



Photo: Griffin LaHue

IRRIGATED COLUMBIA BASIN

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Summary

Soil health related issues in the Columbia Basin vary based on crop, but most responses to a survey underscored issues related to the physical and biological portion of soil. Soils in this region are threatened by wind erosion and degraded soil physical quality. These soils are characterized by largely coarse texture, low organic matter content, low water and nutrient holding capacity, and production systems that rely on heavy use of tillage. Respondents frequently stated that the use of cover crops and alternative tillage strategies could help to overcome these issues. Challenges such as the economics of using soil health improving practices and the lack of ability to effectively monitor soil health changes were ranked high.

Overview

The Columbia Basin is one of the premier agricultural regions in the U.S. The semi-arid dry climate averages about 200 frost free days per year. It has abundant water from the Columbia River providing irrigation for nearly 700,000 acres. Over 70 different crops are grown, including tree fruit (apples, cherries, pears) vegetables (potatoes, onions, sweet corn, green peas) forage crops (alfalfa and timothy hay), and grains (corn and wheat). Cattle and dairy operations exist in the basin.

Information Collection

A survey was sent to the Irrigated Agriculture listserv managed by WSU Extension on February 13, 2020 and was closed on March 7, 2020. 147 crop growers/producers, 54 crop consultants and 16 livestock producers participated, for a total of 217 respondents across production systems.

Since soil health issues and approaches can vary substantially based on production system, survey responses were divided by primary crop identified by participants. Significant numbers of respondents represented tree fruit (60 respondents), grapes (23 respondents), and potatoes (32 respondents), cropping systems covered in other areas of this report. Here we focus on other crops of significance in irrigated Columbia Basin agriculture: blueberries or other small fruit (3 respondents), corn – grain or silage (6 respondents), hay or other forage crops (18 respondents),

hops (4 respondents), seed crops (4 respondents), sweet corn, green peas or other vegetables (12 respondents), and wheat (9 responses). Overall results from the survey are presented in [Appendix 1](#) of this report.

Current Situation

Wind Erosion

The Columbia Basin is prone to high wind events especially in the spring and fall, often when soils are not adequately covered with crops, plant residues or other vegetation. Wind erosion removes fine particles and organic matter from the topsoil which results in lower soil productivity, fertility, water-holding capacity, tilth, structure and water infiltration on dryland and irrigated soils. Unprotected sand, loamy sand and sandy loam soils are the most susceptible to wind erosion (McGuire 2011). Additionally, blowing dust can result in serious traffic accidents, loss of productivity, air quality issues, and respiratory problems in communities surrounding farmland. Efforts to control wind erosion are an ongoing challenge being addressed through the use of cover crops, high crop residue farming, and addition of manure and compost on the most prevalent wind-blown soils. Major efforts are continuing to improve soil health using multiple management strategies thus reducing soil deterioration.



Figure 8. Irrigated mustard cover crop emerging after sweet corn. (Photo: McGuire)

Climate Change and Water Supply

Although the supply of water from the Columbia River is forecast to increase slightly by 2030, the timing of peak supply will shift earlier in the calendar year (late-fall, winter and spring), away from the peak irrigation demands of mid-summer (Hall et al. 2016).

Blueberries or Other Small Fruit

There were three respondents (all producers) who listed blueberries or other small fruit as their main crop, though only two of the respondents answered the questions in full. The issue of greatest importance to this group is nutrient cycling. The most frequently mentioned soil health improving practices of interest are double cropping, relay cropping, intercropping, manure application and no-till. The importance of challenges to improving soil health were noted as high cost of soil improvement practices, short term land leases and lack of information. Both of the respondents in this crop group listed the importance of research or additional information in all four areas (economics, monitoring, benefits, and strategies for improvement) as “high.”

Table 3. Importance of issues related to soil health – Blueberries or other small fruit.

