Importance of Nutrient Cycling to Build Organic Matter

Ray Ward

Ward Laboratories, Inc

Kearney, NE

www.wardlab.com

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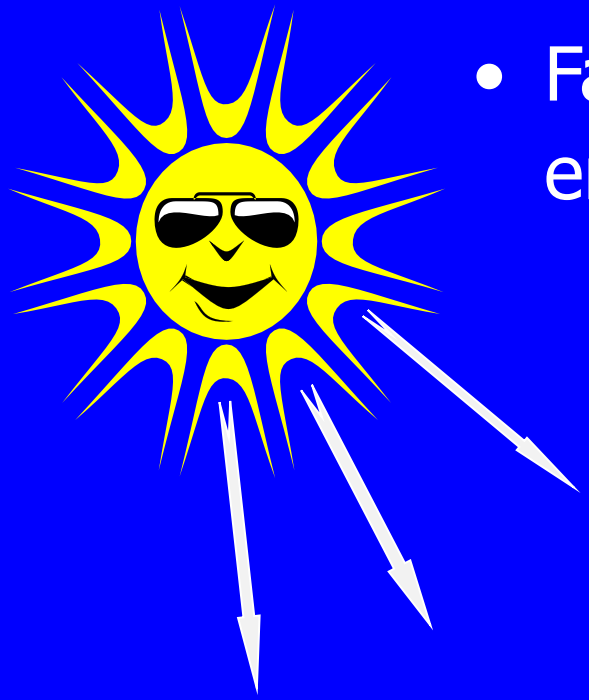
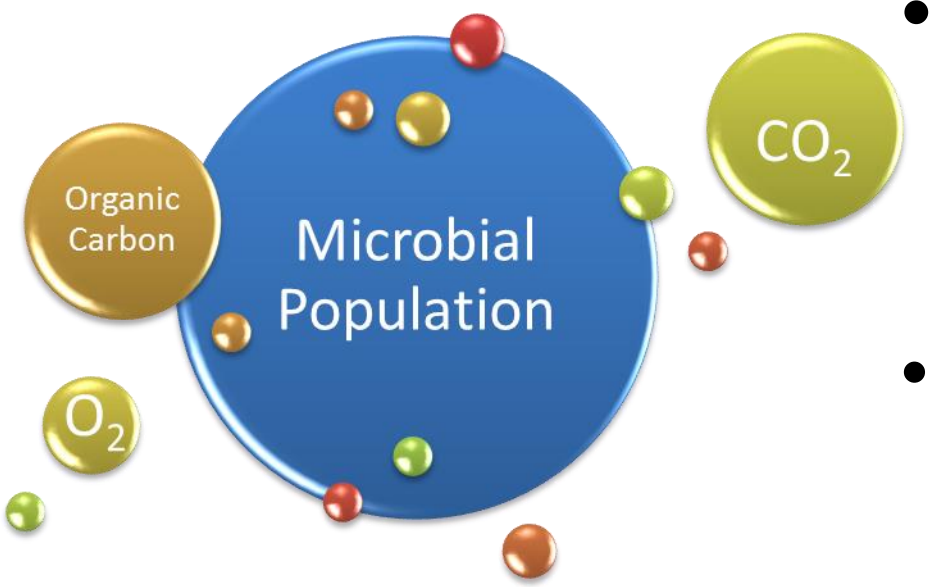


- Farming is all about capturing the sun's energy and converting it to usable products.

