



University of Idaho

College of Agricultural
and Life Sciences

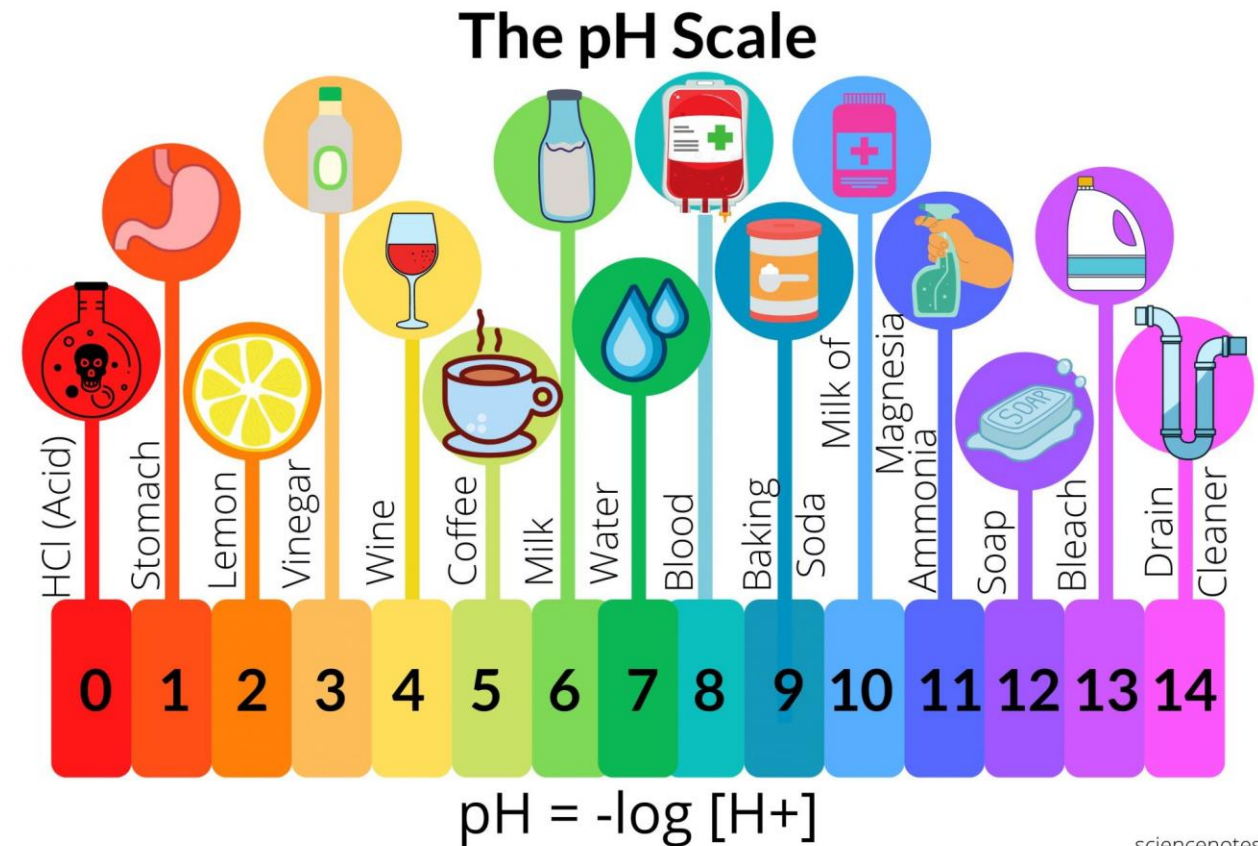


PRECIPITATED CALCIUM CARBONATE AS A LIME AMENDMENT

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pH Matters

- pH is a measure of H^+ concentration and is described in terms of acidity/alkalinity
- pH is measured using a log scale. A 1-unit pH change represents a 10x change in H^+ concentration