	High	Mod	Low
Nutrient cycling	100%	0%	0%
Soil organic matter (SOM) level	50%	50%	0%

Drainage, ponding, runoff	50%	50%	0%
Water-holding capacity	50%	50%	0%
Soilborne disease	50%	50%	0%
Parasitic nematodes	50%	50%	0%
Wind erosion	0%	50%	50%
Water infiltration	0%	100%	0%
Soil tilth	0%	100%	0%
Compaction	0%	100%	0%
Crusting	0%	100%	0%

Table 4. Interest in soil health improving practices – Blueberries or other small fruit.

	High	Mod	Low
Double cropping	50%	0%	50%
Relay cropping	50%	0%	50%
Intercropping	50%	0%	50%
Manure application	50%	0%	50%
No-till	50%	0%	50%
Cover crops	0%	100%	0%
Green manures	0%	100%	0%
Compost application	0%	100%	0%
Strip-till	0%	0%	100%
Reduced tillage	0%	100%	0%
Livestock integration	0%	50%	50%

Table 5. Importance of challenges to improving soil health – Blueberries or other small fruit.

	High	Mod	Low
High cost of soil improvement practices	50%	50%	0%
Short term land leases	50%	50%	0%
Lack of information	50%	50%	0%
Low residue crops	0%	50%	50%

Required tillage	0%	100%	0%
Logistics of using soil improvement practices	0%	50%	50%
Managing high levels of crop residue	0%	50%	50%
Rotation restrictions	0%	100%	0%
Sandy soils	0%	100%	0%

Table 6. Importance of research or additional information – Blueberries or other small fruit.

	High	Mod	Low
Economics of soil health	100%	0%	0%
Monitoring soil health	100%	0%	0%
Benefits of soil health	100%	0%	0%
Strategies for improving soil health	100%	0%	0%

Corn – Grain or Silage

There were six respondents (four producers, two crop consultants) who listed grain or silage corn as their main crop. The importance of issues related to soil health that were most frequently mentioned as being of high importance for this group were soil organic matter (SOM) level and soilborne disease. Cover crops, double cropping, green manures, no-till, and reduced tillage were identified as issues of high importance by the 50% or more of respondents. The most important challenges identified by this group were short term land leases, high cost of soil improvement practices, managing high levels of crop residue, rotation restrictions, and low residue crops. The areas of research that were most frequently identified as being of high importance for this group were monitoring soil health and strategies for improving soil health. One grower in this group offered the following comment:



Figure 9. Irrigated sweet corn in the Columbia Basin. (Photo: Waters)

“Soil variation occurs on every unit often to extreme degrees and often is managed to the mean. Cost efficacy always an issue. Tilt [is] a clumsy and lowbrow hand waving umbrella term for complex biome.”

Table 7. Importance of issues related to soil health – Corn, grain or silage.

	High	Mod	Low
SOM level	100%	0%	0%
Soilborne disease	100%	0%	0%
Water infiltration	83%	17%	0%
Compaction	83%	17%	0%
Drainage, ponding, runoff	83%	17%	0%
Wind erosion	67%	33%	0%
Water-holding capacity	67%	33%	0%
Nutrient cycling	67%	33%	0%
Parasitic nematodes	60%	40%	0%
Soil tilth	50%	50%	0%
Crusting	50%	50%	0%

Other responses: salt accumulation, pH and nutrition

Table 8. Interest in soil health improving practices – Corn, grain or silage.

	High	Mod	Low
Cover crops	67%	17%	17%
Double cropping	67%	33%	0%
Green manures	50%	33%	17%
No-till	50%	50%	0%
Reduced tillage	50%	50%	0%
Relay cropping	40%	40%	20%
Intercropping	40%	40%	20%
Compost application	33%	50%	17%
Manure application	33%	50%	17%
Strip-till	33%	50%	17%
Livestock integration	33%	33%	33%

Other responses: legume inoculation, compost tea and other “snake oils”



Figure 10. Researchers showcasing cover crop trials at a field day. (Photo: McGuire)

Table 9. Importance of challenges to improving soil health – Corn, grain or silage.