L. Paine, 2005

Growing Soil

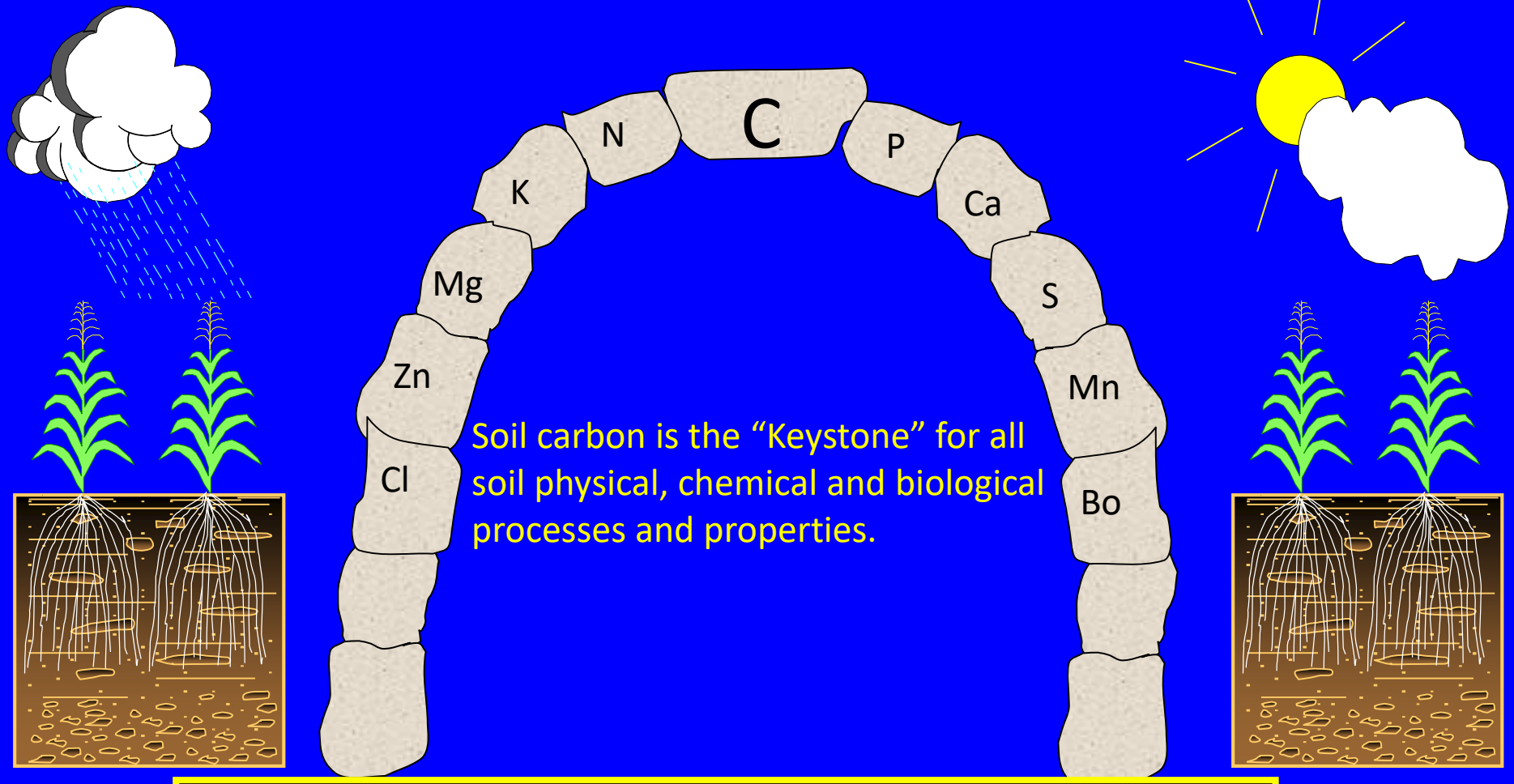
Starts with Soil Biology
Complex Integrated Living System



- **Organic carbon in water drives the system**
- Soil microbes take in O_2 and release CO_2

Soil microorganisms have been in R&D for millions of years.

Carbon is a “keystone” in nutrient cycling!



