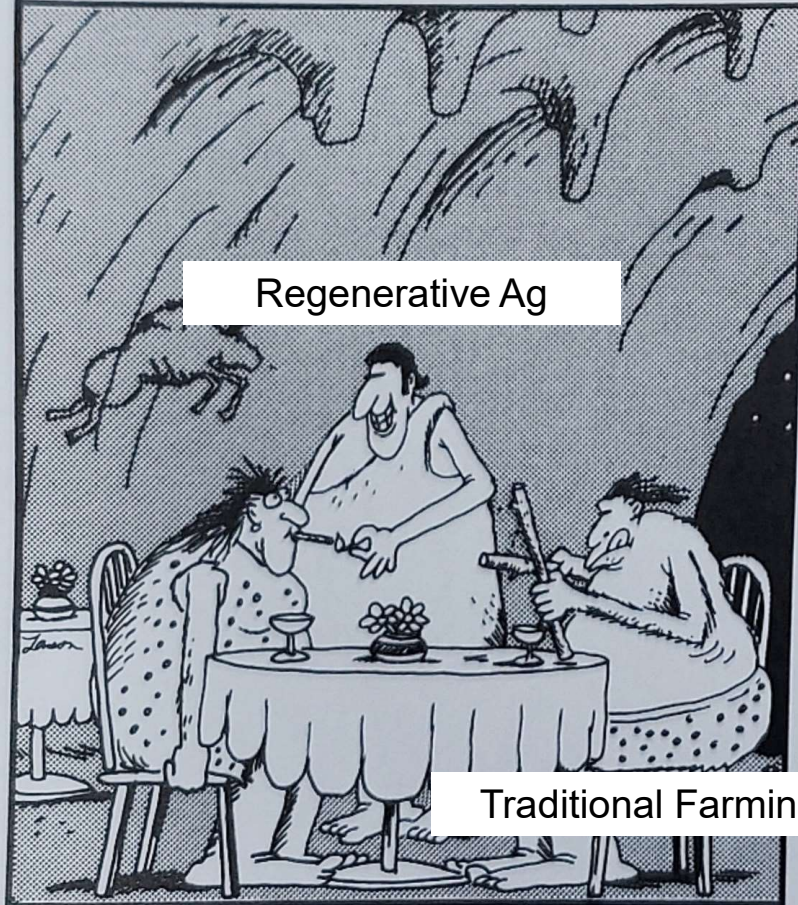


Improving Soil Health in Potatoes



Regenerative Ag



Traditional Farming

As Thak worked frantically to start a fire, a Cro-Magnon man, walking erect, approached the table and simply gave Theena a light.

What is soil health?

- The continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.
- Healthy soil gives us clean air and water, bountiful crops and forests, productive grazing lands, diverse wildlife, and beautiful landscapes.



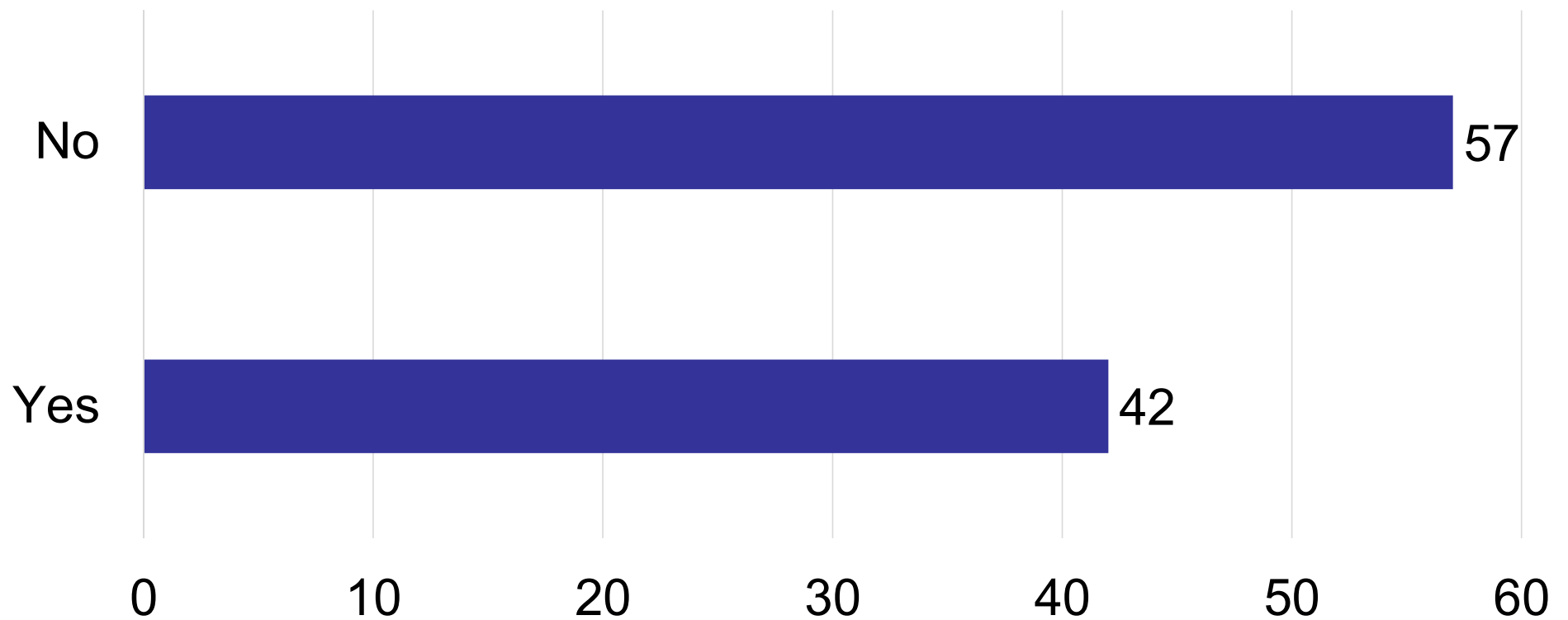
From USDA Natural Resource Conservation Service

