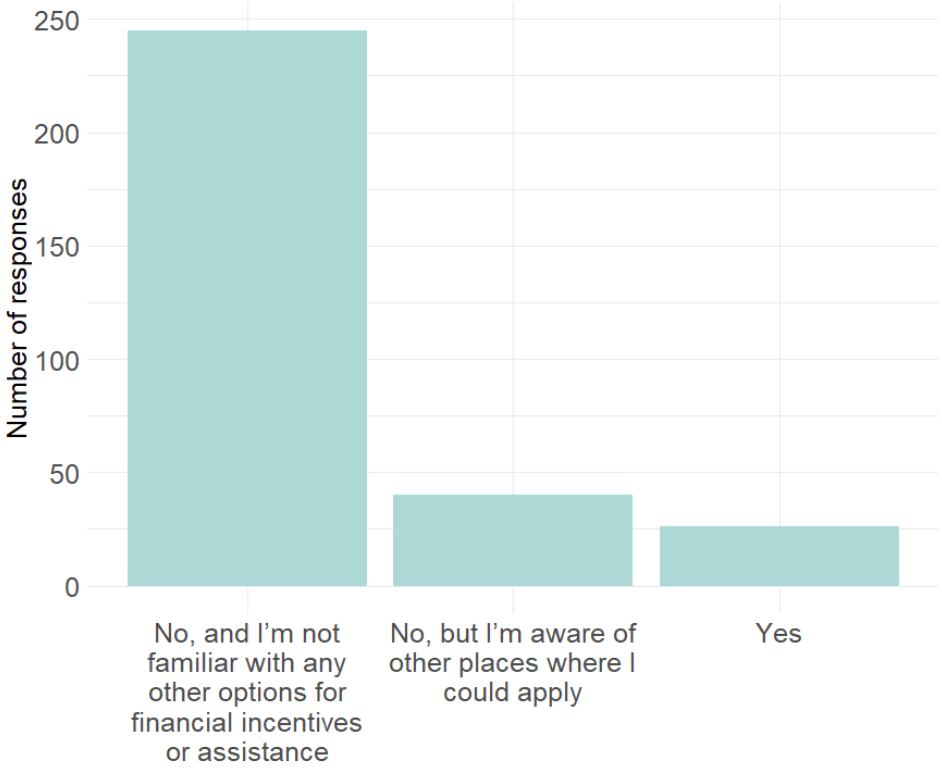


Figure 13. Have survey respondents received financial incentives for soil health practices from sources other than NRCS or MDAR (n = 311)

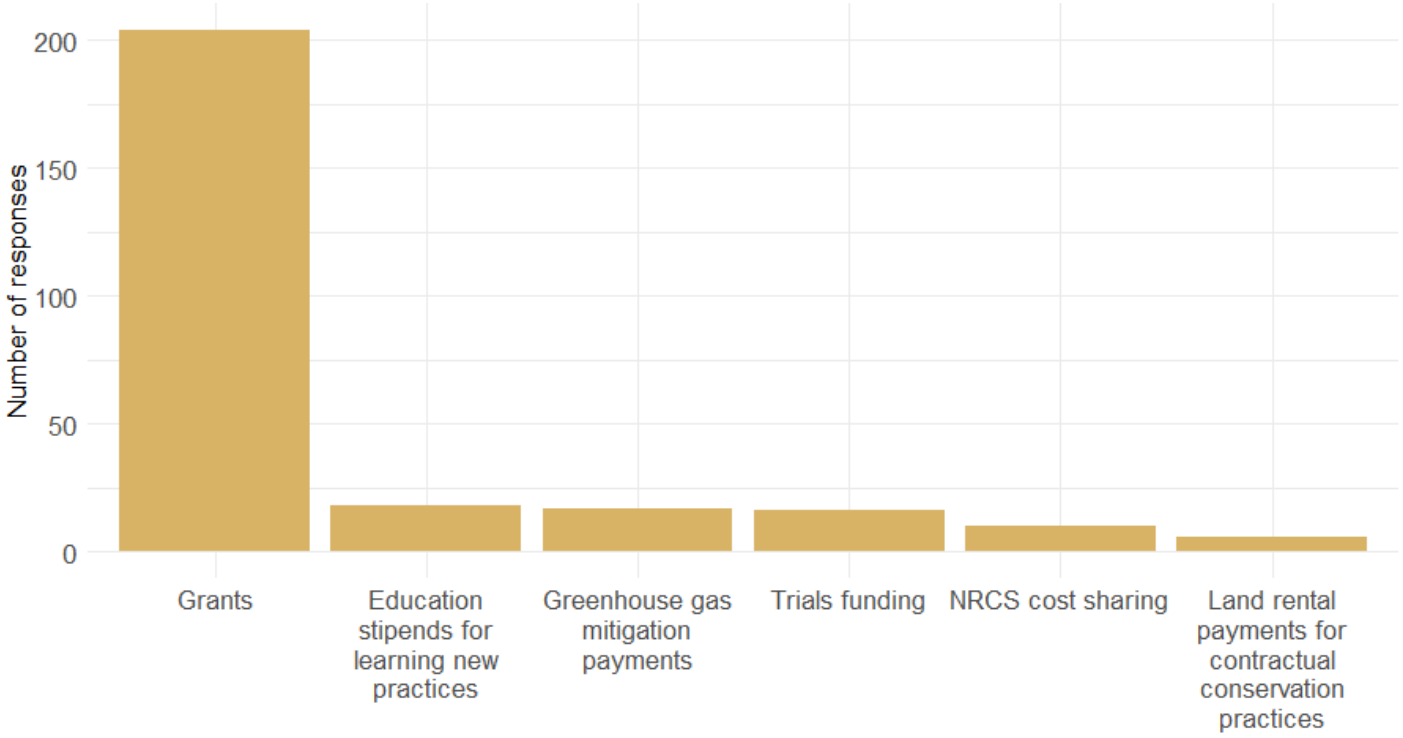


Figure 14. Preferred forms of financial assistance (n = 271)

Barriers to Soil Health Practice Adoption

The farmers responding to this survey were often already using at least one soil health practice—282 reported using cover crops, 304 reported some form of tillage reduction, 273 reported adding carbon amendments, 288 reported mulching, 217 farms reported implementing all three of these practices in some form, 83 implemented at least 2, 24 implemented 1, and only 4 farms reported using no conservation practices from those listed in the survey. However, barriers are still relevant to a) continued use of soil health practices and b) scaling up use of these practices. We asked responding farmers to report on their level of agreement on the following statements about use of soil health practices:

- There is too much uncertainty about soil health outcomes
- I don't have enough time for learning about new practices
- There is too much uncertainty about yield outcomes
- I don't have enough technical support
- The upfront costs are prohibitive

We also asked farmers whether long-term savings of time and money would alter their level of interest in using a soil health practice even if it takes more time and/or money during the first two seasons of use.

Sixty-nine percent of all respondents strongly disagreed with the statement that soil health outcomes are uncertain, 79% strongly agreed that they would use a practice if it would save them money over the long-term, and 82% strongly agreed that they would use a practice if it would save them time over the long-term. As previously stated, these answers again prove that this group of survey respondents is very soil health motivated.

Of all the barriers examined, costs and technical assistance were reported as the largest barriers to soil health practice adoption. This pattern remained generally true across demographic groups, with a few key differences. Farmers who self-identified as women were more likely to identify technical assistance (56% for women vs 34% of men) and costs (62% of women vs 53% of men) as a barrier as compared to men. Compared to white farmers, farmers who self-identified as Asian/Pacific Islander, Black, Indigenous, or Hispanic or Latino/a/x reported costs (74% for BIPOC farmers vs 59% for white farmers), time (32% vs 27%) and uncertainty in soil health outcomes (20% vs 12%) as barriers to practice adoption.

These results suggest that more work needs to be done to reach under-resourced groups in the farming community. In addition, technical and financial assistance should be designed and presented in a way that is accessible and relevant to under-resourced groups. Further collaborative work should be done with input from under-resourced groups to determine best practices for technical and financial assistance accessibility. It is also important to note that many BIPOC and women-led organizations are already engaged in

this work, and future programming should support or enhance this, rather than recreate or dilute it.

Despite costs being among the most consistent barrier to soil health adoption, the majority of farmers (79%) reported that they would implement soil health practices if those practices saved them money in the long term, *even if* they cost more upfront. It is possible that other pressing items (equipment, cash crop costs etc.) take priority when it comes to farm spending, pushing soil health practices lower on the list of priorities for a given season. There is also variability in cost among soil health practices that is not captured by this survey, and it is likely that respondents are thinking about different costs and different practices in the context of these questions.

Identifying and accessing the appropriate equipment for soil health practices can also be a barrier to practice use. We asked whether survey respondents had the equipment they needed to implement the healthy soil practices they wanted to use, and 67% reported that they did not have the equipment they needed. These results did not vary when compared across gender and ethnicity.

When asked why they didn't have the equipment they felt they needed, price was the most commonly cited factor (47%), however many farmers also reported being unsure about the equipment they needed (38%).

When respondents were asked what types of technical assistance would be most helpful to them (Figure 5), the second most commonly selected option was "identifying equipment to help me increase the efficiency of healthy soils practices." Farmers are actively interested in exploring equipment options with technical service providers but may not be at the stage where they are ready to put the time into a grant application or pay out of pocket for expensive equipment when they are not sure if the equipment they have selected will meet all their needs.

Farms reported access to resources and technical support as a barrier to implementation of soil health practices more frequently than time. This is consistent with the conservation practice implementation rate among survey participants (98.8%) and the rate that farms self-identified as soil health focused (67.1%). It is likely that farms with an existing interest in soil health will make time to implement practices as long as they have the resources and feel confident.

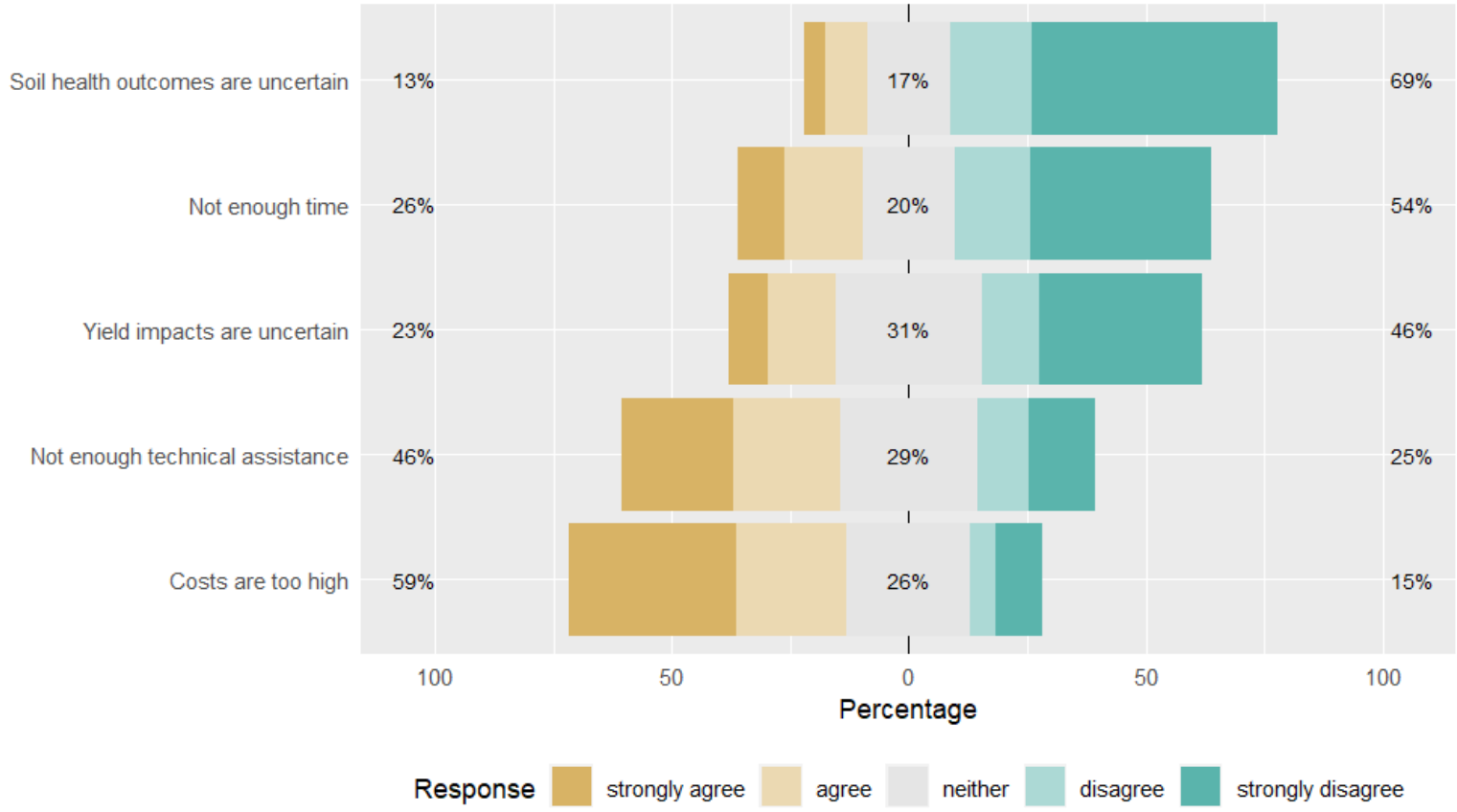


Figure 15. Agreement/disagreement with barriers to use of soil health practices. Responses from all survey participants (n = 328)