Management platform

fertility, variety, irrigation, species, cover crop, manure, rotations, tillage, soil type, erosion, timing,


1 Armor the Soil


Protect the soil from
raindrop splash

Protect the soil from Wind Erosion

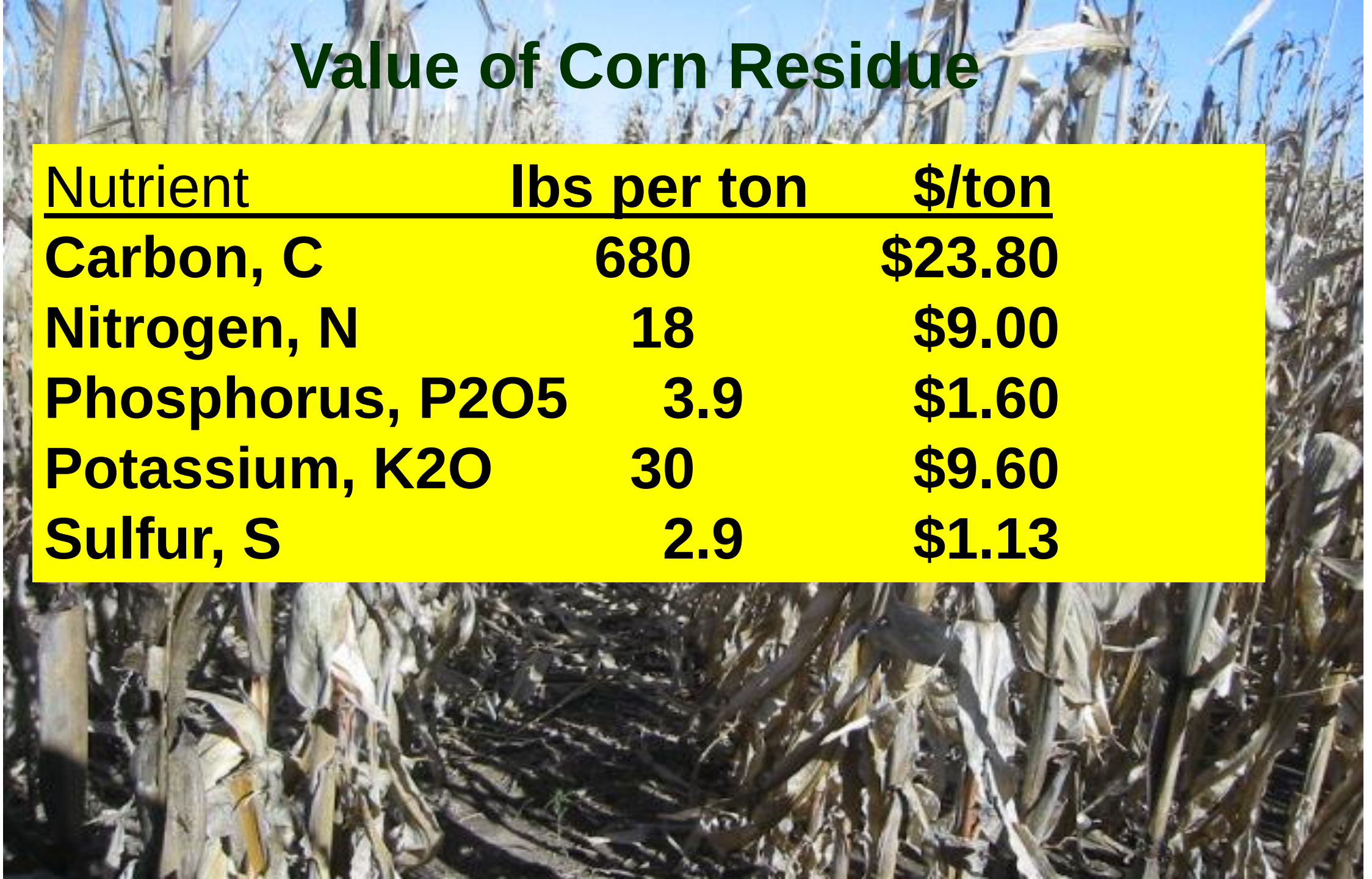
Which soil will dry faster?
Same Air Temperature. Keep Soil Cool!

