



Soil management in Montana: Motivations, challenges, needs, and opportunities

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Prepared by JG Research and Evaluation

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EXECUTIVE SUMMARY

Maintaining and prioritizing soil health in Montana is important for the economic prosperity of Montana's farmers and ranchers and ecological health of the state. The goal of this assessment is to understand the perspectives of producers and agricultural professionals on key metrics of soil health in Montana, promising practices to maintain or improve those metrics, and resources needed to implement those practices.

KEY FINDINGS

- Producers in Montana are motivated to adopt and maintain soil management practices that improve soil health first and foremost by profit, as well as by a desire to improve their own quality of life and their connection to natural ecosystems.
- Producers see Montana-specific ways to apply the five principles of soil health that are promising in terms of their economic and ecological benefits.
- Producers identify changing environmental conditions, challenging financial pressures and institutional barriers, and the social 'status quo' as key barriers to expanding the footprint of soil management practices.
- Producers in Montana want increased and targeted institutional support (from universities, agencies, and the private sector), and expanded social networks and learning opportunities to support new adaptations in soil management practices.

KEY TAKEAWAYS AND RECOMMENDATIONS

Takeaway: Producers want to learn from one another and want support for social learning

Recommendations

- Provide small amounts of seed funding and technical assistance to facilitate peer-learning
- Support opportunities for networking and mentorship across the state through funding and coordination

Takeaway: Research that includes complexity of the real world is needed and wanted

Recommendations

- More funding for long-term and systems-oriented research
- In-field trials and demonstration farms that reflect and better align with relevant questions and curiosities of producers
- Researchers and agency staff 'getting out there' and learning from and with producers

Takeaway: Education and outreach on topics and needs that are relevant to producers

Recommendations

- Communicate about soil health in ways that resonate with producers
- Use storytelling about producers' own experiences to build networks and make it relevant
- Create example balance sheets, income statements, and profit/loss reports

Takeaway: Change requires taking risks and institutions can support trying something new

Recommendations

- Engage bankers
- Provide financial and social support for taking small risks and experimenting with things like new tillage equipment or new crop species and varieties

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BACKGROUND

WHAT IS SOIL HEALTH AND WHY DOES IT MATTER?

Soil is a living ecosystem that cycles and cleans water, captures carbon and other organic compounds, and provides the foundation for food production and agricultural livelihoods. As described by the Natural Resource Conservation Service (NRCS) of the US Department of Agriculture, well-managed soils have “the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.” Maintaining and prioritizing soil health in Montana is important for ecological health and the economic prosperity of Montana’s farmers and ranchers. If our agricultural land is healthy and functioning well, we can grow crops, feed livestock, and make income for generations to come.

NRCS Montana promotes the following five main soil health principles:

1. Minimize soil disturbance
2. Keep the soil armored (residue management)
3. Keep a living root in the soil
4. Increase crop diversity
5. Integrate livestock grazing

Use of these principles over time should result in increased soil organic matter and overall soil ecosystem functioning, which is the key objective of improving soil health.

There are several key characteristics of Montana soils that can continue to be improved upon using the five soil health principles. First, erosion and blowing off of bare ground is a major concern in many parts of the state. The loss of topsoil impacts soil productivity and microbial function, and the dust creates public safety hazard in terms of air quality and visibility. Second, as water availability in Montana becomes a more pressing issue, soil properties that enhance water retention within must be improved in order to sustain a livelihood for Montana’s farmers and ranchers. Finally, soil salinization is a concern in the central and eastern areas of the state, and soil acidification is a growing concern in cropping systems across the state.

PURPOSE OF THIS ASSESSMENT

After Montana Senate Bill 180 was narrowly voted down during the 2021 legislative session, a group of organizations and agencies came together to support and conduct an assessment as part of the Montana Soil Outreach effort to identify soil management needs and opportunities on Montana farms and ranches. The goal of the assessment is to understand the perspectives of producers and agricultural professionals on key metrics of soil health in Montana, promising practices to maintain or improve those metrics, and resources needed to implement those practices. The analysis presented here looks across the information collected to identify common and unique challenges, needs and opportunities for soil management in Montana as well as the implications for policy and programming of these findings.

MODELS FROM OTHER STATES FOR ADDRESSING SOIL HEALTH

Several states surrounding Montana and with similar production system, including Nebraska, Colorado, North Dakota, South Dakota, New Mexico, offer models or examples of practical ways to address soil health at the state level. Each of these states has very robust soil health plans, resources and programming that include themes of succession planning, first-generation farmer/rancher education, initiatives for in-field trials, peer-to-peer networks of

mentors, and detailed workshops and trainings. All of these states have user-friendly, up-to-date, and interactive websites for their programming and initiatives.

The focus on education in South Dakota's soil health efforts could be a model for Montana to look at to expand soil health resources for farmers and ranchers. South Dakota's Soil Health Coalition offers a "South Dakota Soil Health School", which is a three-day intensive soil health workshop. As described on their website, "people saw a need for the sharing of real on farm/ranch experiences with application of science-based conservation practices and systems." South Dakota also offers a Mentor Network that is free, available to anyone, and is currently building a mobile app to connect farmers and ranchers with each other. This type of producer peer-to-peer network seems to be the type of network about which there is interest in Montana. The SD Soil Health Coalition also has a news page dedicated to articles written by farmers and ranchers, for farmers and ranchers. Technical resources available here include a grazing cover crop worksheet, soil health metrics card, healthy soils handbook, and automated and advanced weather stations catered toward agriculture. South Dakota's Soil Health Coalition has built a strong relationship with cooperative extension and has helped their extension program find suitable locations for their research. Working with extension to cultivate a "we are all still learning" culture is something Montana may want to adapt for improvement of our own extension programs. South Dakota also offers educational tips through a podcast, and short, instructional, interview style videos to show what is happening on the ground.

In Colorado, a group much like Grow Montana called the Colorado Collaborative for Healthy Soils supported an outreach and assessment effort that generated a new Soil Health Initiative, which is led by the Colorado Department of Agriculture. Although still getting underway, the intent is to leverage state and federal funds to provide matching grants for soil stewardship activities where the landowner chooses location and practice to be implemented. Producers can self-assess and make plans to improve soil health on their land by using the Saving Tomorrow's Agricultural Resources (STAR) framework, provided by the state Department of Agriculture. A series of STAR programs have emerged with the capacity for conservation districts (CD) to help support producers in changing practices: 3 years of technical support and incentive payments, equipment grants for CDs, and a soil sampling program. The Colorado Department of Agriculture was recently awarded a Climate-Smart Commodities grant from the USDA, which will be used to support the expansion of the STAR program to other western states, including Montana. The Colorado Soil Health Initiative also supports Soil Specialists, who will build farmer-to-farmer networks, provide technical assistance, and help producers find market opportunities, as well as a network of producer mentors.

In North Dakota, cooperative extension offers opportunities for yearly trainings, a leadership team, and a soil health academy. New Mexico also has a robust mentor network called the Soil Health Champions Network, which collaborates with agricultural advocacy groups. Nebraska has a group of farmers, conservationists, and more working together to inform and support producers. This organization is called Sowing the Seeds of Sustainability, and their punch line is, "just say NO to tillage." Nebraska's Soil Health Initiative puts partnerships in central focus, while having "demonstration farms" for comparison of cover cropping techniques, randomized and replicated plots, and crop rotation patterns for educational resources. Nebraska also has its own Nebraska Corn Board through the Soil Health Partnership, which is an effort to focus on one of the state's most productive and popular crops.

Many of Montana's neighboring states have developed the programs described above by learning from other states' successes while adapting to make suitable for themselves. Using these programs as examples, in conversation with the results of the survey and focus groups described in the remainder of this report, provides a starting point for Montana organizations and producers to define promising approaches to addressing soil health challenges in and for Montana communities.

METHODS

DATA COLLECTION

Data collection for this assessment focused on engaging as many people as possible at a relatively high level, through a web-based survey, and by providing people with the opportunity to participate at a deeper level through a series of in-person (as well as one virtual) focus groups. The web survey included minimal demographic questions and three core questions that reflect the goals outlined above (identifying key metrics, practices, and resources for soil health in Montana). The focus groups asked similar questions in more open-ended ways, and also included a presentation on soil management by a producer or agricultural professional as a way to jump-start the conversation.

The survey link was posted to the Montana Association of Conservation Districts website and was sent to listservs and email lists of interested individuals. The survey link was also printed on postcards that were taken to the soil health symposium, field days, and other meetings by members of the Soil Outreach core team. Focus groups were advertised in the same way, and were held in-person in Great Falls, Miles City, Livingston, Dillon, and Kalispell in March and April 2022. A virtual focus group was also held in May 2022.

RESPONDENTS

In total the survey received 243 responses, and about 60 people participated in focus groups. As shown in Figure 1, about two-third of survey were producers and the majority of them live in the central and eastern regions of the state. Table 1 shows the focus group participants by location and type of individual. Overall, almost half (43%) of focus group participants were producers.

Figure 1. Total survey responses by region

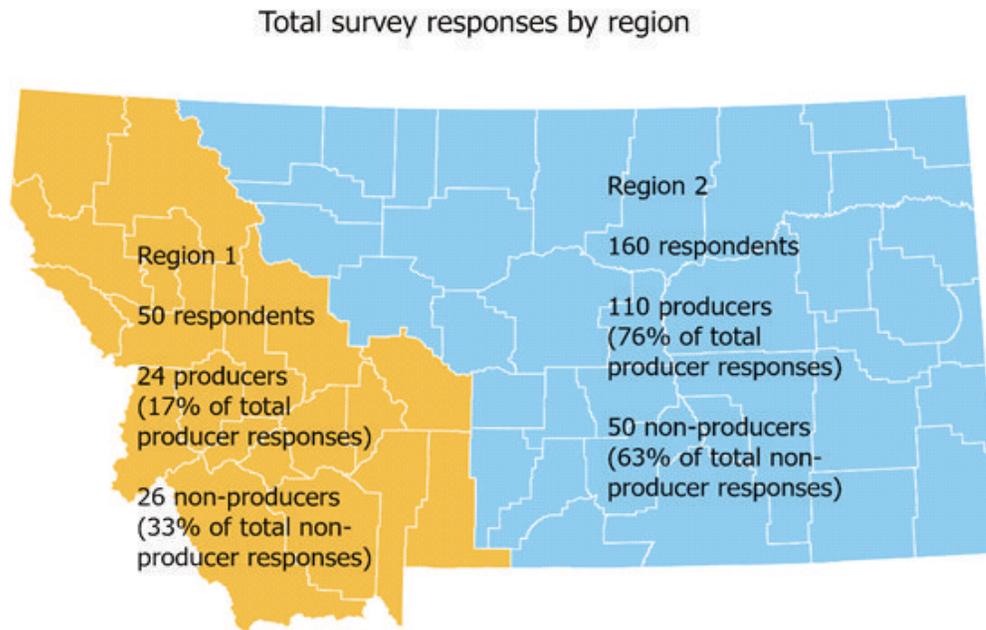


Table 1. Total focus group participation by location

Focus Group Location	Number of Attendees	Producers	Non-Producers
Great Falls	7	5	2
Miles City	8	6	2
Livingston	17	6	11
Kalispell	8	0	8
Dillon	10	3	7
Virtual	11	6	5
Total	61	26	35

Figure 2 shows that among producers who responded the survey, respondents were evenly split between those who only raise crops, those who only raise livestock, and those who do both. Figure 3 shows the types of livestock and types of crops most common among all producers who responded that they produce anything in the given category. Almost all respondents (90%) who raise any livestock raise cattle, and a substantial minority (24%) raise sheep as well. Among producers who grow crops, most grow wheat and/or pulses, with substantial minorities growing oil seeds and hay. The results in Figures 2 and 3 suggest that survey respondents represent the dominant agricultural production sectors in the state.