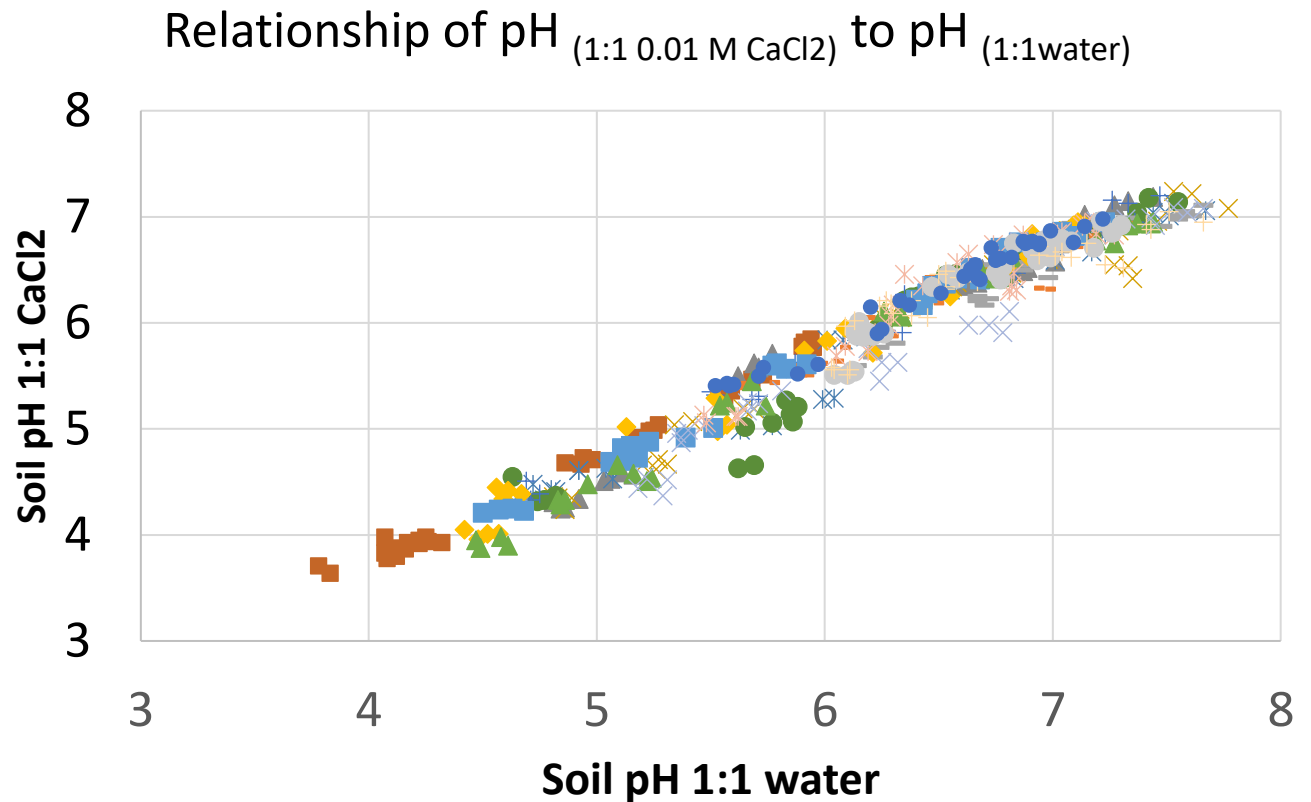
pH measurement method matters

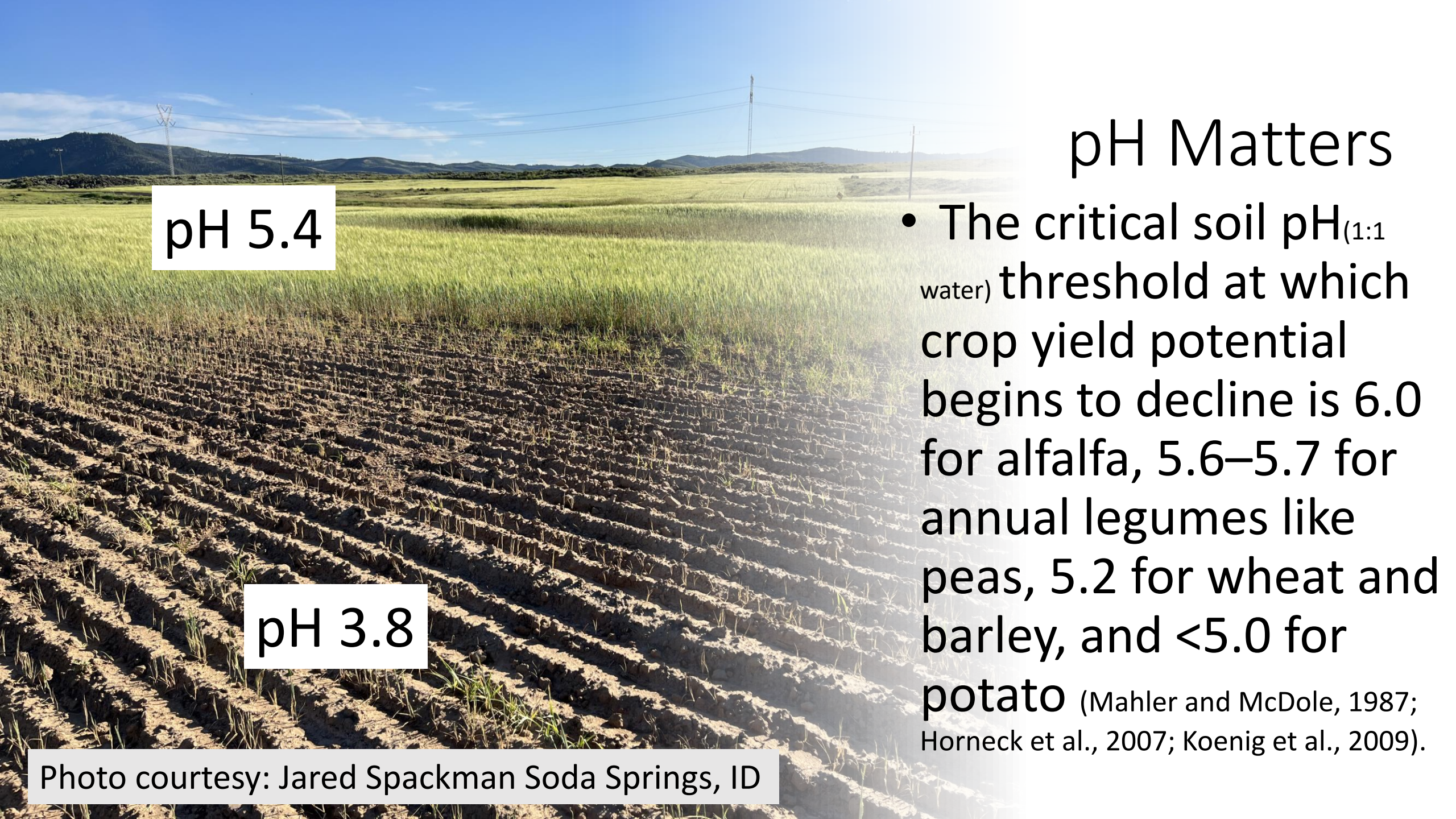
I 16 acidic soils from northern and southern Idaho