Protect the Soil from Erosion by Water


2 Minimum Soil Disturbance

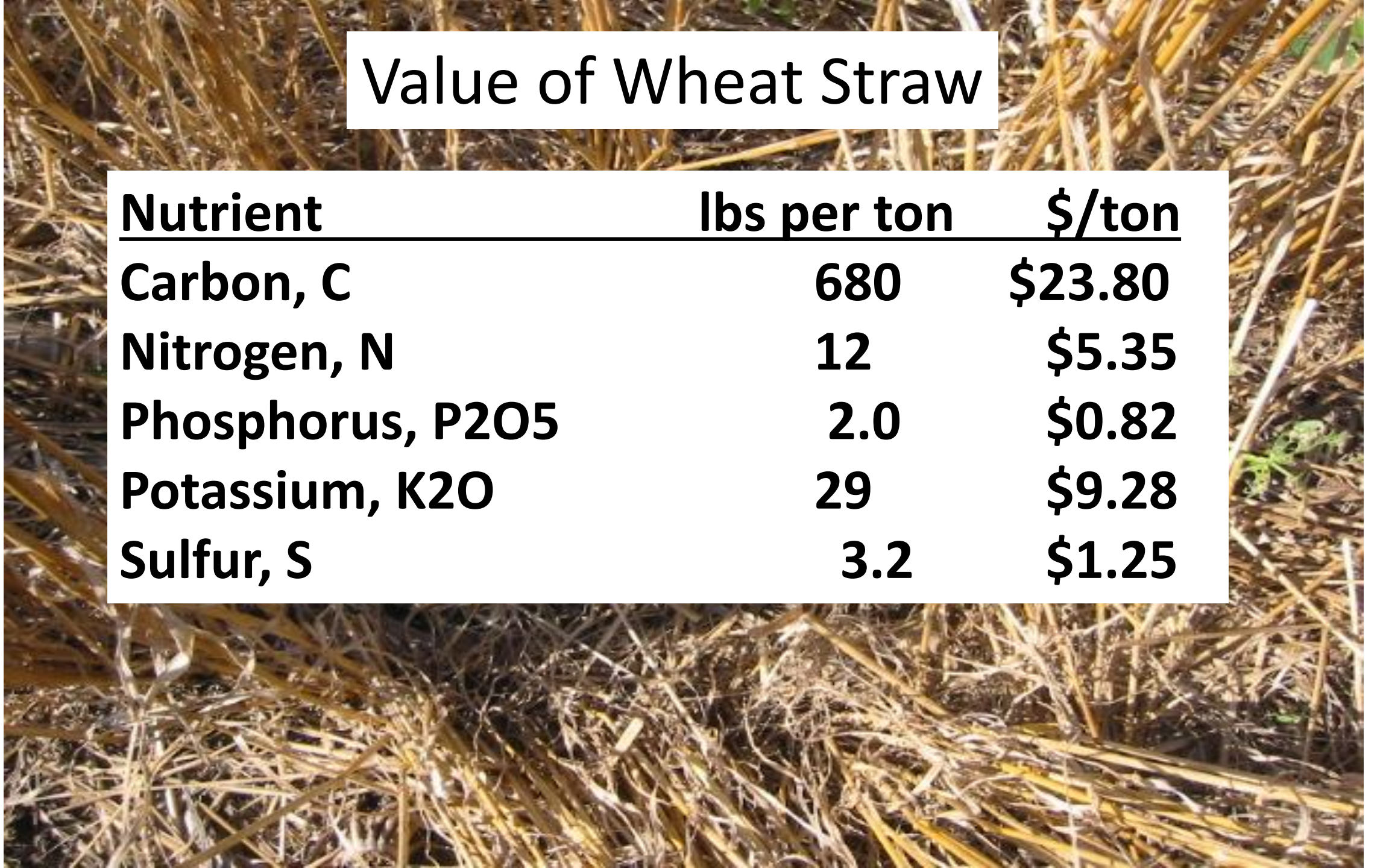
Value of Corn Residue

Nutrient	lbs per ton	$/ton
Carbon, C	**680**	**$23.80**
Nitrogen, N	**18**	**$9.00**
Phosphorus, P_2O_5	**3.9**	**$1.60**
Potassium, K_2O	**30**	**$9.60**
Sulfur, S	**2.9**	**$1.13**



