Renewable Agriculture and Food Systems

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Improving agri-environmental policy design: farmer and administrator insights on voluntary conservation programs

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Research Paper

Cite this article: Irvine R., Wardropper C., Harden S.C., and Yoder L. 2025. Improving agri-environmental policy design: farmer and administrator insights on voluntary conservation programs. *Renewable Agriculture and Food Systems*, **40**, e9, 1–10
https://doi.org/10.1017/S1742170525000067

Received: 09 May 2024
Revised: 05 September 2024
Accepted: 12 February 2025

Keywords:
adoption; agricultural conservation; best management practices; environmental policy; persistence; program effectiveness

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Abstract

Worldwide, voluntary agri-environmental programs encourage farmers to adopt environmentally friendly practices. However, the impact of program design on farmers' participation and long-term practice persistence is unclear. Toward improving program effectiveness, this study illustrates the value of a tailored practice-specific approach to agri-environmental program design. We present a case study of programs promoting cover crops, a conservation practice that can improve soil health and reduce nutrient pollution, drawing from five focus groups with farmers (n = 20) and program administrators (n = 14) in the U.S. Midwest (Iowa, Illinois, and Indiana). Participants perceived cover crop programs to best support farmers is characterized by flexibility and minimal transaction costs. Participants suggested a more data-driven approach to program design particularly for understanding the farm-level economic implications of cover crop use. Integrating financial planning and participatory research components alongside traditional financial incentives and technical assistance were proposed as valuable strategies to enhance program design and broaden the appeal of conservation practices like cover crops.

Introduction

Agri-environmental programs (AEPs) are used worldwide to encourage farmers to adopt management practices that mitigate agriculture's negative environmental and climate impacts (Pineiro et al., 2020). Policies that promote voluntary uptake of conservation practices are more common than mandatory approaches since the latter can be politically and logistically challenging (Holland, Bennett and Secchi, 2020). While the design of voluntary AEPs varies, most provide farmers with financial incentives and technical assistance over a set contract period. In exchange, farmers commit to implementing specified best management practices (BMPs). Agricultural BMPs encompass a broad array of management strategies that enhance environmental outcomes, ranging from optimizing fertilizer application to reducing tillage to planting cover crops. Scholars have found that farmers' awareness of and positive attitudes toward specific programs and the BMPs they promote are among the few variables that consistently predict BMP adoption (Prokopy et al., 2019). Thus, ensuring a positive participant experience in AEPs presents a promising avenue toward scaling BMP use.

Despite their prevalence, AEPs are often operated with limited evidence of their impact (Wardropper et al., 2022). Little is known regarding how program participation affects farmers' long-term behavioral change (i.e., BMP practice persistence) or the resulting environmental benefits derived from sustained BMP use (Yoder et al., 2019). Instead, AEPs tend to follow an 'incentive-adoption-outcome' logic wherein program outcomes are assumed to be realized if sufficient incentives are offered to drive adoption (Pineiro et al., 2020). Given limited data and resources for causal assessments of programs, AEP design often emphasizes additionality, for instance, by counting the number of new acres on which cover crops are planted (Mezzatesta, Newburn and Woodward, 2013; Ribaudo, 2017).

Advocates for a more human-centered approach to program design suggest that improving the participant experience could improve program outcomes (Sorice and Donlan, 2015). To this end, scholars have studied a range of factors that influence willingness to participate in AEPs. No common factors across studies have been found to significantly predict participation, but participation may be associated with individual characteristics including pro-environmental attitudes and higher education (Comerford, 2014), larger farm size (Lynch and Lovell, 2003), and previous adoption of conservation practices (Prokopy et al., 2019). Program attributes may further affect AEP participation (Table 1). Participants typically favor programs that provide 'freedom of choice' (Sorice and Donlan, 2015) and are marked by 'low complexity' (Reimer and Prokopy, 2014; Duke et al., 2021). AEPs that present an economic advantage through enhanced productivity or profitability are also found to encourage farmers to adopt BMPs in the short-term (Pineiro et al., 2020).

Table 1. Program attributes and characteristics associated with program participation

Program attributes	Characteristics associated with willingness to participate	Selected references
1. Recruitment	Participant-initiated; outreach by program staff; promotion via social networks	Arbuckle, 2013; Bressler et al., 2021
2. Enrollment	Streamlined enrollment process; minimal paperwork; low complexity; positive interactions with program staff	McCann and Claassen, 2016; Palm-Forster et al., 2016
3. Contract length	Shorter contracts; enrollment flexibility	Ruto and Garrod, 2009; Yehouenou et al., 2020
4. Participation requirements	Freedom of choice; low complexity; low stringency; self-monitoring; option to stack payments	Reimer and Prokopy, 2014; Chapman, Satterfield and Chan, 2019; Duke et al., 2021
5. Type of support	Technical assistance: a high percentage of costs covered	Garbach, Lubell and DeClerck, 2012; Palm-Forster et al., 2023
6. Administration	Positive staff interactions; administration by an agricultural entity	Reimer and Prokopy, 2014; Sorice and Donlan, 2015; Yehouenou et al., 2020; Han and Niles, 2023b

Despite these insights, AEPs fall short of achieving social and environmental goals (Pineiro et al., 2020). Pannell (2008) argues that policy instruments are frequently 'oversimplified and not made context-specific,' reinforcing Sorice and Donlan's (2015) recommendation to better tailor programs to users. Relatively few studies have assessed farmers' experiences with AEPs (for exceptions, see Medina, Isley and Arbuckle, 2020; Reimer et al., 2023; Houser et al., 2024). Leveraging such insights to inform program design might enhance stakeholder buy-in among farmers who are interested in the potential benefits of using cover crops yet remain hesitant to adopt them (Tellez, Walpole and Wilson, 2021). Additionally, the differential effects of BMP attributes on farmers' management decision-making have been given relatively little attention in AEP design. Recent findings on the persistence and abandonment of different BMPs (Pathak et al., 2023) suggest that long-term decision-making regarding BMP use is heterogeneous and affected by the characteristics of specific BMPs (Swann and Richards, 2016).