I Soil $\text{pH}_{\text{CaCl}_2} = 1.02 * \text{Soil pH}_{1:1 \text{ water}} - 0.45$

$R^2=0.9619$

I If you want to convert from $\text{pH}_{\text{CaCl}_2}$ to $\text{pH}_{1:1 \text{ water}}$ add 0.45





pH 5.4

pH 3.8

pH Matters

- The critical soil pH_(1:1 water) threshold at which crop yield potential begins to decline is 6.0 for alfalfa, 5.6–5.7 for annual legumes like peas, 5.2 for wheat and barley, and <5.0 for **potato** (Mahler and McDole, 1987; Horneck et al., 2007; Koenig et al., 2009).

pH Matters

I Inhibited N-Fixation Nodulation \sim pH < 5.5

I Inhibited nitrification at pH < 5



pH Matters

- Weed and Disease Pressure



Corn Spurry



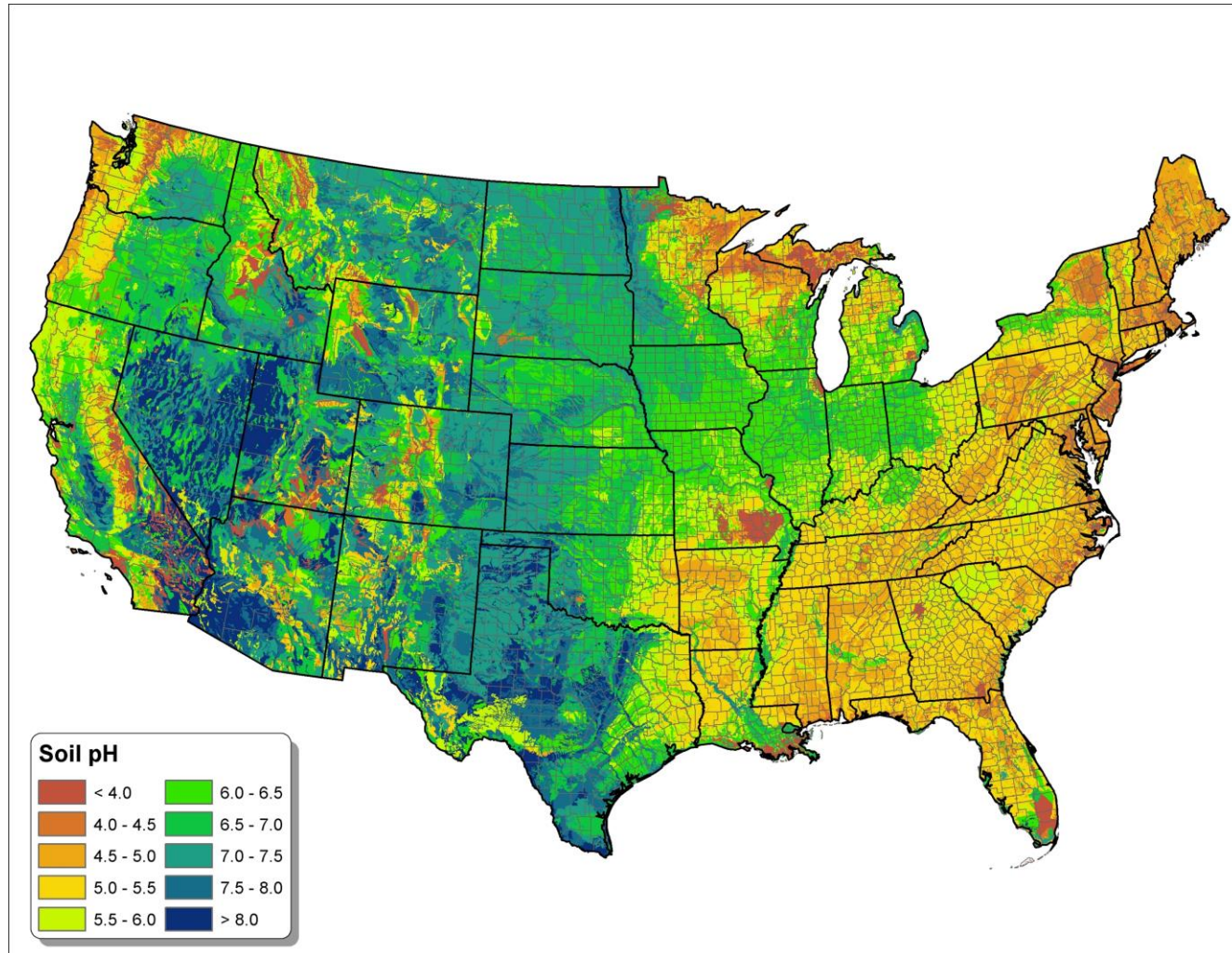
Barnyard Grass

pH Matters

I Pesticide activity

Common name	Trade name	Half-life at different pH values
Fungicide examples		
Propiconazole	Tilt	Most effective in pH 5 to 9; use within 12 to 16 hours
Captan	Orthocide	pH 5 = 32 hours, pH 7 = 8 hours, pH 8 = 10 minutes
Insecticide examples		
Carbaryl	Sevin	pH 7 = 24 days, pH 8 = 2.5 days, pH 9 = 1 day
Dimethoate	Cygon	pH 4 = 20 hours, pH 6 = 12 hours, pH 9 = 48 minutes
Permethrin	Pounce	Optimum stability pH 4
Herbicide example		
Paraquat	Gramoxone Extra	not stable in pH above 7
Plant growth regulator		
Gibberellic Acid	Promalin	A buffered wetting, final spray should not exceed pH 8