Value of Soybean Stubble

Nutrient	lbs per ton	$/ton
Carbon, C	680	$23.80
Nitrogen, N	14.6	$7.30
Phosphorus, P2O5	2.4	$0.98
Potassium, K2O	11.8	$3.78
Sulfur, S	4.6	$1.79



Value of Wheat Straw

Nutrient	lbs per ton	$/ton
Carbon, C	680	$23.80
Nitrogen, N	12	$5.35
Phosphorus, P_2O_5	2.0	$0.82
Potassium, K_2O	29	$9.28
Sulfur, S	3.2	$1.25


3 Diversify Cropping

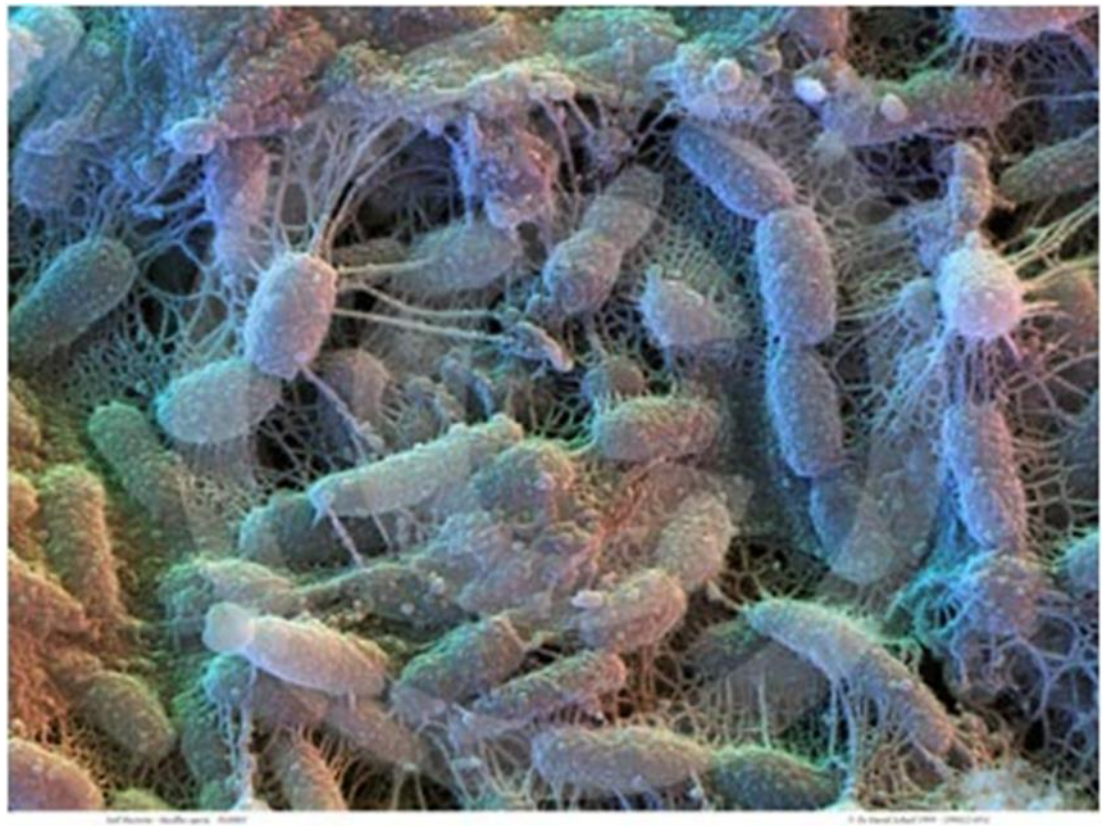
Problems with Monoculture cropping

- Insects and mites transmit diseases to plants, primarily virus diseases by aphids, mites and leafhoppers
- Grasshoppers and army worms can destroy forage that is intended for livestock
- Lack of Beneficial insects
  - Honey bees, Ladybeetles, lace wings, wasps preying mantis


