



# Soil health perspectives of Arizona rangeland stakeholders

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## Introduction

Soil health is broadly defined as the capacity of soil to support a vital living ecosystem that sustains plants, animals and humans. Soil health is related to many functions of natural and managed ecosystems such as water holding capacity, erosion control, nutrient cycling and plant growth. Soil health collectively refers to a large set of physical, chemical, and biological properties of soil systems and how they operate and function together. Accordingly, considering soil health is a rather holistic approach to evaluating soil function in terrestrial ecosystems, either in native or cultivated conditions. Soil health is quickly becoming recognized as a valuable approach of assessment of agricultural productivity and environmental well-being. Unfortunately, climate change is quickly degrading soils worldwide, rendering large swaths of previously productive landscapes unsuitable for plant and animal growth.

Strategies for maintaining and improving soil health are needed to ensure the protection of soils as a nonrenewable resource (Kihara et al. 2020). Although the effectiveness of

soil health management approaches is strongly affected by complex interactions between physical, chemical, and biological properties of ecosystems, if, when and where approaches are deployed are largely driven by social variables such as land manager perceptions and preferences for management end goals (Das et al. 2022). To ensure that soil health strategies are created with the end user in mind so they are widely deployed, an understanding of stakeholder perceptions about soils and soil health is needed.

Therefore, we surveyed 115 rangeland stakeholders in Arizona to understand how managers consider soil health. Our goal was to determine levels of interest in and knowledge of soil productivity and health (e.g. Schohr et al. 2019). We distributed surveys at rangeland soil health workshops around the state of Arizona in Spring 2023. Because soil health can have many definitions (Lehmann et al. 2020) surveys included a definition of soil health and asked a series of questions related to management practices for soil health assessment and maintenance (Table 1).

Table 1. Survey questions

1. What county in AZ do you primarily work in? _____				
2. What is your position? (circle one)				
Rancher	County government	University (not Cooperative Extension)		
Federal government	Cooperative Extension	Gardening industry		
State government	Conservation group	Other _____		
3. How many years have you worked in your current position? (circle one)				
0-2	3-5	6-10	11-20	>20 years
4. How much is soil management/health/biology relevant to your position? (circle one)				
Not at all	A little	A moderate amount	A lot	Almost all I think about
5. What management practices do you use to maintain or enhance soil health on rangelands? (circle all that apply)				
Reduced tillage	Brush management	Grazing		
Altered irrigation types or frequency	Soil organic amendments (e.g. compost, mulch, biochar)	Crop rotation		
Planting of non forage species	Organic fertilizers	Other _____		
Planting of forage species	Micronutrient fertilizers	Compost tea		
Bio-based fertilizers	Prescribed fire			

6. Which of the above answers is most important for maintaining or enhancing soil health on rangelands? (circle one)

Reduced tillage	Brush management	Grazing
Altered irrigation types or frequency	Soil organic amendments (e.g. compost, mulch, biochar)	
Planting of non forage species	Organic fertilizers	Crop rotation
Planting of forage species	Micronutrient fertilizers	Other _____
Bio-based fertilizers	Prescribed fire	Compost tea

7. What are the three most important factors for driving soil health (put in order of 1 for most important, then 2 then 3)

<input type="checkbox"/> Soil type	<input type="checkbox"/> Presence or history of drought	<input type="checkbox"/> Fire history
<input type="checkbox"/> Type/history of grazing	<input type="checkbox"/> Presence of invasive plants	<input type="checkbox"/> Previous land use
<input type="checkbox"/> Type/history of soil management	<input type="checkbox"/> Elevation	<input type="checkbox"/> Surrounding land use
<input type="checkbox"/> Proximity to nearest watershed	<input type="checkbox"/> Topography	<input type="checkbox"/> Irrigation source
<input type="checkbox"/> Other _____		

8. How would you rank soil health in the areas in which you work today compared to 10 years ago? (circle one)

Worse                      The same                      Better

9. What are your top 3 most critical concerns in terms of soil health on rangelands? (put in order of 1 for most important, then 2 then 3)

<input type="checkbox"/> Building organic matter in soils	<input type="checkbox"/> Forage production	<input type="checkbox"/> Native plant production
<input type="checkbox"/> Increasing soil water retention	<input type="checkbox"/> Reducing salinity	<input type="checkbox"/> Reducing soil erosion
<input type="checkbox"/> Maintaining healthy soil microbial communities	<input type="checkbox"/> Other _____	

10. Have you done any soil tests in the last 12 months? (circle one)

No                      Yes

11. What tests have you done? \_\_\_\_\_

12. Do you commonly interpret your soil test results independently or consult with a third party? (circle one)

On my own                      Use a third party

13. Do you find the recommendations provided by soil testing agencies relevant/useful to your land management needs? (circle one)

No                      Yes

14. Why or why not? \_\_\_\_\_

15. On a scale of 1-10, how much you prioritize soil health? (one being not a high priority and 10 being the highest priority)

1    2    3    4    5    6    7    8    9    10

16. Please explain why. \_\_\_\_\_

17. On a scale of 1-10, how would you rate soil health in your ranch/farm/land? (one being soil health is low and 10 being soil health is very high)