What is the problem?

1. Despite frequent use of fumigation, pressure from soil-borne diseases is increasing over time.
2. Soil productivity is declining(?)

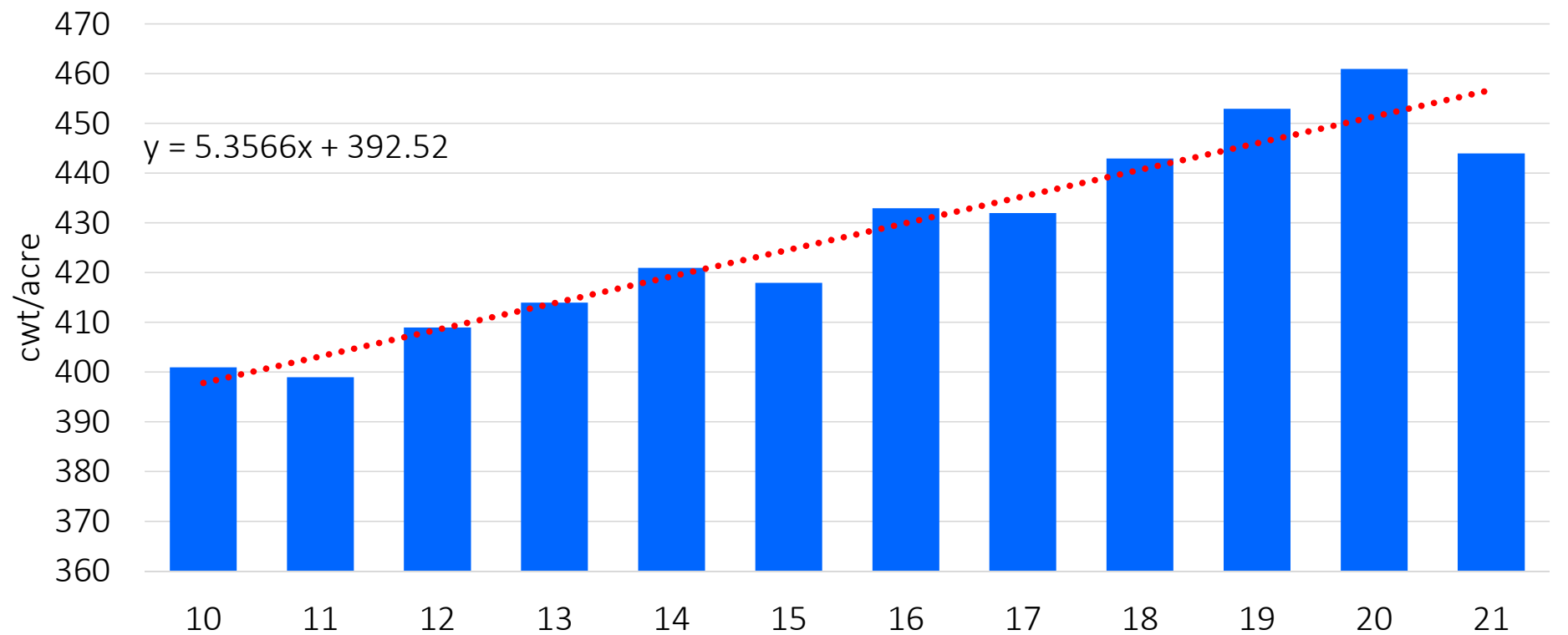


Is your soil productivity declining?



Bars represent the total number of respondents.