	High	Mod	Low
Short term land leases	83%	17%	0%
High cost of soil improvement practices	80%	20%	0%
Managing high levels of crop residue	67%	17%	17%
Rotation restrictions	67%	33%	0%
Low residue crops	60%	20%	20%
Logistics of using soil improvement practices	40%	40%	20%
Sandy soils	33%	50%	17%
Lack of information	20%	60%	20%
Required tillage	20%	60%	20%

Table 10. Importance of research or additional information – Corn, grain or silage.

	High	Mod	Low
Monitoring soil health	83%	17%	0%
Strategies for improving soil health	83%	17%	0%
Economics of soil health	67%	17%	17%
Benefits of soil health	50%	33%	17%

Other responses: nitrogen availability relative to organic fraction and binding, technical data for extended-release fertilizers, microbiome management - the frontier of knowledge, balancing application rates with plant use.

Hay or Other Forage Crops

There were 18 respondents (13 producers, five crop consultants) with hay or other forage crops as their main crop. The issues of highest importance for this group were soil tilth, soil organic matter (SOM) level, nutrient cycling, water infiltration, and water-holding capacity. Practices that garnered the greatest level of interest were no-till, green manures, reduced tillage, cover crops, and manure application. At least half of the respondents in this group listed the high cost of soil improvement and lack of information as challenges of high importance for improving soil health. The areas for more research that were identified as being of the highest importance were benefits of soil health, strategies for improving soil health, and economics of soil health. Other comments offered by respondents in this group were:

“Soil health is something I’ve really focused on the last five to ten years or so. My main strategy has been cover crops and implementing minimum tillage. Have tried flying wheat seed into standing grain corn August 15.”

“Overall status of rotational cropping in the Columbia Basin and new approaches for better soil maintenance as the Odessa/Ritzville Reclamation takes place in the next few years.”

Table 11. Importance of issues related to soil health – Hay or other forage crops.

	High	Mod	Low
Soil tilth	80%	13%	7%
SOM level	75%	25%	0%
Nutrient cycling	69%	25%	6%
Water infiltration	56%	44%	0%
Water-holding capacity	53%	47%	0%
Compaction	47%	47%	7%
Drainage, ponding, runoff	47%	33%	20%
Soilborne disease	47%	40%	13%
Wind erosion	40%	47%	13%
Parasitic nematodes	40%	27%	33%
Crusting	29%	50%	21%

Other responses: correct fertilizers, crop rotation benefits



Figure 11. Researchers obtaining soil samples a part of soil health evaluation. (Photo: McGuire)

Table 12. Interest in soil health improving practices – Hay or other forage crops.

	High	Mod	Low
No-till	64%	21%	14%
Green manures	60%	33%	7%
Reduced tillage	60%	40%	0%
Cover crops	56%	44%	0%
Manure application	56%	31%	13%
Double cropping	47%	47%	7%
Strip-till	46%	46%	8%
Livestock integration	40%	47%	13%
Compost application	38%	44%	19%
Relay cropping	14%	50%	36%
Intercropping	14%	36%	50%

Other responses: legume rotation, nematode restriction

Table 13. Importance of challenges to improving soil health – Hay or other forage crops.

	High	Mod	Low
High cost of soil improvement practices	73%	13%	13%
Lack of information	57%	21%	21%
Logistics of using soil improvement practices	47%	47%	7%

Sandy soils	47%	13%	40%
Managing high levels of crop residue	36%	57%	7%
Short term land leases	33%	67%	0%
Required tillage	29%	57%	14%
Rotation restrictions	15%	54%	31%
Low residue crops	14%	64%	21%

Other responses: cost of equipment

Table 14. Importance of research or additional information – Hay or other forage crops.

