Improve Grassland by improving Soil Health

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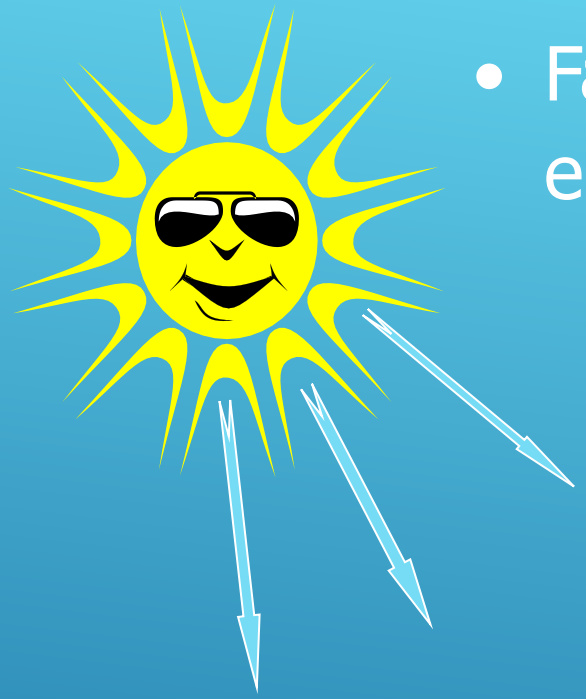
www.wardlab.com

"Guiding producers today to feed the world tomorrow"

Grassland Observations

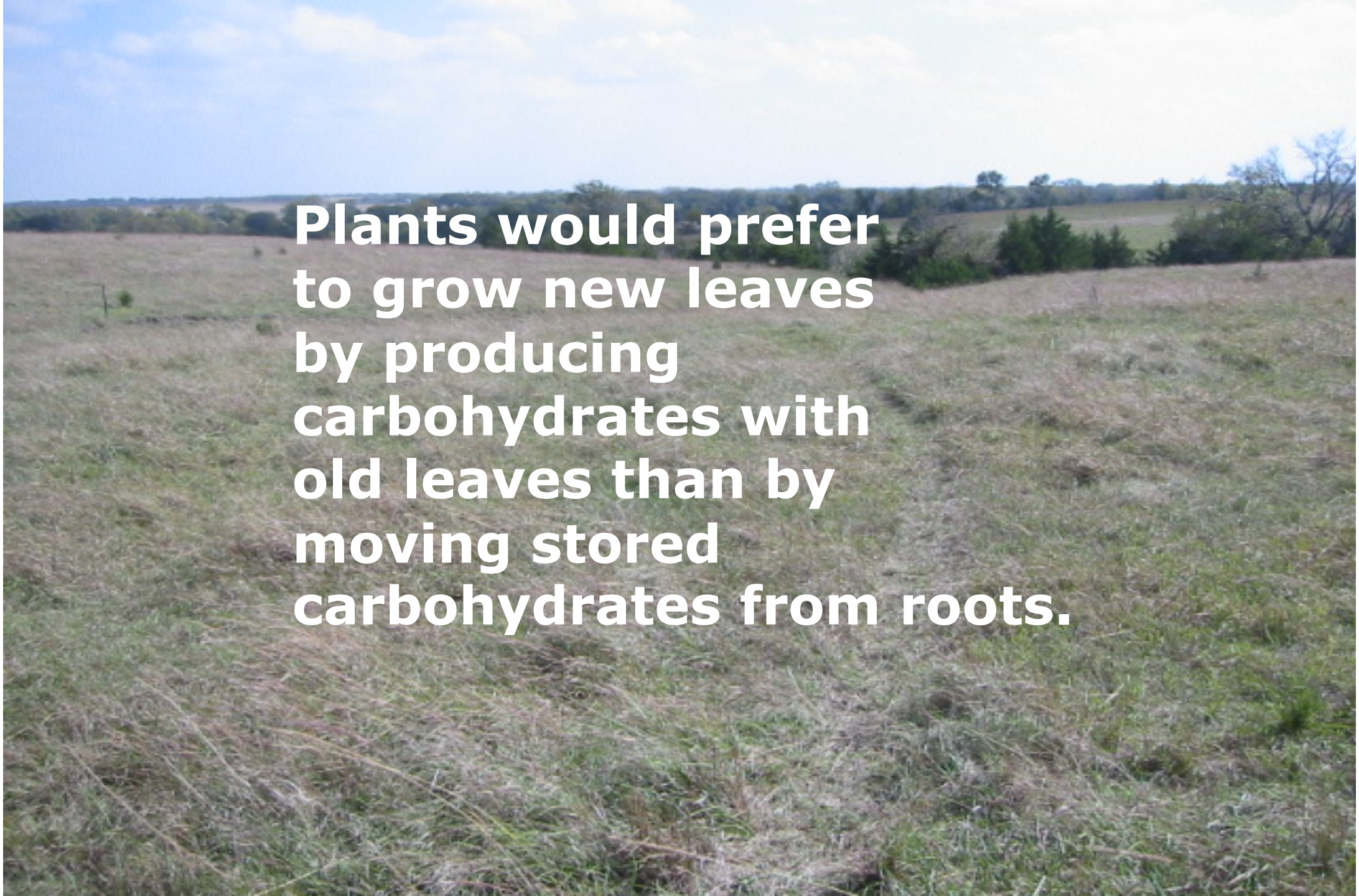
- When driving from Kearney, NE to North Dakota early September 2018
- I noticed overgrazed pastures and range.
- Weedy pastures.
- Tree invasion into some pastures.
- Can we improve the situation?
- So I will discuss how grass grows and how to evaluate the soil to evaluate progress in improving grass.