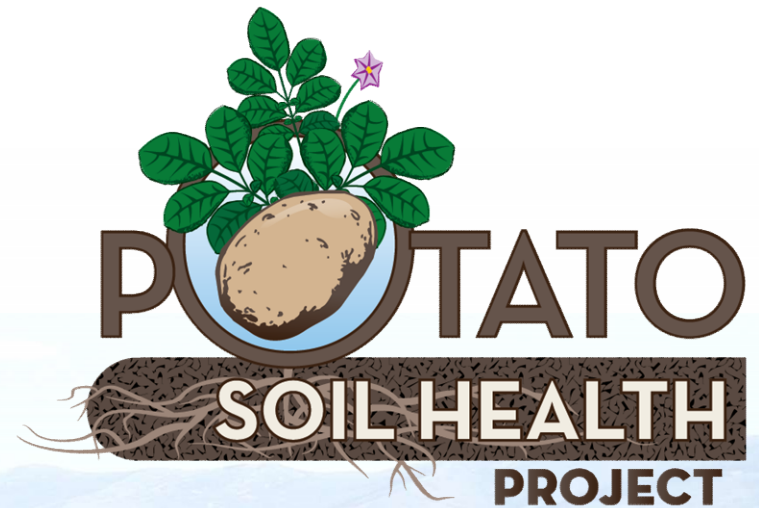
Average Potato Yields, Total US



Data from USDA, Potatoes Annual Summary

Potato Soil Health Project

- Determine how to best measure soil health in potato cropping systems
- Identify tools to enhance soil health
 - Cover crops
 - Soil amendments
 - Rotation schemes
- <https://potatosoilhealth.cfans.umn.edu/>



Reports

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<https://potatosoilhealth.cfans.umn.edu/reports>

× Extension factsheets

- [What makes healthy soils? >](#)
- [What is the microbiome? >](#)
- [Biofumigation: Is it a viable alternative? >](#)
- [Improving soil with cover cropping in potatoes >](#)
- [Soil health indicators for potato cropping systems >](#)
- [Soil-borne pathogens and pests in potato production systems >](#)
- [Fumigation use in potato production systems >](#)
- [Disease suppressive soils >](#)
- [What are beneficial soil microbes? >](#)
- [Potato soil fertility basics and options >](#)
- [Nematodes for soil health >](#)
- [Basics of potato economics >](#)
- [Animal manures as organic amendments in potato cropping systems >](#)

What makes
healthy soils?

Potato Soil Health Factsheet




Soil components

Soil is a living, dynamic body that has five basic components, which combine to give soil unique properties and characteristics.

The five major components of soil are:

- 1) Minerals
- 2) Water
- 3) Organic matter
- 4) Gases
- 5) Microorganisms



Soil health indicators¹

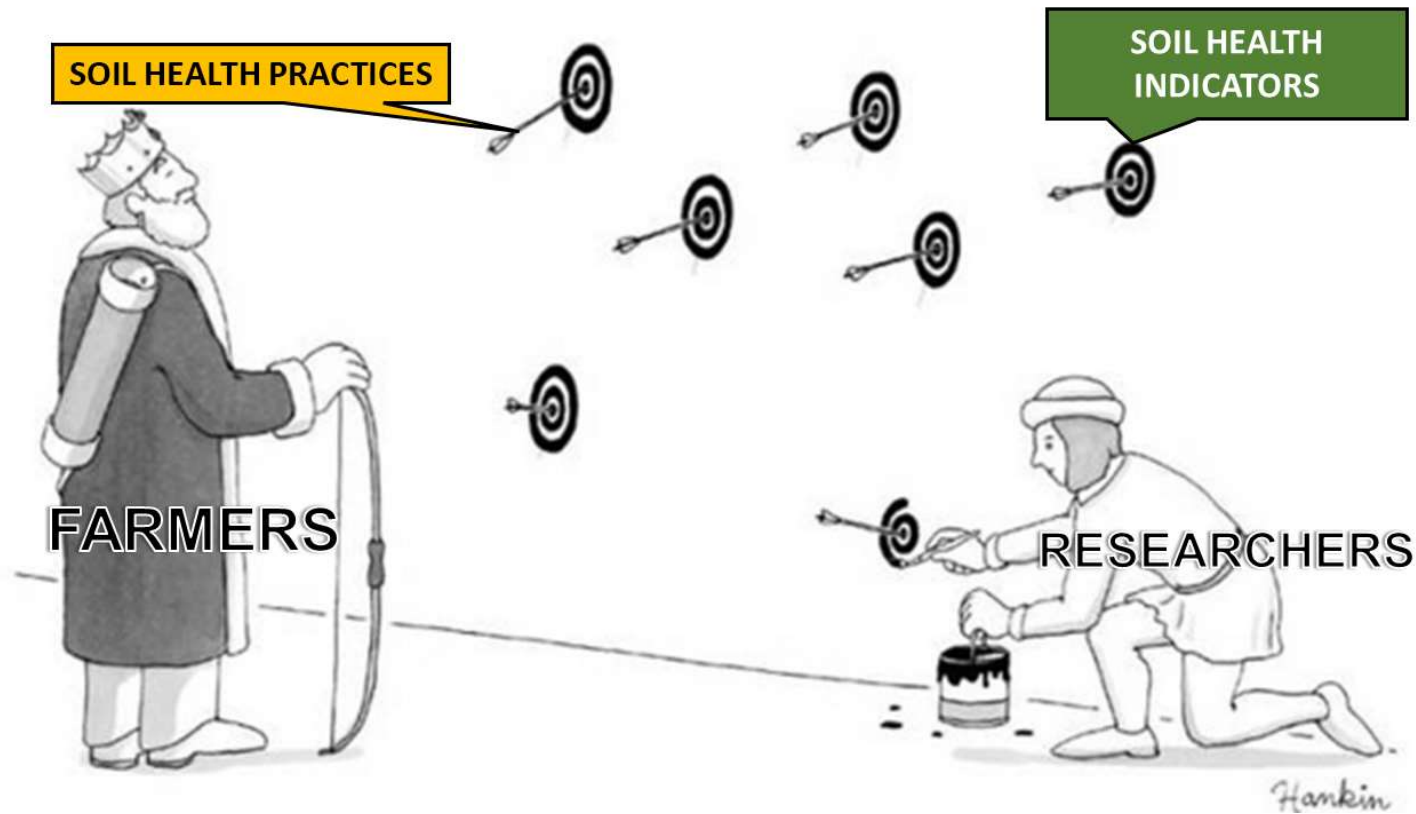
Physical properties
aggregate stability
soil structure
soil porosity
bulk density
water infiltration
water holding capacity
soil available water
soil depth
soil color
Biological properties
earthworms
soil microorganisms
particulate organic matter
soil respiration
soil enzymes
Chemical properties
cation exchange capacity
organic nutrients
parent material
soil pH