Figure 2. Types of production under survey respondents

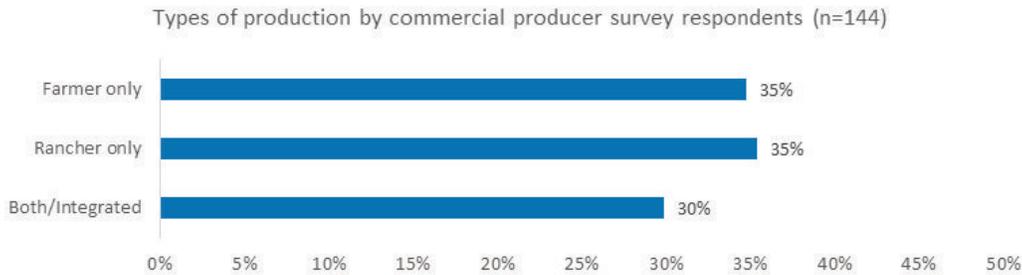


Figure 3. Types of crops and livestock raised by survey respondents

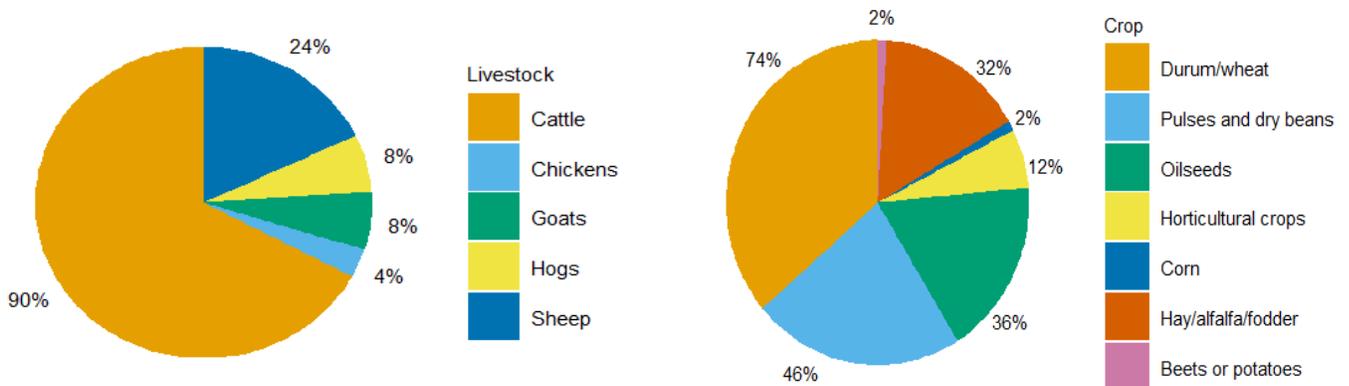
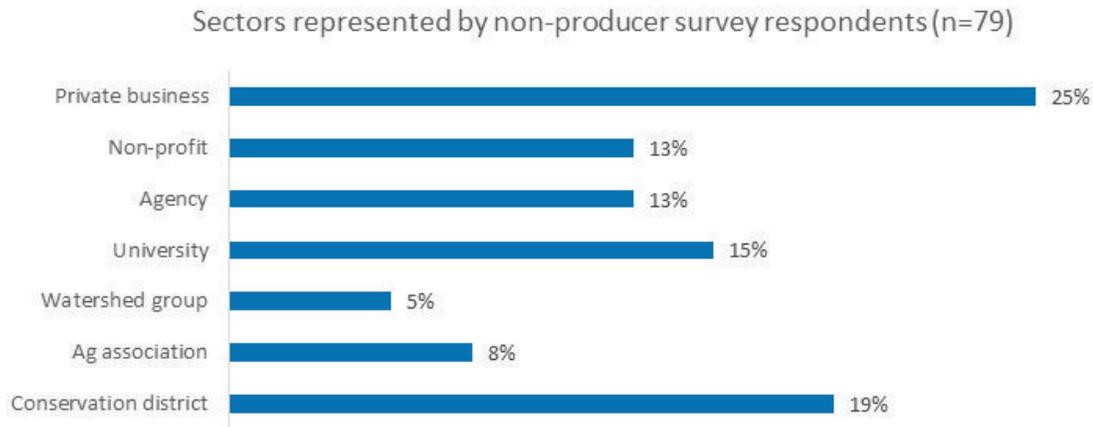


Figure 4 shows the breakdown of non-producer survey respondents by type of organization in which they work. No single institution is dominant, although agricultural organizations and watershed groups are underrepresented.

Figure 4. Non-producer survey respondents

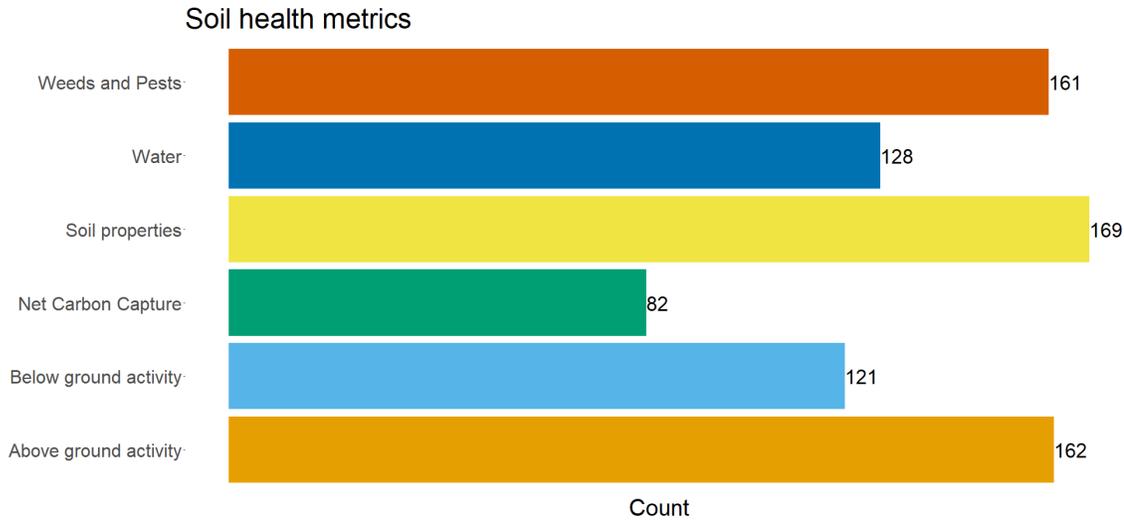


MOTIVATIONS FOR PURSUING SOIL HEALTH

METRICS OF CONCERN

To understand which ways soil health could be improved, the survey asked respondents the following question: Are there any soil health metrics that you feel could be meaningfully improved on Montana farms and ranches? Survey respondents were asked to all that apply.

Figure 5. Top soil health metrics of concern for all survey respondents



The survey included 18 different variables for metrics that the user would choose from, which were then recoded into eight different categories based upon information from interviews and focus group input (see Appendix I). Figure 5 shows that overall, the top three metrics from all survey respondents are “Above Ground Activity,” “Soil Properties,” and “Weeds and pests”.

Figure 6. Soil health metrics of concern by region

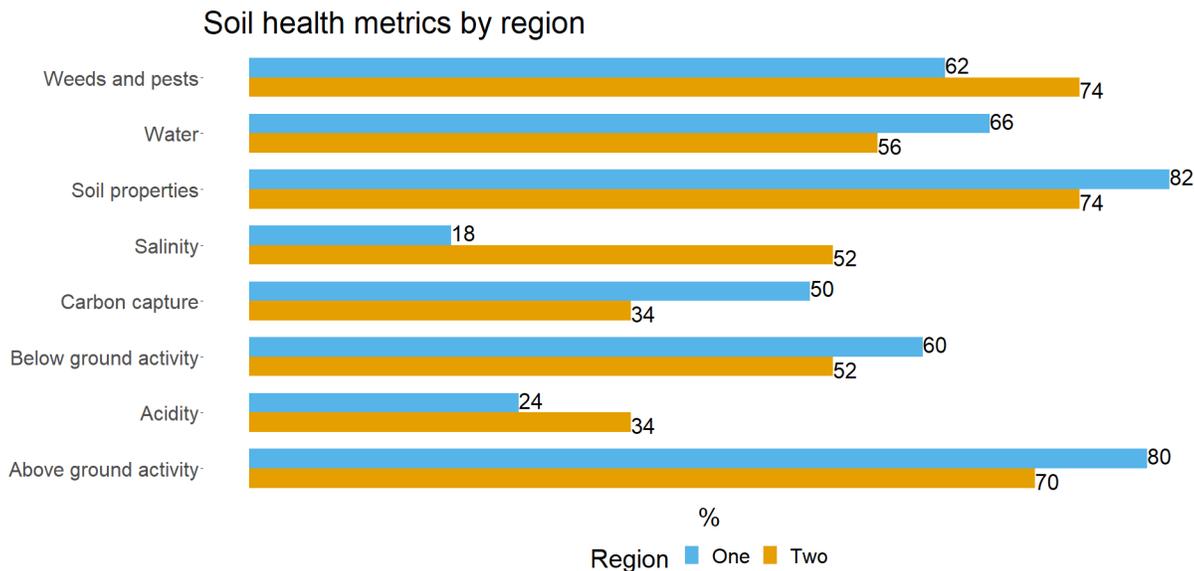


Figure 6 shows the top soil health metrics of concern by region. The only large difference between regions is concern about soil salinity, which is a much larger problem in north-central and northeastern Montana than in the rest of the state. Concern about weeds and pests is also slightly higher in the central and eastern region of the state compared to the west. In the western region, there is more interest in carbon capture as a metric of concern, as well as in soil properties and above- and below-ground activity.