4 Living root in soil all the time

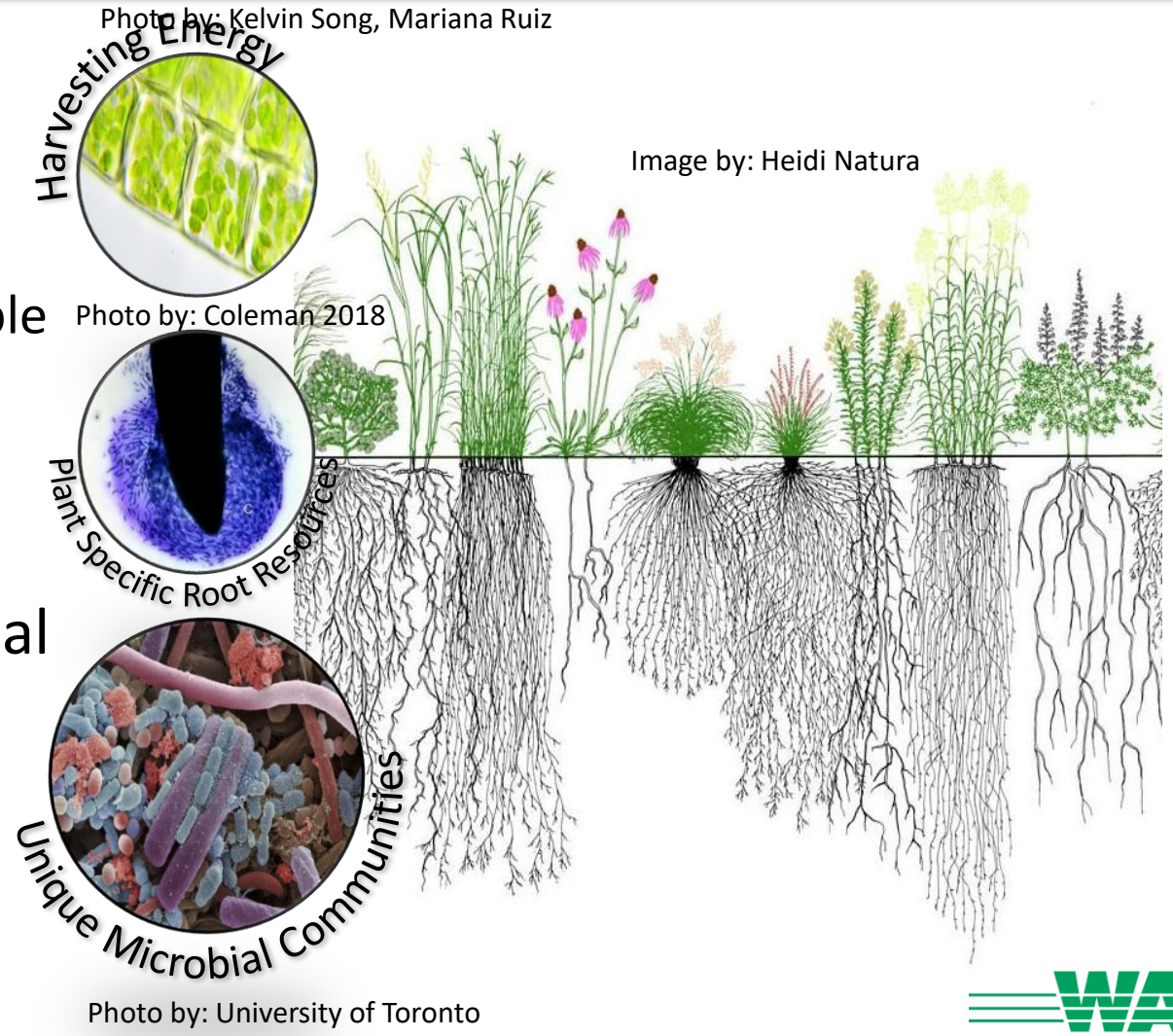

Root Exudate

Microbial Activity - Soil bacteria and fungi 1,000,000-10,000,000 per gram of soil