How do you measure soil health?

- Soil organic matter
- Physical properties
 - Bulk density, infiltration, water holding capacity, compaction, aggregate stability
- Chemical properties
 - Electrical conductivity, reactive carbon, nitrate, pH, P, K
- Biological properties
 - Microbial biomass, respiration, total organic carbon



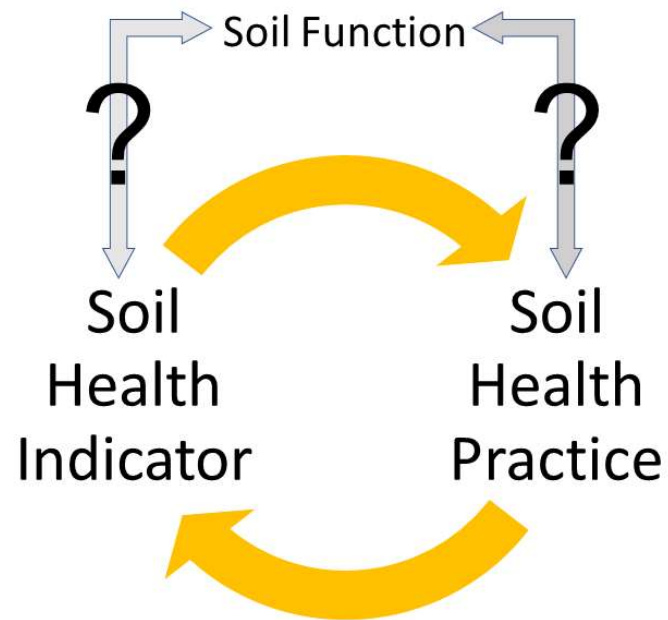
Do soil health indicators indicate soil health?



Andy McGuire, April 13, 2022

<https://csanr.wsu.edu/soil-health-shorts-do-soil-health-indicators-indicate-soil-health/>

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Identify management practices that impact soil health

Rotation Study at Miller Research

3-year rotation

(potato – silage corn – spring wheat - potato)

2-year rotation

(spring wheat – potato – spring wheat - potato)



From Mike Thornton, University of Idaho

University of Idaho
College of Agricultural and Life Sciences

Treatments

1. Burbank – no fumigation
2. Norkotah – no fumigation
3. Norkotah – Metam fumigation
4. Norkotah – summer green manure
5. Norkotah – compost (10 ton/acre)
6. Norkotah – compost + summer green manure



Compost and Green Manure



Crop Yield

	2019	2020	2021	2022
3-Year Rotation	Potato	Silage Corn	Wheat (HRS)	Potato
Burbank – no fumigation	490 c	26.6	85 ab	413 b
Norkotah – no fumigation	584 b	26.6	74 c	437 b
Norkotah – fumigation	641 a	26.0	78 bc	504 a
Norkotah – Summer GM	594 ab	26.4	--	442 b
Norkotah – Compost	611 ab	28.5	90 a	498 a
Norkotah – GM + Compost	578 b	27.8	--	489 a
2-Year Rotation	Wheat (SWS)	Potato	Wheat (HRS)	Potato
Burbank – no fumigation	154 b	383 b	63	349
Norkotah – no fumigation		475 a	67	359
Norkotah – fumigation		484 a	64	412
Norkotah – Summer GM	--	462 a	--	328
Norkotah – Compost	174 a	457 a	74	421
Norkotah – GM + Compost	--	468 a	--	367

Summary from the Miller Research Field Trial

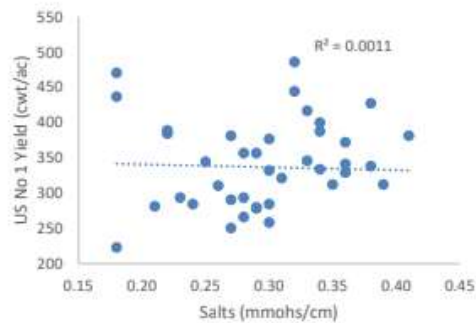
- Fumigation is providing a benefit for soil function (yield and quality)
- Compost amendment improves soil function (yield and quality)
- Dedicated green manures did not help potato yield in this trial
 - Cover crops and green manures have many proven, positive benefits