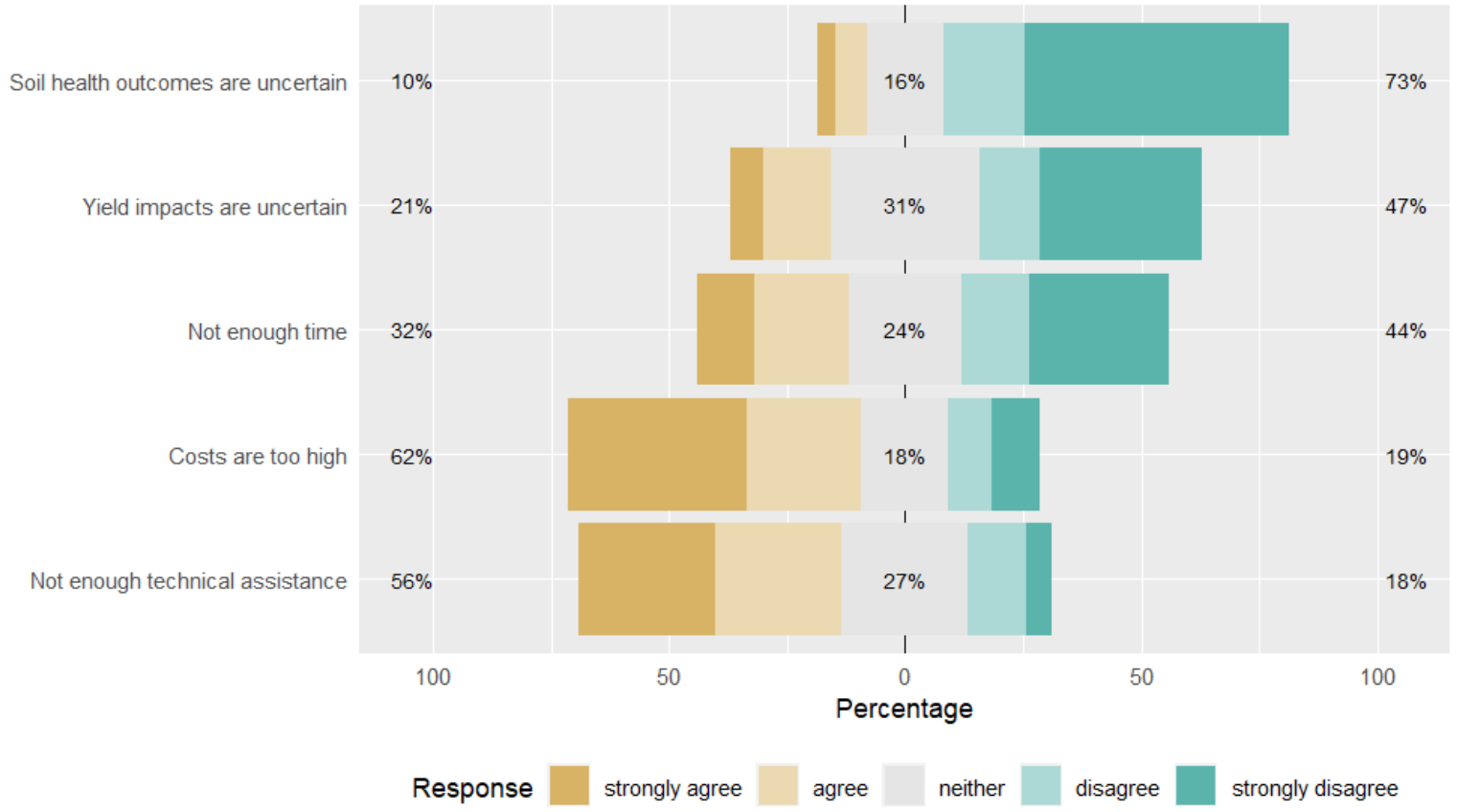


Figure 16. Female farmers agreement/disagreement with barriers to use of soil health practices (n = 159)

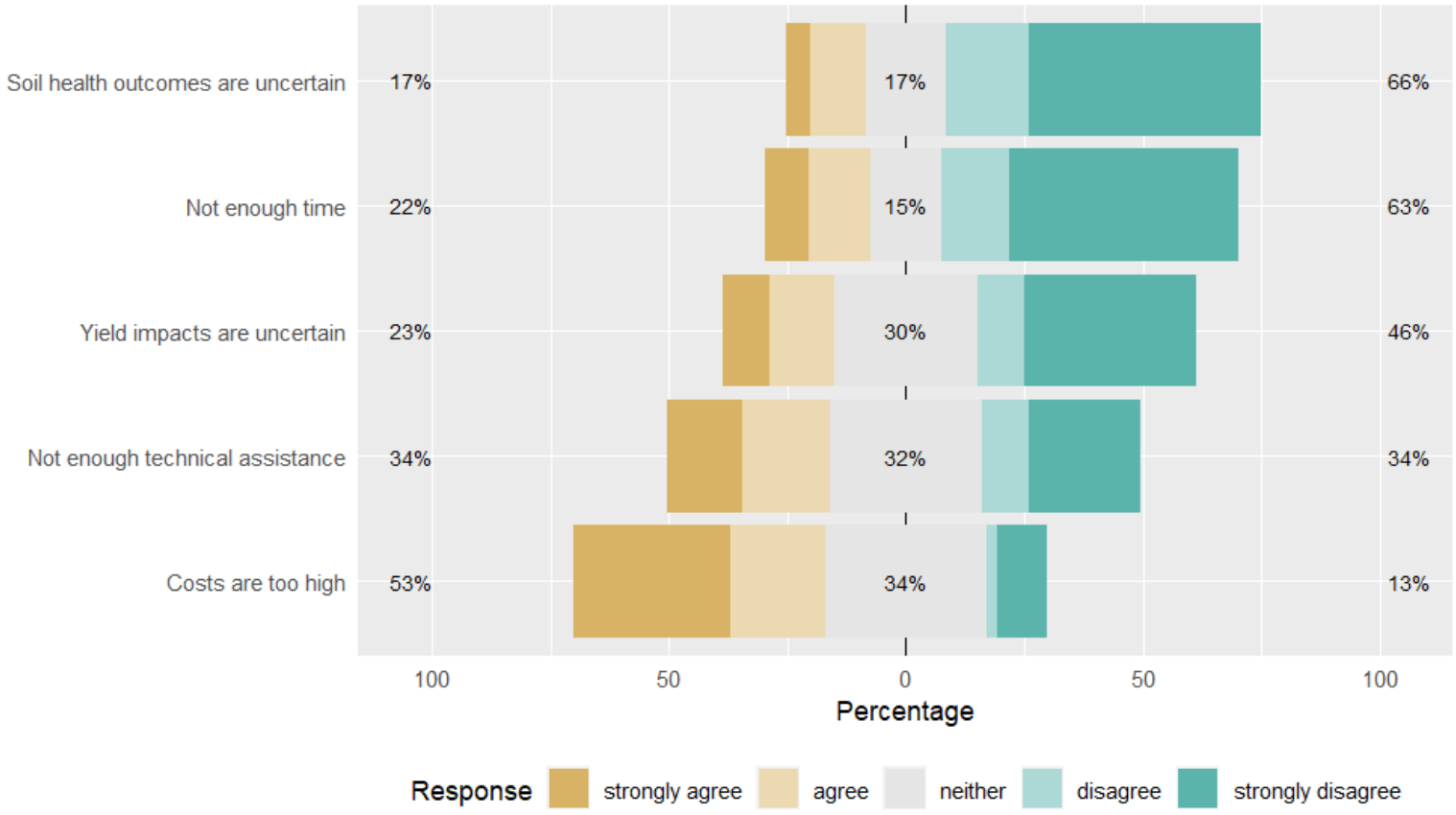


Figure 17. Male farmers agreement/disagreement with barriers to use of soil health practices (n = 144)

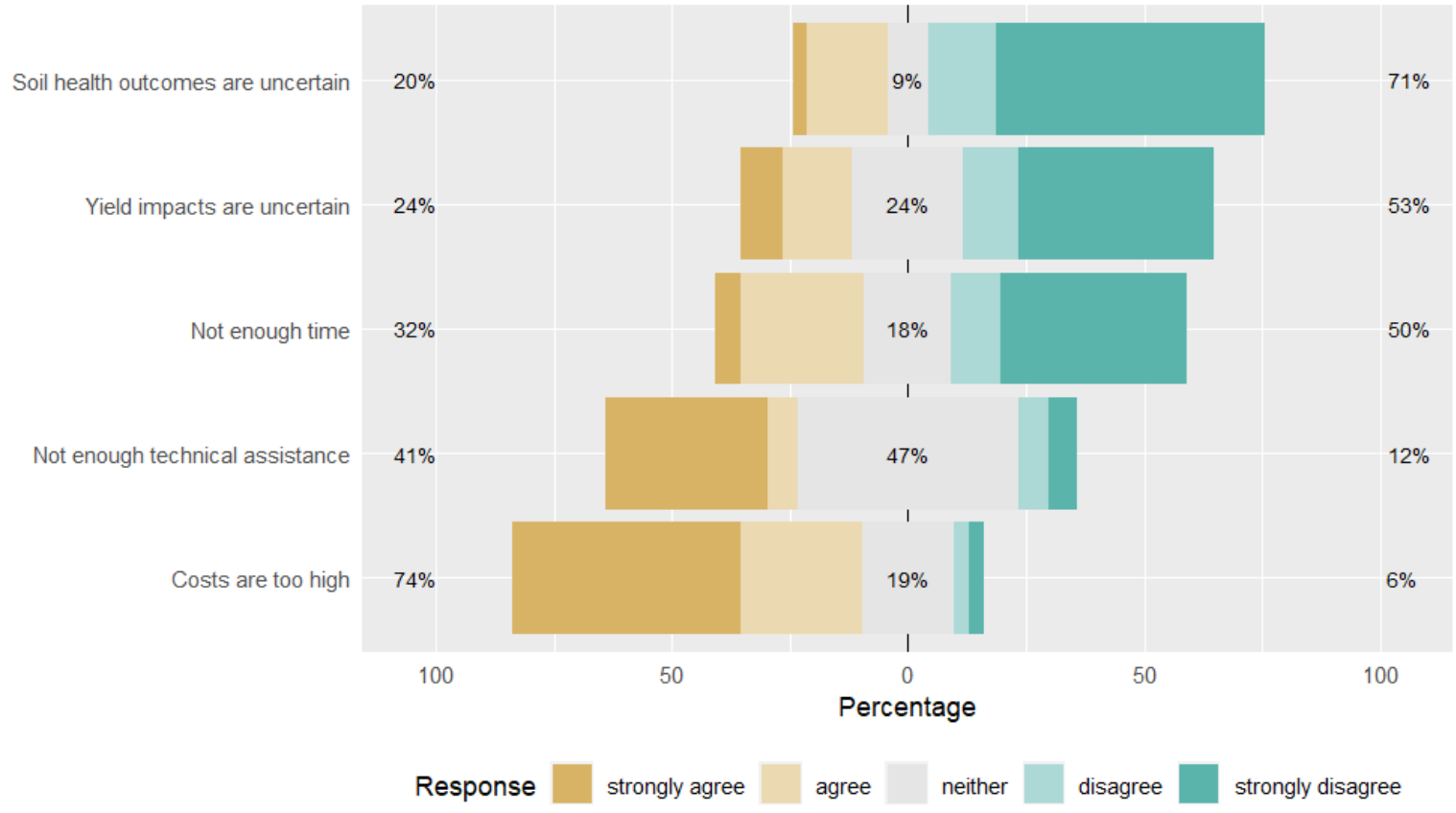


Figure 18. BIPOC farmers agreement/disagreement with barriers to use of soil health practices (n = 43)