We aimed to improve AEP design through a case study of U.S. Midwest farmers' and program administrators' experiences with cover crop programs. Cover crops offer a compelling case study for program design because of their widespread appeal and potential environmental benefits. Typically planted during fallow periods between cash crops, well-managed cover crops can mitigate erosion, suppress weeds, and improve soil health (Wallander et al., 2021). Despite increased investment in supporting cover crop adoption, cover crops were used on <5% of U.S. row crop acres as of 2017 (Wallander et al., 2021). Previous research has identified various drivers and barriers to their adoption, including perceived management benefits like erosion control and challenges such as upfront costs and labor requirements (Arbuckle and Roesch-McNally, 2015; Deines et al., 2023). Some U.S. Department of Agriculture (USDA) programs have been linked to increased cover crop adoption but not necessarily long-term persistence (Park et al., 2022; Guo et al., 2023). Concerningly, a significant percentage of adopters abandon cover crops within 7 years (Dunn et al., 2016; Han and Niles, 2023a), highlighting the need to explore how BMP-specific attributes intersect with AEP design and farmers' decisions over time.

Methods

We investigated how cover crop AEP design could better support farmers' use of cover crops through focus group discussions with AEP administrators (n = 15) and corn/soybean row crop farmers (n = 20) who had direct experience with these programs. This study, approved by [institution redacted for peer review] Internal Review Board (#17886), is part of a broader research effort examining cover crop insurance discount programs in the adjacent U.S. I-states (Iowa, Illinois, and Indiana), which offer a $5 per acre reduction on crop insurance premiums for enrolled cover crop acres. Consequently, all participants were recruited from the I-states region.

Our research draws from five focus groups conducted in Spring 2023: three in-person sessions with farmers, one in each of the I-states, and two online sessions with AEP administrators. Each 90-minute discussion followed a parallel semi-structured format (see Appendix A) tailored to either farmers or administrators. The discussions were moderated by the research team and partner organization representatives and were audio recorded with participants' permission. We chose focus groups over individual interviews because of the exploratory and collaborative nature of this project (Prokopy, 2011). However, this method poses challenges, such as sample bias, since participants may not fully represent the broader population's viewpoints. The focus group approach also presents the possibility that dominant voices overshadow quieter ones (Parker and Tritter, 2006), thereby complicating the ability to quantify the degree of agreement or disagreement among participants.

Toward mitigating these challenges, we aimed to foster a representative sample through intentional participant recruitment. Administrators were recruited via email from the I-state's crop insurance discount programs and from mid- and senior-level USDA programs that promote cover crops, such as the Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP). Farmer participants were similarly recruited via email from crop insurance discount program lists; thus, all had participated in their respective state's program. All but one farmer had also participated in a USDA cover crop AEP at some point in their farming careers, and some additionally had participated in cover crop AEPs offered by non-profit organizations or private-sector entities.

A summary of the participating farmers' demographic data and farm characteristics (Table 2) was compiled from information they shared during focus group discussions and supplemented by an optional online survey delivered post-discussion using Qualtrics. The survey allowed farmers to offer additional feedback. However, farmers did not include any additional perspectives.

Given the complexities of accurately quantifying how strongly participants agreed or disagreed on various topics (Parker and Tritter, 2006), we present the results without specifying the number of individuals who supported or opposed any given topic, except in

https://doi.org/10.1017/S1742170525000067 Published online by Cambridge University Press

Table 2. Farm and demographic characteristics of farmer participants

Category	Min	Max	Average	Median	N[a]
Farm size (acres)	294	4000	1292	875	11
Cover crop (acres)	294	2500	783	560	11
Cove crop intensity (% of farm)	13%	100%	84%	100%	13
Years experience w/ cover crops	5	35	15	12	13
Age	43	78	61	64	9

[a]Farm and demographic information was provided by participants in a short online survey following the focus group discussion. Not all farmers provided responses or complete responses to the survey despite repeated follow-up efforts by the authors.

cases of unanimity. While we do not claim generalizability from our focus group sample, participants' wealth of experience with using cover crops coupled with having participated in cover crop AEPs provided valuable insights into the strengths and weaknesses of cover crop AEP design and how such programs might better support farmers' use of cover crops. Despite the limitations of focus groups, this approach allowed for rich, interactive discussions that were invaluable to our study.

In the focus group discussions, participants shared their perceptions of how characteristics of cover crops and the design of cover crop AEPs affect participating farmers' experiences with cover crop adoption and persistence. Focus group discussions were transcribed verbatim and then coded and analyzed using a qualitative, pragmatic iterative coding approach (Tracy, 2013) using NVivo 14 software. Dialogue was first coded by topic, according to the six program attributes identified in the AEP design literature (Table 1): recruitment, enrollment, contract length, participation requirements, type of support, and administration. Within each code, quotes used in this analysis were selected to reflect the perspectives participants voiced on what aspects of each program attribute were effective, what areas needed improvement, and any recommendations or proposed solutions for future cover crop AEP design. Beyond coding pertaining to each of the program attributes, an additional theme related to 'data' emerged across all focus group discussions. The lead author and a research assistant coded the transcript independently and then discussed all differences in the codes they applied to achieve agreement on applying the codes. This approach was used instead of an inter-coder reliability score to ensure that coders discussed all of their differences in interpretation (Chinh et al., 2019). 'Data' was used to code dialogue on the role or potential value of quantitative information associated with various program attributes. We report participants' insights on an attribute-by-attribute basis from recruitment to administration, interpreted within the broader context of AEP design literature, with a focus on how characteristics of these attributes affect participants' overall program experiences, beyond just the willingness to participate in a cover crop AEP.