- Farming is all about capturing the sun's energy and converting it to usable products.

L. Paine, 2005

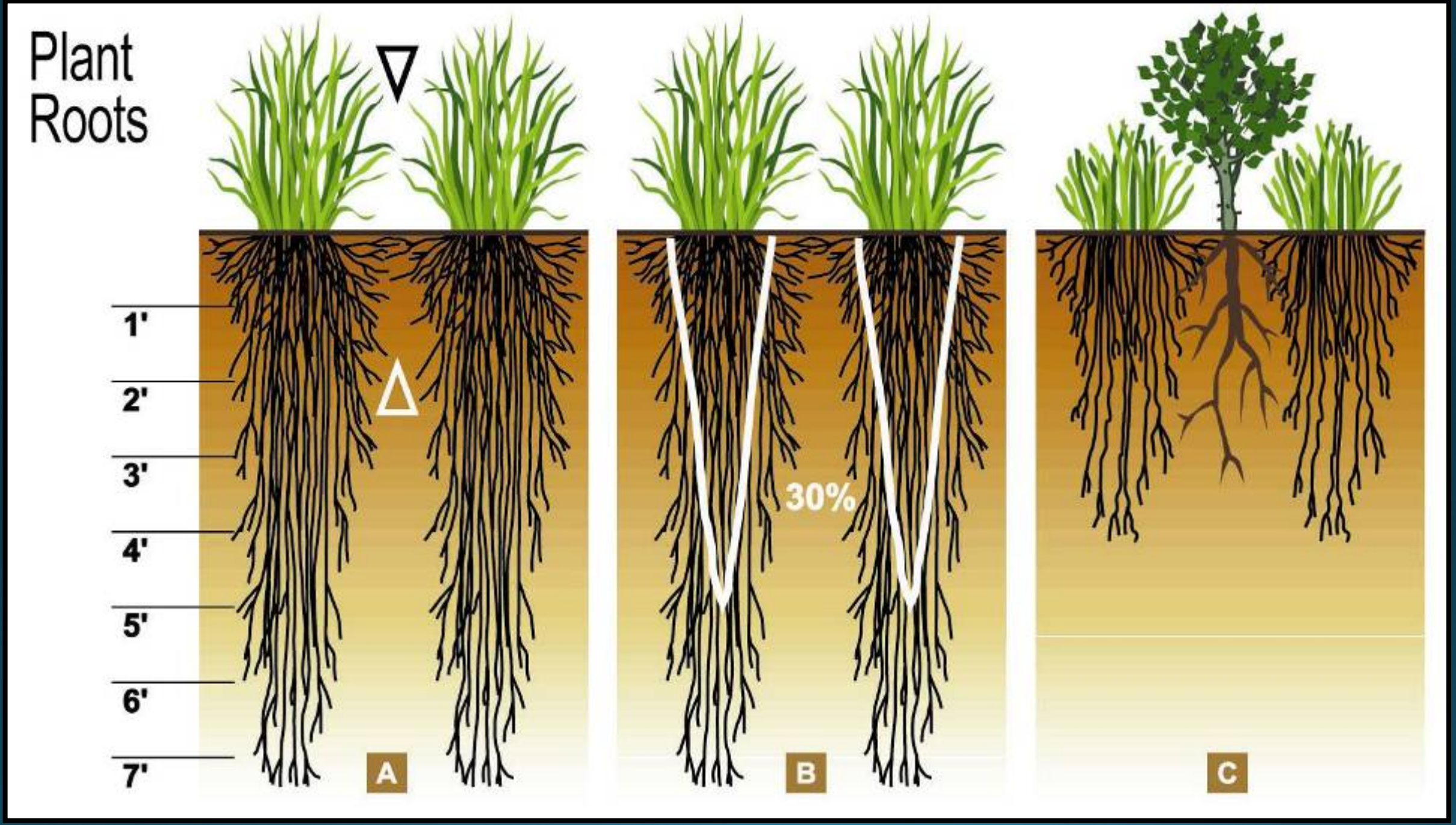
- If we start by maximizing the amount of energy we capture, all other steps in the process have greater potential to yield profits.



Plants would prefer to grow new leaves by producing carbohydrates with old leaves than by moving stored carbohydrates from roots.