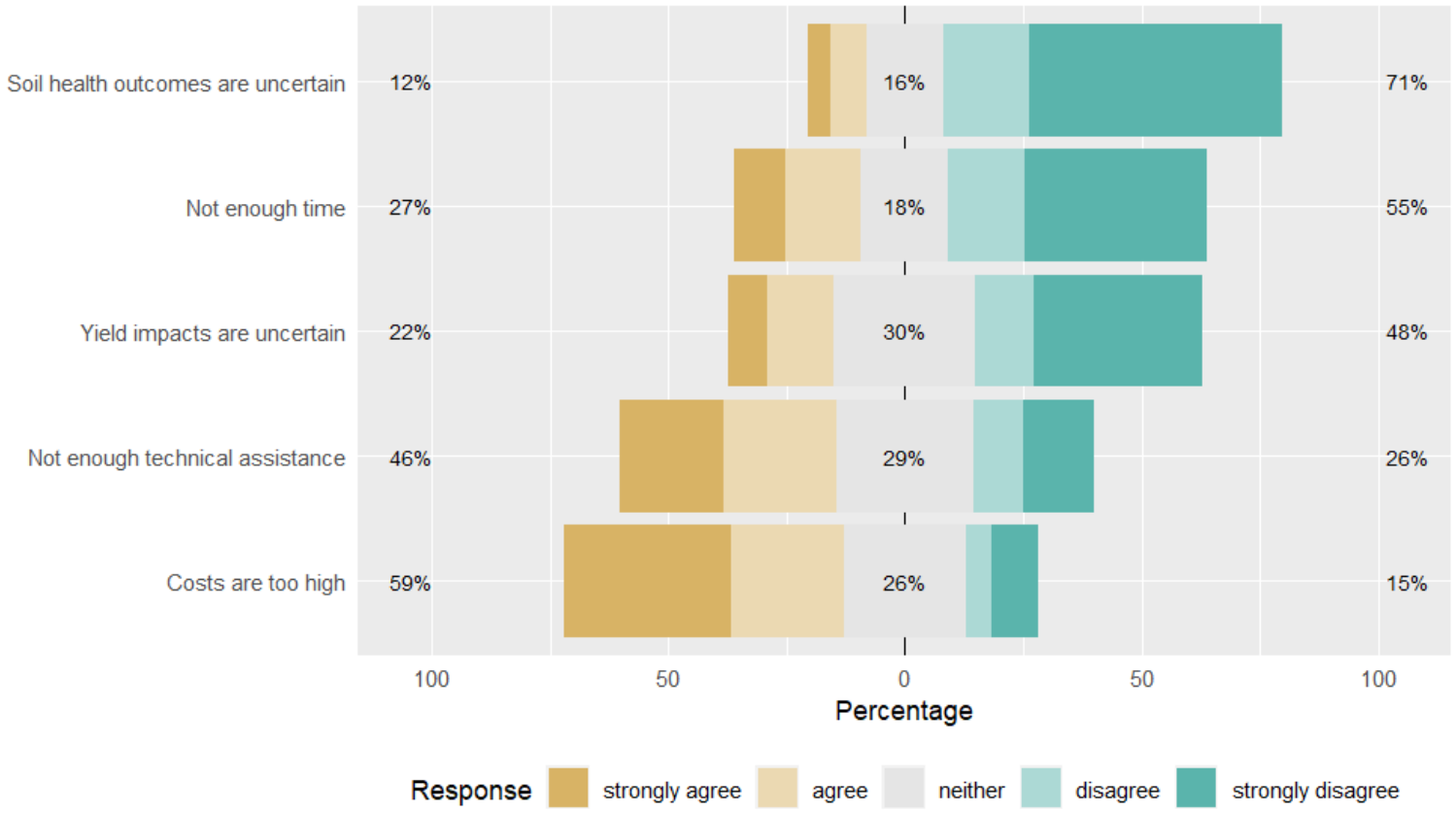


Figure 19. White farmers agreement/disagreement with barriers to use of soil health practices (n = 280)

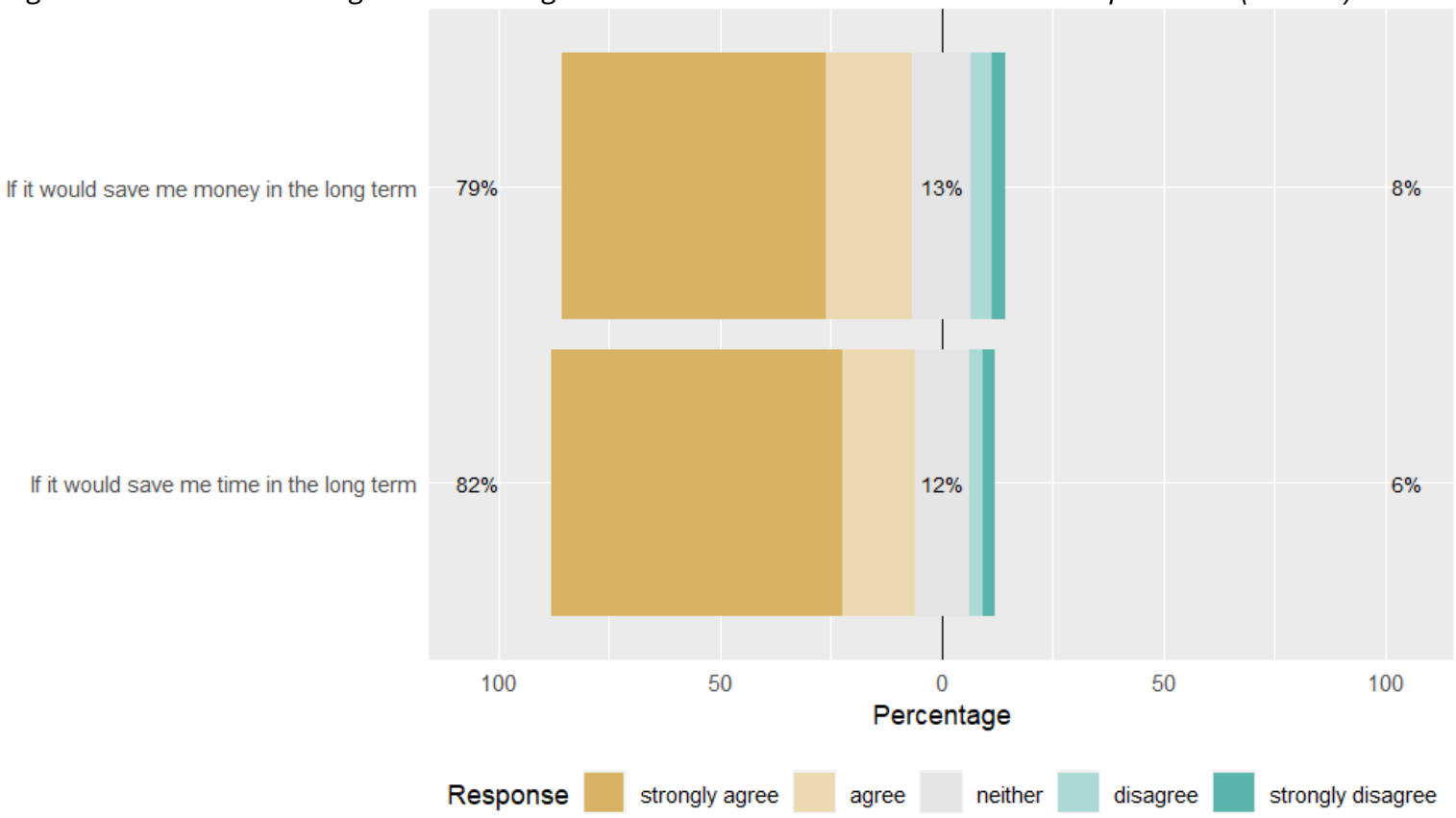


Figure 20. Would survey respondents use a soil health practice if it took more time/money the first two years if it would save them time/money in the long term (n = 328)

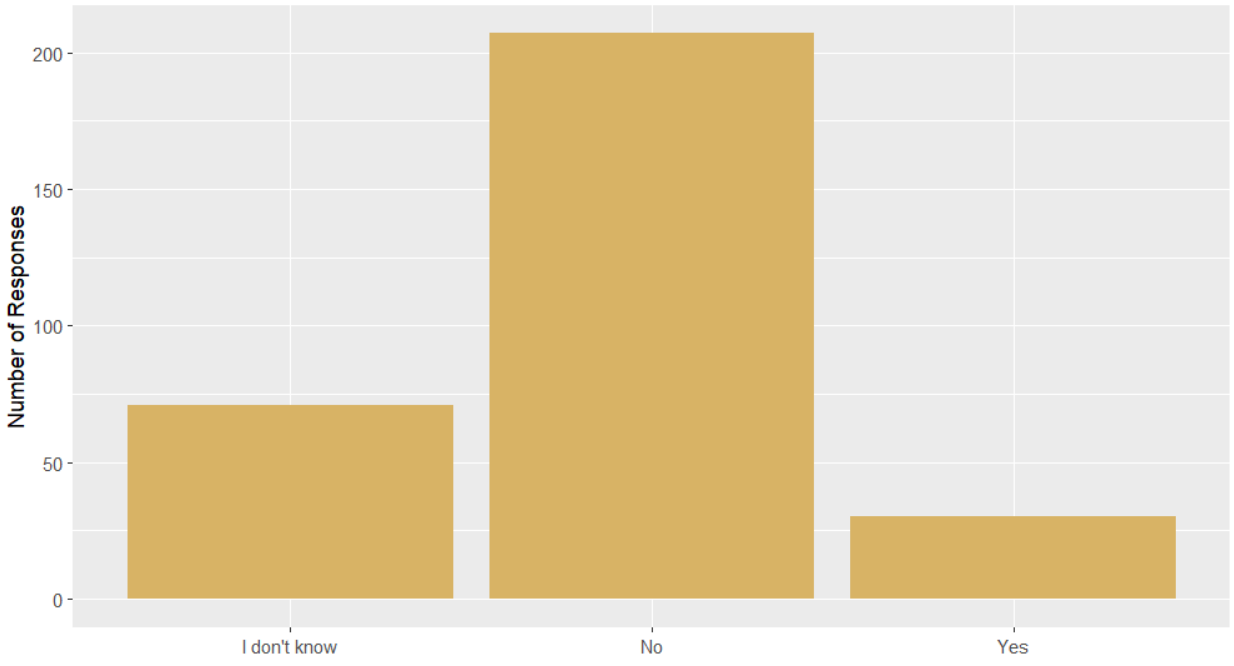


Figure 21. Do you have the equipment you need? (n=308)

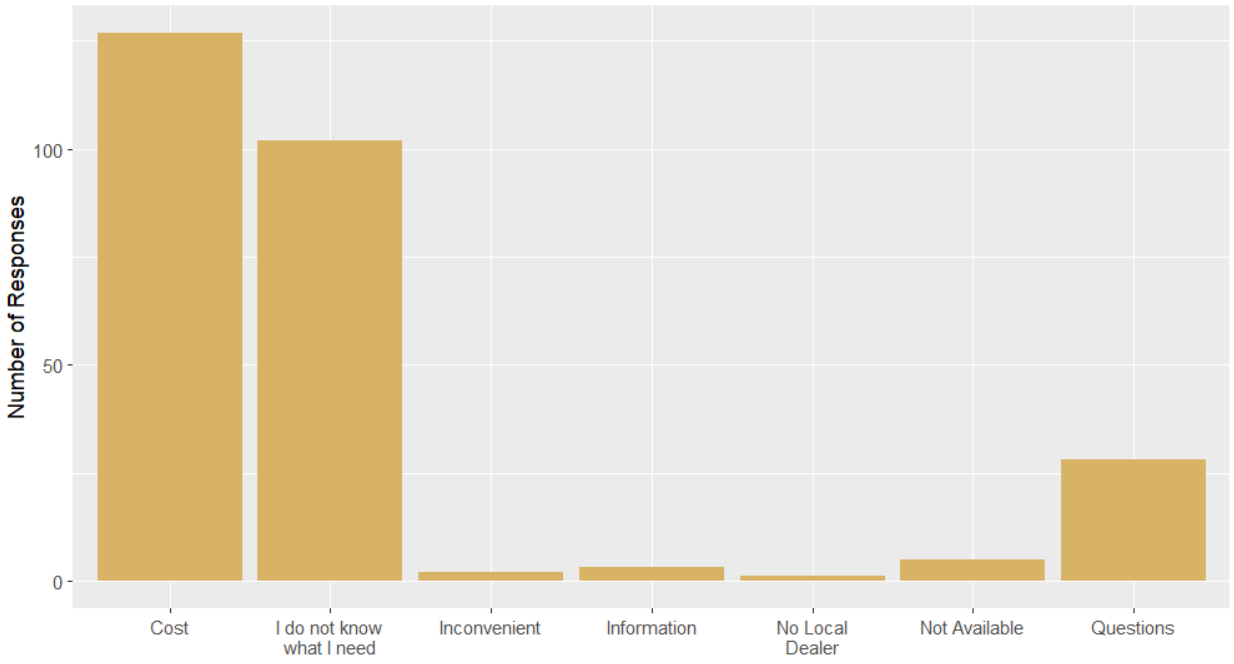


Figure 22. What is the reason you do not have the equipment you need? (n=269)

Soil Test Analysis

Over the course of the MACSHP program, AFT worked with farmers to collect 268 soil health samples across the Commonwealth. While many participating farmers had collected soil samples before (82% of participants indicated that they have worked with lab-based testing services before), participants felt that if soil sampling were less costly, they would likely do it more often. Generally, participating farmers indicated that they soil test at least once every three years, with the majority reporting that they conducted annual soil testing.