Results

Recruitment

Farmers and administrators expressed similar perspectives that active recruitment of cover crop program participants was unnecessary. Most farmers chose to participate in cover crop programs of their own volition or the influence of their agricultural networks. Farmers described how social networks play an instrumental role in program recruitment, describing how sometimes 'The only reason I know about them is because of a neighbor' (Farmer10), and that recruitment, 'Has to be at the personal level … It's gotta be my neighbor talks to me' (Farmer3). Relatedly, administrators discussed that cover crop programs like EQIP can largely rely on passive recruitment, that is participant-initiated interest, because demand far exceeds programmatic capacity (Admin34; Admin31). However, farmers and administrators across all focus groups independently identified planning benefits that might be achieved through more active recruitment. Farmers and administrators agreed that 'For [cover crops] to actually succeed, that [initial] management discussion [about cover crops] needs to take place the winter before when you're also considering your cash crop decisions' (Admin32). Farmers and administrators expressed that farmers are often unaware that cover crop planning needs to happen so far in advance. Thus, active recruitment was perceived to better enable farmers, administrators, and even auxiliary cover crop businesses to better prepare for the manifold implications of cover crop adoption.

Participants also spoke to an unintended outcome of relying on passive recruitment: that cover crop programs largely self-select for farmers who hold some degree of intrinsic motivation for using cover crops. One administrator shared that, 'I don't think that we're really … looking for conventional farmers that are reluctant to try cover cropping' (Admin34). Some farmers and administrators suggested that active recruitment of such farmers might be counterproductive toward reaching bigger picture cover crop goals: namely, long-term practice persistence. This is because conventional farmers were perceived to be more monetarily motivated or economically risk averse to using cover crops, thereby raising concerns of practice abandonment. Speaking to this point, an administrator expressed uncertainty in the value of targeting conventional farmers based on the perception that, 'If there was [a] cost there [to using cover crops], then they're gonna drop out' (Admin34).

In contrast, some farmers and administrators from across focus groups felt that programs could benefit overall cover crop policy goals by actively recruiting farmers who are uncertain about trying cover crops. Participants emphasized that engaging this population might be possible if programs utilize a more data-driven approach. Across focus groups, participants unanimously emphasized that farmers could make better informed decisions if they have access to data that quantifies how cover crops impact soil health and production outcomes. One farmer shared the idea that programs could increase program buy-in by conducting a 'conservation assessment' for prospective participants that could quantify the impacts of current management practices, '*And then show,* "Hey, [cover crops are] a tool that, over time, can help reduce erosion [and] eventually [increase] organic matter, etc.…"' (Farmer6). One farmer argued that current subsidy programs basically convey to farmers, 'I'm gonna pay you to do something that maybe you don't believe in, but you like [getting paid],' while a data-driven program would 'empower you to make a decision. That's different' (Farmer10).

Enrollment

Participants unanimously spoke to the need for program enrollment to be characterized by: 'Simplicity. Keep it simple' (Farmer13). As one administrator summarized, 'Making things easy is probably the biggest thing, and meeting people where they're at … [finding] the level it takes to get them to say 'yes', and want to

https://doi.org/10.1017/S1742170525000067 Published online by Cambridge University Press

do [cover crops]' (Admin33). For some farmers, 'simplicity' of enrollment was described as less 'red tape' (Farmer5). If given the option to choose between participating in different cover crop programs, farmers indicated strong preference for programs where 'the application process is simple' (Farmer5). Other participants described 'simplicity' in terms of reducing the transaction costs of enrollment. Farmers and administrators provided multiple suggestions to 'streamline' the process that could 'help our producers and quit hindering them' (Admin35); these included: minimizing the amount of paperwork required to enroll, having program staff do data entry on behalf of participants, and offering an online enrollment option.

Some farmers also saw value in increasing interagency collaboration and data sharing. Whereas farmers conceded that to participate in a cover crop program, 'You're gonna have multiple steps no matter what' (Farmer2), farmers spoke with frustration of the repetitive, seemingly duplicative paperwork they had to file with different agencies in relation to their cover crop use and subsequent enrollment in a cover crop program (Farmer2; Farmer5).

Contract length

Program participation requires farmers to sign a contract of a set duration, typically from 1 to 5 years in length. 'Options' and 'flexibility' were two common themes related to contract length that emerged across focus groups. Interestingly, participants did not strongly favor shorter or longer contract lengths, but instead discussed the costs and benefits associated with either. As one administrator described, different contract lengths will appeal to different farmers, and one is not necessarily '[b]etter than the other. How many years does somebody need…assistance? Again, everybody's on a different spectrum there' (Admin33). Likewise, some farmers expressed preference for 1-year contracts, whereas others saw benefits of longer commitments (>3 years), and many spoke to the pros and cons of both.

Shorter contracts were seen as appealing to farmers who may be uncertain about the benefits of participation (Farmer13). Additionally, farmers and administrators noted that shorter contracts enable farmers to respond more swiftly to changes in the agricultural marketplace. For instance, an administrator pointed out that cover crop prices fluctuate based on supply and demand, yet cost-share rates often remain unchanged, resulting in increased expenses for farmers (Admin30). Consequently, shorter contract lengths may be favored by farmers seeking flexibility to adjust cover crop decisions according to market conditions.