Figure 7. Soil health metrics of concern by type of respondent

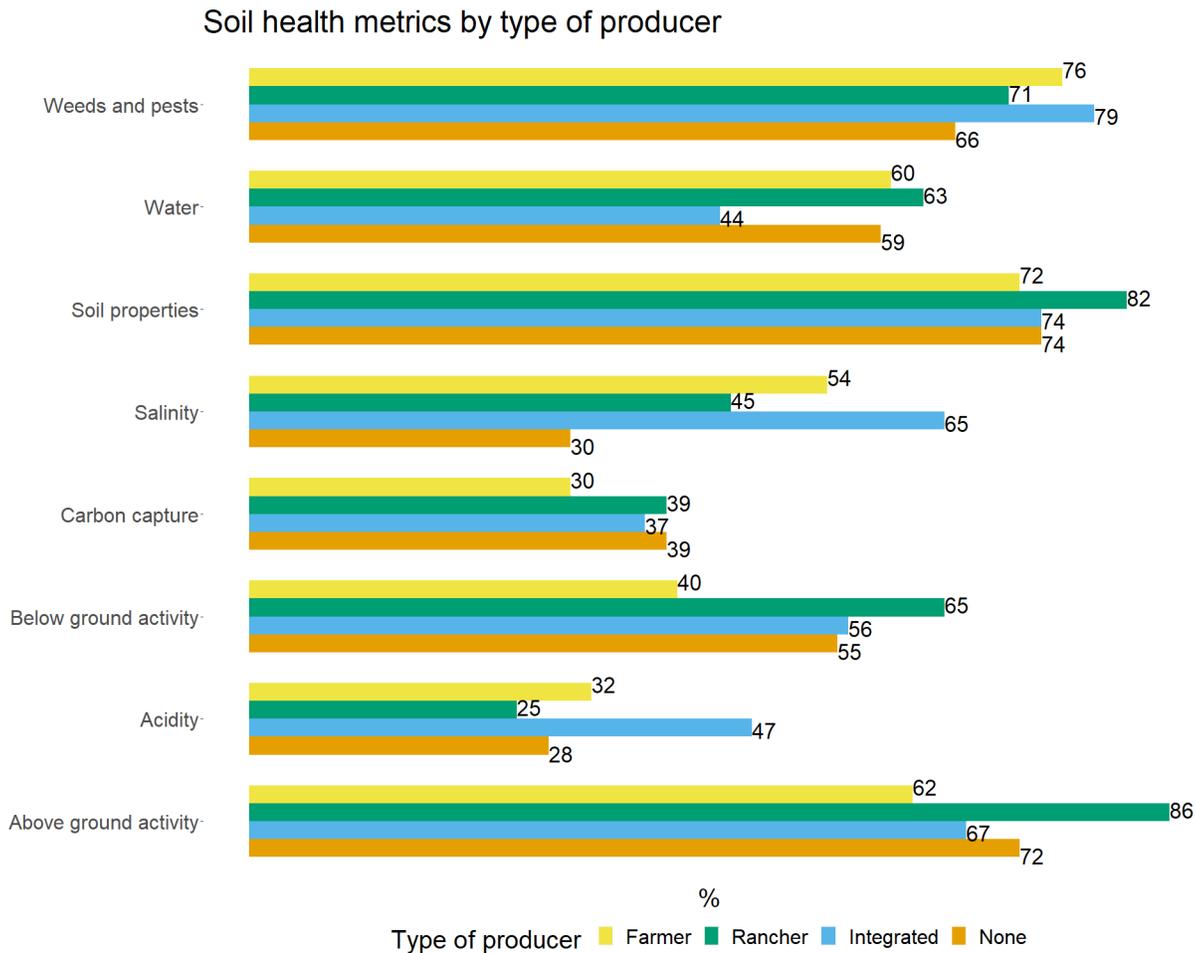


Figure 7 shows soil health metrics of concern for each type of survey respondent – farmer only, rancher only, producers with both crops and livestock (integrated systems), and non-producers (none). Overall, there are not substantial differences among types of people in terms of soil health metrics of concern. In general, farmers seem less concerned about all soil health metrics, and ranchers seem to prioritize those associated with soil properties and function (above- and below-ground activity). Producers with both crops and livestock were more likely to highlight both soil salinity and soil acidity as key metrics of concern.

ECONOMICS OF SOIL HEALTH

When all is said and done, making a profit (to make a living) comes before anything else, and soil management and improved soil health can be a mechanism to increase profit. A producer from the Great Falls focus group emphasized the importance of profit over anything else, “if we’re not profitable, all our efforts would be just negated.” The obvious foundational reason for prioritizing economics in agriculture is to be able afford the land and make a living doing something you love. For many focus group participants, it seemed like economic stability and viability was a

way to ensure that their investments in the soil and the land are maintained. Focus group participants emphasized how impactful Ranching for Profit has been for their decision-making, in part because it makes the connections between better soil management practices and increased profits explicit. As one service provider said from the Miles City region, “I think that's maybe what's probably [more] important than anything in soil health, is it's got to make money for the producer. Probably before even addressing soil health.”

The motivating factor behind any ranching or farming operation is making a profit: “The indicator of soil health is financial stability, not soil temperature.”, says a service provider from the Kalispell focus group. If you are not making a profit, everything else is for naught. However, most farmers and ranchers in the focus groups have adopted improved soil health practices in order to improve or do better by their operation, starting with increased economic stability. People show up to meetings, engage with each other and are receptive to the communication of organizations on the pretext that their operation will do better – profit wise. A bonus is that doing better profit wise is intertwined with caring more for soil and soil health. What is working is marketing soil health practices as linked other concepts such as profit increase, better quality of life, less input costs, etc.

“There's the economic part which is nothing viable unless is profitable and more sustainable. And then there's the environmental part. I'd say what motivated us to begin with wasn't anything more than the dollar, right? Not to get rich, but if we're going to do this we have to pay the bills.” – Producer, Livingston focus group

Making a profit by streamlining or simplifying an operation included selling haying equipment in order to graze cattle, not paying for gas to run tractor while relying on cover crops, reducing fertilizer and pesticide use as soil “goes back to nature.” Farmers and ranchers selling haying equipment and turning to grazing, and others haying and selling hay, are both making these changes for increased profit.

“And then we eliminated our hay production, which allowed us to slow down a little bit, or concentrate on other stuff as it were. And so, we were able to lease out our hay ground to have another guy put it up. And then sold all our haying equipment. And we weren't needing the amount of hay because of our grazing practices.” – Producer, Miles City focus group

IMPROVED QUALITY OF LIFE AND RELATIONSHIP TO NATURE

The five principles of soil health are to a certain extent indicative of an undisturbed ecosystem. Of course, in agriculture you cannot have an undisturbed ecosystem, but many of the current soil health practices and initiatives are aiming to “get back to nature,” or mimic what a healthy ecosystem looks like: living root and crop cover for water infiltration, large grazing animals back on land, plant species diversity (including native plants), and minimal soil disturbance. For example, a producer from the Miles City focus group shared that they broadcast crop seeds by using their pigs to turn up the dirt and integrate the seed into the soil. Most ways that folks integrate livestock into croplands will end up being beneficial to the soil health.

“And I think we'll have to come back to where it was back when there was nobody here, before Lewis and Clark. And we had bison on the prairies, on the range. And you had predators that were keeping them together and over how long that was thousands of years, we built a very nice top soil with a lot of infiltration. Was there no erosion at all? I think there probably was at some time when you had some really high rainfall in one time, but it was a whole lot less and it was a healthy soil with a lot of organic matter, a good carbon cycling.” – Producer, Great Falls focus group

Another aspect of trying to work more with nature instead of against is moving calving to later in the spring- just like mammals do in the wild. Not only does this increase chance of survival and ease of birth (for animal and rancher), but it also improves quality of life. No one has to get up in the early hours of a February morning and help a cow give birth; moving calving time has ranchers nearly enjoying the process, or least not as stressed. Although not directly related to a soil health metric, changing calving dates change feeding and grazing practices, and all in all can support adaptive grazing management that does address soil health principles.

“Our working with nature more or less correlates with the cattle and a lot of people calve in January and February. That was because pounds pay. Do the deer calve in February and January? No, they calve in May, June, July when it's hot, nice, green

grass. *“Why would you force your animals to be in that kind of environment? That's not really working with nature. That's working against nature because you're forcing them to do something that's probably not natural to them. You can add more to that, but that's where I was going with that.”* -Producer, Great Falls focus group

Soil health practices are most often implemented to improve profits, but many producers emphasized the increase quality of life for farmers and ranchers that come with a change in practice. Improvements noted by focus group respondents related to adopting regenerative agriculture practices and tuning into their soil health include more time with kids, vacation time, kids engaged in farming/ranching/soil health topics, decreased financial stress, and easier calving seasons. Improved quality of life has become the measure of success for soil health for many producers, and makes coming home and continuing to ranch much more appealing to the next generation.

“Our quality of life has improved with regenerative agriculture, because we actually have time to vacation now, and do things...we don't have to feed all winter or put up hay.” – Producer, Miles City focus group

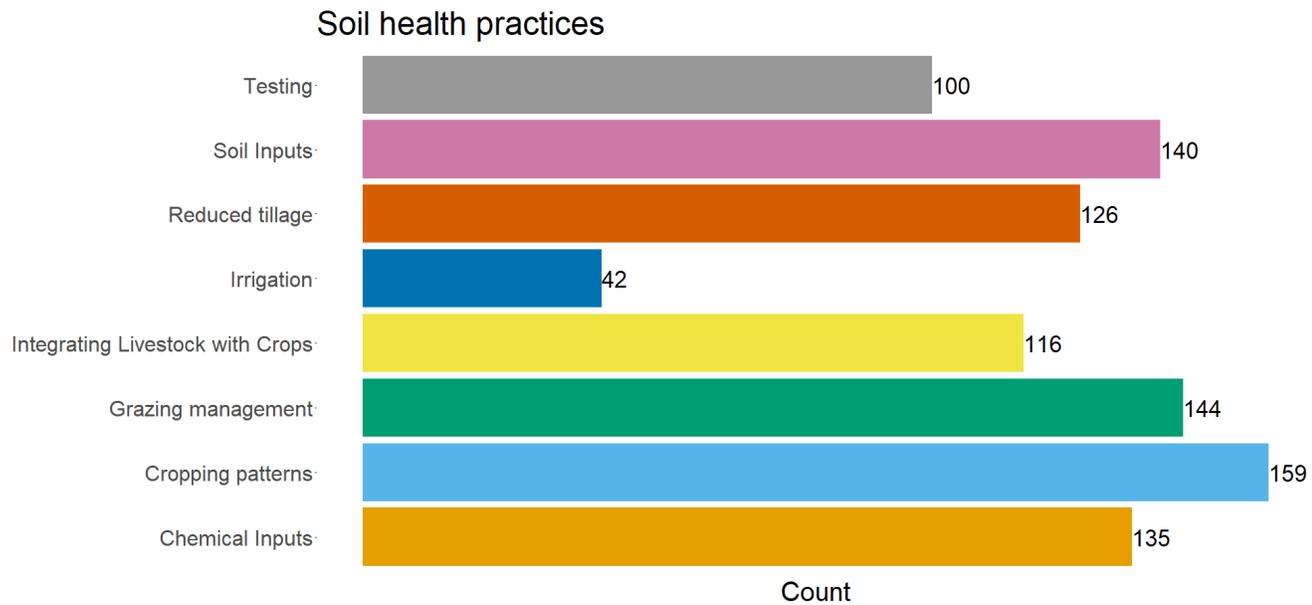
APPROACHES AND CHALLENGES TO BUILDING SOIL HEALTH

While the survey was focused on soil health metrics and tools to improve soil health, the focus group conversations centered on the centrality of personal relationships for ranchers and farmers in making decisions about soil management practices. Themes of peer-to-peer producer learning and collaboration, tradition and the status quo, and generational succession have so far turned out to be some of the most important drivers of changes in soil management. As noted above, focus group participants emphasized the positive impacts on the lives of farmers and ranchers and their families that came from addressing their soil health. These changes have added stability and diversity to people's livelihoods, and impacted their happiness and quality of life, and the excitement to connect with peers and have meaningful conversations on these topics was apparent.