While CASH tests submitted include several of the same chemical indicators that a routine nutrient analysis would, they also include biological and physical assessments of soil health. In total, CASH analyses include 12 indicators. Available water capacity, surface and subsurface hardness, and aggregate stability as physical indicators; organic matter, soil protein, soil respiration, and active carbon as biological indicators; and soil pH, phosphorus, potassium, and micronutrients as chemical indicators. All 12 indicators are given a score and rolled up with equal weights to an overall score for soil health.

CASH tests can be an illuminating addition to regular nutrient testing. Many of the measured indicators change slowly over time and the CASH test was designed to identify limiting factors of soil health, so these tests are best done several years apart. Submitting samples every three to five years can help to track impacts of management changes.

Overall Soil Health Results

Participating farmers tended to receive high CASH scores overall, with scores averaging 74.53 out of 100. The variability was considerable, however; one standard deviation was 13.72 points. The minimum score was 28.48 and the highest score was 99. This wide range can be partially contextualized by the different enterprises of participating farms. We would expect fields in year-round living cover, like a pasture, to perform better on several soil biological indicators than fields that are annually tilled for crop production, as an example.

Figure 23 describes the scores received for various indicators. The Cornell Soil Health Lab has developed scoring curves based on soil texture and previous lab results to give indicators a score from 0–100. These scores are most useful when diagnosing a limiting factor of soil health for a field or farm. The remainder of the discussion of CASH results will cover the lab results instead of the adjusted scores.

Indicators that farmers are already actively managing, like potassium, phosphorus, and pH tended to receive high scores, close to 100. As discussed earlier, many participating

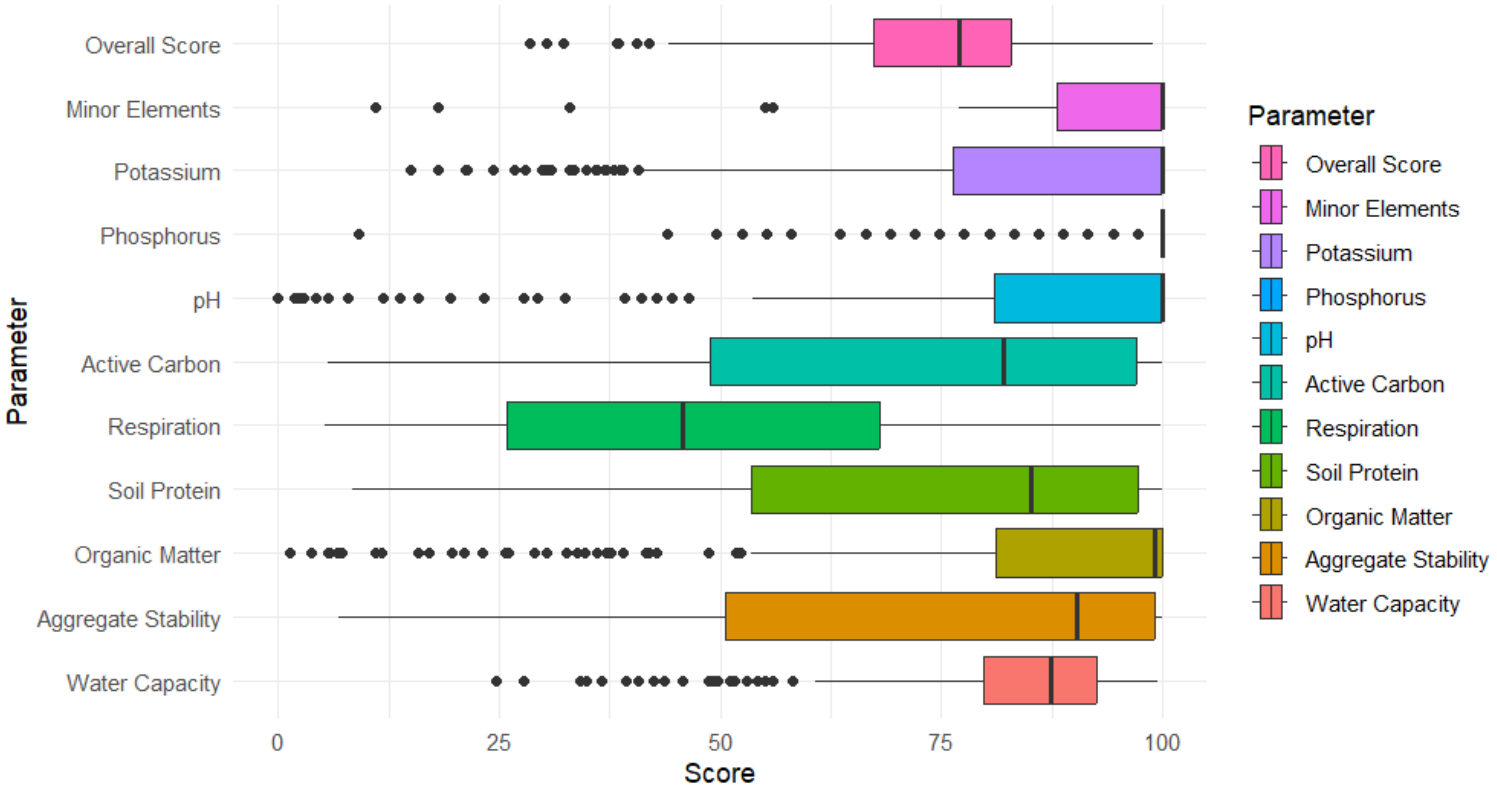


Figure 23. Overall CASH scores for MACSHP participants between 2021 and 2023 (n = 268).

farmers test their soils annually, or at least once every three years, to determine nutrient needs. The chemical indicators are top of mind for farmers throughout the season while other indicators may not be as immediately apparent.

Biological indicators tended to lag, with respiration as the worst performing of the indicators. The other indicators in this group, active carbon, soil protein, and organic matter, tended to perform better but overall, the biological indicators had wide variability.

Surface and subsurface hardness were removed from figure 23 because readings were not taken for every sample. Not every farmer had access to a penetrometer to take readings in the field and field readings can vary widely based on soil conditions. Subsurface hardness (psi readings from 6–18 inches) is presented as a boxplot in figure 27.

Chemical Indicators

The chemical indicators (Phosphorus, Potassium, and pH) were among the highest performing indicators in the CASH test among participating farms. Phosphorus ranged from 1.5 to 497.3 ppm, with a median value of 8.45 ppm. 75% of participating farms had phosphorus values below 14.82 ppm. The University of Massachusetts flags results above 14 ppm for potential environmental concern, so it is encouraging to see that the majority of

participating farms do not have high phosphorus levels. Field history is also a factor in phosphorus. A legacy of chicken or cow manure as a biological amendment can contribute to high phosphorus levels in the present as it is relatively immobile in the soil.

Potassium ranged from 15.20 to 633.40 ppm, with a median value of 79.85 ppm. The optimum range in Massachusetts is between 100 and 160 ppm, so this trend of less-than-optimal potassium levels should be noted and managed to optimize soil health. Insufficient potassium can restrict plant growth and water use efficiency, which can be a major issue for farms relying on cover crops to improve soil health.

Soil pH ranged from 4.61 to 7.62 with a median value of 6.34. Soil pH has a significant effect on soil health and optimal crop growth, so this is an important indicator for farmers to monitor, especially given that different crops require specific pH ranges. Knowing the production type for each field may lend more clarity to this indicator. Several acid loving plants are regularly grown in New England, including blueberries, and this is not reflected in the score provided by Cornell. As an example, a pH of 5.5 may receive a score of 0, with the caveat that acid loving plants may prefer pH in this range.

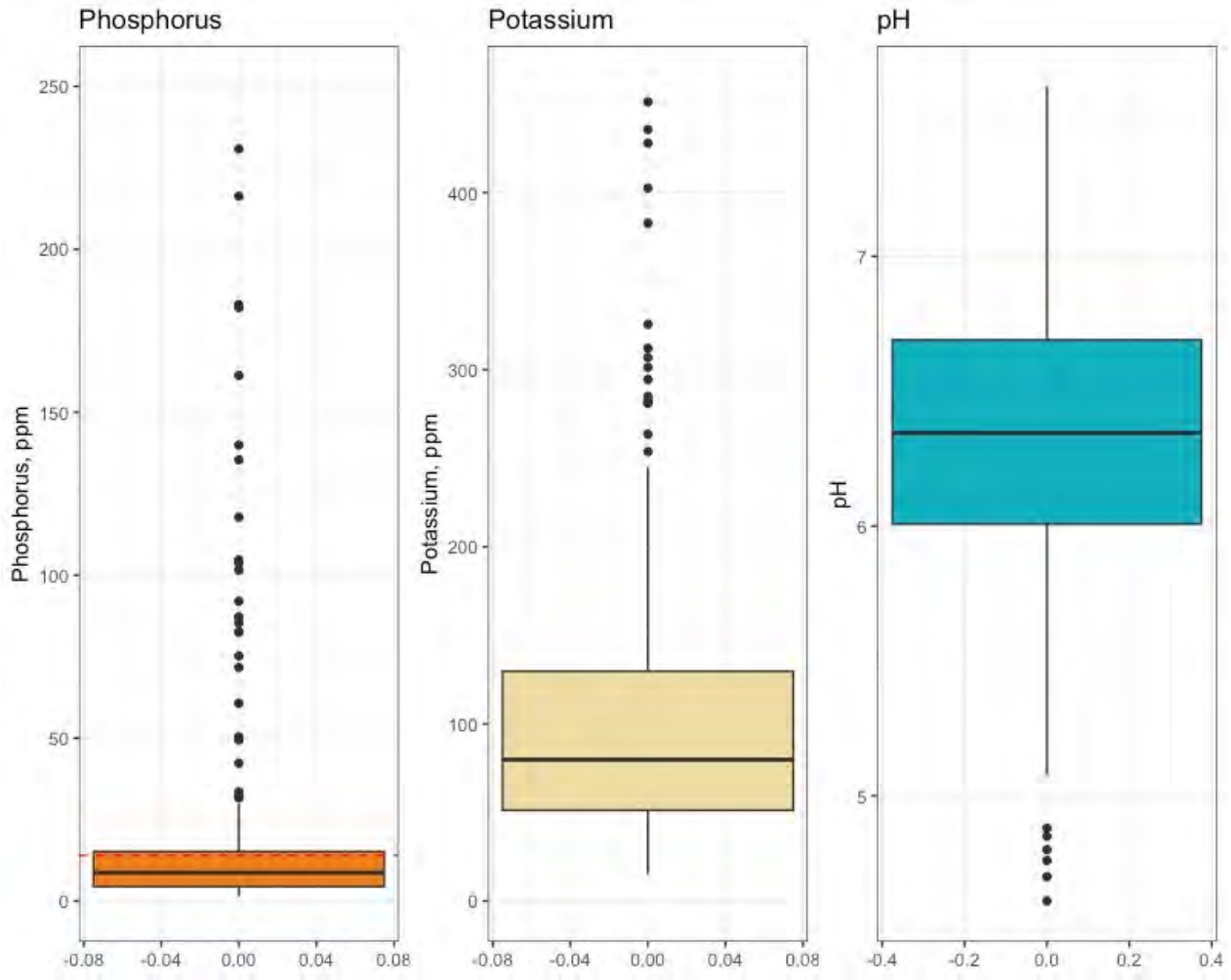


Figure 24. Phosphorus, Potassium, and pH values with outliers removed.

Table 14 Phosphorus, potassium, and pH values among MACSHP participants

	Minimum	*Q1*	*Median*	*Mean*	*Q3*	*Maximum*	*Standard deviation*
Phosphorus, ppm	1.5	4.5	8.9	26.85	15.83	497.3	66.56
Potassium, ppm	15.2	52.8	82.15	188.86	139.32	13677.4	859.01
pH	4.61	6.01	6.34	6.32	6.69	7.63	0.56

Physical Indicators

Aggregate stability is measured using a rainfall simulator and results are presented as the percentage of aggregates remaining. Aggregate stability ranged from 4.14% to 96.95% with a median value of 58.13%. Several factors can help to explain this variability, from tillage history, time between tillage and sample collection, and weather variability. Figure 25 shows a trend in the relationship between tillage depth and aggregate stability. As tillage depth increases, aggregate stability tends to decrease. Aggregate stability is an essential indicator in terms of erosion risk and organic matter conservation; these results indicate that reducing tillage depth could improve aggregate stability.