	High	Mod	Low
Benefits of soil health	73%	20%	7%
Strategies for improving soil health	73%	20%	7%
Economics of soil health	64%	21%	14%
Monitoring soil health	47%	47%	7%

Other responses: impacts of compaction

Hops

Four respondents (one producer, three crop consultants) listed hops as their primary crop. Soil organic matter level was the issue of greatest importance to this group, with cover crops, green manures, compost and manure application all listed as practices of high interest to 50% or more of respondents in this group. The high cost of soil improvement practices is the most important challenge identified by this crop group. Strategies for improving soil health is the research area of greatest importance identified by this group.



Figure 12. Hop field in Columbia Basin (Photo: Benedict)

Other comments offered by respondents in this group:

“It is becoming a bigger deal each and every year.”

“Tillage is the main inhibitor to soil health in our system. We remove residues due to potential disease carryover, but I would like to learn more about that.”

“I believe this is a very important topic which needs attention, especially in perennial crops like I deal with. It isn’t as easy to amend soil health in perennial crops and not all people are willing to spend the \$\$ to improve it without actually seeing a measurable way to justify it.”

Table 15. Importance of issues related to soil health - Hops.

	High	Mod	Low
SOM level	50%	50%	0%
Water infiltration	25%	50%	25%
Soil tilth	25%	75%	0%
Compaction	25%	75%	0%
Nutrient cycling	25%	75%	0%
Parasitic nematodes	25%	50%	25%
Wind erosion	0%	25%	75%
Drainage, ponding, runoff	0%	100%	0%
Water-holding capacity	0%	100%	0%
Crusting	0%	50%	50%
Soilborne disease	0%	33%	67%

Table 16. Interest in soil health improving practices - Hops

	High	Mod	Low
Cover crops	75%	25%	0%
Green manures	75%	0%	25%
Compost application	50%	50%	0%
Manure application	50%	50%	0%
No-till	25%	25%	50%
Reduced tillage	25%	25%	50%
Livestock integration	25%	0%	75%
Double cropping	0%	0%	100%
Relay cropping	0%	0%	100%
Intercropping	0%	0%	100%
Strip-till	0%	0%	100%



Figure 13. Hop trellis system. (Photo: Benedict)

Table 17. Importance of challenges to improving soil health - Hops.

	High	Mod	Low
High cost of soil improvement practices	100%	0%	0%
Short term land leases	25%	0%	75%
Required tillage	25%	25%	50%
Logistics of using soil improvement practices	25%	50%	25%
Rotation restrictions	25%	0%	75%
Lack of information	0%	25%	75%
Low residue crops	0%	25%	75%
Managing high levels of crop residue	0%	50%	50%
Sandy soils	0%	67%	33%

Table 18. Importance of research or additional information - Hops.

	High	Mod	Low
Strategies for improving soil health	100%	0%	0%
Benefits of soil health	75%	25%	0%
Economics of soil health	50%	50%	0%
Monitoring soil health	50%	50%	0%

Other answers offered by respondents: soil health in grass-based rotations

Seed Crops

Four respondents (all producers) listed seed crops as their primary crop. The issues that were identified as being of high importance by this group were wind erosion, soil tilth, water-holding capacity, soilborne disease, water infiltration, compaction, and nutrient cycling. Reduced tillage was the one soil health improvement practice considered to be of high interest by 50% of respondents. The challenges this group identified as most important were low residue crops, high cost and logistics of soil improvement practices, and sandy soils. Research areas that were of greatest interest to this group were monitoring of soil health, benefits of soil health, and strategies for improving soil health.

Table 19. Importance of issues related to soil health – Seed crops.

	High	Mod	Low
Wind erosion	100%	0%	0%
Soil tilth	75%	25%	0%
Water-holding capacity	75%	25%	0%
Soilborne disease	75%	0%	25%
Water infiltration	50%	0%	50%
Compaction	50%	25%	25%
Nutrient cycling	50%	50%	0%
Parasitic nematodes	33%	0%	67%
SOM level	25%	75%	0%
Crusting	25%	50%	25%
Drainage, ponding, runoff	0%	25%	75%

Table 20. Interest in soil health improving practices – Seed crops.