PROMISING PRACTICES FOR SOIL HEALTH

To understand which ways practices are most effective, survey respondents were asked the following question: What strategies, systems, or methods do you feel could improve these metrics? Survey respondents were asked to select all that apply.

Figure 8. Promising practices to improve soil health



As shown in Figure 8, overall results from the survey show that most respondents see most types of improved soil management practices as having the potential to address the metrics that they identified as needing to be addressed in Montana. The only categories of practices that were selected by fewer than 50% of respondents were testing, which still was seen by a sizable minority as a promising approach, and irrigation, which was selected by less than 20% of respondents.

Figures 9 and 10 show differences by region and by type of producer. No substantial differences exist by region, although there is slightly more interest in irrigation practices in western Montana, which is not surprising given that there is more irrigated agriculture in the region. When analyzed by producer type, ranchers were much more likely than other producers to identify grazing management and livestock integration with crops as promising practices, likely because these are practices that they know well. Ranchers and non-producers were also more likely to identify irrigation as a promising practice, even though ranchers are less likely to use irrigation themselves. Those producers

with both crops and livestock were more likely to identify tillage and chemical inputs as sets of practices that are promising for addressing soil health metrics.

Figure 9. Promising practices by region

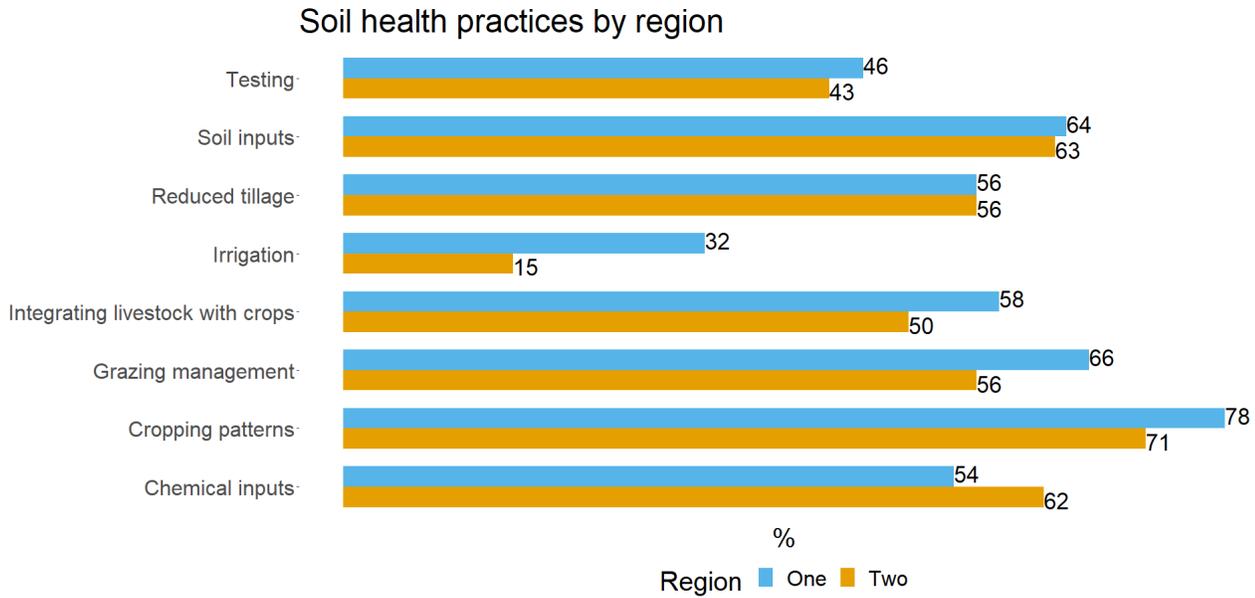
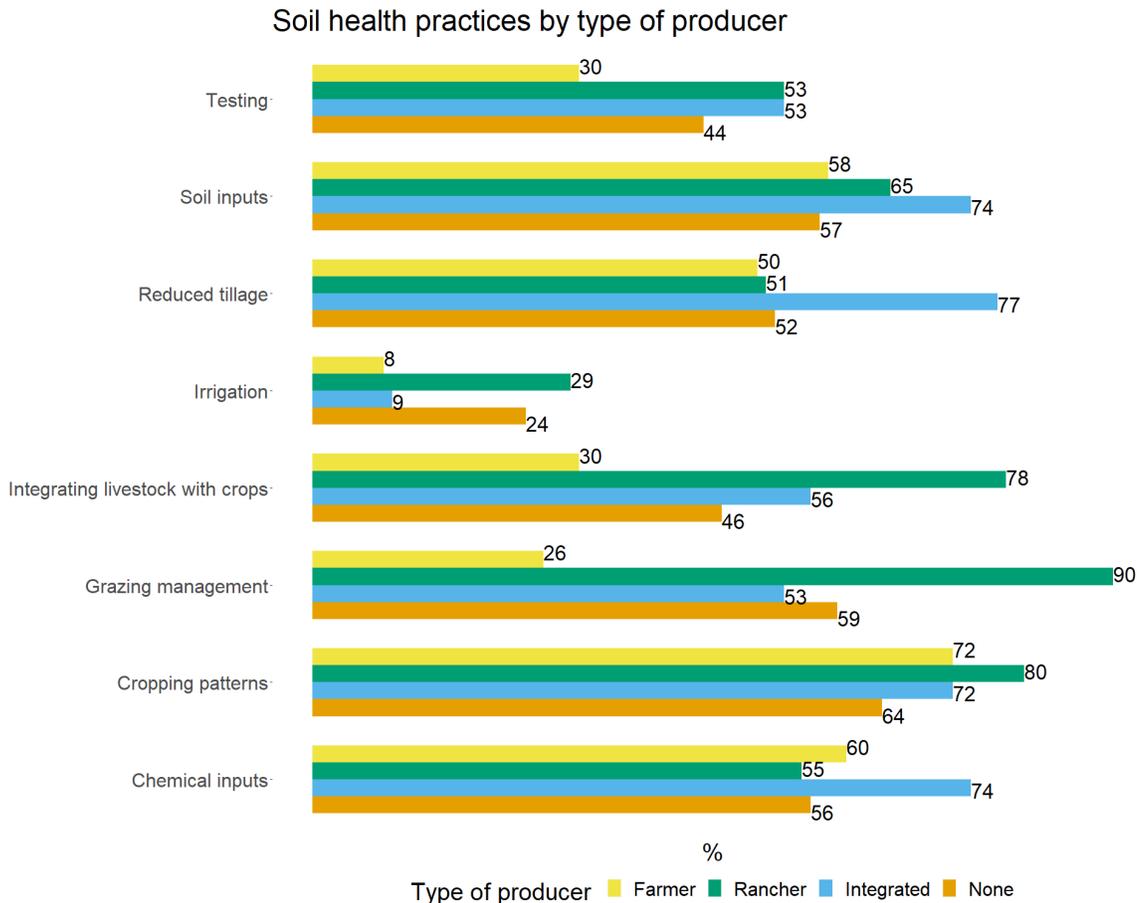


Figure 10. Promising practices by type of producer



Maintaining living roots, crop diversity and soil armor

Crop rotations were the top category of practices identified by survey respondents overall, and there was substantial agreement across the state and across producer types. Crop rotations include cover-cropping and inter-cropping, both of which cover the soil and keep live roots within the soil, which are two of the soil health practices. Living roots and soil cover are both extremely important for retaining water when it does rain, and keeping precious irrigated water in the soil.

“Yeah. Keeping the ground covered so the moisture stays in it is a big key lately, especially when, like he said, we're not going to get much water from irrigation systems this year. So we're trying to keep whatever we do get in the ground as much as possible.”
– Producer, Dillon focus group

Another aspect of crop rotations that helps build soil health is inter-cropping. Intercropping different species with each other is helpful in establishing biodiversity, safe-guarding in case one species doesn't seed well or a pest takes to it, and in building nutrients. For example, one producer in the Great Falls focus group talked about how diversified intercropping can address disease concerns: “The peas can provide a little bit of nitrogen to the flax. The flax can provide a little more disease resistance to the chickpeas.”

Minimizing soil disturbance

One of the best ways to build soil health is by switching from standard tillage to reduced or no tillage for crop planting. One specific change that many producers in Montana are making is from a hoe drill to a disc drill, which creates the least amount of soil disturbance. Minimal disturbance to the soil helps increase water infiltration and retention, which is crucial to growing, especially in Montana's increasingly drought-prone environment.

“We've been on the verge of desert for decades, and now you look at the water balance. And if this continues to be the case, we are sitting very clearly in a desert ecosystem. But on his farm, they've been practicing no-till for a couple of decades now, and he really attributes the fact that he continues to get good yields or even better yields than a lot of his neighbors to the fact that they've been practicing no-till.” – Producer, Dillon focus group

Integrating livestock into cropping system and manage grazing

Having a system where livestock and crops coexist is one of the five principles of soil health, and for good reason. When you integrate livestock into your cropping system, animals leave manure for nutrients, graze down crops to encourage new growth, and overall create better soil health and biodiversity. The producers who know the benefits to their soil are trying to create more opportunities for livestock/crop integration: “But we grow cover crops to integrate our livestock into our crop land, which we're trying to do more and more of all the time.” says a producer from the Great Falls focus group.

Grazing livestock versus feeding hay relates to multiple soil health principles. Not only does grazing lend itself to less cost for hay and gas for tractors but having livestock on cropland replenishes the nutrients in the soil by cycling nutrients the way nature intended. Many ranchers have now considered growing grass and other grazing fodder as a core part of their operation.

“We're here to grow grass. We're here to graze grass. I mean really that's what it comes down to is we're capturing sunlight and turning it into a product that we can sell and trying to do that in such a way that every year we can produce more and give more back to the land.” –Producer, Livingston focus group

CHALLENGES TO BUILDING SOIL HEALTH

Drought and environmental conditions

Many of the farmers and ranchers who participated in focus groups expressed becoming increasingly aware of the impending immediacy of drought conditions as they affect production. Drought conditions occur when a region experiences below average precipitation and affect groundwater amounts, soil moisture, crop yields, and general water shortage. Drought has become somewhat of a norm for most farmers and ranchers in Montana due to the lack of precipitation during the past few years. For some, drought awareness comes with anxiety and disheartenment. For others, the awareness of drought has encouraged practices that better improve water retention within the soil and can adapt to the changing climate.

“I think we hear sort of two major things, I think, lending to an increase interest in soil health, and that's the immediacy of this drought has got people thinking about, of course water availability or lack thereof. And I think a lot more people have started to recognize that the soil is our sponge. And so you can't do a whole lot to control precip[itation] other than reservoirs, ditches, that sort of thing. And you can't do a whole lot to control temperature, and temperature it's pretty clear is going up in our area. – Producer, Dillon focus group

The changing climate is somewhat of a given; it's how farmers and ranchers react and adapt to these changing conditions that will affect the outcome of agricultural production in Montana. Soil has the potential to store moisture. However, unhealthy soils will not allow water infiltration, leading to runoff and exacerbating the impacts of flooding like that seen in the upper Yellowstone watershed in June 2022. As one participant noted in the Dillon focus group, “the whole world depends on four inches of top soil when it rains.”

Financial and development pressures

Alongside a changing Montana cultural demographic is a changing land-ownership demographic.