Conversely, longer contracts were perceived favorably by some participants because they would require longer-term use of cover crops, regardless of external factors. Relatedly, the option to extend a contract 'might be able to convince people to hang around' (Farmer16) and continue using cover crops during economic downturns. Longer contracts were also perceived favorably by some participants because they reduce farmer's transaction costs associated with program enrollment or re-enrollment. As one farmer shared, 'I like the longer commitment. I only have to fill out paperwork once and then … it's a done deal' (Farmer9). Multi-year contracts were also perceived to best align with the time frame needed to overcome the cover crop learning curve and for quantifiable soil health and production benefits to accrue. Discussing these points, a farmer described how, '*With cover crops, it's like chili: the more you warm it up the better it gets. The more years you cover crop, the more benefits you're gonna see*' (Farmer9).

Program requirements: eligibility, practice technical specifications, and compliance

Considering limited program funding, farmers and administrators tended to support program eligibility requirements that prioritize new cover crop users rather than established practitioners. This was based on the widely shared perspective that the learning curve with cover crops is steepest in the early years of adoption. However, many farmers expressed that learning is an ongoing process with cover crops and that long-term users could still benefit from access to financial and technical support.

Practice technical specifications are the standards used to guide conservation practice implementation. Technical specifications were primarily described as a hindrance but not a total barrier to participating in cover crop programs. Administrators recognized that practice specifications such as seeding rates or tile spacing requirements can present compliance challenges but saw them as necessary measures of accountability since 'it's public money being used' (Admin32). Farmer participants shared similar reflections that striking the right balance between rules that promote versus impede farmers' use of cover crops is difficult to define. In the words of one farmer, '[it's] a juggling act, but I think … there's gonna have to be a line drawn in the sand in saying, 'You need to do this or above to participate" (Farmer9).

However, some farmers perceived practice specifications to be at odds with their perception of how best to improve soil health on their farms. For example, one farmer shared that he had adopted cover crops and no-till simultaneously, but that this almost lost him access to financial support; since contract extension is often contingent upon enhancing or adding new practices, he described how, 'If you wanted to play the game and really knew it, you should've taken it a little easy' (Farmer11). In contrast to this perspective, others felt that requirements for incremental practice addition or expansion were smart, explaining that, 'baby-stepping people into … programs' (Farmer1) is important so that farmers do not get overwhelmed by too many management changes all at once and potentially discontinue using cover crops altogether.

Despite individual differences of opinion, many farmers and administrators agreed that program specifications can be too rigid. This 'black or white' (Farmer15) approach was perceived to sometimes hinder farmers' ability to practice adaptive management. Planting, termination, and species selection and seeding rate requirements were the most commonly mentioned standards that participants perceived as challenges to cover crop use. Many farmers felt that rigid adherence to such standards could be at odds with farmers' acquired management experience and site-specific knowledge.

Other participants advocated that programs should be more tailored to local contexts. An administrator discussed this issue, describing how 'especially in northern Iowa, [planting/termination cut-off dates are] a big challenge' because of 'the growing season … [being] more limited' (Admin33). Farmers echoed this sentiment, with one Illinois farmer arguing that because of differences in geographies' climates, 'there's no such thing as a statewide program' (Farmer12).

Participants generally agreed that compliance should have minimal transaction costs but that some form of monitoring and verification has its place to ensure 'proper follow through' (Farmer1). Similarly, an administrator described that '[while] the checks and balances … can be seen as a barrier … there's a certain level that's gonna be required' (Admin33). Some farmers suggested that programs should require a data collection and sharing

https://doi.org/10.1017/S1742170525000067 Published online by Cambridge University Press

component. Proponents of doing so perceived data as an essential factor for farmers and administrators to make well-informed decisions about cover crop use. 'Having that data is what empowers people to continue to do it. Or if the numbers are terrible and it doesn't work, we need to know that. Good or bad' (Farmer10). Collecting and sharing hyperlocal data was perceived to be important because it would be more trusted by farmers than regional or national data. As one farmer described, 'That on-farm data makes the difference. If we have on-farm data in our area, we can trust that. We do not have to … look at somebody else's data. We can trust what we got in the area' (Farmer12). Conversely, other farmers felt that data collection and sharing could be a barrier because of transaction costs and privacy concerns. One farmer observed that 'most farmers don't want to do trials on their farm because they're a hassle' (Farmer2). Other farmers expressed that privacy concerns about data sharing might limit some farmers' willingness to participate. As a case in point, participants tended to be in favor of having access to hyperlocal data, such as soil tests and yield results but expressed hesitation as to whether they would be willing to share their personal information with others. Speaking to this dissonance, one farmer noted, 'That's my biggest … not fear, but realization … we need to advertise and talk about what we're trying to accomplish [with cover crops] … [but] I'm kind of on the edge about being private about my information' (Farmer9).

Type of support

Financial assistance

All farmers had received financial incentives for cover crops through their participation in one or more programs over the course of their farming careers. Almost all farmers had direct experience with cost-share, wherein the farmer and the AEP provided a portion of the funding for BMP implementation. Most farmers felt that 'an incentive of cost-share has its place' (Farmer3). As one farmer explained, '[Financial support] help [s] offset some of the learning … it costs some money to learn that stuff. So, yes it does help' (Farmer14). Administrators likewise held mostly positive perspectives on the role of cost-share. Most administrators felt that cost-share works well for farmers, describing how 'People don't typically say any negatives about our cover crop cost-share. We pay fairly well' (Admin34). However, another administrator noted that farmers' perceptions of cost-share are likely influenced by the amount they receive.