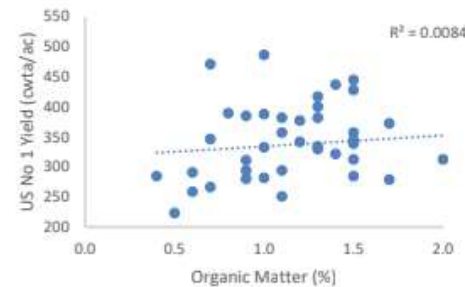
Objective 2 – Field Survey Results

- Yield negatively correlated with *Verticillium* (MN and ID).
 - Soil health indicators did not correlate to yield.

Are any of these factors related?

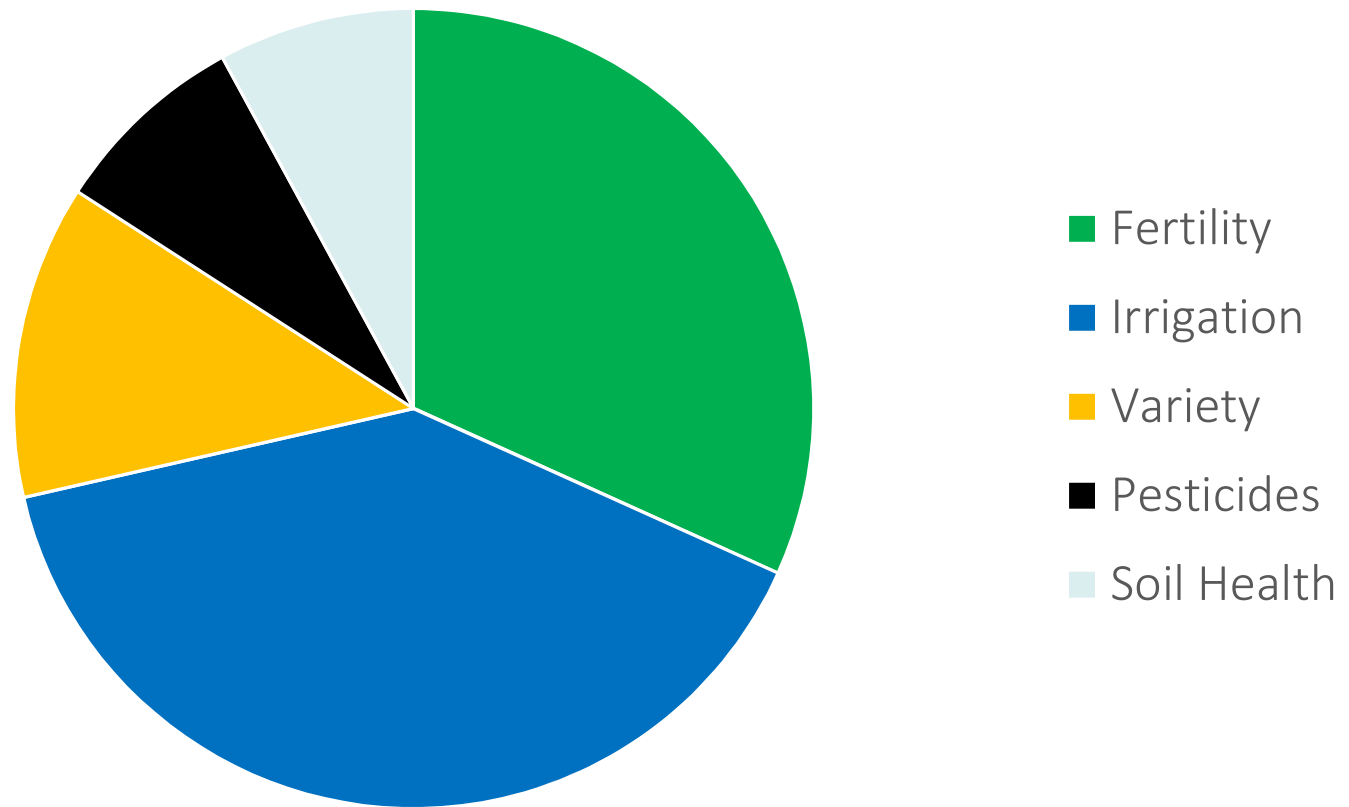


From Mike Thornton, University of Idaho

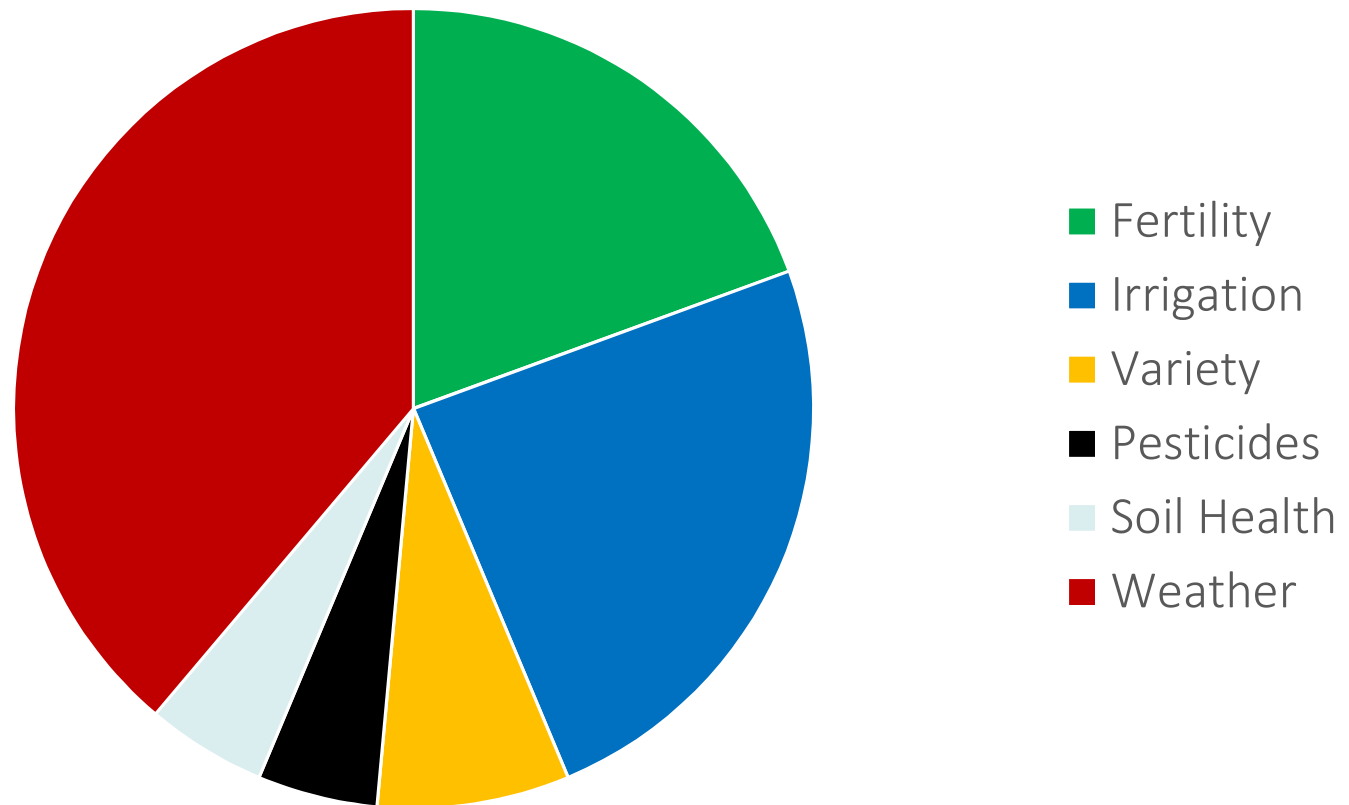


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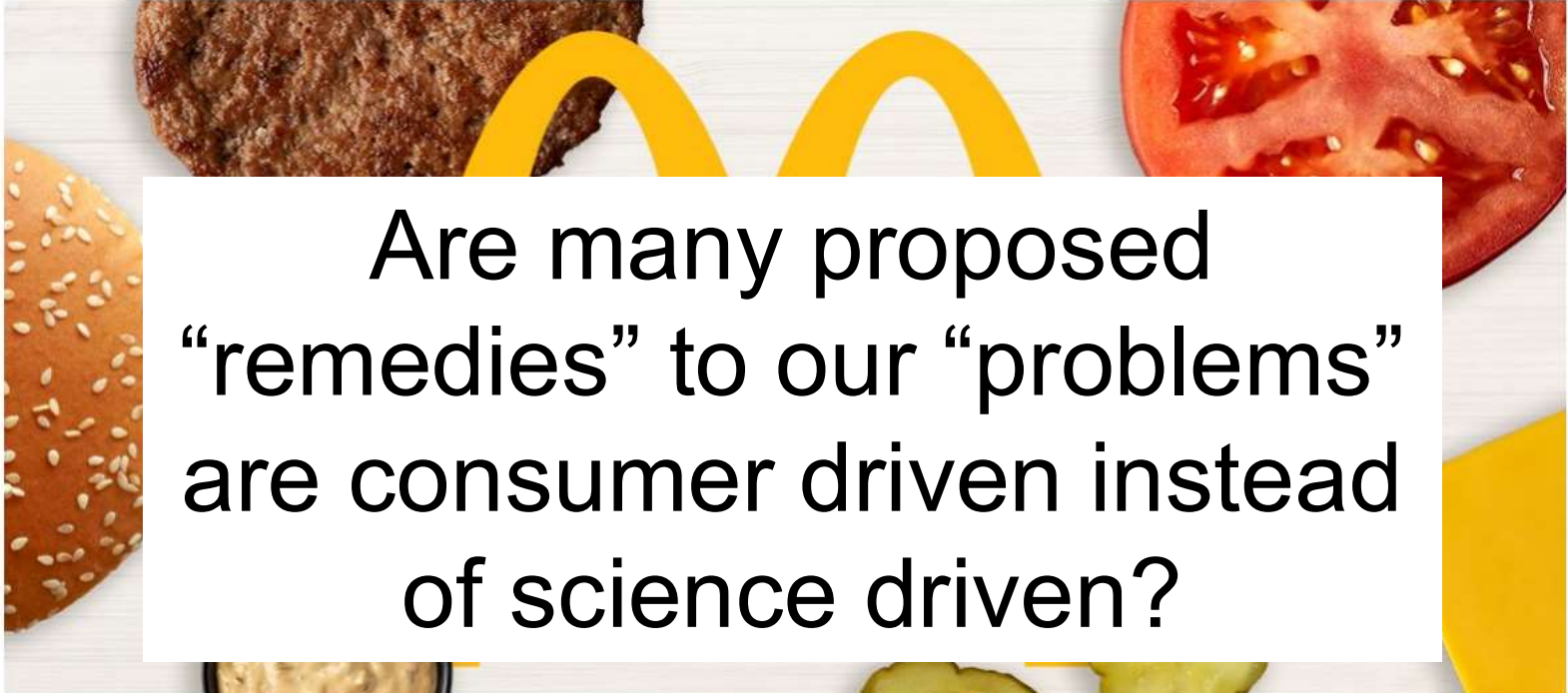
What contributes to yield?