“Demographics are changing. There are fewer and fewer family ranches left. In the sense there still are intact ranches, but they're owned by someone who's not interested in owning cows or running cows. So I think something else with the soil health needs to address that changing demographic. And I think there's a great opportunity to bring those high net-worth people and their influence into the fold.” – Producer, Livingston focus group

This shift in land demographic is lending to the degree of attention farmers and ranchers are paying to land they do own and work on. Many farmers and ranchers are lowering stocking rates to mirror smaller plots, which are in part due to the arrival and purchasing power of high net-worth people moving to rural farming and ranching areas. Not only does this lessen their input costs but changing stocking rates to match what their land can handle is a better practice for building soil health.

With a higher-net worth population of landowners allows space for an expanded land lease program idea: working with high net-worth home owners who have land in Montana and using their land to graze cattle. This benefits the ranchers, giving them more grass to graze, it benefits the soil by bringing livestock onto the land, and it looks good for the high net-worth land owner because they are doing something to interact with the community.

“For us, it's an opportunity. The people that are coming in and if they got enough money to buy land and Paradise Valley, they're probably not looking to make any money off of it. That's not a real positive. That's not really a possibility, but by trying to show them what we're doing, we'll just graze it for free. We're doing you a favor.” – Producer, Livingston focus group

Crop insurance and private lenders were discussed by some focus group participants as challenges to taking the risks associated with making major changes to production practices. Part of the challenge is the time horizons associated with both insurance and credit, which are generally annual or over the course of a few years. In contrast, the transition from tillage and chemical fertilizer to rotations that keep ground covered and roots in the ground often cause a dip in productivity for a few years, as soil rebuilds and new production practices are self-sustaining.

“I mean, because you can't expect one year of continuous crop and it changes the biology. It's five or six years and then they're producing the same amount that they did before. I think that the risk is the years till you get there. Right? And especially with guys that are just starting or younger farmers, that's a big risk. Plus the insurance does not help them out, and so it promotes the wheat fallow system as compared to continuous cropping system.” – Producer, Great Falls focus group

In addition to mismatches in time horizons, producers note a mismatch in the priorities of private lenders, which focus on maximizing both producer profit and loan amounts, and production practices that decrease external inputs and costs and scale back operations overall, so that profit per acre or head increase while overall production decreases. This mismatch, and especially the way that private lenders require payback plans, can not only create roadblocks for adopting more soil-friendly management practices but can also exacerbate the ecological challenges and impacts of production practices that are focused only on gross profit.

"I'll just say financing sometimes drives the number of animals that a person has to run, and sometimes that does not balance with what the land is capable of. Not real often, but it happens. Then you go out and start working on a grazing plan with the guy and he says, "I got 420 head." And it's like, "Got enough grass for 320." And he says, "I have 420 head. We got to make this work." Going to buy three trucks worth of hay just to balance the equation without destroying three extra pastures...it came down to that's what his bank told him he had to run in order to make the land payment. I mean, he's trying to pay for the ranch, right?" – Producer, Dillon focus group

Social inertia

The largest challenge to expanding the use of soil management practices observed through the survey and the focus groups was that the farmers and ranchers who want to be involved, are involved. The farmers and ranchers who are not involved seem to not have an interest or are hard to reach. If you do reach these people, there is a large chance they might reject any new school of thought due to the financial pressures they face, as well as a general orientation toward doing things as they have always been done. How can you involve people who do not want to be in the conversation, but would benefit from it?

"The problem in this area, most folks have livestock and that's a 365-day thing, so we don't have a lot of farmers here that have time to go to a lot of meetings. That's the problem, just getting folks out. So I don't know how you overcome that. But you can do it with dollar signs. If you could get them interested and show them that this is one of the things you could do to help." – Producer, Dillon focus group

Generational know-how is an evident barrier to expanding the networks of many of the farmers and ranchers in Montana. There are many people who have been doing it one way for years or for generations, and therefore believe, "we don't need to know it, we already know it." There was consistent conversation about young farmers and ranchers convincing their parents to try no-till drilling or year-round grazing. Most of the time, it seemed the older generation would eventually be willing to try something new. But without the younger generation posing the ideas, nothing would change.

WHAT PEOPLE NEED TO SUPPORT SOIL HEALTH IN MONTANA

In order to understand what types of resources or support would be most useful in building soil health, survey respondents were asked the following question: What resources or forms of assistance would be most useful to make these improvements? Survey respondents were asked to select all that apply.

MOST USEFUL RESOURCES

Figure 11. Resource needed to support soil health practices

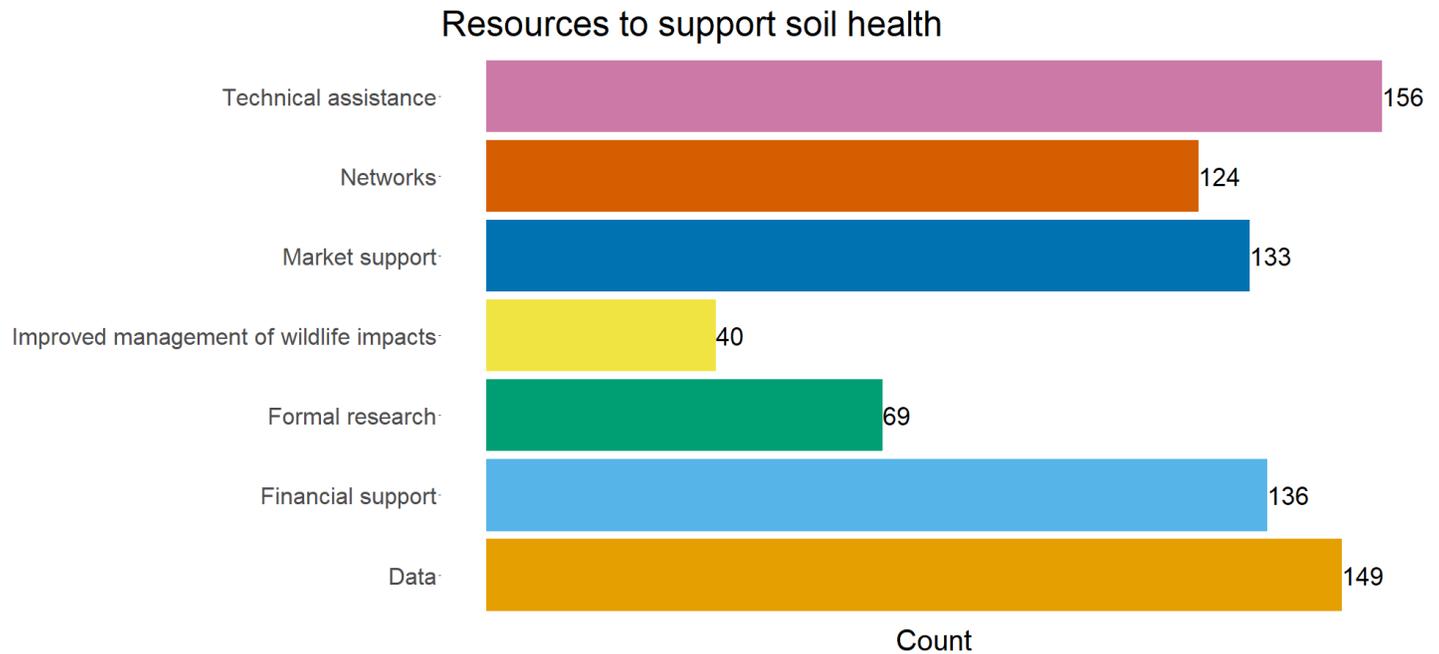


Figure 11 shows the types of resources most identified by survey respondents as being helpful in supporting the adoption of practices that could improve soil metrics. Overall, most respondents felt that most types of resources would be helpful and focus group participants added nuance to how these resources could and show be deployed to maximize impact. Figures 12 and 13 show differences by region and by producer type in the types of resources identified as most useful. No substantial differences exist by region in terms of resources identified. When analyzed by producer type, ranchers are much more likely than any other producer type to see networks and financial assistance as a needed resource, and producers with both livestock and crops are more likely to identify research as a useful resource as compared to other types of producers.