	High	Mod	Low
Reduced tillage	50%	25%	25%
Green manures	25%	75%	0%
Cover crops	25%	50%	25%
Livestock integration	25%	50%	25%
Compost application	25%	25%	50%
Double cropping	0%	50%	50%
No-till	0%	50%	50%
Manure application	0%	25%	75%
Strip-till	0%	25%	75%
Relay cropping	0%	0%	100%
Intercropping	0%	0%	100%

Table 21. Importance of challenges to improving soil health – Seed crops.

	High	Mod	Low
Low residue crops	75%	0%	25%
High cost of soil improvement practices	50%	25%	25%
Logistics of using soil improvement practices	50%	25%	25%
Sandy soils	50%	25%	25%
Short term land leases	25%	75%	0%
Required tillage	25%	0%	75%
Rotation restrictions	25%	25%	50%
Lack of information	0%	75%	25%
Managing high levels of crop residue	0%	50%	50%

Table 22. Importance of research or additional information – Seed crops.

	High	Mod	Low
Monitoring soil health	100%	0%	0%
Benefits of soil health	100%	0%	0%
Strategies for improving soil health	75%	25%	0%
Economics of soil health	25%	75%	0%

Sweet Corn, Green Peas, and Other Vegetables

This group encompasses a number of vegetable crops, including sweet corn and green peas and consisting of 12 respondents (nine producers, three crop consultants). At least half of the respondents in this group listed the following issues as being of high importance: soil tilth, water-holding capacity, nutrient cycling, water infiltration, compaction, drainage, ponding, runoff, soilborne disease, wind erosion, and SOM level. The practices of greatest interest to this group for improving soil health are compost application, cover crops, green manures, reduced tillage, and intercropping. The high cost of soil improvement was the challenge identified as being of high importance by the majority of respondents in this group. This group expressed significant interest in each of the four areas for potential research.

Other comments offered by respondents in this group were:

“I would like to see plots on ways to reduce weed seed banks in organic fields. Also, what crop or cover crop affects organism health in soil.”

“We have already implemented many soil health practices: strip till, reduced till, compost application, cover crops, livestock integration, etc. my main interest is in soil health practices to reduce soil fungal pathogens.”

“Importance of organic matter and the soil on Columbia Basin.”



Figure 14. Root system of strip tilled corn (left) and full tilled corn (right). (Photo: McGuire)

Table 23. Importance of issues related to soil health – Sweet corn, green peas, other vegetables.

	High	Mod	Low
Soil tilth	84%	11%	5%
Water-holding capacity	79%	16%	5%
Nutrient cycling	79%	21%	0%
Water infiltration	74%	16%	11%
Compaction	68%	21%	11%
Drainage, ponding, runoff	68%	16%	16%
Soilborne disease	63%	32%	5%

Wind erosion	58%	11%	32%
SOM level	58%	37%	5%
Crusting	47%	37%	16%
Parasitic nematodes	47%	53%	0%

Other responses: fungal diversity



Figure 15. Strip tilled onions. (Photo: McGuire)

Table 24. Interest in soil health improving practices – Sweet corn, green peas, other vegetables.

	High	Mod	Low
Compost application	94%	0%	6%
Cover crops	78%	22%	0%
Green manures	67%	28%	6%
Reduced tillage	56%	44%	0%
Intercropping	53%	35%	12%
Livestock integration	44%	19%	38%
Manure application	41%	29%	29%
No-till	41%	24%	35%
Relay cropping	31%	44%	25%
Double cropping	29%	57%	14%
Strip-till	22%	56%	22%

Other responses: ridge till



Figure 16. Strip till planting of sweet corn into green cover. (Photo: McGuire)

Table 25. Importance of challenges to improving soil health – Sweet corn, green peas, other vegetables.