Distribution of Acidic Soils in the US



I Majority of intermountain west soils are calcareous with a $\text{pH} > 7$

I Areas with high precipitation, frequent fertilizer applications

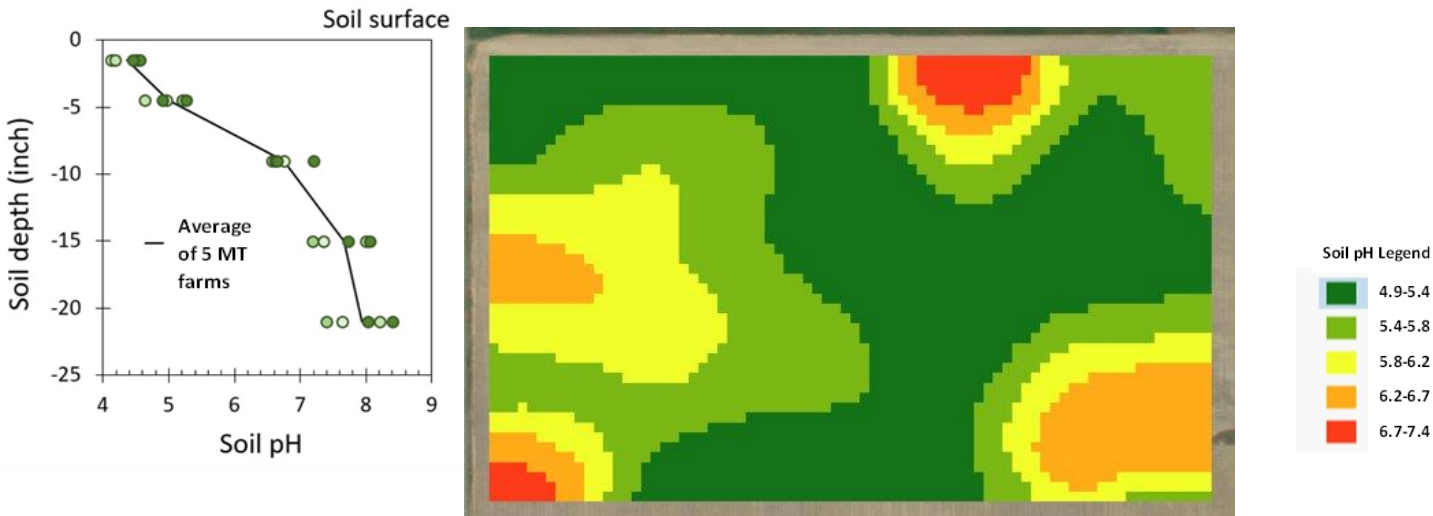
I Idaho

- Northern and Central regions
- 160,000 acres in eastern Idaho

I Montana

- 24 to 56 counties (>500,000 acres)

Distribution of Acidic Soils within a Field



I A 50-ac field can have a pH range of 4.9 to 7.9

I Might consider collecting soil samples from 0-3" rather than 0-6" to better detect low soil pH areas

I Potential tools: grid sampling, remote sensing, on-the go sensor technology (eg VERIS)

Precipitated calcium carbonate as a lime source



- I Many Lime sources: calcium oxide, calcium hydroxide, calcium and magnesium carbonates, marl, blast furnace slag, fly ash
- I “Sugar beet lime”
- I Byproduct of sucrose stream purification
- I Add calcium oxide and carbon dioxide to remove P, K, Mg, Na and other impurities

Precipitated calcium carbonate as a lime source



- I The area surrounding Amalgamated Sugar Company beet processing plants typically have pH of 7.5 – 8.5
- I End up with stockpiles at the plants
- I 386,911 tons of PCC produced annually
- I **In 2018, total stockpiles were 12.6 million tons**

Precipitated calcium carbonate as a lime source

Property (as applied basis)	Value (SEM)
pH	8.6 (0.1)
Dry Matter (%)	77 (3)
Calcium Carbonate Equivalent (%)	72.9 (1.4)
Total N (lb/ton)	5.9 (0.3)
Phosphorus ¹ (P ₂ O ₅ , lb/ton)	22 (2)
Potassium ¹ (K ₂ O, lb/ton)	4 (1)
Calcium ¹ (lb/ton)	486 (19)
Magnesium ¹ (lb/ton)	16.0 (0.6)
Sulfur ¹ (lb/ton)	9.6 (1.0)
Salts as EC ¹ (mmhos cm ⁻¹)	1.5 (0.2)

- I “Sugar beet lime”
- I Byproduct of sucrose stream purification
- I Add calcium oxide and carbon dioxide to remove P, K, Mg, Na and other impurities

Precipitated calcium carbonate as a lime source

- I How much PCC is needed to remediate soil pH?
- I How long does the application last before soil pH returns to pre-liming levels?
- I 0, 2, 4, 6 ton/ac “as is” PCC
- I 0-2, 2-4, 4-6, 6-8, 8-12”
- I 4 sites in Fall 2021;
5 sites in Fall of 2023