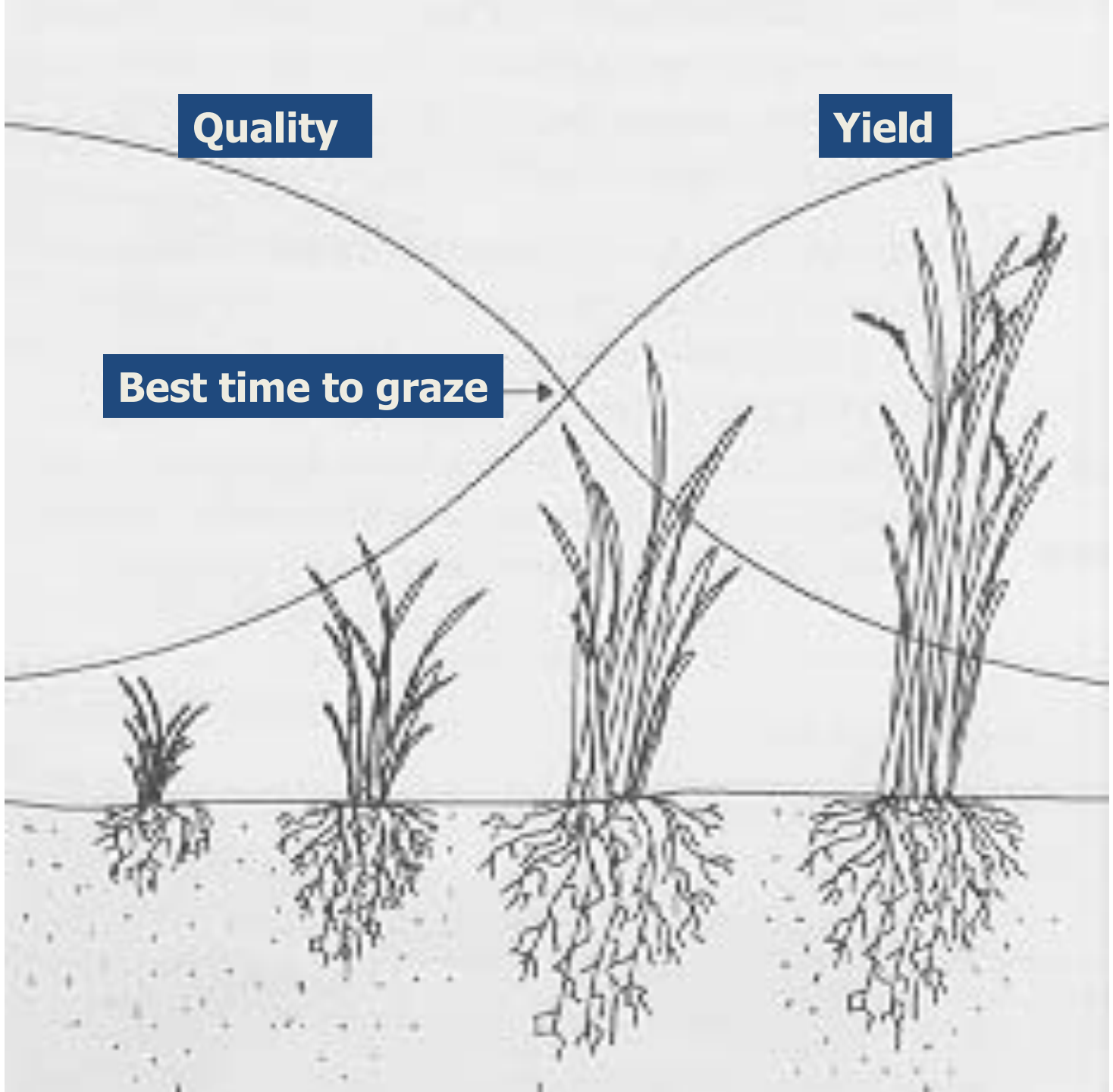
Grass Health

1) Each year 30 percent of each grass plant's root system must be replaced plus try to expand the existing root system.
2) Constant removal of vegetative growth from the surface greatly impairs the ability of the plant to replace the root system loss, let alone expand the root system.
3) Continual removal without rest significantly damages the health of the root system. Overgrazing allows weed growth to occur and endangers the pastures ability to be a "sustainable" resource.