The Relationship between Plants and Microbes

- Plants trade photosynthetic compounds for unavailable nutrients
  - Plants provide root exudates (simple and complex compounds)
  - Microbe scavenge the soil for additional nutrients to live and reproduce
- Plants cultivate different microbial communities
  - More plants present provide a microbial community with higher diversity



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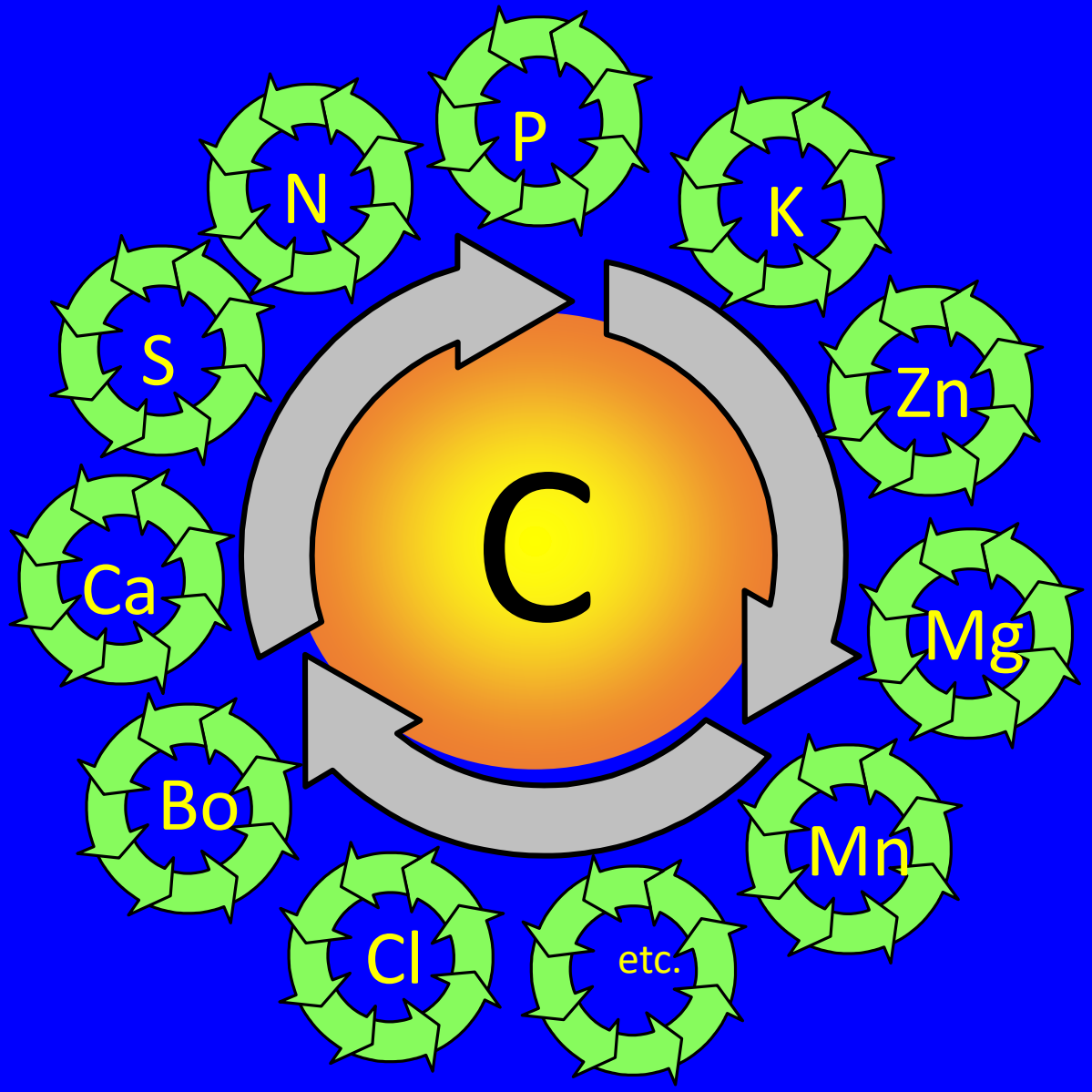
5 Livestock