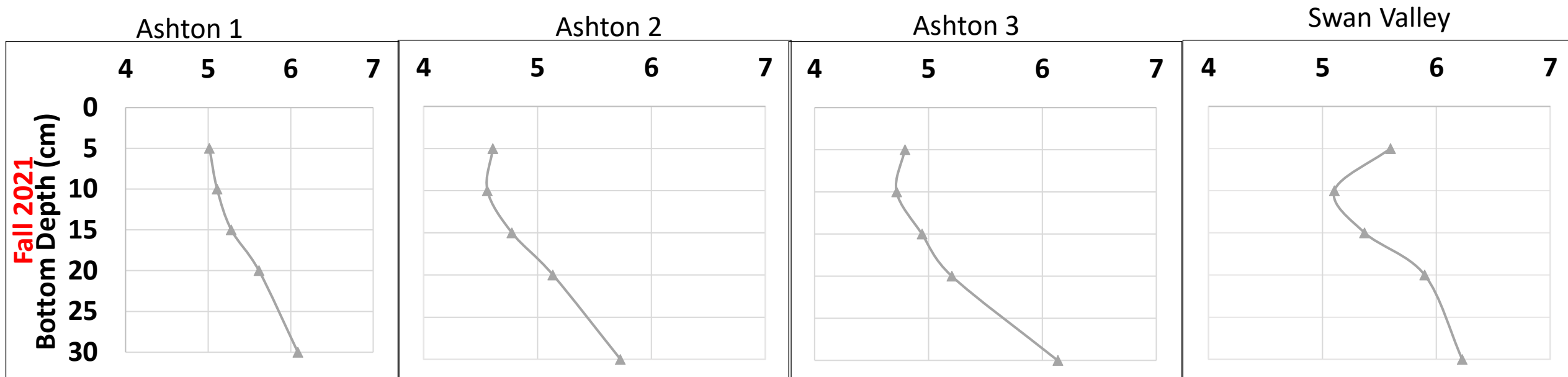


Liming did not impact crop yield or other metrics relative to the non-limed control

Lime Rate (Mg ha⁻¹)	Ashton 1		Ashton 2		Ashton 3		Swan Valley	
	2022	2023	2022	2023	2022	2023	2022	2023
	SWSW	Potato	HRSW	Barley	HWSW	Barley	Barley	Canola
	Bu ac ⁻¹	Mg ha ⁻¹	Bu ac ⁻¹	Bu ac ⁻¹	kg ha ⁻¹	kg ha ⁻¹	Bu ac ⁻¹	kg ha ⁻¹
0	111a	32.5a	94a	33a	NA	90a	99a	NA
4.4	107a	32.5a	96a	30a	NA	86a	104a	NA
8.8	103a	35.0a	97a	32a	NA	77a	115a	NA
13.2	111a	32.75a	111a	32a	NA	60a	95a	NA
P>F	0.799	0.827	0.408	0.986	NA	0.461	0.409	NA

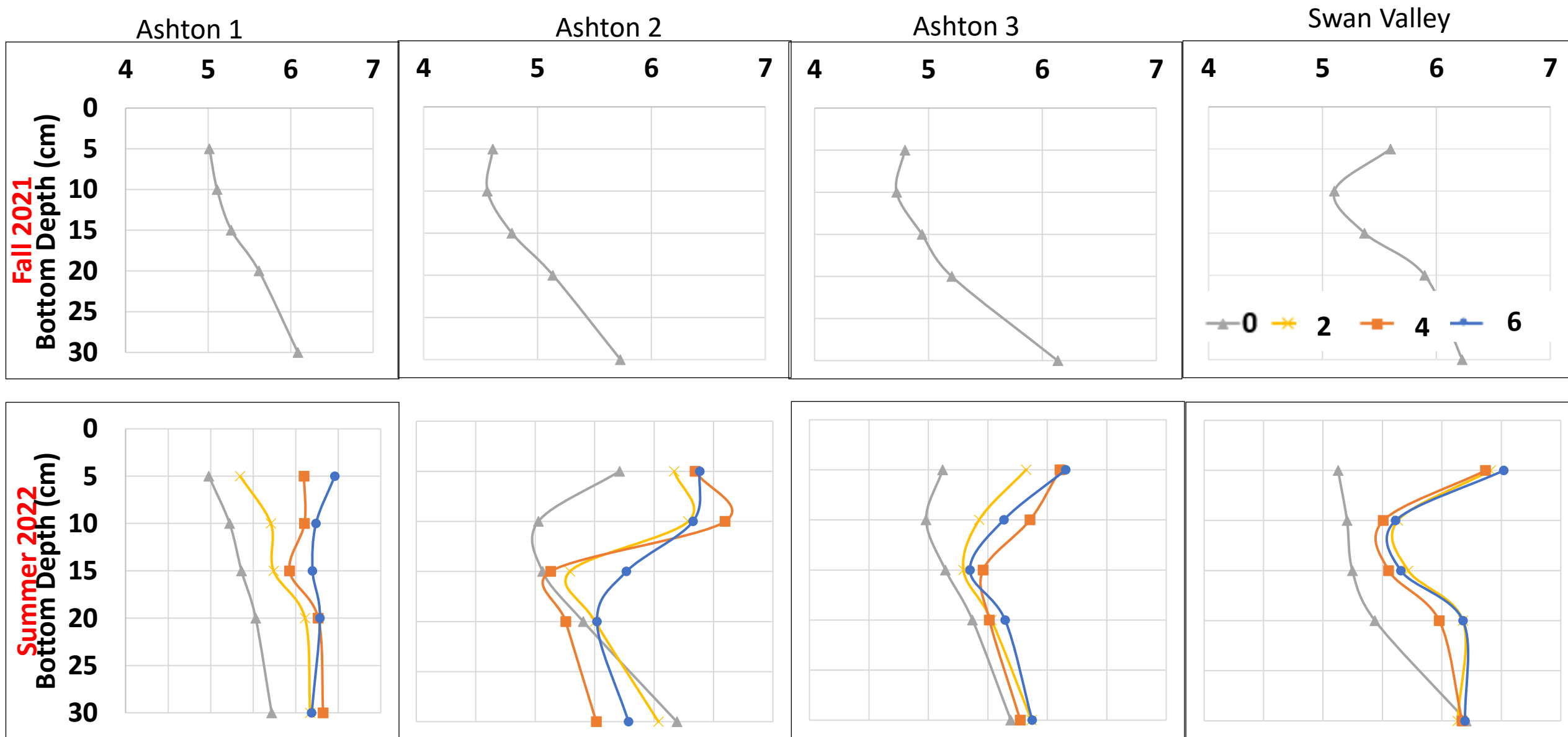
I There was a trend of increasing yield with increasing PCC rate at Sites 1, 2, and 4 in 2022.