Plant Roots
1'
2'
3'
4'
5'
6'
7'
30%
A
B
C

Forage Growth Curve

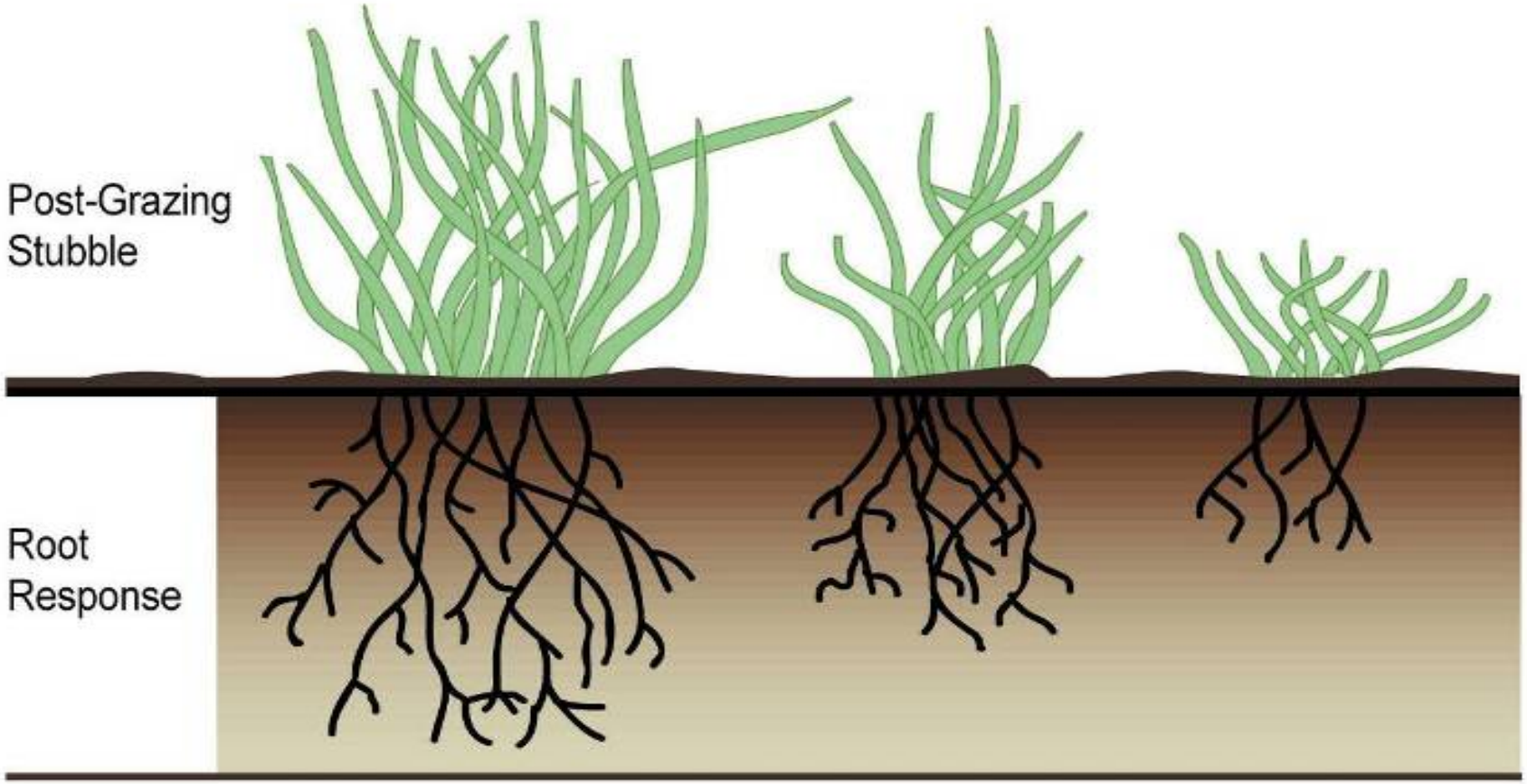
Stage of maturity greatly influences forage quality and availability of nutrients.



Grass Health

1) Plant roots stay strong and healthy when grazing periods are short and rest or recovery periods are long.
2) When grazing periods are long and rest/recovery periods are short, root systems begin to suffer.
3) When grazing periods are continuous and rest/recovery periods are nonexistent, root and plant vigor decreases.