What contributes to yield?



Our Commitment to Quality



Are many proposed
“remedies” to our “problems”
are consumer driven instead
of science driven?

At McDonald's, we take great care to ensure that what we serve every day is safe, quality food. That means we use 100% real beef patties seasoned with just a pinch of salt and pepper. It means our Egg McMuffin® is made with a freshly cracked egg. And, our Filet-O-Fish® sandwich is made with 100% whitefish sourced from sustainably managed fisheries. It means our Chicken McNuggets® are made with white meat chicken. Simply put, it means real, quality ingredients and always evolving what matters to you.

Some thoughts on metam fumigation...

- + Reliable method for reducing *Verticillium* in the soil.
- + Improves N utilization in plants (healthier root systems)
- Very expensive and toxic.
- Not as hard on the microbes in the soil as many believe.



How do you measure the toxicity of a pesticide?

- Mode of action
- Toxicity to fish – 96 hr LC_{50}
- Acute dermal LD_{50} for rabbits/rat
- Toxicity to birds – 8 day LC_{50}
- Long-term health effects
- Toxicity to bees
- Plant surface residue half-life
- Toxicity to beneficials
- Soil residue half life
- Groundwater and runoff potential

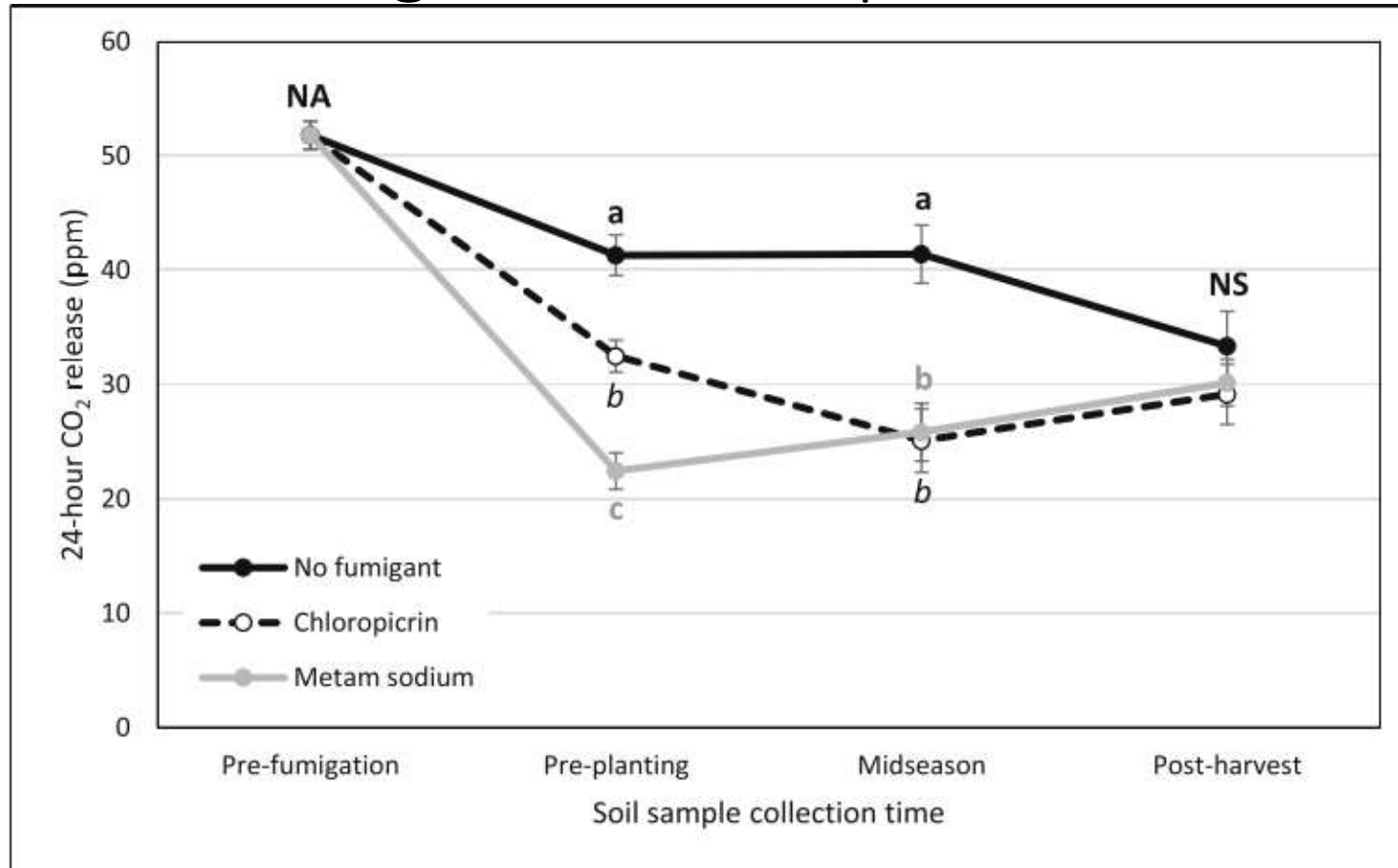


Sustainability(?) of Products – Verticillium Wilt