Surface and Subsurface hardness were measured in the field using a soil penetrometer. Values above 300 psi can indicate restricted root growth and a reduction in pore space. Surface hardness was highly variable regardless of the tillage history. Subsurface hardness ranged from 65 to 813 psi with a median value of 348 psi. 25% of measurements were under 295 psi, meaning the majority of sampled fields have potential compaction challenges. Like aggregate stability, tillage history and weather variability can impact penetrometer readings. However, the consistency of these results indicate that compaction can often be a limiting factor for soil health, even in reduced tillage systems.

Available water capacity is a measure of water suspended in the soil that is available for plants and other soil life to use. Of all the indicators, available water capacity is among the most dependent on soil texture (the size of particles in the soil). This relationship is generally borne out in figure 26. The medium textured soils (the loams and silt loams in figure 26) tend to have higher available water capacity than the sandy loams do. There is some overlap, but the potential to improve water holding capacity is limited by soil texture.

Table 15. Aggregate stability by tillage depth

Tillage depth	*n*	*Minimum*	*Q1*	*Median aggregate stability*	*Mean aggregate stability*	*Q3*	*Maximum*	*Standard deviation*
no till	162	6.02	50.22	69.05	63.44	80.08	96.95	21.72
0-7 inches	44	5.6	35.12	55.94	51.15	66.28	81.67	19.6
7-9 inches	23	14.29	25.93	44.34	44	53.12	76.57	19.36
>9 inches	24	4.55	16.11	22.36	26.45	33.73	77.89	17.49
NA	15	4.14	37.62	61.86	59.71	87.77	95.55	32.02

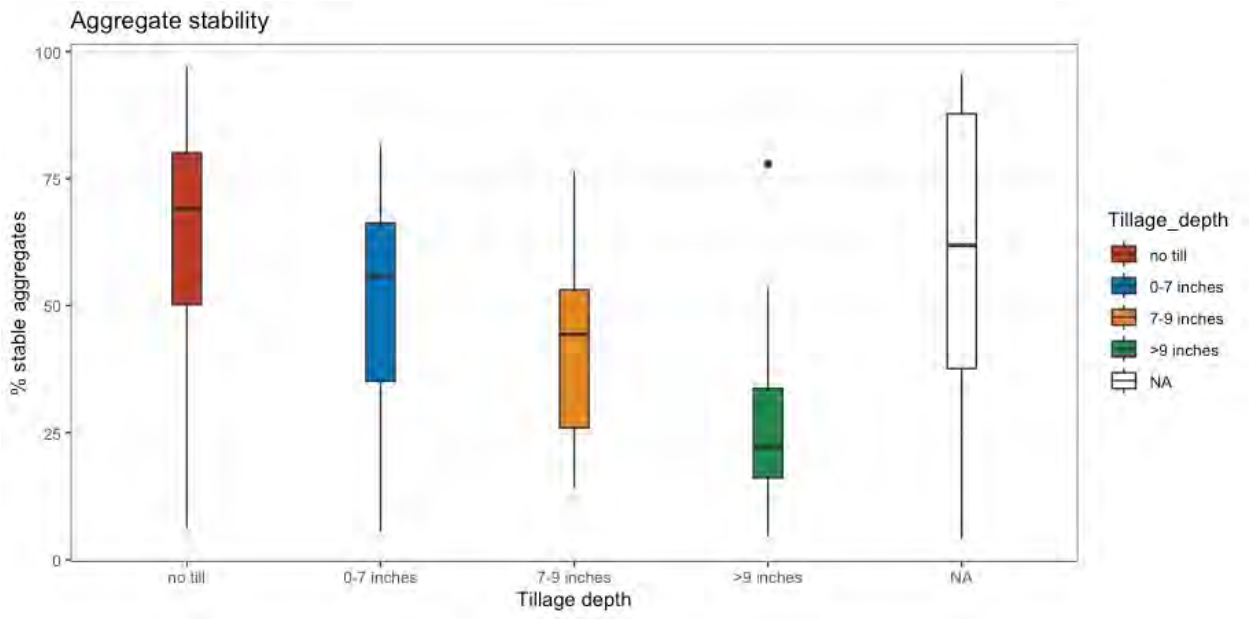


Figure 25. Boxplots show aggregate stability measures by tillage depth among 268 soil samples in Massachusetts.

Table 16. Surface hardness by tillage depth

Tillage depth	*n*	*Min*	*Q1*	*Median surface hardness*	*Mean surface hardness*	*Q3*	*Max*	*Standard deviation*
no till	162	6	162.38	215.8	224.44	274.67	654	101.82
0-7 inches	44	6.25	97.92	190.2	176.56	240.22	374	102.86
7-9 inches	23	6.25	122.82	170.9	161.7	177.15	298.6	80.08
>9 inches	24	18.75	18.75	93.75	85.53	142	154.4	65.04
NA	15	100	169.65	239	253.49	342.68	428	112.89

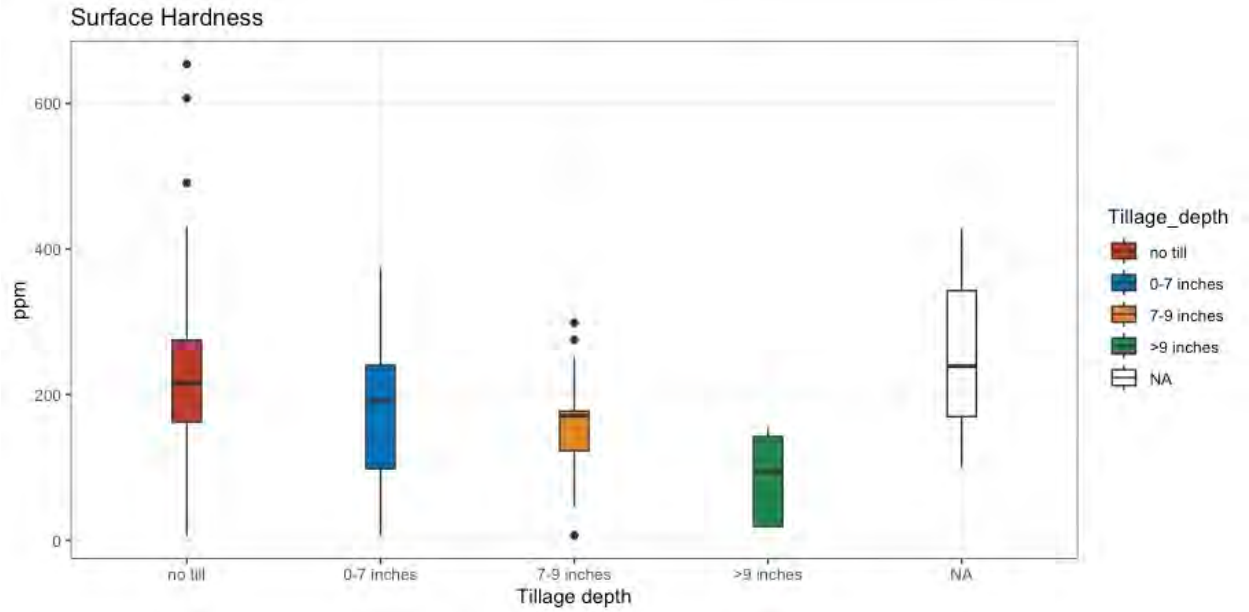


Figure 26. Boxplots show surface hardness measures by tillage depth among 268 soil samples in Massachusetts.

Table 17. Subsurface hardness by tillage depth

Tillage depth	*n*	*Min*	*Q1*	*Median subsurface hardness*	*Mean subsurface hardness*	*Q3*	*Max*	*Standard deviation*
no till	162	65	296.2	345.33	373.44	446	813.8	126.21
0-7 inches	44	200	293.75	365	363.96	436.8	558	99.94
7-9 inches	23	231.25	264.01	338.48	331.41	392.69	449	75.81
>9 inches	24	243.75	300	300	335.1	334.38	497.4	96.37
NA	15	175	319.8	497	432.17	551.1	598.6	147.72

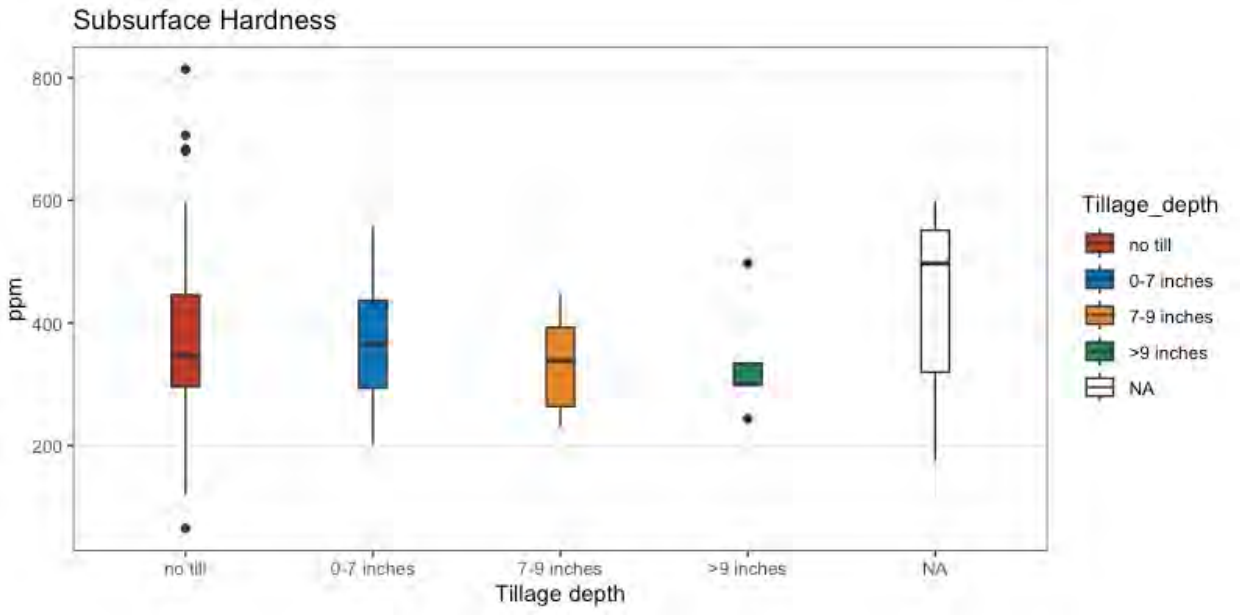


Figure 27. Boxplots show subsurface hardness measures by tillage depth among 268 soil samples in Massachusetts.

Table 18. Available water capacity by soil texture

Soil texture class	*n*	*Min*	*Q1*	*Median available water capacity*	*Mean available water capacity*	*Q3*	*Max*	*Standard deviation*
loamy sand	16	0.08	0.11	0.12	0.12	0.13	0.16	0.02
sandy loam	105	0.12	0.18	0.2	0.2	0.22	0.29	0.03
loam	95	0.19	0.22	0.24	0.24	0.25	0.28	0.02
silt loam	45	0.21	0.25	0.27	0.27	0.29	0.34	0.03
sandy clay loam	3	0.25	0.26	0.26	0.26	0.26	0.26	0
clay loam	2	0.24	0.24	0.25	0.25	0.25	0.25	0.01

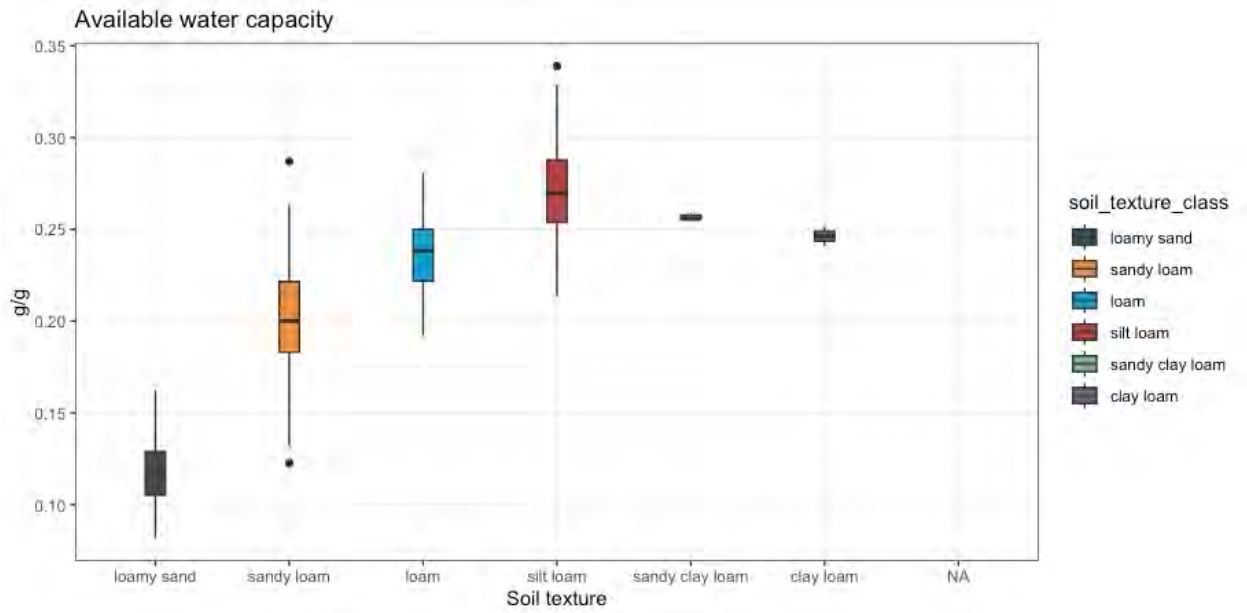


Figure 28. Boxplots show availability water capacity by soil texture among 268 soil samples in Massachusetts.