Stubble/Pasture Health



Grazing Period	Short	Long	Continuous
Recovery Allowed	Long	Short	None

Grazing management affects roots

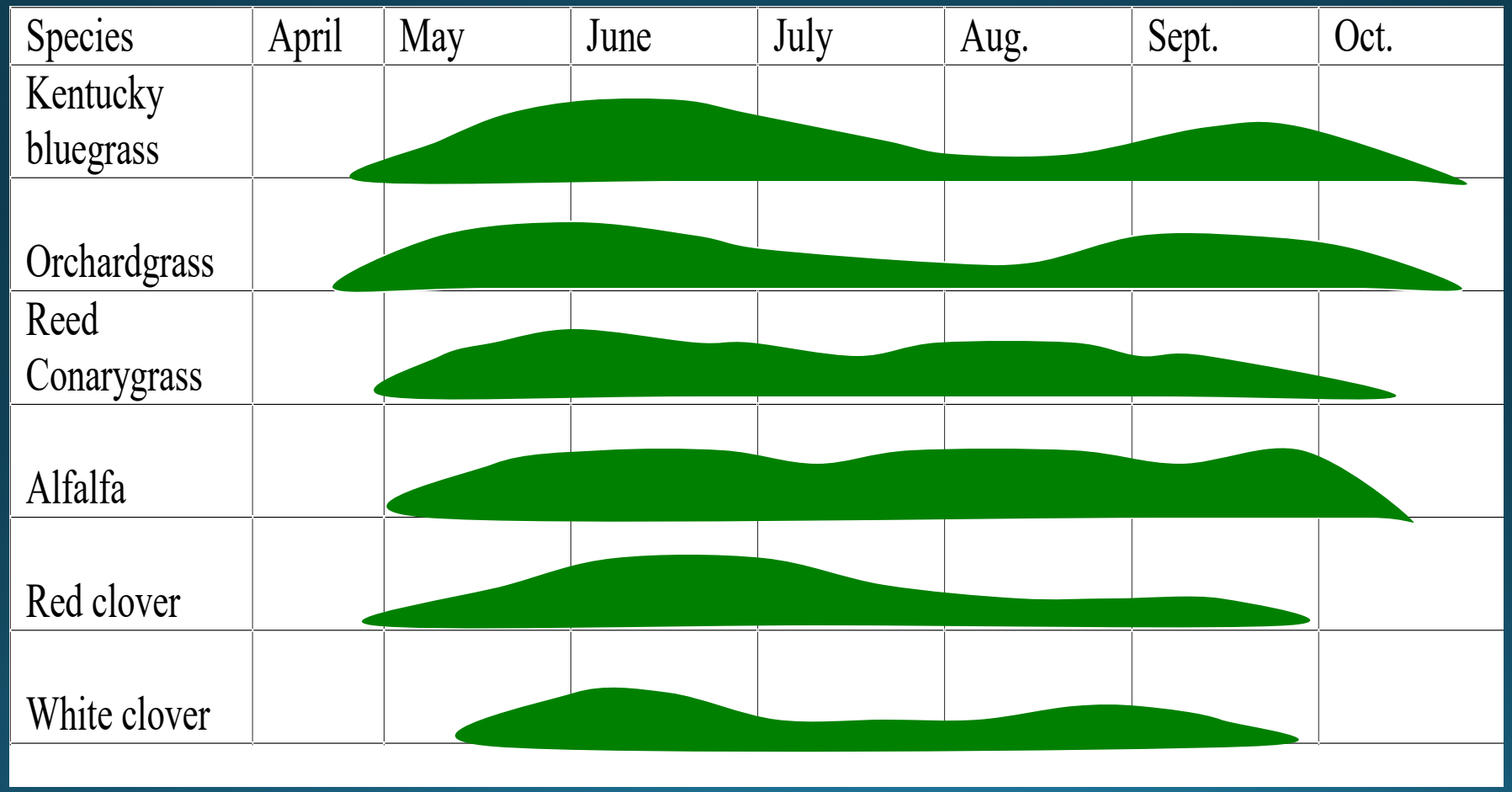
Table 1

	% Root Growth Stoppage Three Days After Forage Removal			
% Forage Removal	Test 1	Test 2	Test 3	Test 4
90	100	100	100	100
80	100	100	91	81
70	78	97	77	76
60	50	80	54	36
50	2	8	38	13
40	0	0	0	0
30	0	0	0	0
20	0	0	0	0
10	0	0	0	0
0	0	0	0	0

This represents four tests with three different grass species. From Crider, 1955.

Note that somewhere between 40% and 50% of the forage can be removed without stopping root growth.

Seasonal growth patterns in forages



What’s best for the water?

Rainfall Simulator

- https://www.youtube.com/watch?v=z9K9idBcJLY
- Stan Boltz, NRCS, Huron SD
- Demonstrates soil loss from overgrazed grassland
- 2 inches of water applied on the overgrazed grass did not wet the 2 inch deep pan of soil. There was soil in the runoff water.
- Tall grass prairie sample wet the soil and had no runoff water.
- Must see.

Soil Health basics

1. Armor the ground
2. Minimal soil disturbance
3. Plant diversity
4. Living root in the soil all the time
5. Livestock

Factors Affecting Active Nutrient Uptake

Oxygen

Biological Activity

Temperature

Ion Interference


What’s best for the grass?

Soil pH

- Neutral pH 6.2 – 7.2
- Very Acid less than 5.1
- Moderately acid 5.1 – 5.6
- Alkaline 7.3 – 7.8
- Very alkaline 7.9 – 8.4

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Buffer pH

- Measures total acidity
- Buffer pH measures the amount of H ions (acidity) held on cation exchange
- Lime recommendation

  (7.0 – Buffer pH) times 4 = Tons of ECC per acre

  Tons of ECC divided by effectiveness = Tons of ag lime per acre

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EC (soluble salts) mS/cm

- **Soluble Salts (EC), mS/cm (mmho/cm)**
- 0.1-0.75 No crop hazard
  - EC can be an indicator of soil life
- 0.75-1.5 Yield reduction on sensitive crops
- 1.5-3.0 Moderate yield reduction
- 3.1+ Severe yield reduction

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Soil Organic Matter

- Enhance crop productivity
- Build soil fertility
- Improve structure
- Build aggregate stability
- Increase nutrient retention
- Increase water holding capacity

Organic Matter

- Range 1 to 5+ %
- One percent OM contains
  - 1000 lbs of N
  - 220 lbs of P2O5
  - 140 lbs of S
  - All other nutrients