Despite support for financial incentives, participants expressed uncertainty about payments in their current form, and some offered alternative approaches. For example, some administrators felt that cost-share has 'made an [positive] impact, but until you develop a culture where [cover crops are] the way to farm, you're gonna have a hard time getting everybody on board' (Admin35). Multiple farmers emphasized the importance of financial support in the first year of cover crop adoption, with one arguing that 'you need to basically pay for the entire [cover crop] operation…the first year' (Farmer1). At the same time, farmers noted that there should be, 'a graduated [scheme with] full funding the first year, and then cutting it back as you go' (Farmer2) since there is a need for long-term financial sustainability of adoption.

In addition to cost-share, focus group participants discussed their perspectives on other types of financial support available through cover crop programs. Farmers and administrators held mixed perspectives on how well crop insurance discounts or carbon payments support farmers in using cover crops. For example, many farmers were neutral or slightly positive toward the crop insurance discount approach but felt that it was too little to drive cover crop adoption or practice persistence. Farmers expressed similar views of carbon program payments, which were largely perceived to be too small.

Most farmers and administrators expressed interest in the possibility of synergies between different approaches to financial incentives. When discussing 'how these programs can fit together' (Admin33), participants discussed two avenues. The first of these, stacking payments from different programs simultaneously, was generally perceived favorably. Farmers liked the idea that stacking financial incentives would lower the cost per acre of using cover crops. The second of these was the possibility of leveraging different types of financial incentives over time. Administrators in particular expressed interest in the possibility of starting new cover crop users with cost-share support and then transitioning them to options, such as the crop insurance discount approach, which would allow long-term cover crop users to maintain some financial benefits when they lose eligibility elsewhere (Admin33).

Technical assistance

Technical assistance, including knowledge support, was widely perceived as a positive aspect of cover crop programs by both farmers and administrators. As one farmer summed it up, 'You gotta have somebody help you get through the bad years. There are gonna be failures in cover crops. If you have one [bad experience] and … it didn't work, you've got to have … support' (Farmer4). Connecting farmers with the technical and informational knowledge they need to successfully manage cover crops (e.g., species selection, seeding rates, management timelines) was perceived as an aspect of program support that works well enough, but that could be improved upon. Farmers described the importance of having access to knowledgeable program staff who can help them troubleshoot problems as they arise. Some farmers felt that staff turnover limited programs' ability to deliver optimal technical support but noted that this varies by geography and program. Other farmers voiced the need for more 'boots on the ground' (Farmer12), while another suggested that cover crop programs develop 'a good video library' (Farmer16) so that farmers can access technical information on-demand for any aspect of cover crop management.

A novel approach to cover crop knowledge support that emerged in both farmer and administrator focus groups was the possibility of incorporating a financial literacy component into cover crop programs. This suggestion stemmed from the broader observation that 'Most farmers don't sit down and do their actual budgets … They take [a] shoebox full of receipts … to the banker. And then the banker tells them how their operation's doing' (Farmer1). This problem was perceived to be aggravated by the prevalent focus in agriculture on yield rather than profitability. In the context of cover crop use, where the impact on yield is not always straightforward (Myers and Watts, 2015; Deines et al., 2023), understanding profitability becomes crucial. Illustrating this point, a farmer explained how his use of cover crops and no-till has resulted in, 'My yields … have gone up slightly. But my net profit has gone up dramatically. Because I'm putting [on] the same amount of seed … fertilizer, [and] chemical[s], for a better yield overall than what I was getting before' (Farmer2). Similarly, an administrator stressed the need to shift farmers toward a profitability focus, stating, 'We're trying to blur the lines that [using cover crops] is a conservation practice, and it's a production practice. And so, to do that, the landowners and farmers … need to see that as to how it benefits them' (Admin33). Thus, improving financial literacy was perceived to support this

https://doi.org/10.1017/S1742170525000067 Published online by Cambridge University Press

paradigm shift and provide cover crop users with the financial skills necessary to understand the economic impacts associated with cover crop use.

Connecting farmers with the equipment they need to manage cover crops was also discussed as an important aspect of technical support. Many farmers have their own equipment, but not all do. Farmers saw value in having access to a network of resources to draw from, 'whether it's … county [extension] or it's another fellow farmer that you could go to and say, 'Can I borrow this?' or 'What would you recommend?' or 'What are you using?' (Farmer12). Other participants recommended that technical support could better serve farmers if it was tailored to farmers' level of experience with cover crops. In the first year of program participation, multiple farmers recommended 'a lot more handholding' (Farmer3). They felt that new cover crop users would benefit from program staff, 'eliminating variables for people who are new to it … tell them this is the formula to make it work … this is the seed mix that you're gonna use, and then coaching [them]' (Farmer4). Participants across focus groups also called for discussions between program staff and prospective participants to happen earlier in the year so that there is adequate time to prepare farmers for success. Farmers and administrators emphasized that many first-time cover crop users are unaware of the timeframe needed to 'change [their] operation to accommodate the cover crop' (Farmer4; Admin30). Many do not realize that using cover crops may require alterations to their herbicide and nutrient management plans. Additionally, a longer planning window was perceived to increase new cover crop users' options in terms of sourcing cover crop seed, securing the best cover crop seed prices, or lining up custom application operators.