Figure 12. Resources needed by region

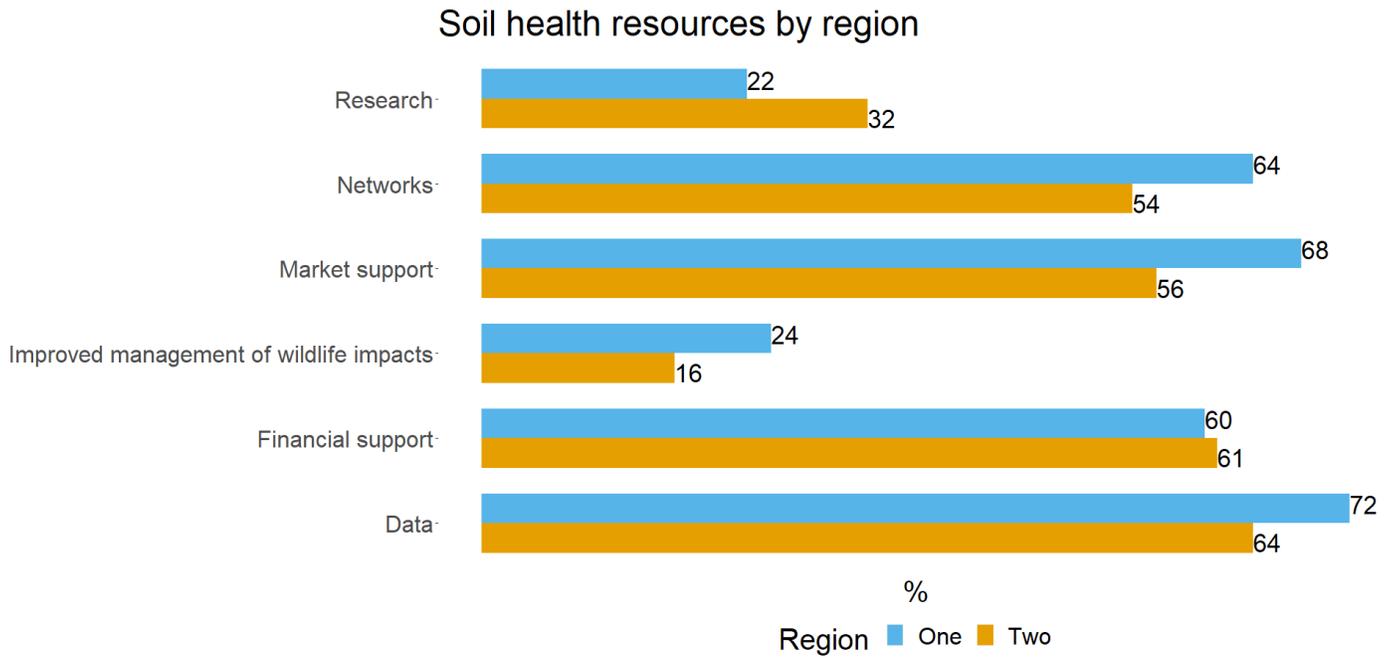
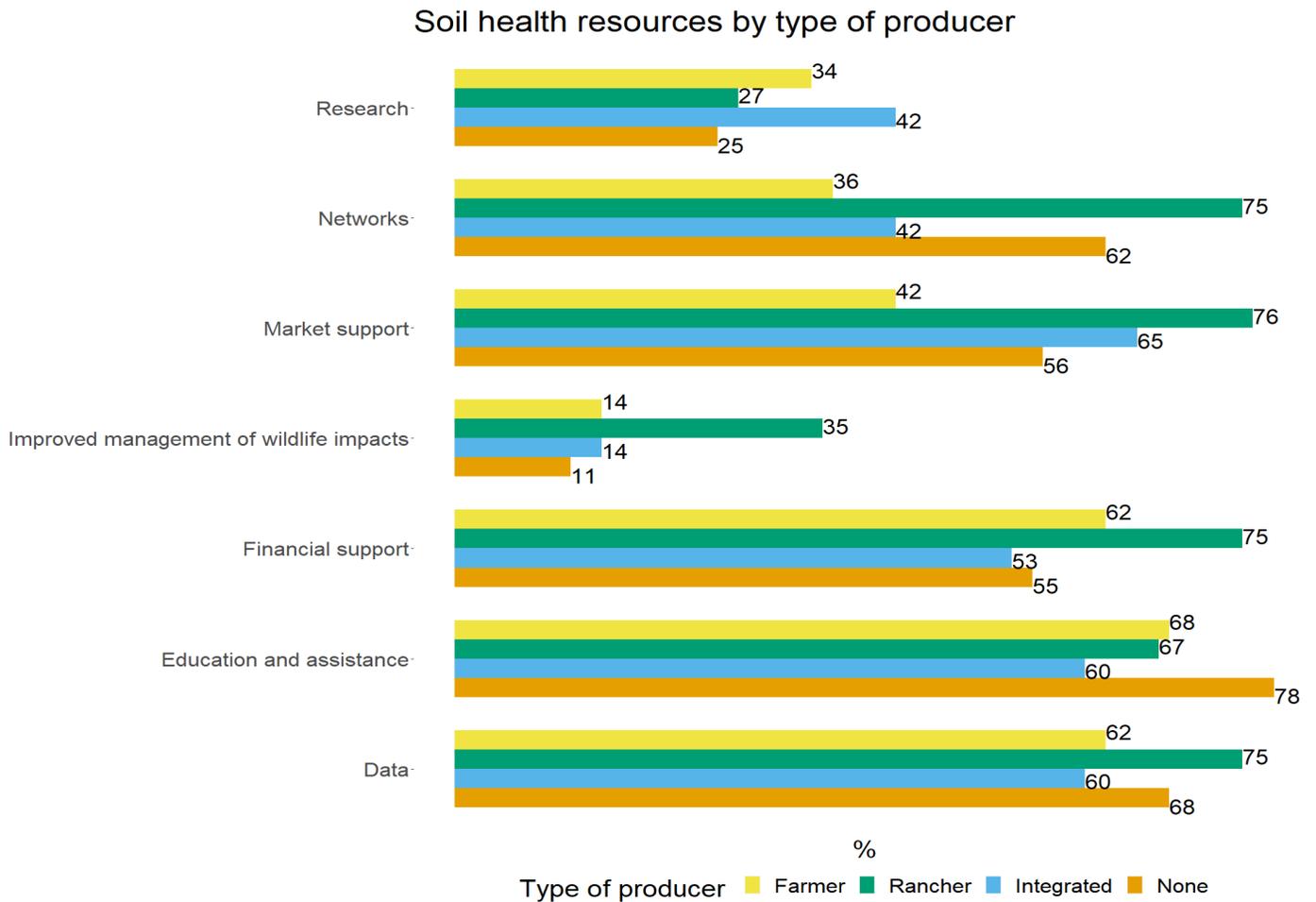


Figure 13. Resources needed by producer type



INSTITUTIONAL SUPPORT

Basic soils education

The consensus from focus groups was that reiterating and detailing the basics of soil health is extremely helpful and encouraging to farmers and ranchers. Those who are already aware can always learn more, and it's a launching point for interest at any knowledge base.

"I think the basic education is a key and we got that from the survey at the Soil Health Symposium. I'm over here and I know the basics, but you have to keep going back to the basics because you're getting different levels of people at each symposium. This next one, we're going to do a soil health 101 because you got to keep, and I know some people are like, "Oh, I've already heard that before." Yeah, well not everybody has." – Service provider, Livingston focus group

Starting soil health education in school is another tool that could support producers in more rural communities. If the youngest generation was learning about erosion, moisture retention, living roots and the importance of covering soil in science class as well as in 4-H and FFA, the next generation of farmers and ranchers would be a lot more interested in soil health. Across focus groups people expressed the idea of adding soil health education into the curriculum of elementary schools in ranching areas, and in addition working to pass down these values from parents already engaged in the soil health conversation. All ranch parents dream to have their kids come back and take over. As one rancher in the Miles City focus group put it, "Push it on the little people... we are raising some soil health nerds."

Technical assistance

Both producers and agency employees expressed frustration with many federal conservation programs that can be used to support soil management. Programs like CSP, EQIP, and others have made it possible for many of the producers who participated in the focus groups to take risks and try new practices with some financial and technical support. At the same time, the shift away from the technical assistance that most want to be providing and toward simply providing money has undermined the holistic approach that many producers and employees want to take to soil health. As one NRCS specialist from the Kalispell focus group put it, "The conversations that I have, it's not, 'I have this issue, do you have any suggestions for fixing it?' It's like, 'What aid do you have available right now that I can apply for?' That's it. It's literally like, 'What's on the table with money?' And that's all they care about."

In addition to basic soils education, focus group participants highlighted the need for infrastructure education, specifically related to fencing and irrigation. Folks expressed being tied to their existing practices due to the permanence of their fencing or system of watering.

"But you do something somewhere and you're like, okay, well this is good, but this would've been better. Note to self. So we've started leasing additional properties. One of them across the river from us. We're on the east side of the river. And with the assistance I got from Dave on designing stuff and the experience I got from what didn't work, we built out the infrastructure on there and we actually grazed cows there this winter." – Producer, Livingston focus group

Renting or sharing equipment makes it easier for farmers and ranchers to try new methods and experiment with recommended regenerative agriculture practices that are better for soil health. Buying a new form of equipment while not knowing how and if it will work is a huge cost barrier to farmers and ranchers- especially those farming on a small plot of land. While some conservation districts offer no-till drills for rent or lease, many don't, and it became clear this would be a very beneficial use of funds. Being able to borrow and try out equipment is a means of technical assistance that would aid farmers and ranchers – who might be looking to try a new practice without the massive cost of buying equipment – immensely in taking risks and trying new practices to improve soil health.

"One of the reasons they're not doing no-till is because there isn't, they don't have no-till drills. They don't own no-till drills. They don't operate on a big enough land base that they can afford to get rid of their current [system] and everything else and then convert to a no-till system. Because the cost is too high to get into it. So that is one challenge. It's a very real challenge. I think

more people would be doing no-till if they, you know, could afford the equipment based on their land base.” - Service provider, Kalispell focus group

“Just try, if you have a 640 acre field, just try 160 of it, just to see. Our conservation district has a small scale, no-till drill so you could just rent that and try to cover crop cocktail on that. Just start small scale so you don't feel so overwhelmed and just focus or play with that. Then once you get more comfortable and done your own research, then you can expand. That's somewhat how we started a little bit.” – Producer, Great Falls focus group

Risk management tools

Farmers and ranchers engaged in regenerative agriculture practices need a new approach to banking to match changes in production practices. Currently, bankers are making money when producers can't turn a profit and must take out loans, instead of incentivizing them to shift to practices that provide financial stability. According to a producer in Miles City, “They [bankers] lose business because ranchers are starting to make a profit [when they adopt regenerative practices]. And they don't like that.” This new wave of service providers should include private crop advisors interested in a more holistic management approach as well. Many focus group participants felt that understandably, crop advisors push fertilizer, because they have deals with fertilizer companies, and aren't attuned to supporting farmers and ranchers moving away from fertilizer use.

Crop insurance and subsidies as potential risk management tools are also not doing its part to support those who are actively trying to improve their soil health. Subsidies for crop failure or a bad year are another mechanism for farmers and ranchers to be dissuaded against improving their soil health. Producers who apply for government funding when their crops are not doing well, and get a check, will be less likely to dive into why their crops are failing, or what they could do better next year.

“If your field's blowing, I'm sorry, that should be a check against you. Maybe your rate is lower this year. If you have good soil cover and you like... I understand the government doesn't have enough money, they don't have enough staff, but if you could come look at our place, then look at maybe our neighbor's place. How come he's getting more money than we are? You're giving that guy handouts as far as I'm concerned, because he didn't do the work and research that we're trying to do.” – Producer, Great Falls focus group

If someone's soil is eroding, they should face consequences instead of receiving payments through cost-share or subsidies. If the government wants to be engaging in aiding farmers and ranchers, they should be promoting and incentivizing practices that promote building soil health instead of giving out money to keep practices the same and further deplete soil health.

University research and extension

Consistent across all focus groups was a feeling that at best university research, including research at agricultural experiment stations, is irrelevant for producers and at worst, it could actively dissuade people from trying new practices. The highly controlled nature of field trials and experimental design keep falling short of what these farmers and ranchers need in terms of support. In addition, research tends to focus on a few well-known practices and has not expanded to include the diversity of new and innovative practices related to soil health with which many Montana producers are actively experimenting.

“Their cover crop work, if they would've asked me to design a research project that would fail so that no one would ever want to do cover crops again, I would've done what they did. And so I think they wanted to do cover crop project one time so that they would never have to do it again, so they could go back to doing variety trials, to know which one makes a half a bushel more than the next.” – Producer, Great Falls focus group

As one example, focus group participants in western and central Montana had a lot of negative feedback about failure and disaster upon trying the no-till drill. If more funding was put towards research and outreach that could support farmers and ranchers in learning how to apply these practices (not just that it is good to use this equipment), there

might be an increase in adoption to some of these soil health building practices. Education without instruction on specifics seems to not be working for producers.

“No-till has been... They've tried it around here, but I really don't know personally of anybody that's really had very good success. I've had neighbors try it. In fact, one neighbor he's gone non, but he's tried it since the eighties in a couple different drills, but he hasn't been able to... They've tried different things. They did put a culture package on a no-till drill, which really helped because in our situation, if you're irrigated, you have so much crop aftermath that they couldn't get the seed to soil contact by just running a spike down in the ground and drilling.” – Producer, Dillon focus group

NETWORKS AND OPPORTUNITIES TO LEARN

While the survey was focused on soil health metrics and tools to improve soil health, the focus group conversations centered on the centrality of personal relationships for ranchers and farmers in making decisions about soil management practices. Themes of peer-to-peer producer learning and collaboration, tradition and the status quo, and generational succession have so far turned out to be some of the most important drivers of changes in soil management. Most notable from the focus group discussions were the positive impacts on the lives of farmers and ranchers and their families that came from addressing their soil health. These changes have added stability and diversity to people's livelihoods, and impacted their happiness and quality of life, and the excitement to connect with peers and have meaningful conversations on these topics was apparent.