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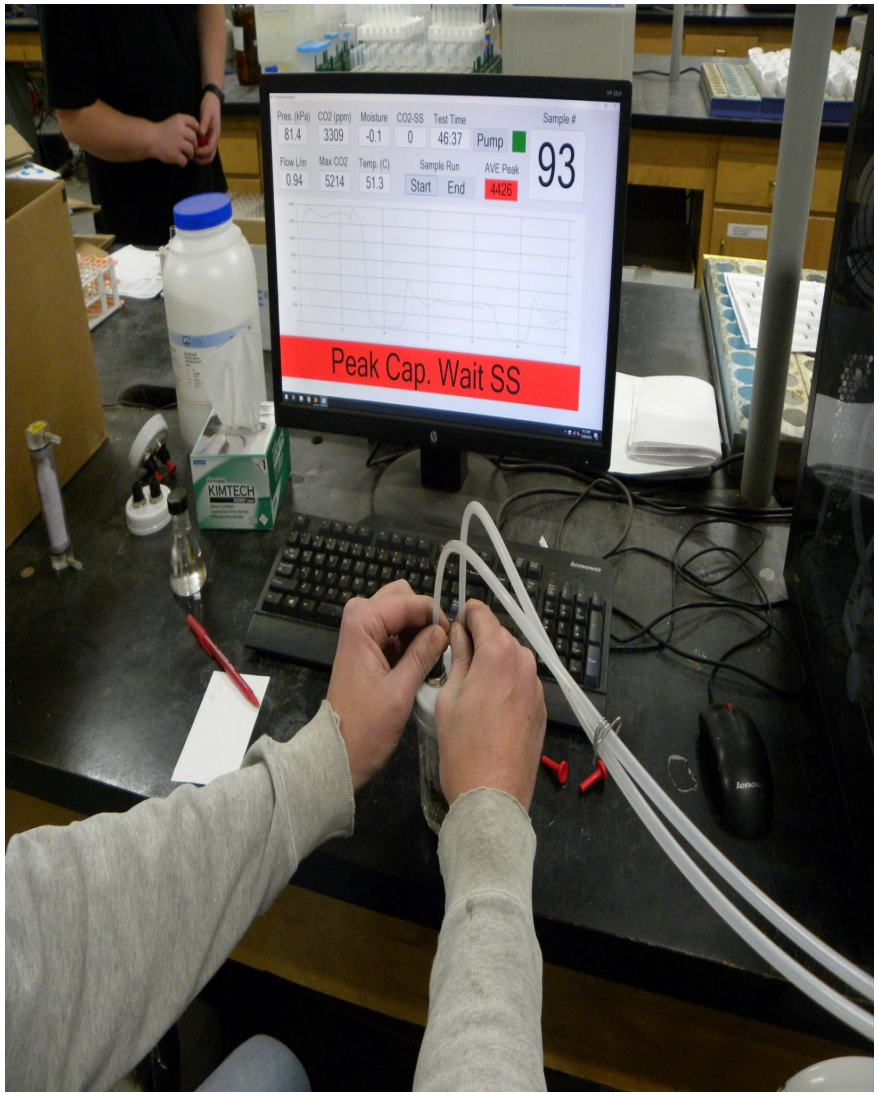
Haney Soil Health Test

- **Three parts:**
  - **CO2-C 24 hr.** respiration test to measure microbial biomass
  - **Water extract** for measuring carbon and nitrogen in the soil solution
  - **H3A extract** mimics plant uptake of plant nutrients

Respiration 24 hr. CO2 burst

Soil Respiration

- Lab vs Field Techniques
- How much CO2-C is produced in 24hrs
- Represents microbial biomass and potential for activity and nutrient cycling
- Related to a soil's fertility, texture and organic matter content



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CO2-C 24 hr. Respiration test

Good number

60 to 150 ppm CO2-C

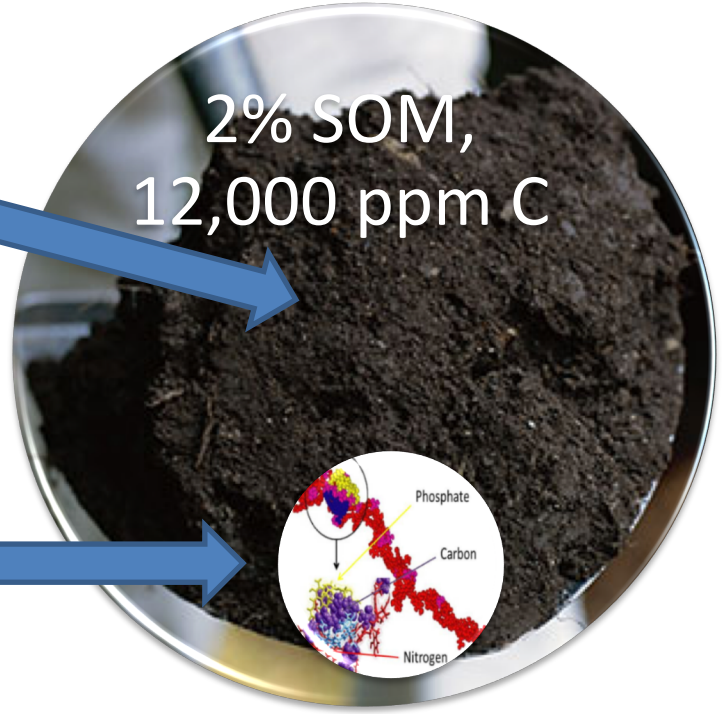
Could be as high as 800 ppm CO2-C

Water Extract

Soil Organic Matter is the "House" microbes live in, **Water Extractable Organic Carbon** is the "**Food**" they eat.