pH increases with deeper sampling depths



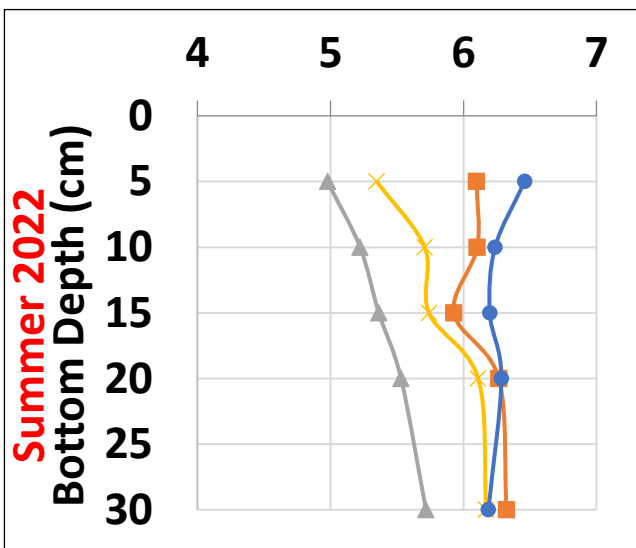
I Initial soil pH_{water} values ranged from 4.6 to 5.5 (0-2") and 5.8 to 6.2 (8-12")

PCC increased soil pH -0.36 to 1.57 units in top 6"