Biological Indicators

The biological indicators assessed were among the poorest performing indicators on participating farms. Compared with these biological indicators, it is more apparent when physical and chemical soil health are lacking. Erosion from poor physical soil health can leave gullies in the field and compaction can limit plant growth. Chemical deficiencies can lead to reduced yield and other plant health challenges that are immediately visible aboveground. To get a good sense of biological soil health when walking through a field, a farmer would need to dig a hole and spend time looking for telltale signs of soil life, ideally at multiple times throughout the year. Some farmers *do* have the time to do this or have prioritized it, but not all. The indicators included in the CASH test are a great way to introduce the idea of testing for soil biology to farmers.

Other commonly used testing packages do not include biological indicators, except organic matter. Among farmer participants, organic matter ranged from .73% to 10.08% with a median value of 4.4%. Half of all samples had an organic matter value of 3.21% to 5.64%.

Active carbon is the portion of carbon in the soil that is readily available as a food source. It tends to be a leading indicator for soil respiration. Active carbon values ranged from 143.9 to 1353.3 ppm with a median value of 647.2 ppm.

Respiration was the worst performing indicator overall. It is measured in a lab by re-wetting a sample and capturing emitted CO_2 over the course of 48 hours. Values ranged from .116 to 1.478 g CO_2 / g soil with a median value of .568 g CO_2 / g soil. It is important to note that respiration testing is an indicator of the overall activity of life in the soil. This type of testing does not tell us what is in the soil, specifically. Results should be combined with in field assessment to help understand the types of soil life that may be present.

Variation in all the biological indicators can partially be explained by differences in field management. These indicators are likely to have higher scores on a well-maintained permanent pasture because living roots are present year-round, and tillage is minimal.

Table 19. Organic matter content by tillage depth

Tillage depth	*n*	*Min*	*Q1*	*Median organic matter*	*Mean organic matter*	*Q3*	*Max*	*Standard deviation*
no till	162	0.83	3.78	4.92	4.93	6.16	9.73	1.89
0-7 inches	44	1.36	3.38	3.9	4.21	5.06	10.08	1.64
7-9 inches	23	2.05	2.88	4.03	3.99	5.21	6.02	1.16
>9 inches	24	0.74	2.21	3.15	3.16	3.82	7.72	1.5
NA	15	1.05	3.62	5.44	4.71	6.07	8.05	2.09

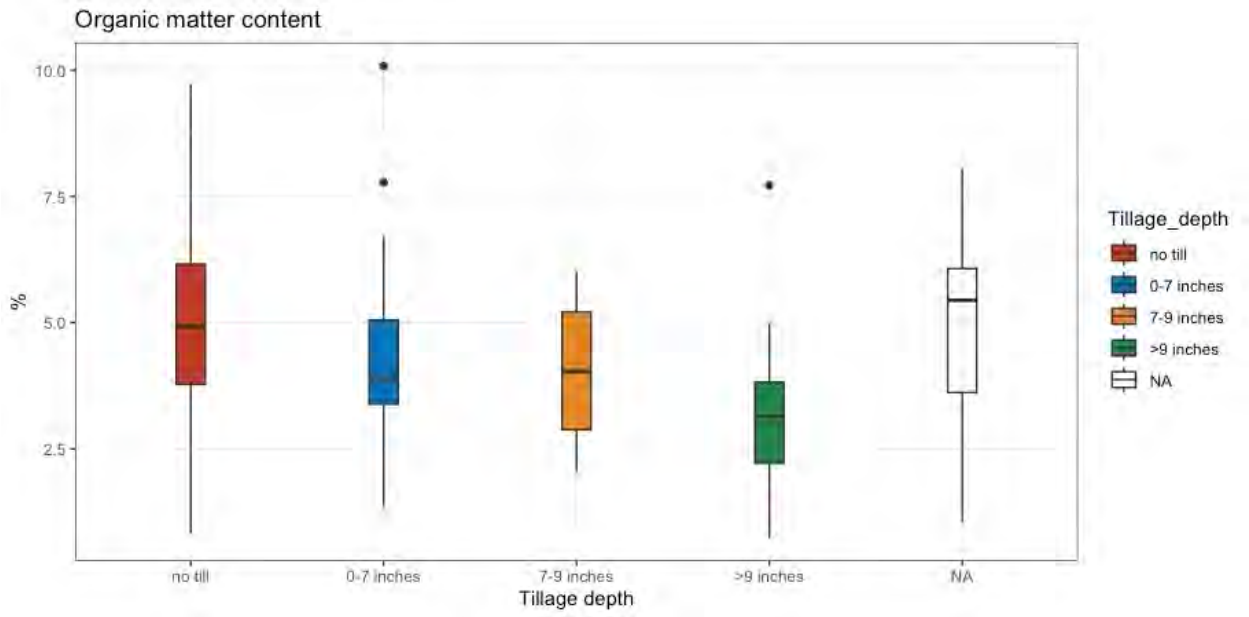


Figure 29. Organic matter content by tillage depth

Table 20. Microbial respiration by tillage depth

Tillage depth	*n*	*Min*	*Q1*	*Median respiration*	*Mean respiration*	*Q3*	*Max*	*Standard deviation*
no till	162	0.12	0.48	0.64	0.67	0.84	1.48	0.27
0-7 inches	44	0.15	0.36	0.47	0.5	0.63	1.1	0.2
7-9 inches	23	0.24	0.37	0.49	0.48	0.54	0.96	0.17
>9 inches	24	0.2	0.27	0.35	0.47	0.61	1.08	0.25
NA	15	0.27	0.47	0.72	0.84	1.09	2.03	0.45

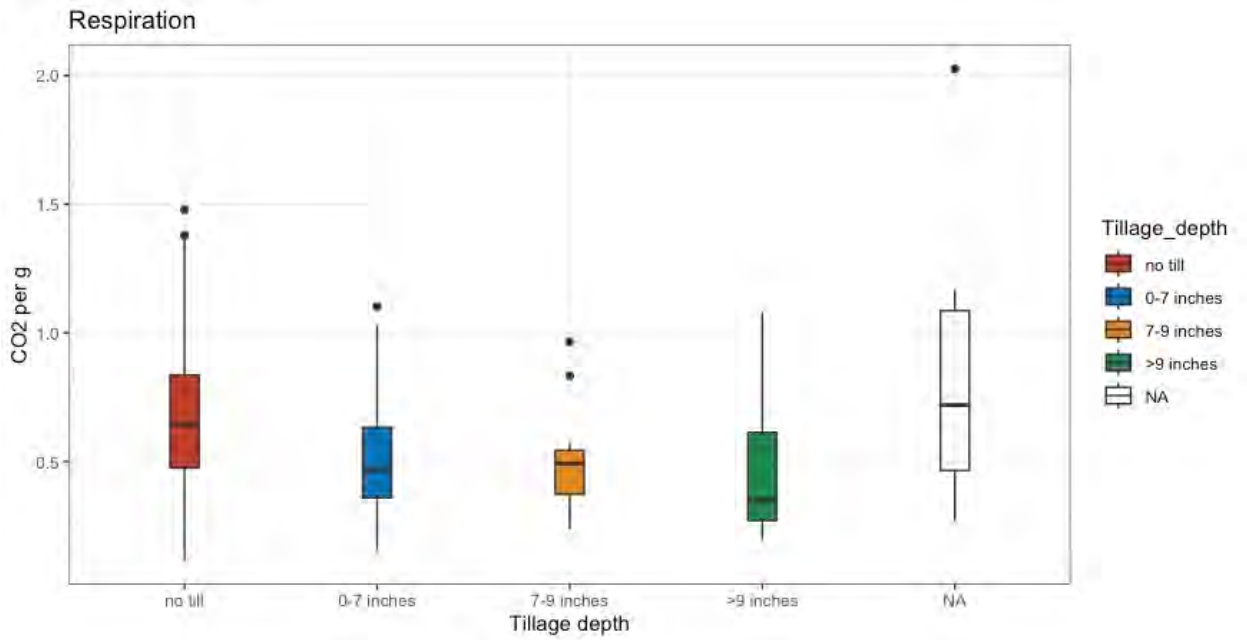


Figure 30. Soil microbial respiration by tillage depth

Table 21. Active carbon by tillage depth in ppm

Tillage depth	*n*	*Min*	*Q1*	*Median active carbon*	*Mean active carbon*	*Q3*	*Max*	*Standard deviation*
no till	162	143.9	479.11	679.95	691.3	874.8	1249.2	236.4
0-7 inches	44	213.2	436.46	634.43	628.46	752.4	1353.3	237.71
7-9 inches	23	401.4	457.08	770.63	686.49	877.3	981.57	210.81
>9 inches	24	194.2	314.32	452.61	478.97	553.7	1191.7	221.09
NA	15	249.6	608.6	631.74	636.65	796.1	846.73	195.21

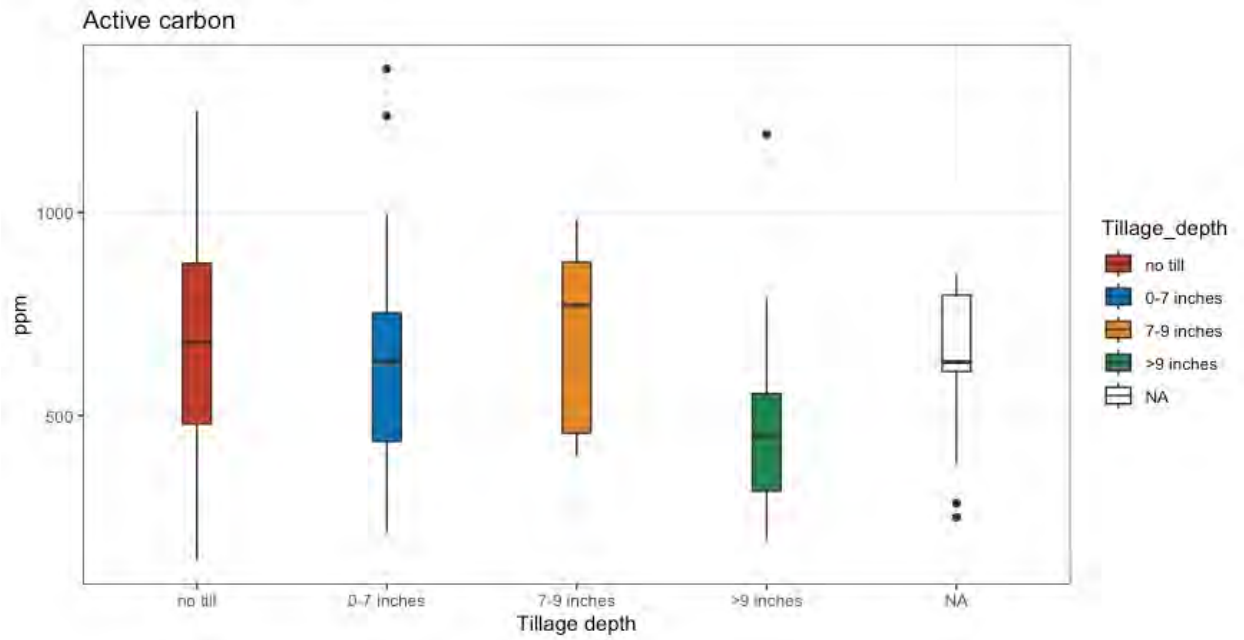


Figure 31. Active carbon by tillage depth

Limitations

The accompanying survey did not ask farmers specific questions about the fields they had collected samples from. While we know that most of the farmers implemented conservation practices on their farm, we don't know if they were implemented on the specific tested fields. Collecting this information in the future may help to explain some of the variability in each of the CASH indicators.