Participants also described how technical support could be improved for more advanced cover crop users. For example, some farmers suggested that technical support should become more flexible with time and allow for adaptive management as farmers gain experience. Farmers and administrators emphasized that technical support should make space for farmers to experiment, learn from those experiences, and apply those lessons. For example, one farmer described how an ideal program, 'would not say there's a specific implement that you have to use [to plant cover crops, but] instead ask: what fits your program?' (Farmer12). However, across focus group participants expressed that cover crop use presents ongoing challenges and opportunities for learning. For this reason, there was some interest among farmers that 'You need to keep the tech[nical] assistance available' (Farmer9) even after their program contracts conclude, as doing so might improve long-term practice persistence outcomes.

Administration

'Trust' emerged as an important aspect for focus group participants when considering the administering entity of cover crop programs. As one farmer pointed out, 'Every farmer has a preference of who they trust … You've got your trusted people and then others that you don't. But it's different, I think, for everybody' (Farmer7). Despite individual differences, many farmers expressed a preference for programs to be administered by government or non-profit entities rather than corporate ones. Farmers saw value in, 'Having somebody knowledgeable … [who is] not a salesman. Someone who's not gonna make a penny' (Farmer9) from the advice they provide, nor will they charge a fee for access to that information.

Furthermore, some participants doubted the private sector's capability to provide the necessary expertise to optimally support cover crop users. Some farmers noted the lack of research and development on cover crop seed. Others perceived a misalignment of interests, particularly between fertilizer/chemical dealers and cover crop users. As one farmer described, 'We're getting zero [information], basically, from our retailers … They're not making any money off of [cover crops] … They don't wanna sell less fertilizer … [And] if you're getting to become a conservationist [by using cover crops] … you're gonna be conscious of what your soil tests are saying [and may use fewer inputs]' (Farmer12).

Discussion

Many AEPs receive little assessment as to their effectiveness (Pineiro et al., 2020). Characteristics of program design and specific BMPs influence farmers' practice adoption, persistence, or abandonment decision-making (Swann and Richards, 2016; Dayer et al., 2017; Pathak et al., 2023), yet there is insufficient understanding of how these characteristics shape participants' program experiences and long-term management choices (Pannell and Claassen, 2020). Our focus group-based study on cover crop programs is among the first to evaluate aspects of program design for a specific BMP: cover crops. We found that participants' commentary on cover crop program enrollment processes, program requirements, and administration align with findings from environmental program literature suggesting participant preferences for simplicity, low stringency, and public-sector versus private-sector involvement (cf., Sorice and Donlan, 2015; Chami et al., 2023). Interestingly, participants across focus groups expressed support for enhancing the role of data in multiple aspects of cover crop program design, especially pertaining to recruitment, type of support, and program requirements. The discussion that follows aims to improve understanding of how cover crop programs can better support farmers' program experiences and use of cover crops, and provide lessons learned for other AEPs.

Active recruitment and data-driven program design may broaden the appeal of cover crop programs

Farmers and administrators highlighted the importance of centering the participant experience in cover crop program recruitment processes. In alignment with the broader literature (Bressler et al., 2021), participants emphasized the role of social networks in driving farmer awareness of and (dis)interest in cover crop programs. This underscores the importance that farmers' program experiences, whether positive or negative, play in shaping the perception of the broader network beyond that of the individual participant. Since programs largely rely on passive recruitment driven by farmer-generated interest, it is to the benefit of broader program outcomes to ensure positive program experiences that support word-of-mouth recruitment. Relatedly, participants discussed that a more active approach to cover crop program recruitment could enhance support for farmers. This change might address two pitfalls associated with the current reliance on passive recruitment. First, active recruitment was expected to extend the planning timeline, thereby improving farmers' program experiences and potentially increasing their likelihood of success with cover crops. This is because, at present, reliance on passive recruitment often provides insufficient time for farmers or administrators to coordinate necessary farm-wide management adjustments before planting cover crops, such as modifying cash crop species selection, herbicide regimes, equipment modifications, or cover crop seed sourcing.

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Second, active recruitment was perceived to help expand the reach of cover crop programs beyond highly motivated adopters. Because most cover crop programs rely on farmer-generated interest, we found that cover crop programs unintentionally self-select for participants who are more likely to try cover crops irrespective of financial subsidies. Increasing active recruitment could help cover crop programs manage self-selection bias (Wilson and Hart, 2001) and promote broader engagement (Tellez et al., 2021). Targeting cover crop programs to a wider range of farmers stands to maximize the impact of public investments in AEPs and contribute to more widespread buy-in with cover crops. To this end, participants described how an active recruitment process could benefit from being paired with a more data-driven approach that provides quantitative insights on the impact of cover crop use. For example, participants suggested that cover crop programs should include a conservation assessment or provide agronomic and economic data to prospective participants on how cover crops might impact their specific production outcomes and overall profitability. Such a data-forward approach to recruitment was seen as particularly beneficial for enhancing program appeal among farmers who are skeptical or unaware of cover crop benefits. Data collection could additionally provide greater information on the value of subsidies, the degree of additionality and corresponding environmental benefits, and improved knowledge for future technical assistance. The availability of hyperlocal data may also encourage greater communication among farmers participating in programs. Since farmers noted the importance of their social networks in recruiting, the potential for a virtuous cycle could occur if successful cover crop approaches can be identified and shared more readily, as well as avoiding common pitfalls, such as insufficient planning timelines.

Financial planning could bolster technical assistance and support the business case for long-term management

One of the common tensions in voluntary programs is the lack of long-term additionality and sustained change in farmers' management practices after financial payments have ended (Sorice and Donlan, 2015). A promising idea generated by focus group participants toward addressing this challenge is to extend the technical assistance timeline and incorporate a financial literacy training component. Most AEPs are designed such that financial incentives and technical assistance conclude at the same time. However, farmers in our study made a compelling case that long-term practice persistence could be better supported if farmers have access to training and mentoring beyond the conclusion of financial subsidies. This would arguably instill greater ownership of the management process, especially if financial planning support helps farmers uncover enhanced profitability or other benefits that they might not otherwise discover on their own.