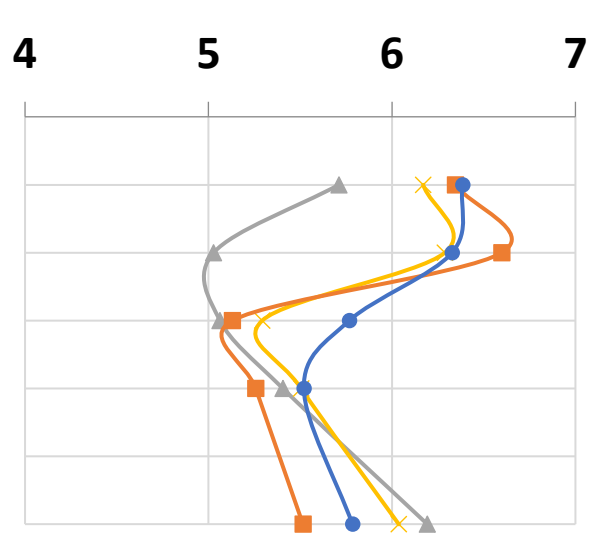


After 1 yr, PCC increased soil pH 0.06 to 2.0 units in top foot

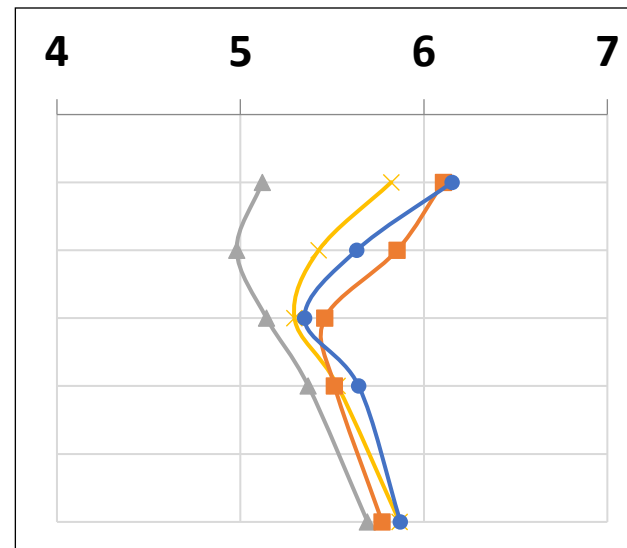
Ashton 1



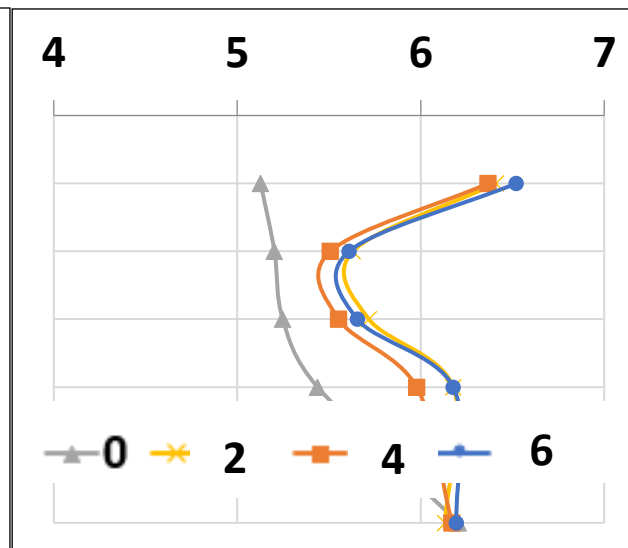
Ashton 2



Ashton 3

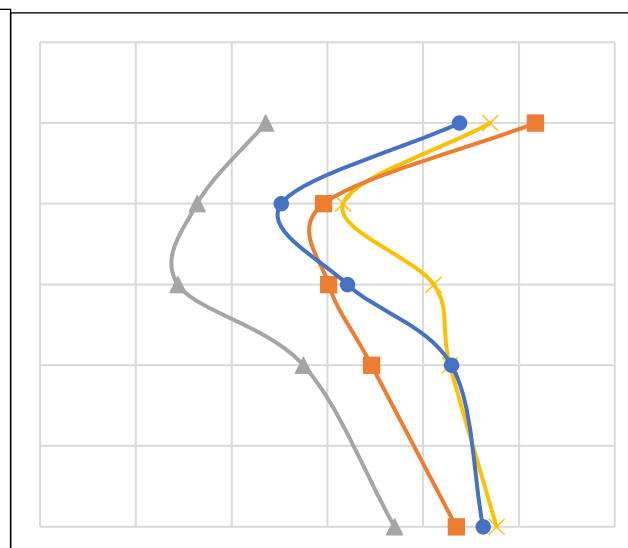
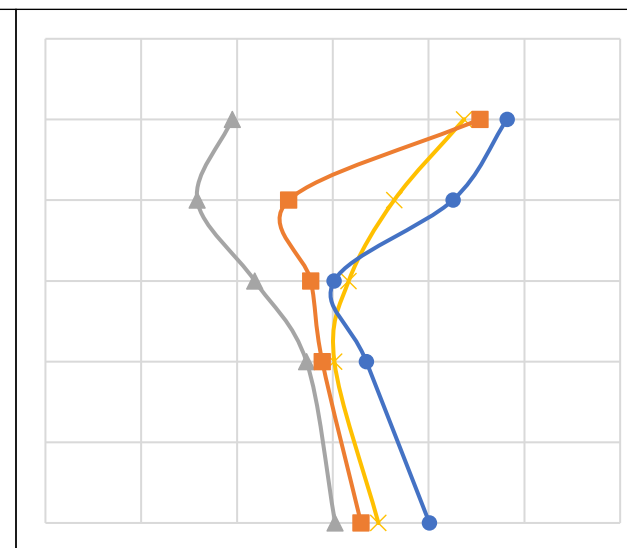
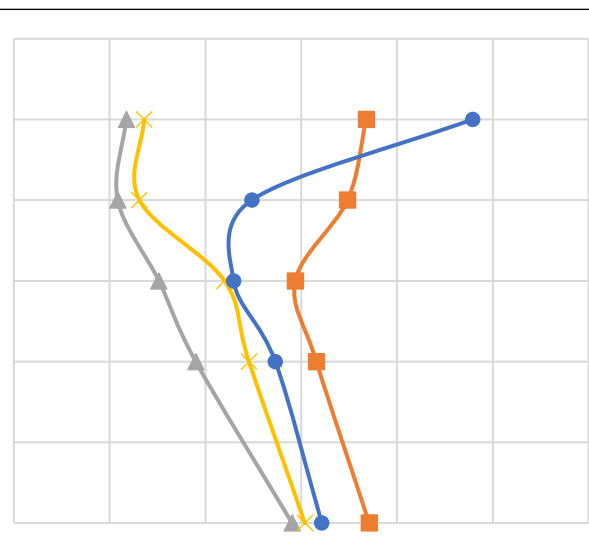
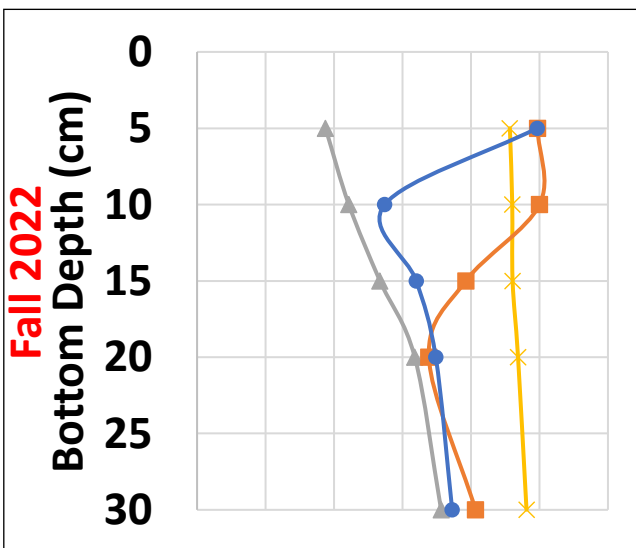