For several questions, we examined differences along demographic lines among survey participants. While the response rate for farmers self-identifying as Asian/Pacific Islander, Black, Hispanic or Latina/o/x, Indigenous, and other ethnicities generally matched the 2022 Census of Agriculture, the total number of responses was small. For this reason, these ethnicities were all rolled into the BIPOC category for the purposes of our analysis. It is entirely possible that nuance in levels of access exist between these groups that this survey was not able to uncover.

We also don't know which samples represent vegetable fields, pastures, or other specific growing systems. Indicators will likely fall into different ranges depending on these factors and would also explain some of the variability in the data, especially among the biological indicators.

Recommendations

Together, the results of the statewide producer survey and the soil health testing data provide rich information to inform and improve soil health programming in Massachusetts.

Our preliminary analysis identifies gaps and opportunities for programmatic approaches that will best support adoption and continued use of soil health practices, as well as strategies to make support services more equitable.

First, we recommend continued provision of no-cost soil testing and soil test interpretation for farmers. This was widely requested, and our data supports the idea that free testing and interpretation will increase utilization of soil tests as a decision support tool to help farmers improve soil health. Routine soil tests are a relatively easy and inexpensive way to help farmers actively address organic matter and pH levels – two barriers to soil health and overall productivity on farmed soils. Lab testing from land grant universities is a familiar and affordable way to access information about these two indicators. CASH testing packages can be expensive, though a-la-carte options are available if greater detail about specific indicators that are not included in a standard nutrient analysis would be helpful.

Education and technical assistance needs are clearly identified with the data showing that farmers a) enjoy learning from and seek out knowledge from each other, b) prefer in-person and on-farm learning opportunities, and c) prefer that technical assistance is delivered on the farm. We therefore recommend increased support for fostering farmer-to-farmer connection and learning, and prioritizing in-person, on-farm technical assistance and learning events. Farmers can succeed in learning from each other when they are supported to do so in an on-farm setting—this support can be provided by non-profits, or state or federal government entities. One-on-one technical support is also desired by the survey population. We recommend that this support be individualized and delivered in-person whenever possible.

There is room for improvement in outreach and enrollment strategies for financial assistance programs. Financial assistance was the educational topic most requested by survey respondents, yet less than a third of respondents were participating in an NRCS program at the time of the survey, 79% of respondents reported that they didn't know of any sources of financial assistance outside of NRCS and MDAR, and cost is routinely identified as the top barrier to using soil health practices.

Survey responses reveal a demographic gap in farmer awareness about available financial assistance programs. It is possible that inequitable outreach practices are a contributing factor. White male farmers were consistently more likely to know about financial assistance programs, were more likely to be contacted by staff about opportunities to enroll and were more likely to receive support from staff in applying. We recommend a strong focus on partnering with organizations led by BIPOC, women and LGBTQ+ farmers to increase awareness of opportunities and to improve accessibility of the financial assistance application process.

Barriers to using soil health practices including difficulty identifying technical assistance, cost, time, and uncertainty in soil health outcomes were reported more frequently by

women and BIPOC farmers. Here again we recommend technical assistance via partnership with existing organizations led by BIPOC, women and LGBTQ+ farmers.

Equipment knowledge and access are also consistent barriers to implementation of soil health practices. Farmers reported that they either did not know what equipment they needed, or they were not sure if the equipment they had was the most appropriate. This uncertainty bore out in reported applications to the MDAR equipment grant program; the vast majority of respondents have not applied. We recommend expanding the number of opportunities farmers have to learn about equipment and its application in soil health practice adoption. Events like equipment demo field days, farmer round tables focused on the details of equipment use, or equipment share programs can go a long way towards improving farmer knowledge.

Finally, we recommend increasing the number of grant programs with a focus on soil health generally and providing grant writing assistance to farmers. Grants were, by far, the most requested form of financial assistance. Depending on how grants are structured, they can offer more flexibility than cost share programs do. However, given the barriers to financial support seen among NRCS programs, it is crucial that other grant programs take the necessary steps to conduct outreach in an equitable and accessible way. We recommend a strong focus on partnering with organizations led by BIPOC, women and LGBTQ+ farmers to provide grant opportunities that are relevant and accessible to under-resourced groups. We also recommend that grant making organizations consider opportunities to engage farmers who have submitted successful grant applications in the past to assist other farmers through farmer-led workshops, mentorship, or consulting roles.

Beyond MACSHP

As a result of the foundational work of MACSHP, the AFT New England Climate and Agriculture team developed several regional projects. These include the Farmer-Led Innovations Program, the No More Normal Farmer Roundtables, the Soil Health Management Planning Cohorts, and the New England Soil Health Survey.

Both our No More Normal Roundtables and our Farmer-Led Innovations projects were inspired by and evolved out of a MACSHP roundtable organized at Atlas Farm by Julie Fine in February 2022. The focus was to facilitate conversation amongst experienced, medium-scale farmers sharing what has and has not worked in their efforts to reduce tillage, which is their primary strategy for improving soil health. The impetus for this roundtable included ideas contributed by the Soil Health Advisory Committee, MACSHP survey responses, and MACHSP soil health demonstrations. The Roundtable model piloted in that first event led to the formation of the No More Normal Roundtable, which has been a regular component of the MACSHP project for 3 years.

The topical focus of that 2022 event— experienced, medium scale organic farmers trying to reduce tillage—we determined to be an unmet need as a direct result of our work in the farming community in the beginning phases of MACSHP. AFT applied for additional, complimentary funding to build a cross-regional program bringing together medium-scaled organic farmers in Maine and Massachusetts to form a peer-support working group to develop solutions for advancing tillage reduction on tractor scale organic farms. This program is now in its second iteration with a Connecticut cohort. We continue to grow this program across New England and are planning future northern New England cohorts.

Another need identified through MACSHP was improved access to technical support and financial assistance for soil health; a majority of survey respondents do not and have not had NRCS grants. Additionally, the most valued form of technical support by survey respondents was a visit from a service provider to the farm along with follow-up technical support. In order to bridge these gaps, MACSHP's original program lead, Caro Roszell, acquired NRCS certification in Soil Health Management Planning and developed a Soil Health Management Planning Cohort Program, which assists farmers to develop their own soil health management plans according to NRCS technical standards over the course of a year in a peer-supported classroom style format. The program begins with a visit to each farm, soil testing, In-Field Soil Health Assessment, and results in a Soil Health Management Plan that can be submitted to NRCS for cost-share consideration, potentially resulting in an EQIP or CSP contract.

Soil health sampling was a consistently popular aspect of MACSHP programming. Starting in 2024, AFT was able to expand soil testing beyond MA to CT, VT, and NH. This soil sampling effort is a partnership with the USDA Agricultural Research Service Food Systems Research Unit and expands upon the survey work done as part of the MACSHP project. In addition to soil health testing, participating farmers are completing a social science survey focused on management decisions and field history to build a coupled dataset with soil health results. This new regional dataset will address many of the limitations discussed previously in this report.

Conclusion

Soil health, farmer experience, and appropriate solutions are variable across farms and across the Commonwealth. The information presented in this report can serve as a baseline for knowledge, practice, and action among soil health practitioners. It is clear that many farmers in Massachusetts are a wealth of soil health knowledge and experience that could be shared with others who are eager to learn. Farmer-led, farmer-focused efforts can go a long way towards improving soil health knowledge outside of the group that participated in MACSHP programming. Several clear opportunities exist to improve access to financial and technical support services to address stated needs for things like equipment, soil amendments, and other crucial materials for conservation practice implementation. As soil health leaders in the nation, Massachusetts farmers have come a long way, and the next step is becoming clearer.

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Appendix A:

Project Overview

American Farmland Trust and the Massachusetts Department of Agriculture have convened a Soil Health Advisory Committee who are working to identify how technical support and financial assistance for healthy soils practices can be strengthened in the Commonwealth. Your feedback will help to inform and shape future technical support, financial assistance, and other programs.

Thank you in advance for sharing your valuable input.

Privacy & Data Use: Your trust is important to American Farmland Trust. We will protect your personal information (such as your contact information and demographics) when sharing raw survey results with our partner agencies, and will anonymize all responses in published results unless you explicitly give us permission to attribute your answers (we will ask you at the end of the survey about this).

1. Name and Farm Name

Name (First, Last):

Farm Name

* 2. County

* 3. State

- ◯ Massachusetts
- ◯ Other New England State (CT, RI, VT, NH or ME)
- ◯ Outside of New England

* 4. Acres in cultivation:

5. How do you market your products? (Choose all that apply)

- ☐ Direct to consumer: CSA
- ☐ Direct to consumer: farmers market or farm stand
- ☐ Restaurant sales
- ☐ Wholesale
- ☐ Other (please specify)

6. My farm is (Choose all that apply):

- [ ] Conventional
- [ ] Certified Organic
- [ ] Organic, not certified
- [ ] Soil health focused (i.e. using practices to not only maintain but actively increase soil organic matter and build soil health)
- [ ] Other - Please explain

7. Primary Enterprise (enterprise that provides the largest proportion(s) of the farm's income). If you you have more than one enterprise with relatively equal contribution to the farm's income, then select up to your top three enterprises:

- [ ] Hay (or other forage crop)
- [ ] Corn, Silage
- [ ] Corn, Grain
- [ ] Dairy (Cows, goats, and other milking animals)
- [ ] Livestock, Non-dairy (meat, eggs)
- [ ] Grain
- [ ] Vining Fruit
- [ ] Small Fruit / Berries (excluding cranberries)
- [ ] Cranberries
- [ ] Tree Products (Orchard Fruit, Christmas Trees, Tree Forage)
- [ ] Vegetables, Various and/or Diversified, 1-3 different vegetable crops
- [ ] Vegetables, Various and/or Diversified, 3-10 different vegetable crops
- [ ] Vegetables, Various and/or Diversified, Greater than 10 different vegetable crops
- [ ] Other (please specify):

8. If you chose "vegetables," please tell us what your top three crops are:

Demographics

A note about our race and gender demographic questions: We understand that there are historic and persistent disparities in access to services and resources in the agricultural industry. By providing demographic information, we will be better able to understand, record, report on, and work to address these gaps. If you prefer to not provide this information, please select "Prefer not to say" for each category.

9. I identify as:

- [ ] Female
- [ ] Male
- [ ] Non-binary/gender expressive
- [ ] Prefer not to say
- [ ] Prefer to self-describe:

10. I identify as (choose all that apply):

- [ ] Indigenous
- [ ] Asian/Pacific Islander
- [ ] Black
- [ ] White
- [ ] Hispanic or Latino/a/x
- [ ] Some other race, ethnicity, or origin
- [ ] Prefer not to say
- [ ] Prefer to self-describe:

* 11. How many years have you been farming?

Soil Health and Farming Practices

12. Which of these options describe your tillage practices (Please select more than one option if a portion of your acreage is in different tillage regimes)

- [ ] Standard tillage (plowing and/or harrowing used)
- [ ] Reduced till (changes have been made to farming systems to reduce plowing and harrowing events in the field)
- [ ] Minimum tillage (no more than one plowing and/or harrowing event per year per field)
- [ ] Strip till (bands of no-till between small bands of till)
- [ ] No-till (no plowing or harrowing)
- [ ] Hand-scale soil management practices (no-till without tractors)
- [ ] Permanent pasture, orchard or other perennial crop that requires no tillage
- [ ] Other (please describe)

Soil Health and Farming Practices

13. Have you considered trying no-till or strip-till? What has prevented you from doing so?

14. Do you currently own any no-till equipment (including tractor-based and hand-scale equipment)?

- ◯ Yes, I own and currently use it
- ◯ No
- ◯ Yes, I own no-till equipment but do not currently use it.

Soil Health and Farming Practices

15. Please tell us why you do not currently use your no-till equipment.

16. Do you plant cover crops on any of your fields, plots, or beds?

- ◯ No
- ◯ Only when I have financial assistance to do so
- ◯ Yes, single species cover crop that winter kills
- ◯ Yes, single species cover crop that over winters
- ◯ Yes, multi-species (mix). Please share species:

17. Which of the following do you use on all or some of your fields, plots or beds? Please select all that apply.

- ☐ Compost
- ☐ Hay, straw, leaves, or wood chip mulch (purchased in)
- ☐ Hay, straw, leaves or wood chip mulch (produced on-farm)
- ☐ Mulch grown in place (ie managing cover crops for residue / soil cover)
- ☐ Plastic mulch or tarps
- ☐ Biodegradable plastic mulch
- ☐ Manure or digestate
- ☐ None

18. Do you have livestock?

- ◯ Yes
- ◯ No

Education and Technical Support

For the purposes of this section, "education" is the activity of learning through resources or events that are created for a public or group audience, while "technical assistance" is one-on-one education or assistance that is delivered directly to you or to a small group of decision makers from your farm via phone/video calls, emails, written plans, field visits and/or meetings.