1    2    3    4    5    6    7    8    9    10

18. Why? \_\_\_\_\_

19. What are the top three major indicators for soil health in your properties? (put in order with 1 as most important)

<input type="checkbox"/> High plant cover	<input type="checkbox"/> High forage quality	<input type="checkbox"/> Soil color
<input type="checkbox"/> Water holding capacity	<input type="checkbox"/> Soil chemistry	<input type="checkbox"/> Soil microbial communities
<input type="checkbox"/> Soil 'look'	<input type="checkbox"/> Noticeable soil erosion	<input type="checkbox"/> Soil texture
<input type="checkbox"/> Presence of biocrusts	<input type="checkbox"/> Other _____	

20. Have you ever changed or altered your soil management practices?

No                      Yes

21. If yes, what was the reason for this change? \_\_\_\_\_

22. What impact (if any) did this change have on your soil? \_\_\_\_\_

23. What is your most important soil health question for extension personnel and researchers at UA?

\_\_\_\_\_

\_\_\_\_\_

## What we found

Individuals from every county in Arizona completed our survey. The most participants were from Pima (18), Coconino (15), Graham (15) and Cochise (13); the least were from Mohave (1), Apache (3) and Navajo (4). Respondents noted their affiliations as the federal government (29), Cooperative Extension (18), other (16, which appeared to consist mostly of industry professionals), ranchers (9), conservation groups (9), state government (6), university (6), followed by non-profit, county government, and the gardening industry. Respondents noted that they were 0-2 years in their current position (37), 6-10 years (20), 3-5 years (18), >20 years (12) and 11-20 years (11). Most respondents noted that soil health is very relevant to their position. Fifty percent noted that it is relevant to their position 'a lot' while 11% noted it is 'almost all I think about' in comparison to only 2% that noted soil health is not relevant to their position at all. Respondents also identified a large range of management practices they used to maintain soil health on rangelands (Table 2).

The management practice that was deemed most important for maintaining or enhancing soil health on rangelands was brush management and planting of non-forage species weighted equally (individuals who have 0-2 years experience in their current position); brush management only (individuals who have 11-20 years experience in their current position); and grazing (individuals with 3-5 years, 6-10 years or >20 years in their current position). The three most important factors driving soil health, differed depending on experience (Table 2).

The majority of respondents noted that soil health was a high priority; e.g. scored 10 out of 10 (26), 9 out of 10 (11) and 8 out of 10 (22). Of these top scoring individuals, the majority (21) noted that soil health is better today than it was ten years ago. When looking at all respondents together, an interesting contrast was revealed. Nearly equal numbers of respondents indicated that, compared to 10 years ago, they considered soil conditions to be better (32) and soil conditions are the same (30). The top three most critical concerns in terms of soil health on rangelands include: native plant production

(23); increasing soil water retention (21); and reducing soil erosion (20).

Respondents noted that the top three indicators for soil health are: high plant cover (first); noticeable soil erosion (second); and soil water-holding capacity (third). Thirty-six of our respondents noted that they had conducted a soil test in the past 12 months, and these tests largely included soil

Table 2. Answers to survey question: *What management practices do you use to maintain or enhance soil health on rangelands?* \*Fill in answers to 'other' included rest from grazing (3), seedballs (2), and biocrust (2).

Management practice	Number of respondents
Brush management	48
Grazing	46
Prescribed fire	34
Soil organic amendments	25
Planting of forage species	21
Planting of non forage species	18
Reduced tillage	16
Other*	14
N/A	11
Altered irrigation	10
Crop rotation	9
Organic fertilizer	7
Bio-based fertilizer	6
Micronutrient fertilizer	5
Compost tea	3

Table 2. Order of factors most important for driving soil health, based on number of years in current position.

Experience	Top most important	Second most important	Third most important
0-2	Soil type	History of soil mgmt.	History of land use
3-5	Soil type	History of grazing	History of soil mgmt.
6-10	Soil type	History of grazing	History of drought
11-20	History of soil mgmt.	History of grazing	History of land use
>20	History of drought	Soil type	History of grazing

salinity, pH, and soil stability. Many respondents interpret test results on their own (36) rather than using a third-party (27). Fifty-three respondents noted that they find recommendations provided by soil testing agencies relevant to their land management needs (only 4 said no).

The final component of the survey asked respondents to note critical soil health knowledge gaps. Answers to this open ended question were grouped by theme. The most common knowledge need was 'scaling up techniques that work at small scales to larger, management level scales' (12), followed by 'increasing soil organic matter' (10), 'restoring degraded agricultural and mined areas' (7), and 'increasing water-holding capacity' (7).

## Interpretation

This survey highlights the critical importance of soil health for the work of almost every group associated with rangelands in Arizona. Soil management still largely occurs through traditional range management approaches, but newer approaches that have shown promise in research - such as the application of soil amendments - are gaining traction and should be considered. This work also demonstrates that individuals with dissimilar levels of experience consider soil health and soil management in different ways. This suggests that when identifying research needs and providing outreach to rangeland stakeholders, that experience level should be considered to provide targeted programming. Moreover, this programming should incorporate the discussion of techniques that can be scaled up from small, experimental units to management relevant units.

There is a lot of excellent work occurring across the state to address soil management on working landscapes and partnerships will be critical to ensuring that information gets into the hands of range end users. This survey can be used to understand the variety of soil health priorities and knowledge levels of individuals who work, at least in part, on rangeland systems in Arizona, ultimately guiding effective extension programming.

## References

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