To support the decision-making process, participants voiced widespread interest in integrating more data into cover crop program support. However, the scarcity of quantitative information on cover crop impacts remains a limitation. Our focus group conversations suggest that cover crop programs could be uniquely positioned to help address this knowledge gap. In agreement with the work by Lobry de Bruyn, Jenkins and Samson-Liebig (2017), incorporating a data collection component into cover crop programs could increase stakeholder buy-in with cover crops since data provides a compelling case for or against using a practice in a way that resonates with farmers in a manner distinct from financial subsidies. Programs might facilitate data collection through on-farm trials or by monitoring the impacts of cover crop use on the same field over multiple years. However, it is essential that AEPs avoid overburdening farmers with excessive reporting requirements, as too onerous a data collection process could deter participation and reduce the program's overall effectiveness. Additionally, ensuring field data is shared anonymously is crucial, though concerns about confidentiality and potential misuse may still make some farmers hesitant to participate. Farmers' comments on the lack of comparable data highlight the opportunity to vastly improve farmers' and researchers' understanding of how cover crop use impacts aspects of soil health, climate risk mitigation, and agronomic outcomes. Therefore, we see strong potential for cover crop support to facilitate building a data-driven case for cover crops that could enhance farmers' program experiences, increase engagement among less-intrinsically motivated farmers, and support a greater degree of practice persistence after cost-share payments cease. Financial planning and hyperlocal data to enable better analysis are already central to commodity crop production; extending this approach to AEP design would be prudent (Bodrud-Doza et al., 2023).

Careful consideration of flexibility in program design could facilitate greater long-term buy-in with cover crops and promote adaptive management

In alignment with the broader literature (cf., Sorice and Donlan, 2015), farmers typically preferred flexibility (i.e., freedom of choice) to respond to market forces and personal preferences. However, they expressed diverse justifications regarding the ideal duration of cover crop programs. Both shorter (1–3 years) and longer contracts (3–5 years) were perceived to present advantages and drawbacks that could impact participants' program experiences and contribute to differential long-term management choices and corresponding conservation outcomes. Notably, although longer-term contracts may constrain farmers' ability to adapt to dynamic market and weather conditions, they were perceived to better support aspects of learning how to manage cover crops and to generate greater benefits to soil health outcomes.

Regardless of contract length preferences, financial incentives to support cover crop adoption were generally viewed favorably. However, participants again voiced support for program flexibility in the sense that many advocated for financial assistance to be delivered more strategically. Multiple focus group conversations identified the possible value of cover crop programs covering 100% of the costs over the first year and reducing the level of financial support in succeeding years. It seems intuitive that a financial subsidy winds down as experience increases.

Relatedly, counter to the expectation that participants in environmental programs would prefer 'low stringency' (c.f., Duke et al., 2021; Chami et al., 2023), focus group participants advocated for a greater degree of prescriptive guidelines, or 'handholding', in the early years of cover crop program participation. However, this was paired with the desire for gradually transitioning to increased flexibility to allow for greater farmer-directed decision-making as management experience increases. The picture that emerges from this is that farmers want flexibility that takes the learning curve into account, helping them avoid early mistakes that could discourage further use of cover crops while also allowing them to apply their knowledge and managerial skills as they gain experience. The desire for specific recommendations in the early years of cover crop program participation may stem from the challenges new cover crop users face in discerning pertinent information for their operations. It may also reflect farmers' comfort and familiarity with

https://doi.org/10.1017/S1742170525000067 Published online by Cambridge University Press

working with agronomic advisors who provide specific management recommendations.

Research on low participation in AEPs has argued that one factor that discourages farmers from participating is the lack of reputational credit they are given for their managerial skills (Burton and Paragahawewa, 2011). The desire for more autonomous decision-making in later years of program contracts highlights the challenge of designing cover crop AEPs to meet the varying needs and preferences of farmers while also working efficiently toward achieving programmatic goals. While there is the potential that farmers' management would be worse without prescriptions, the potential upside is that farmers could deepen their managerial knowledge and skill by making their own decisions. If paired with monitoring for programmatic evaluation, it could provide further data to inform cover crop technical assistance and financial planning. More flexible approaches would also potentially lead to farmers being more interested in participating in cover crop AEPs and generating positive word-of-mouth within farmer networks. By applying these lessons, AEPs focused on other practices, such as nutrient management, conservation tillage, or integrated pest management, could similarly benefit from approaches that balance flexibility with structured support, ultimately leading to more effective and widespread adoption of conservation practices across various agricultural contexts.

Conclusions

Our findings highlight the importance of tailoring AEPs to the specific context of the management practice(s) being facilitated. Three key themes emerged from our focus groups that provide insights into how cover crop programs can better support farmers in using cover crops effectively: the need for a human-centered approach to program design, the value of tailoring program design to the characteristics of the BMP being promoted, and leveraging data to support improved cover crop management and stakeholder buy-in. Adopting a human-centered approach to optimize participants' experiences is crucial for enhancing the effectiveness of cover crop programs. Participants emphasized the need for more evidence-based decision support tools to guide cover crop management decisions. Exploring approaches to cover crop program design, such as integrating participatory research with traditional technical and financial assistance, alongside the inclusion of a financial literacy component, could serve as pathways to better support farmers in their use of cover crops. Concurrently, these measures have the potential to bolster the business case for cover crop adoption and long-term practice persistence.