19. Where do you find education and information about soil health? **Please choose all that apply.**

- [ ] Other farmers I know
- [ ] Farmer-led sessions at conferences, live workshops or webinars
- [ ] Attending agricultural company representative's sessions at conferences, workshops or webinars (ie equipment, fertilizer and cover crop seed company representatives)
- [ ] Specialist-led sessions at live workshops, conferences or webinars (ie researchers, NRCS service provider or extension agents).
- [ ] NRCS workshops
- [ ] Extension workshops
- [ ] Conservation District workshops
- [ ] NOFA workshops
- [ ] Trade publication and/or books
- [ ] Podcasts/YouTube/Online research
- [ ] Other (please specify)

20. Where do you currently seek/ access technical assistance for soil health? Please choose all that apply.

- [ ] Other farmers I know
- [ ] Representatives from agricultural supply / product company
- [ ] Representatives from a soil lab
- [ ] A soil conservationist that I know from NRCS
- [ ] Someone I know at Extension / land grant university
- [ ] Someone I know at my local Conservation District
- [ ] Someone I know at NOFA
- [ ] Contacting local NRCS office, Extension, Conservation District or other agency through general information lines (ie there is no specific person that I reach out to directly)
- [ ] I hire a consultant
- [ ] I don't use any technical support
- [ ] Other (please specify)

21. Do you currently have an EQIP, CSP or AMA contract with NRCS?

- ◯ Yes
- ◯ No
- ◯ No, but I have had one previously
- ◯ I don't know what one or more of these are

22. Have you been contacted by someone from NRCS or a Conservation District to invite you to apply for services?

- ◯ Yes
- ◯ No

23. Have you received support from NRCS or your Conservation District (CD) to apply for services (technical and/or financial)? Please choose the option that best describes your experience:

- ◯ Yes, I reached out to NRCS or my CD and they helped me apply for services.
- ◯ Yes, I was contacted and invited to apply for services from someone at NRCS or my CD, and they assisted me in applying for services.
- ◯ No, I contacted NRCS and/or my CD but I did not hear back and/or get the help I needed.
- ◯ No, someone from NRCS/my CD contacted me but I did not follow through with an application.
- ◯ No, I receive services from NRCS but I don't need any help applying.
- ◯ I didn't know I could get assistance applying for services.

24. Have you applied for an MDAR grant for no-till equipment?

- ◯ Yes and it was awarded
- ◯ Yes and it was not awarded
- ◯ No

25. Have you received financial incentives for soil health practices (eg. tillage reduction, cover cropping, mulching, erosion reduction, and biodiversity support practices) from sources other than NRCS or MDAR?

- ◯ No, but I'm aware of other places where I could apply
- ◯ No, and I'm not familiar with any other options for financial incentives or assistance
- ◯ Yes. Please specify program or source:

26. If small grants of $5,000-10,000 were available to farmers to support healthy soils practices adoption, what would you spend it on that would best help you meet your soil health goals?

27. Do you use lab-based soil testing services?

- ◯ Yes
- ◯ No

Education and Technical Support

28. Please share how often you have your soil tested:

- ◯ Never
- ◯ Once every three years or less
- ◯ Every other year
- ◯ Annually
- ◯ Twice a year or more

29. Do you use any services to help you interpret your soil test results?

- ◯ Yes
- ◯ No

30. If soil testing were free or less costly, would you use this service more often?

- ◯ Yes, only if it were free
- ◯ Yes, if it were less costly or free
- ◯ No

Challenges in Adopting Soil Health Practices

Please use the slider to indicate the degree to which each statement applies to you

When considering adopting a new healthy soils practice, I have been or I am limited in my ability to implement it because:

31. I don't have enough time for learning new practices

Neutral / Not applicable

Agree Disagree

32. The upfront costs are prohibitive

Neutral / Not applicable

Agree Disagree

33. There is too much uncertainty about yield outcome

Neutral / Not applicable

Agree Disagree

34. There is too much uncertainty about the soil health outcome

Neutral / Not applicable

Agree Disagree

35. I don't have enough technical support

Neutral / Not applicable

Agree Disagree

36. If a given soil health practice would **save me time** in future seasons, even if it takes more time for the first two seasons, I would implement it.

Agree Neutral Disagree

37. If a given soil health practice would **save me money** in future seasons, even if it costs more for the first two seasons, I would implement it.

Neutral / Not applicable

Agree Disagree

38. Do you have all the equipment you need to implement the healthy soils practices you want to adopt?

- Yes
- No
- I am not interested in adopting any healthy soils practices.
- I don't know

Challenges in Adopting Soil Health Practices

39. Please select your reason for not having access to needed equipment:

- ◯ I don't know where to find information on equipment
- ◯ I'm not quite sure what equipment I need
- ◯ I have some specific questions about equipment brand, size and features that I need to get answered before I make an investment
- ◯ It is not commercially available
- ◯ It is available but hard to find a local dealer
- ◯ It is available but too expensive
- ◯ It is available via equipment sharing program but inconvenient to access

40. Choose the statement that you feel most reflects your experience:

- ◯ I have enough educational resources on healthy soils practices and time to learn
- ◯ I have time to learn about soil health but not enough resources or technical support
- ◯ I have enough resources about soil health but not enough time to learn
- ◯ I'm not interested in adopting any new soil health practices

41. Which of the following forms of technical support would be most helpful to you. **Please select only 3.**

- ☐ On-farm visit and follow-up recommendations on field soil health and practices by a technical specialist
- ☐ Soil lab results analysis and recommendations for amendments application
- ☐ Compatible cover crop combination for my production system
- ☐ Nutrient management
- ☐ Manure management
- ☐ Technical support on feed management / grazing management
- ☐ Methods of increasing soil organic matter compatible with my production system.
- ☐ Identifying equipment to help me increase the efficiency of healthy soils practices
- ☐ A consultation with an farmer experienced in the healthy soils practices or systems you need support with

42. Which of the following education formats would be most helpful to you. **Please select only 3.**

- [ ] On-farm field days
- [ ] Live webinars with Q&A
- [ ] Recorded webinars
- [ ] Recorded field days
- [ ] Farmer roundtables discussions with prompts and facilitation
- [ ] Farmer roundtables, open-ended
- [ ] Farmer-led workshops with farmer discussion following
- [ ] Farming conferences with workshops from farmers, researchers and agriculture companies

43. What topics are you most interested in learning more about? **Please select only 3.**

- [ ] Soil health indicators for farmers
- [ ] Equipment options for tillage reduction
- [ ] General farm systems for tillage reduction
- [ ] Cover crop choices
- [ ] Crop variety choices for tillage reduction
- [ ] Planting green
- [ ] Roller crimping
- [ ] Planting methods for tillage reduction
- [ ] Tillage reduction and nutrient management planning
- [ ] Transition support for organic
- [ ] Transition support for tillage reduction
- [ ] Transition support for cover crop rotations
- [ ] Time saving and efficiency within soil health practices
- [ ] Transition support to implement or expand grazing and pasture
- [ ] Financial assistance available for farmers for soil health and how to access it

44. Which form of financial assistance would be most helpful to you?

- ◯ Grants
- ◯ Greenhouse gas mitigation payments
- ◯ NRCS cost sharing
- ◯ Trials funding
- ◯ Land rental payments for contractual conservation practices
- ◯ Education stipends for learning new practices
- ◯ Financial assistance for equipment rental
- ◯ Other (please specify)

45. I am generally most interested in receiving technical assistance through:

- ◯ Farm visits
- ◯ Phone
- ◯ Video call
- ◯ Email

Survey Wrap-Up

46. I would like to be contacted about (select all that apply)

- [ ] Financial assistance opportunities made available through this Soil Health Program
- [ ] Available technical assistance from AFT and partner organizations
- [ ] Available financial assistance from AFT and partner organizations
- [ ] Education events such as Soil Health Field Days and workshops
- [ ] Not interested, please do not contact me
- [ ] Other (please specify)

47. If you would like to be contacted regarding opportunities related to this program, please provide your phone number, email address, or both in the spaces provided.

By providing your email address and/or phone number you agree to receive communications from AFT, unless you stated "do not contact me" in your response to the question above.

Email Address

Phone Number

48. Would you be willing to participate in a **paid** interview with project staff to discuss your experiences with soil health practices?

- ◯ Yes
- ◯ No

49. Please share any suggestions for platforms or networks where we might advertise this program to a diverse range of farmers across Massachusetts in the future (e.g., listservs, networks, etc.).

50. I give AFT permission to use the information provided in this survey for public communications regarding the MDAR grant program and as a means to engage the public in farmland access and agriculture.

- ◯ Yes, anonymously
- ◯ Yes, and you can attribute the quote to me (using my name and my farm name)
- ◯ Contact me first for permission
- ◯ No

51. Thank you so much for taking the time to fill out our survey! You are helping to shape the future of soil health programs in Massachusetts. Before you go, is there anything else you want us to know?

Appendix B: Sample CASH Report

Comprehensive Assessment of Soil Health

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences
School of Integrative Plant Science, Cornell University, Ithaca, NY 14853
https://soilhealthlab.cals.cornell.edu

Grower: Calyx Farm
skelemer rg

Agricultural Service Provider:
Aysha Tapp Ross

Sample ID: BBB3198
Field ID:
Date Sampled:
Given Soil Type:
Crops Grown:
Tillage:
Coordinates:

Measured Soil Textural Class: **loam**

Sand: **46%** - Silt: **38%** - Clay: **16%**

Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	0.23	86	
physical	Surface Hardness	161	51	
physical	Subsurface Hardness	275	59	
physical	Aggregate Stability	79.1	100	
biological	Organic Matter Soil Organic Carbon: 4.06 / Total Carbon: 4.06 / Total Nitrogen: 0.27	5.8	100	
biological	ACE Soil Protein Index	14.7	99	
biological	Soil Respiration	0.7	68	
biological	Active Carbon	764	92	
chemical	Soil pH	5.9	72	
chemical	Extractable Phosphorus	6.5	100	
chemical	Extractable Potassium	110.1	100	
chemical	Additional Nutrients Ca: 988.6 / Mg: 170.5 / S: 17.3 Al: 115.6 / B: 0.1 / Cu: 0.15 Fe: 5.4 / Mn: 2.6 / Zn: 0.7		88	

Overall Quality Score: **85** / Very High

Supplemental Soil Testing (see last page of report)

Soluble Salts (Conductivity)
0.25 mmhos/cm

Measured Soil Health Indicators

The Cornell Soil Health Test measures several indicators of soil physical, biological and chemical health. These are listed on the left side of the report summary, on the first page. The "value" column shows each result as a value, measured in the laboratory or in the field, in units of measure as described in the indicator summaries below. The "rating" column interprets that measured value on a scale of 0 to 100, where higher scores are better. Ratings in red are particularly important to take note of, but any in yellow, particularly those that are close to a rating of 30 are also important in addressing soil health problems.

- **A rating below 20 indicates *Very Low (constraining)* functioning and is color-coded red.** This indicates a problem that is likely limiting yields, crop quality, and long-term sustainability of the agroecosystem. In several cases this indicates risks of environmental loss as well. The "constraint" column provides a short list of soil processes that are not functioning optimally when an indicator rating is red. It is particularly important to take advantage of any opportunities to improve management that will address these constraints.
- **A rating between 20 and 40 indicates *Low* functioning and is color-coded orange.** This indicates that a soil process is functioning somewhat poorly and addressing this should be considered in the field management plan. The Management Suggestions Table at the end of the Soil Health Assessment Report provides linkages to field management practices that are useful in addressing each soil indicator process.
- **A rating between 40 and 60 indicates *Medium* functioning and is color-coded yellow.** This indicates that soil health could be better, and yield and sustainability could decrease over time if this is not addressed. This is especially so if the condition is being caused, or not being alleviated, by current management. Pay attention particularly to those indicators rated in yellow and close to 40.
- **A rating between 60 and 80 indicates *High* functioning and is color-coded light green.** This indicates that this soil process is functioning at a non-limiting level. Field soil management approaches should be maintained at the current intensity or improved.
- **A rating of 80 or greater indicates *Very High* functioning and is color-coded dark green.** Past management has been effective at maintaining soil health. It can be useful to note which particular aspects of management have likely maintained soil health, so that such management can be continued. Note that soil health is often high, when first converting from a permanent sod or forest. In these situations, intensive management quickly damages soil health when it includes intensive tillage, low organic matter inputs, bare soils for significant parts of the year, or excessive traffic, especially during wet times.
- **The Overall Quality Score** at the bottom of the report is an average of all ratings, and provides an indication of the soil's overall health status. However, the important part is to know which particular soil processes are constrained or suboptimal so that these issues can be addressed through appropriate management. Therefore the ratings for each indicator are more important information.