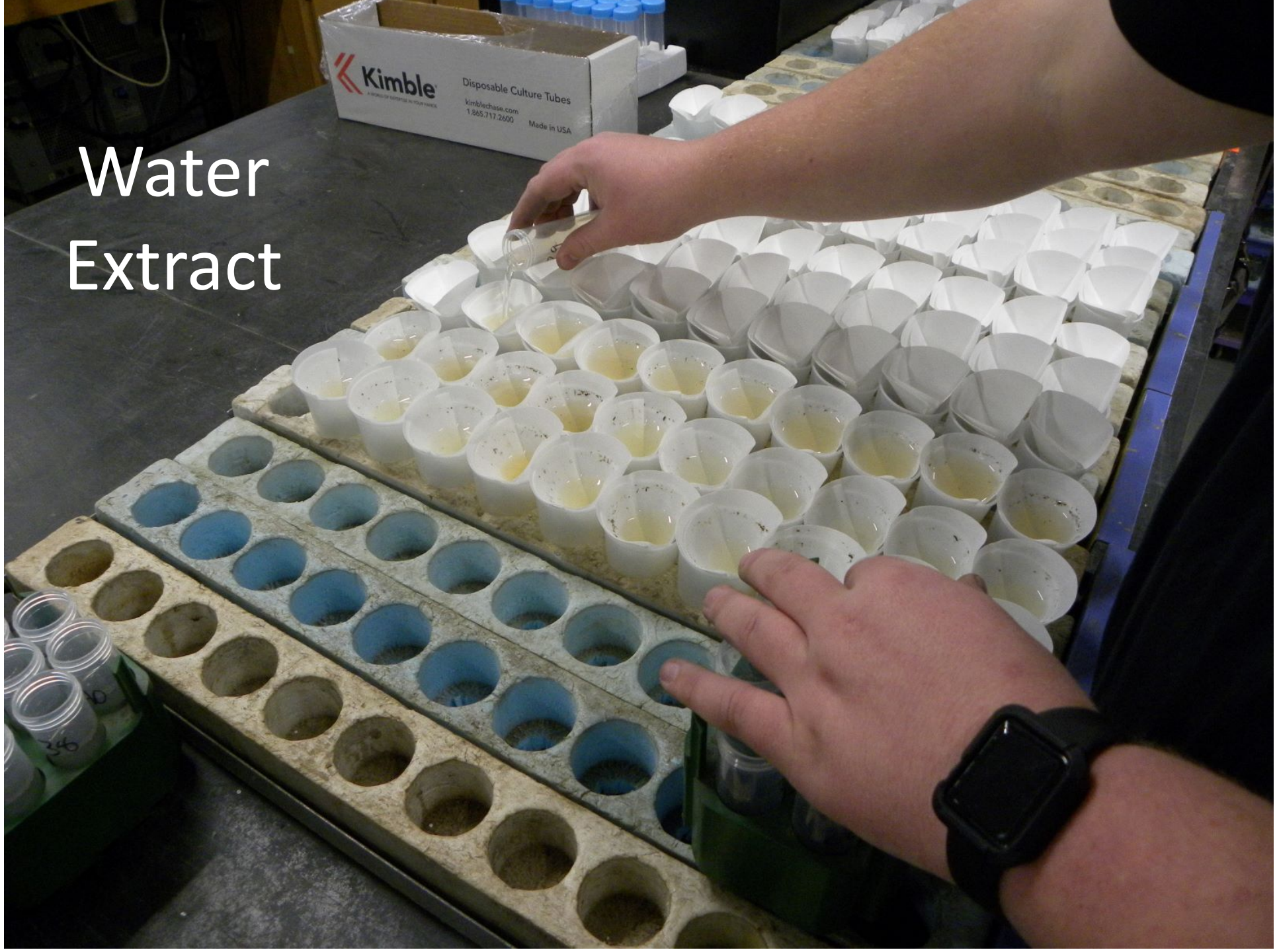
House

Food



100-300 ppm C from water extract = microbial food


Kimble
Disposable Culture Tubes
Made in USA
LID OPEN



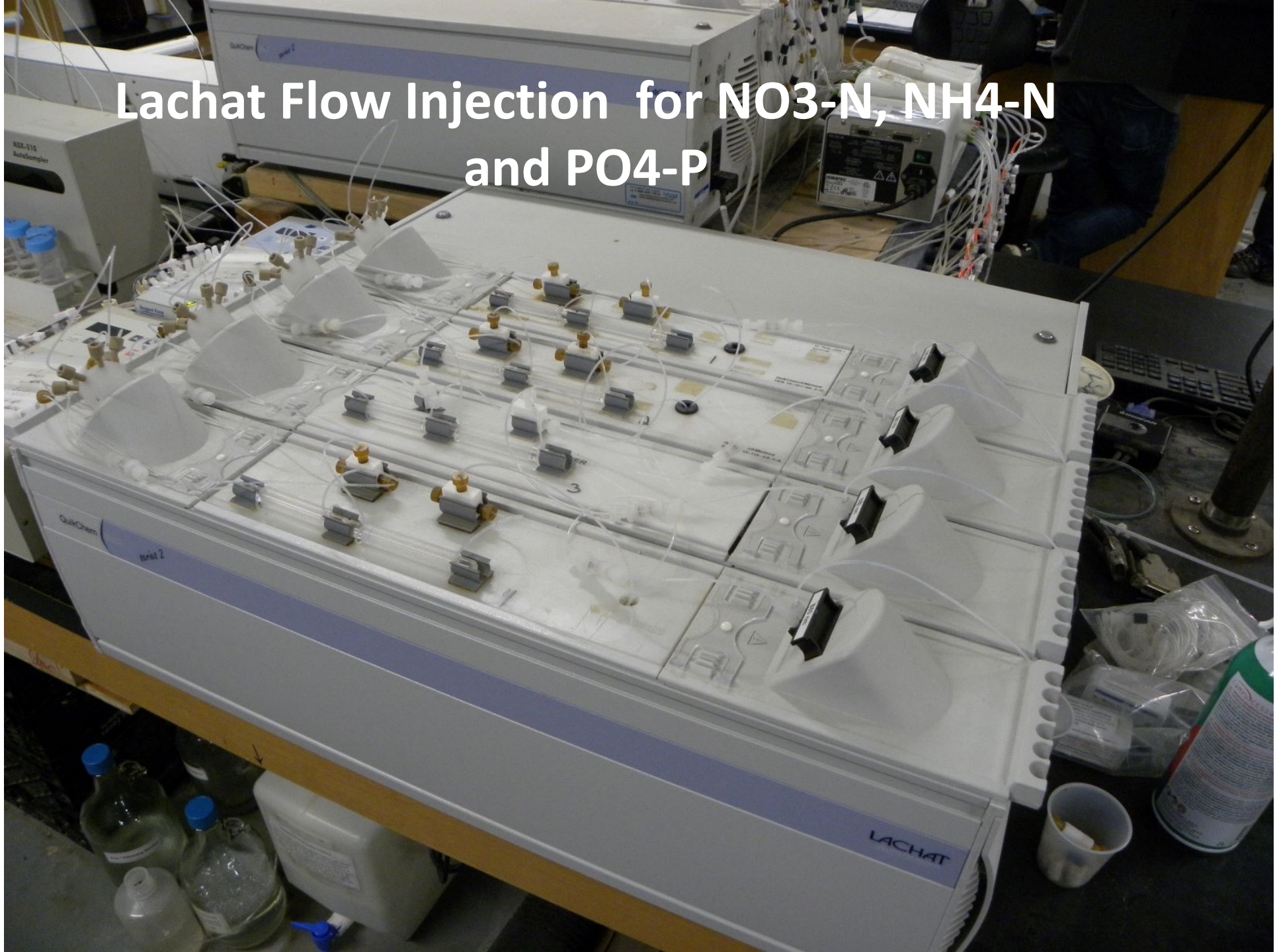
Water Extract

Total Organic Carbon
Total Nitrogen

Haney Water Extract

- **Total Organic Carbon (WEOC)**
- It is soluble in water and the food for microbes.
  - Good number is 100 to 300 ppm C depending on CO2-C burst test.

Lachat Flow Injection for NO3-N, NH4-N and PO4-P



Haney Water Extract

- **Total Nitrogen**
- **Organic Nitrogen (WEON)**
  - What is left after subtracting nitrate and ammonium.
  - WEON 40 to 60 % of total N is excellent
  - This is the N that is missed in regular soil tests

MAC Calculation

- **Microbial Active Carbon (%MAC)**
  - (Respiration 24 hr CO2-C / WEOC) * 100
    - WEOC = water extractable organic carbon
  - For example: (77.0 / 182) * 100 = 42.3
  - A good reading
  - Like to see above 20 % and below 80 %

Soil Health Calculation

- CO2-C respiration
- C:N ratio
- WEOC
- WEON
- **Soil Health** = (CO2-C/10) + WEOC/50 + WEON/10
- Good score greater than 10

H3A Test

- A soil extracant that mimics organic acids produced by living plant roots to temporarily change soil pH to increase nutrient availability.
- Organic acids are excellent sources of food for microbes. Soil pH soon returns to normal pH.
  - Malic acid 1.2 g/2L
  - Oxalic acid 0.6 g/2L
  - Citric acid 1.0 g/2L

H3A - ICAP

H3A Extract of other Nutrients

- **Macronutrients:**
- ICAP Phosphorus = 18 to 25 ppm P
- Potassium = 60 - 80 ppm K
- Calcium = based on pH
- Magnesium = 35 ppm Mg
- Sodium = low as possible
- Sulfur = 2 - 5 ppm S

H3A Extract of other Nutrients

- **Micronutrients:**
- Zinc = 0.50 ppm Zn
- Iron = 3.0 ppm Fe
- Manganese = 7.0 ppm Mn
- Copper = 0.70 ppm Cu

Haney – “Ask the Right Questions”

The Haney Test or Soil Health Tool was designed to help answer the following questions:

What condition is your soil in?

- Going beyond just fertility

Is your soil balanced?

- To benefit soil microbes

What can we do to help?

- No-till, living cover, redirect focus…SOIL ECOLOGY and plant/microbe/soil interactions

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Thank you