Author contribution. Rachel Irvine contributed to the investigation, formal analysis, and writing—original draft. Chloe Wardropper contributed to the conceptualization, funding acquisition, and writing—review and editing. Seth C Harden contributed to the conceptualization and writing—review and editing. Landon Yoder contributed to the conceptualization, funding acquisition, investigation, formal analysis, writing—review and editing, and supervision of the research.

Funding statement. This research was supported by the National Science Foundation [2206086] and The Nina Mason Pulliam Charitable Trust [F106507-NMPCT072020WhiteRiver].

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Appendix A: Focus Group Question Guides

Farmer focus groups

1. Name/County/What first got you interested in using cover crops.
2. Was there an early challenge that you had to learn your way through? And what did you do to overcome it?
3. Was there anyone that you were able to ask for help or guidance, such as a mentor or advisor, to help you through the learning curve? How did they help you?
4. How did you hear about your state's crop insurance premium discount program? Was the enrollment process straightforward or were there any difficulties?
5. What, if any, other cover crop programs have you enrolled in? What aspects did you find the most appealing (or helpful)?
6. What aspects of the program did you find the most frustrating (or unhelpful)?
7. Imagine that you were responsible for getting other farmers to enroll in a cover crop assistance program.
   a. What would be the main goal of the program?
   b. How would you design the program to maximize its appeal?
   c. What would sign-up and enrollment look like?
   d. What types of support would you want to see offered in an ideal program?
   e. What would the eligibility requirements to participate in the program look like?
8. Given that there are multiple programs currently available, is the idea of being able to combine program payments for the same acres appealing or does participating in multiple programs simultaneously seem too complicated?
9. What is your sense of how relationships between farmers affect information sharing about cover crops? Is that helping or hindering cover crop adoption?
10. Voluntary carbon payments have become a possibility in recent years. What questions do you have about these options and are you interested in them for your farm?
11. Is there anything else about cover crop management or programs that you think we should know?

Program administrators' focus groups

1. From your perspective, what outcomes do a crop insurance premium discount program/cover crop assistance program aim to achieve?
2. From your vantage point, what motivates or discourages farmers' interest in participating in a crop insurance premium discount program/existing cover crop assistance programs (EQIP/CSP/RCPP)?
3. How does your agency approach the recruitment of new participants and manage the retention of existing and past participants?

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4. Are there things that you wish your program did differently to strengthen its ability to recruit and enroll farmers?
5. What feedback, if any, do you get from farmers about the $5 per acre rate/ about the financial and technical assistance that is available? From your perspective, is this rate/assistance sufficient?
6. Imagine if your program was not constrained financially, how would you invest your resources to promote greater use of cover crops?
7. How does your program evaluate cover crop performance in terms of climate risk mitigation and reduction of risk of crop insurance claim/ with respect to cover crops? What do you see as the strengths and weaknesses of this approach?
8. What information do you wish you had to improve your program's outcomes, whether farmer preferences, economic outcomes, scientific research, etc.?
9. Are there significant barriers to farmers' adoption of cover crops that are beyond the scope of your program to address? If so, what suggestions do you have for what might be effective in addressing those challenges?
10. Voluntary carbon markets have generated interest in policy circles in the past couple of years. Do you see the development of these as synergistic with your program or do they present any problems or conflicts that policymakers should consider?
11. Is there anything else regarding cover crop assistance programs that you would like to tell us?

Appendix B: Codebook Used in Qualitative Coding of Transcripts

Thematic code	Definition	Example from transcript
Recruitment	Participants describe how they became involved in cover crop AEPs and/or how they perceive other farmers to become engaged with cover crop AEPs, identify what does (not) work well, and identify possible improvements to better support farmers' recruitment to cover crop AEPs.	A farmer describes how they were interested in trying cover crops so they sought out a cover crop AEP that would provide financial and technical assistance to do so.
Enrollment	Participants describe their experiences with enrollment processes and perceptions of experiences with enrollment processes in cover crop AEPs, identify what does (not) work well, and identify possible improvements to better support farmers' enrollment in cover crop AEPs.	A farmer describes a preference for a simple, online enrollment process rather than a paper-heavy application process.
Contract length	Participants describe their experiences and perceptions with different contract lengths associated with cover crop AEPs that they have (not) participated in, identify what does (not) work well with different contract lengths, and identify possible ways contract length can better support farmers in cover crop AEPs.	A farmer describes their preference for shorter contracts so that they can try different cover crop AEPs as they become available.
Participation requirements	Participants describe the participation requirements associated with cover crop AEPs, identify what does (not) work well, and identify possible improvements to better support farmers to participate in cover crop AEPs.	A farmer describes the desire for more self-determination in deciding the timing of how late they can plant cover crops in a given season.
Support type	Participants describe the financial and technical support that they (do not) receive through participation in cover crop AEPs, identify what does (not) work well, and identify possible improvements to better support farmers in cover crop AEPs.	A farmer describes the value of having access to knowledgeable staff who can troubleshoot management challenges in real-time.
Administration	Participants describe their experiences with the administrative aspects of cover crop AEPs, identify what does (not) work well, and identify possible improvements to the administration of cover crop AEPs to better support farmers.	A farmer describes that they value the perceived neutrality of a government entity administering a cover crop AEP rather than a corporate one.
Data	Participants describe data uncertainties associated with cover crop management and agronomic and environmental outcomes; participants identify knowledge gaps and the value that quantitative data could bring to farmers' decision-making around using cover crops and to inform cover crop AEP design.	A farmer describes how they would benefit from local field trial data that quantifies the impact of cover crop use on yield response.

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