	High	Mod	Low
High cost of soil improvement practices	61%	28%	11%
Lack of information	47%	41%	12%
Required tillage	47%	35%	18%
Logistics of using soil improvement practices	47%	53%	0%
Sandy soils	35%	53%	12%
Managing high levels of crop residue	29%	59%	12%
Short term land leases	28%	33%	39%
Rotation restrictions	28%	61%	11%
Low residue crops	24%	71%	6%



Figure 17. Cucurbits grown in the Columbia Basin. (Photo: Waters)

Table 26. Importance of research or additional information – Sweet corn, green peas, other vegetables.

	High	Mod	Low
Strategies for improving soil health	94%	6%	0%
Benefits of soil health	89%	11%	0%
Economics of soil health	83%	17%	0%
Monitoring soil health	67%	28%	6%



Figure 18. Columbia Basin sweet corn. (Photo: Waters)

Wheat

Nine survey respondents (five producers and four crop consultants) listed wheat as their main crop. Over half of respondents in this group listed the following as high importance issues related to soil health: water infiltration, SOM level, soil tilth, water-holding capacity, nutrient cycling, and soilborne disease. The practices with the greatest level of interest for wheat producers were no-till, reduced tillage, and cover crops. The greatest challenges to improving soil health for wheat systems were identified as the high cost and logistics of using soil improvement practices. All areas of potential research (strategies, economics, benefits, and monitoring) were of high importance to a majority of respondents in this group. Dryland wheat production is covered elsewhere in this report.

Other comments offered by respondents in this group:

“As a grower and a business leader of an enterprise that serves growers, I think it important to build upon substantial progress made--reducing waterborne soil erosion 85%, reducing dust 6-fold, reducing stubble burning 22-fold. A fine foundation to build upon. A major contribution to habitat restoration for salmon.”

“Very complicated. Not well understood.”

“Tissue testing looks like an important tool, along with the forms of the nutrients being applied.”



Figure 19. No-till drill planting a cover crop into wheat stubble. (Photo: McGuire)

Table 27. Importance of issues related to soil health - Wheat.

	High	Mod	Low
Water infiltration	89%	11%	0%
SOM level	89%	11%	0%
Soil tilth	78%	22%	0%
Water-holding capacity	78%	22%	0%
Nutrient cycling	78%	22%	0%
Soilborne disease	67%	22%	11%
Wind erosion	44%	33%	22%
Compaction	44%	56%	0%
Drainage, ponding, runoff	44%	44%	11%
Crusting	33%	56%	11%
Parasitic nematodes	22%	56%	22%

Other answers offered by respondents: pH, falling number, soil organisms

Table 28. Interest in soil health improving practices - Wheat.

	High	Mod	Low
No-till	78%	22%	0%
Reduced tillage	78%	11%	11%
Cover crops	56%	22%	22%
Green manures	44%	11%	44%
Double cropping	44%	11%	44%
Relay cropping	44%	22%	33%
Livestock integration	44%	44%	11%
Intercropping	33%	44%	22%
Compost application	33%	22%	44%
Strip-till	33%	33%	33%
Manure application	11%	22%	67%

Other answers offered by respondents: microbial amendments, micronutrients, Rhizobacters, noxious weed management.



Figure 20. Mustard green manure coming through wheat stubble. (Photo: McGuire)

Table 29. Importance of challenges to improving soil health - Wheat.

	High	Mod	Low
High cost of soil improvement practices	89%	11%	0%
Logistics of using soil improvement practices	67%	22%	11%
Lack of information	33%	67%	0%
Required tillage	33%	22%	44%
Managing high levels of crop residue	33%	44%	22%
Rotation restrictions	33%	44%	22%
Low residue crops	22%	56%	22%
Short term land leases	11%	56%	33%
Sandy soils	11%	33%	56%

Other responses: yield protection, microorganism interactions

Table 30. Importance of research or additional information - Wheat.

	High	Mod	Low
Strategies for improving soil health	100%	0%	0%
Economics of soil health	78%	22%	0%
Benefits of soil health	78%	22%	0%
Monitoring soil health	56%	44%	0%

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