Product	Field Use EIQ					Cost
	Rate/acre	Consumer	Worker	Ecological	Field	\$/acre
Vapam HL (metam sodium)	40 gal	1132.8	3385.7	6666.3	3728	300
Vydate (oxamyl)	4.1 pt	11.6	12.4	155.8	31	55
Elatus (azoxystrobin + benzovindiflupyr)	7.1 oz	0.8	1.1	8.9	3.2	23
Velum Prime (fluopyram)	6.84 fl oz	1.5	1.1	4.8	3.1	51

Reduced Toxicity of Pesticides – Cannot exceed 2500 EIQ values
Proposed McCain Regenerative Ag Guideline

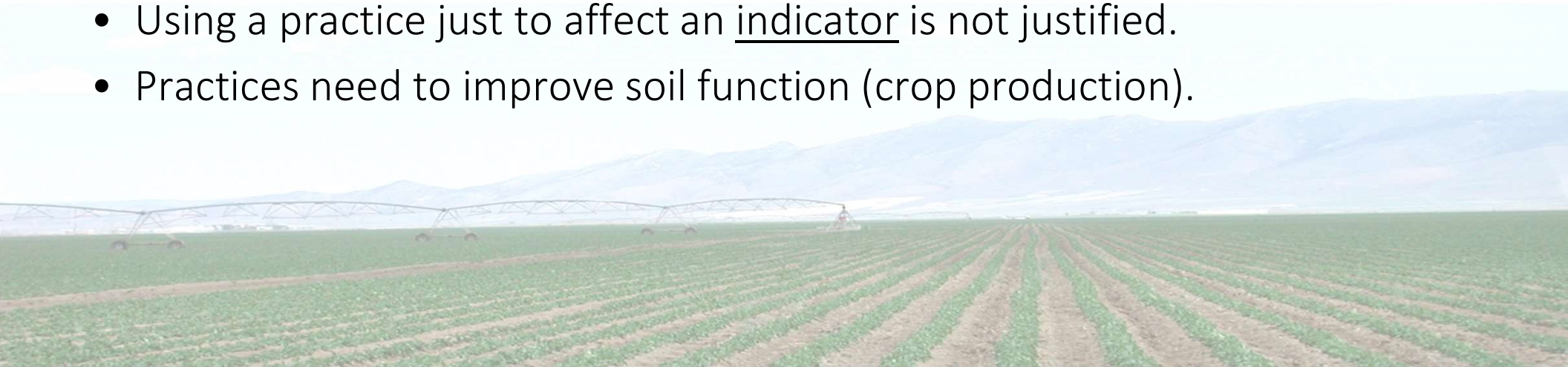
Effect of Fumigation on Respiration in Soil




From Crants et al., 2021. Am. J. Potato Res. 98:285-303

So are these true?

1. Despite frequent use of fumigation, pressure from soil-borne diseases is increasing over time (?)
 2. Soil productivity is declining (?)
- More research is needed to validate “soil health” practices.
 - Using a practice just to affect an indicator is not justified.
 - Practices need to improve soil function (crop production).



A good resource



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[Cover Crop Mixtures, Biodiversity, and Agriculture](#), Crops & Soils Magazine, Nov-Dec, 2021


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**Andrew Mc...**
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Replying to @agronomistag

Regenerative ag is fond of taking what happens in a specific place or circumstance, and generalizing that