Peer-to-peer networks

The peer-to-peer connection aspect is really important for this conversation, and for changing the way people are thinking about their soil and land management practices. Something heard consistently across focus groups was the desire for more peer-to-peer engagement and structured conversation facilitated by the actors already involved (extension agents, conservation districts, NRCS). Farmers and ranchers are always paying attention to their neighbors but will rarely go over and talk to their neighbor about what he or she is doing. There is a visible delight in the anonymity of sharing best practices in a safe space: “People are interested in what we do and how we do it,” said a producer in Great Falls region. But the “how” gets lost in existing egos and neighbor-to-neighbor social patterns (or lack thereof). People also expressed an interest in participating in land lease or cow leasing programs, where young ranchers who have cattle but not enough land can try out year-round rotational grazing in collaboration with another producer who has land but no cattle. Using the existing networks to cultivate these types of relationships and spaces for conversation would be beyond valuable to both soil health and to the educational growth of many farmers and ranchers.

“We were working a bit with the neighbor and we had planted some cover crops on the field and he put his cows on. I'm not a livestock farmer. If I had livestock, I would soon to have dead stock. And that's not the idea. So with that, we're trying to find the right partnership with people. Now, some of the thing is that generally you've got good grain farmers and good cattle farmers. It's rare to have a good grain and cattle farmer. That seems to be difficult.” – Producer, Great Falls focus group

Sharing numbers

One conversation that came up in almost every focus group was an interest in being able to view other producers' books or balance sheets to understand the economic benefits of changing soil management approaches and incorporating regenerative agriculture practices. Many people are skeptical; trying something new is scary because of the prospect of failing and losing money. However, making changes involves taking financial risk, and as one rancher said, “If you're not failing, you're not ranching.” Understanding the economics of any individual change can be a challenge and understanding the economics of a set of fairly big changes to land, soil, crop, and livestock management feels overwhelming to many producers. Focus group participants emphasized that being able to see not only how the numbers pencil out but also what line items to even include in the balance sheet would be incredibly valuable. The most comfortable way to do this could be to share books anonymously, with identifying details removed, or by integrating financial information from several producers into an example balance sheet. Some ranchers expressed that they would be more than willing to sit down one on one with someone to share his numbers

over a cup of coffee but would never open their books to just anyone. There is a huge amount of trust building that would be less of a barrier if people could share books and numbers anonymously.

Communication

Adoption of new and different management practices requires more successful communication, in all the meanings of communication. As mentioned, marketing soil health workshops to better appeal to the farmers and ranchers who are not already engaged in the conversation is very important. Additionally, creating spaces for farmers and ranchers to share ideas and experiences was a consistent thread. People want to talk to each other but won't do so without it being facilitated (and maybe free lunch or cookies involved). Things that could come out of these organized conversations: more grazing leases, networking niche soil health practices to help livestock and/or fields (apple cider vinegar to cows, composting techniques), better community and support system for farmers and ranchers interested in soil health.

IMPLICATIONS AND RECOMMENDATIONS

Key takeaway: Producers want to learn from one another and want support for social learning

Producers trust one another and appreciate learning from real world experience. Opportunities for one-on-one learning, network building and producer-led training were all identified consistently in focus groups as being crucial to supporting individual producers' shifts toward practices that maintain and build soil health. The financial and time costs associated with this kind of learning and sharing are not huge but still exist, and small investments that can support social learning in all kinds of settings would be very helpful in catalyzing more connections among producers.

Recommendations:

Provide small amounts of seed funding and technical assistance to facilitate peer-learning

Producers talked about wanting agencies and other organizations that support soil health to provide 'backstopping' for social learning. This could include small amounts of funding for travel costs, food and room rentals, and other costs associated with in-person learning. It could include hosting a web-based platform for producer networking. It could also include scholarships for producers to attend existing training opportunities, perhaps with the expectation of then passing forward some of what was learned (a modified train-the-trainer approach). Technical assistance providers can also offer specific and targeted expertise for producer-led training and workshops (for example, the rainfall simulator or an equipment demonstration).

Opportunities for networking and mentorship

Many of the surrounding states with robust soil health programming have mentorship programs. Similar to showcasing success stories around soil health practices, a mentor network would function so that folks who are new to regenerative practices could have a peer who has gone through the same process of switching it up and improving the operation. This mentor network aids both in the emotional and fear-based aspect of these changes but could also lend advice on what to do and what not to do. Funding for this program would come from NRCS, or a state-based soil health program.

However, a successful peer-to-peer or mentoring network in such a large and rural state such as Montana is a tricky organization. This might look like more intentional and inclusive regional meetings, held in one county and available to several adjacent counties, or perhaps a digital space such as an app or forum where producers would be able to communicate with their mentors without needing to meet in person.

Key takeaway: Research that includes complexity of the real world is needed and wanted

There is a gap between research topics and approaches taken by university scientists, and what producers feel would most help them enhance their soil health practices. To better serve these folks, studies that keep long-term goals in mind, conducting in-field "real world" research, and more intentional communication with farmers and ranchers when conducting research to make sure the projects and information will be useful.

Recommendations:

More funding for long-term and systems-oriented research

Studies need to run on longer time scales (at least five years) and need to look at the interactions and dynamics of multiple production practices simultaneously. For example, expanding cover crop research in the state to include focus on planting multiple species and grazing rather than tilling the cover crops would provide knowledge for producers with both crops and livestock who are experimenting with such systems. Similarly, conducting field trials

of the whole soil health system in varying places across Montana, to include geographic diversity in studies, would help make the research more relevant to more producers across the state.

In addition to adding complexity to research on specific topics, there is a more general interest in systems-oriented research, which would look at both ecological and economic variables, and would not try to isolate the impact of a single production decision (like choice of cover crop species) on a single soil metric (increased nitrogen availability, for example). Whole-system research takes more time and relatively more money, but also has the potential to increase knowledge exponentially since many dimensions of the system are being measured simultaneously. There are some current federal funding opportunities that support this research approach, and more can and should be encouraged and sought from both state and federal sources.

In-field trials and demonstration farms

One of the clear takeaways from producers in focus groups was frustration with trial plots and test systems. If researchers and extension agents were able to focus more research and outreach time on farms and ranches, two-way communication would be enhanced and research outputs would be more immediately useful to producers. Additionally, the use of demonstration farms could be helpful in adjunct to sharing success stories about farmers and ranchers building soil health. Research test plots would be much more useful to producers if they could visit and learn about what they could do better, instead of what might be going wrong in the test plot. Using test plots to show practices in action would be a powerful form of soil education.

Getting out there and talking to producers

A key takeaway of soil health work is centered around successful and intentional communication. As mentioned above, there was a consensus of frustration with not being heard by researchers and extension agents. A lot of this has to do with isolated research and test plots taking the place of field visits and real challenges that farmers and ranchers are experiencing but not able to communicate to universities. Based on input from producers, university extension agents might be more successful in making site/ranch visits rather than doing isolated research on plots. In addition, research should expand to look at innovative practices, especially those that decrease the use of external inputs.

Key takeaway: Education and outreach on topics and needs that are relevant to producers

People need to make a profit. One reason that ranchers so consistently talk about Ranching for Profit is because of the way it is marketed: the concepts are soil health centered, but the branding is about making a better profit on your operation. Ranching for Profit helps producers look at the economics of each ranch or farm enterprise and evaluate its profitability. Farmers and ranchers need support and education when looking at the economic parts of their operating; Ranching for Profit school helps them do this and provides a network of people to talk to long after the program is through.

People also want to improve their quality of life, and as heard throughout the focus groups, switching to regenerative and soil health friendly practices have made life as a farmer or a rancher a lot easier and more enjoyable. Highlighting the ways in which improved soil health can improve lifestyles (getting the kids interested, less work and better working times of year, able to diversify operation, less input costs, and even vacation time) would encourage producers to join the conversation around soil health and improved practices.

Recommendations:

Communicate about soil health in ways that resonate with producers

If agencies can focus their branding for soil health education and soil health workshops by using the keywords of what farmers and ranchers really want out of changing their practices (increased profit and quality of life), people who are not already involved in the conversation would be much more willing to listen and give new practices a try.

Talk about above ground activity, weeds and pests, and soil properties. Talk about decreased costs due to decreased use of inputs. Talk about quality of life!

Use storytelling about producers' own experiences to build networks and make it relevant

For folks who are interested in soil health and changing their practices to improve their operation, education might not be all that is necessary to begin. The barrier to entry is based on fear that these changes will cause them to lose money, or ruin what is currently working. Sharing successful case studies of soil health stories might showcase to those scared to try something new that these practices will help their operation in the long run.

Create example balance sheets, income statements, and profit/loss reports

Having an anonymous system for sharing numbers was a very clear thread of interest. As noted, farming and ranching are there to make a profit before all else. Many farmers and ranchers consider switching to regenerative practices to improve soil health but are dissuaded by the risk of failure and the initial cost of trying something new. Making example balance sheets with producers' input and output costs is an idea discussed at the focus group that received a lot of positive feedback.

The hesitation that comes along with this idea is that sharing numbers with another producer is a very hard, vulnerable thing to do. Sharing anonymously would be ideal, for example removing folks' names from a balance sheet before sharing. A producer in Paradise Valley mentioned he would be much more inclined to sit down one-on-one with another farmer or rancher where they have a cup of coffee and talk through the spreadsheet. This way, it is more personal, and less room for judgment or ridicule

Key takeaway: Change requires taking risks and institutions can support rather than limit trying something new

Making changes can create short-term economic and social risks. Encouraging change takes more than education, research and/or creating spaces for idea sharing. Change also requires institutional support in the form of technical assistance, engaging the stakeholders who are involved but might not be at the forefront of the conversation, and starting to think systematically about why these changes are not occurring in the first place. If the government wants to be involved in providing subsidies and grants to farmers and ranchers, those incentives should be allotted to the producers who are trying to improve soil health and failing, not just failing due to an inflexibility to try new things. The follow-through to support producers in making these changes in practices to build soil health is crucial to seeing an end result.

Recommendation:

Engage bankers

The bankers who are currently involved with farmers and ranchers work in a system in which if a crop fails to do well, and a farmer takes out money in the form of a loan, the banker makes money on the interest paid. Focus group participants engaged in practices to regenerate their soil was that they are no longer in need of as many loans- even as bankers encourage loans because they also want to make a profit.

The problem is the system of bankers that currently works with producers are used to “the way it always has been” – where ranchers and farmers take out loans instead of fixing their root problems (the soil), and bankers make money off of the interest. The problem isn't with bankers, it's with the incentive structures and default assumptions built into the system. Engaging bankers in the dialogue of how farmers and ranchers are doing better by their operation is key in fixing this broken system.