Swan Valley

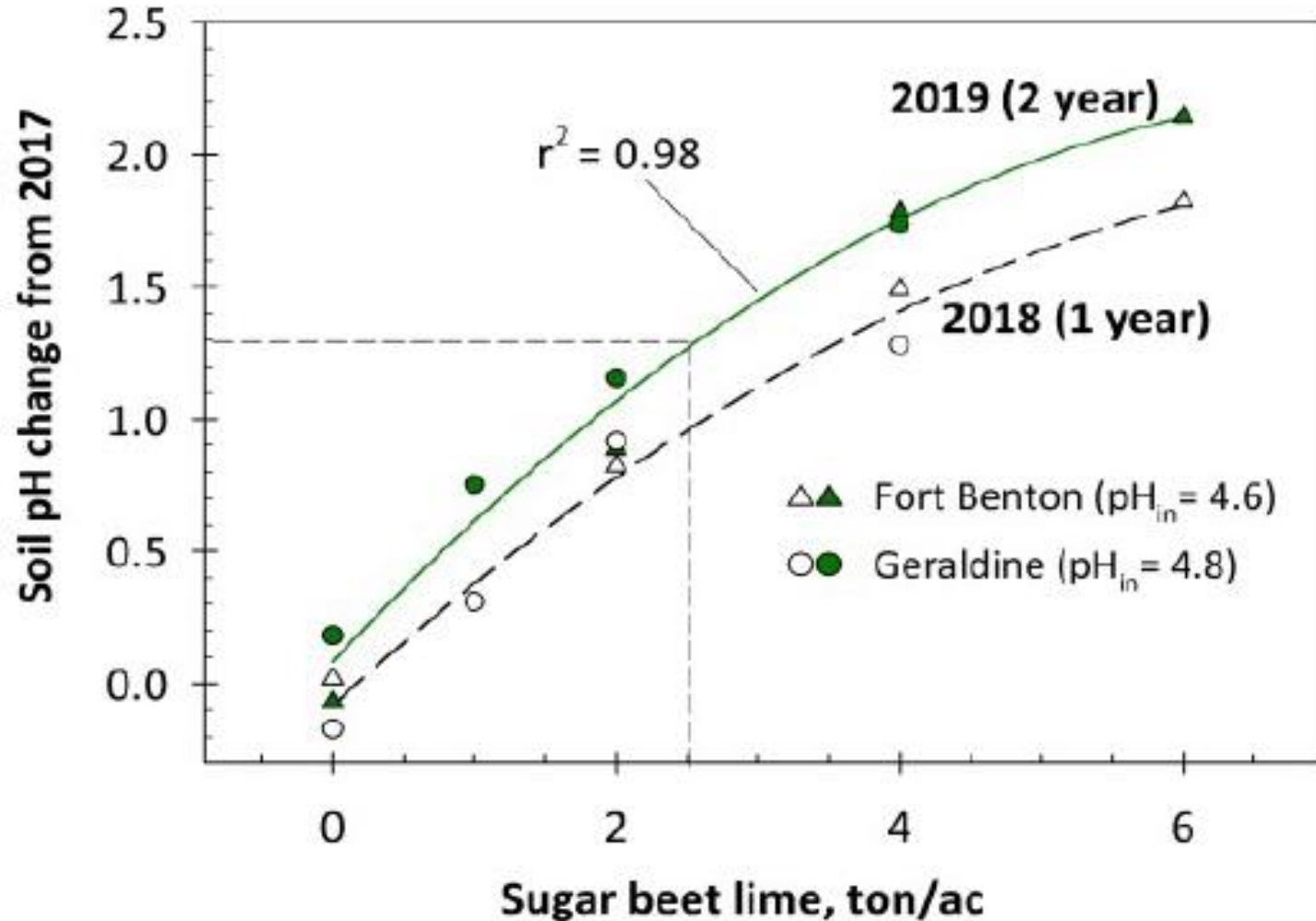


0 2 4 6

Fall 2022



2.5 tons/ac of PCC required to raise soil pH from 4.7 to 6.0



- I Under dryland conditions, tillage is necessary as PCC did not wash into the soil profile
- I Expected PCC application to remediate soil for 15 – 20 years

Liming can be a considerable expense



	Idaho	Montana
PCC Transportation	\$25/t	\$35/t
PCC Application	\$20/t	\$12/t
Cost for 2.5t/ac	\$112	\$118
Cost over 5 yr	\$22.40	\$23.60
Cost over 15 yr	\$7.47	\$7.87

Do PCC applications negatively affect crop production on alkaline soils?

PCC rate (ton/ac)	Total applied (ton/ac)
0	0
3 applied annually for 4 years	12
10 applied annually for 4 years	40
40 single application	40

Do PCC applications negatively affect crop production on alkaline soils?

- I No significant impact on PCC on sugarbeet, dry bean, and barley crop yields relative to the non-limed control
- I Compared to the control, the bicarbonate soil P concentration increased by 21 lb P₂O₅/ac (12 ton/ac rate) and 80 lb P₂O₅/ac for the 40 ton/ac treatments

Do PCC applications negatively affect crop production on alkaline soils?

I No significant increase in soil pH remaining near 8.3 over the study

Does Beet Lime Increase pH on High pH Soils? (No!)

Lime Rate	Sample date	Sample date	Sample date	Sample date	Sample date	Sample date	Sample date
	9-08	10-09	08-10	11-11	10-12	10-13	10-14
1 ton	7.8	7.7	7.9	7.8	7.7	8.0	7.7
2 ton	7.9	7.9	8.1	7.9	7.9	8.0	7.9
3 ton	7.9	7.9	8.1	7.9	7.9	8.1	7.9
4 ton	7.8	7.8	7.9	7.7	7.8	8.1	7.9
5 ton	7.8	7.8	8.0	7.9	7.9	8.0	7.9
6 ton	8.0	7.9	8.2	8.0	8.0	8.1	7.9

Beet lime applied September of 2008 1:1 routine soil pH method



QUESTIONS?

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