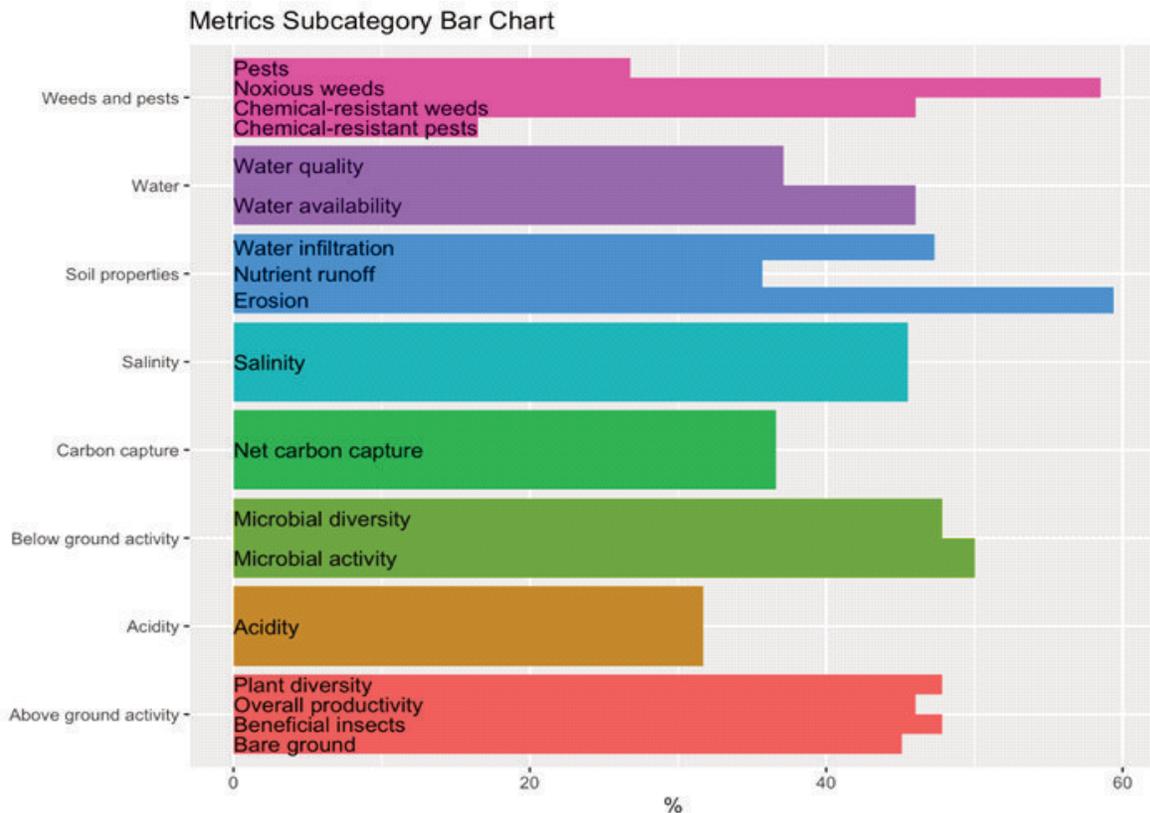
Provide support for taking small risks and experimenting

Based on the number of times producers noted that it would be helpful to have a no-till drill or a seeder for diversified cover crops for rent or lease by their Conservation District, investing in equipment rental seems to be a clear pathway to facilitating broader experimentation among producers. Being able to rent or lease a piece of equipment is very encouraging for those interested in trying out a new practice, but unable to fully commit due to the financial burden of buying equipment. Similarly, cost-share programs can help producers invest in small infrastructure improvements like movable electric fencing, mobile water troughs, and habitat protection to enable wildlife management that also protect crops. In addition, the government subsidies and payments going out to failed cropping systems should require proof of having at least tried to change the practice and address the issue. Incentivizing practices that build soil health is crucial to the fate of farms and ranches across the state and country.

APPENDIX: FULL SURVEY DATA RESULTS

Soil health **Metrics** recoding:

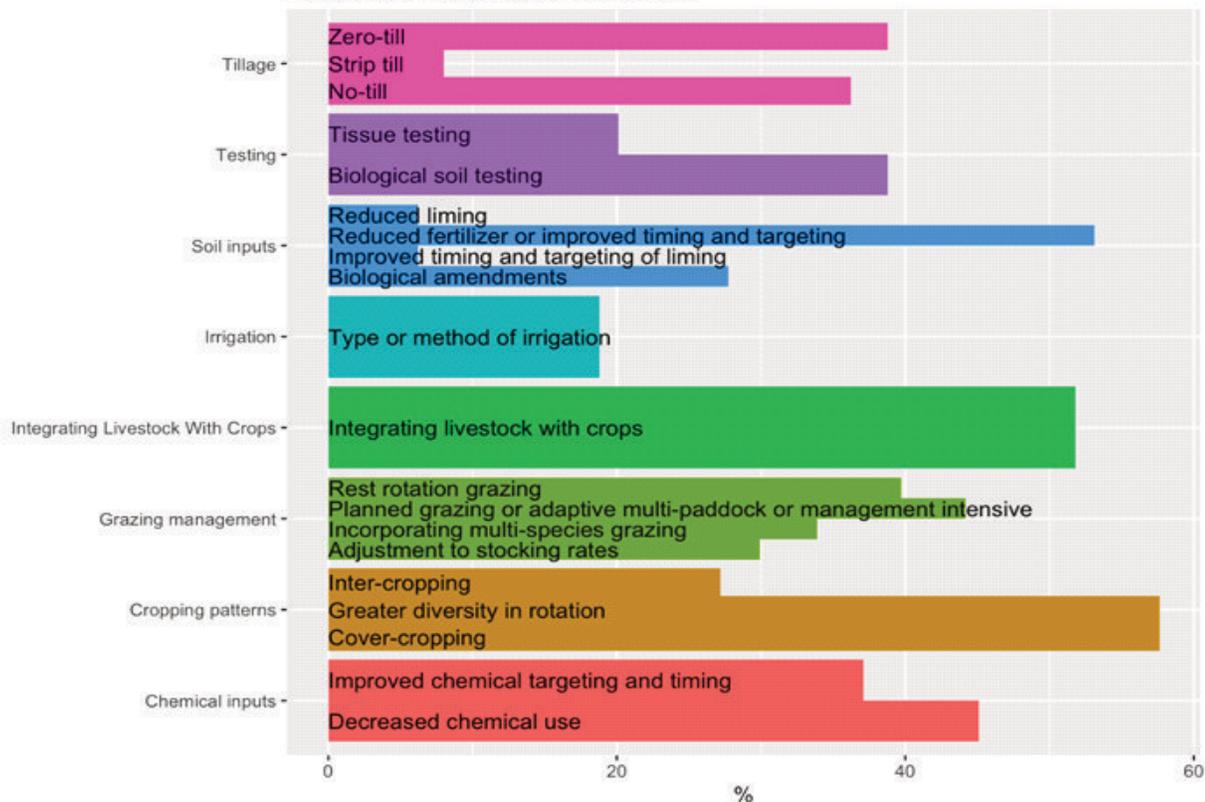
New Variable	Original variables
Soil Properties	Water infiltration
	Erosion
	Nutrient runoff
Above ground activity	Plant diversity
	Bare ground
	Overall productivity
	Beneficial insects
Weeds and pests	Noxious weeds
	Chemical-resistant weeds
	Pests
	Chemical resistant pests
Below ground activity	Microbial diversity
	Microbial diversity
Water	Water availability
	Water quality
Salinity	Salinity
Acidity	Acidity
Net carbon capture	Net carbon capture



Soil health **Practices** recoding:

New variable	Original variables
Soil inputs	Reduced fertilizer or improved timing
	Biological amendments
	Reduced liming
Chemical inputs	Improved timing and targeting of liming
	Decreased chemical use
Irrigation	Type or method of irrigation
Cropping patterns	Greater diversity in rotation
	Cover cropping
	Intercropping
Tillage	Zero-till
	Strip till
	No till
Grazing management	Rest rotation grazing
	Incorporating multispecies grazing
	Adjustment to stocking rates
	Multi-paddock or planned grazing
Testing	Biological soil testing
	Tissue testing
Integrating livestock with crops	Integrating livestock with crops

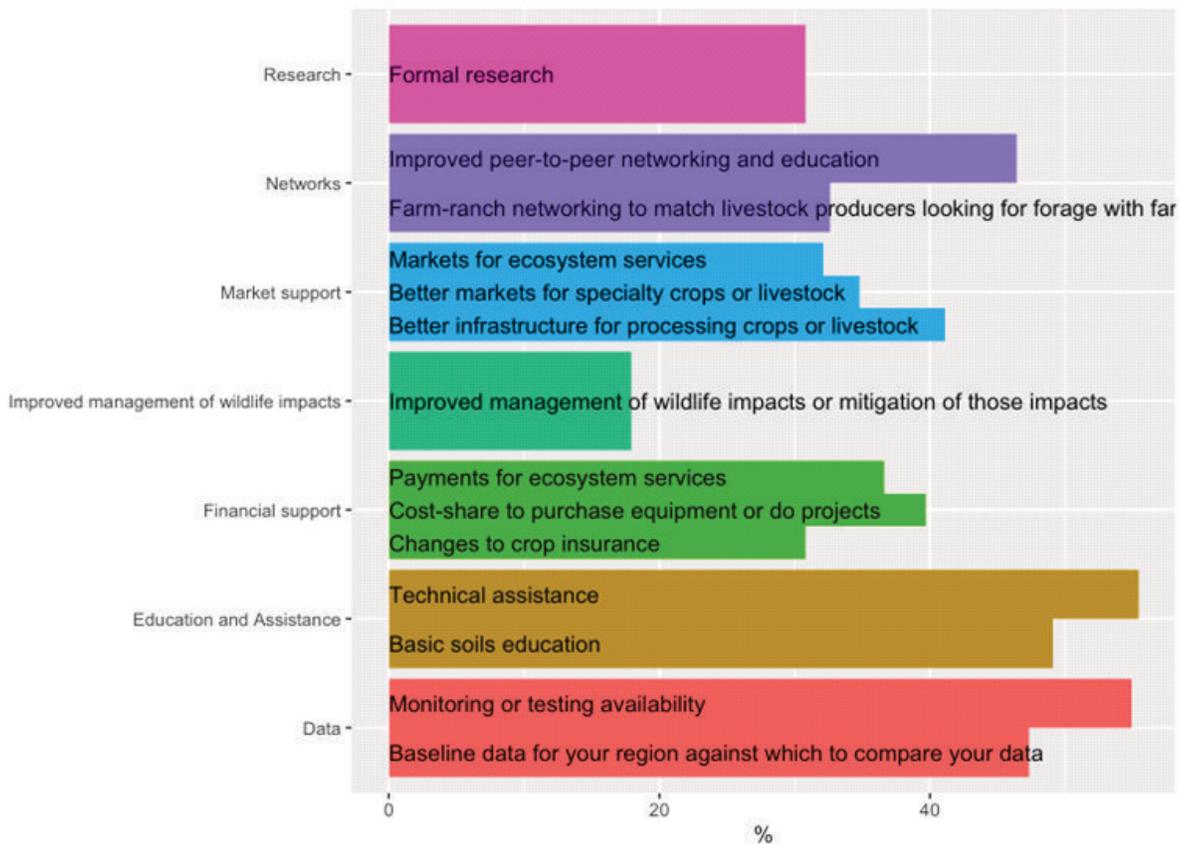
Practices Subcategory Bar Chart



Soil health **Resources** recording:

New variable	Original variables
Technical assistance	Technical assistance
	Basic soils education
Data	Monitoring or testing
	Baseline data
Formal research	Formal research
Networks	Peer-to-peer networking
	Farm-ranch networking
Financial support	Cost-share for equipment or projects
	Payment for ecosystem services
	Changes to crop insurance
Market support	Markets for ecosystem services
	Better markets for specialty crops or livestock
	Better infrastructure for processing
Improved management of wildlife impacts	Improved management of wildlife impacts

Resources Subcategory Bar Chart





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