Biological nutrient cycling requires carbon!



The Carbon Cycle

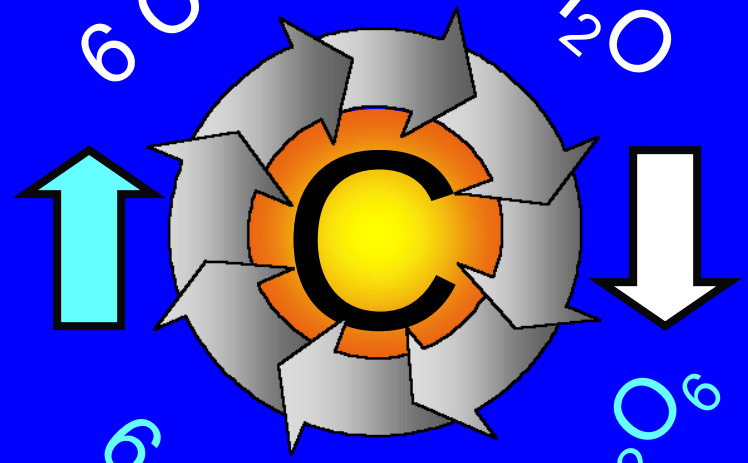
Photosynthesis

$6CO_2 + 6H_2O$

Energy Release

The devil is in the details!

Beckism #101

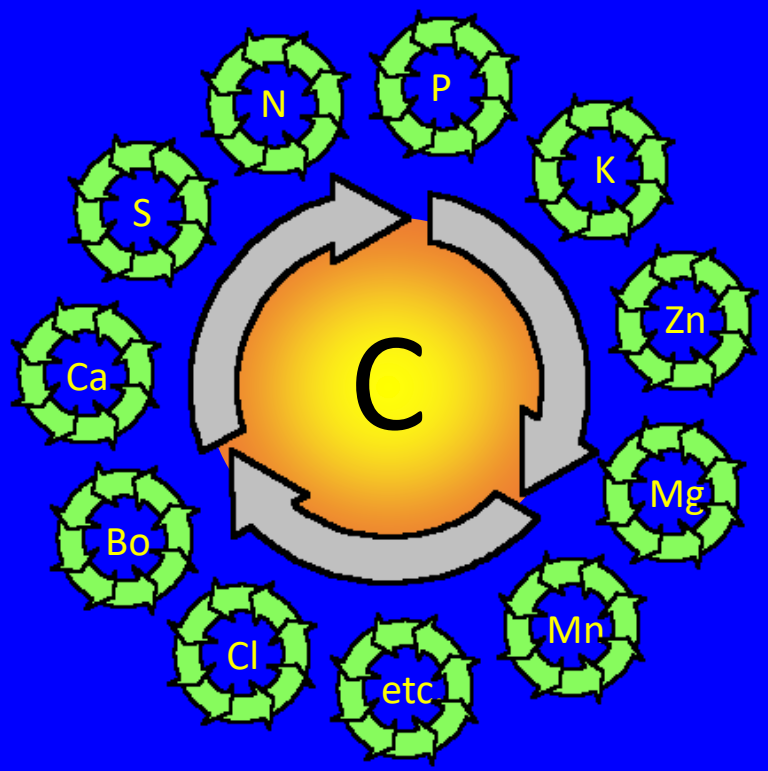


Energy Capture

$6O_2 + C_6H_{12}O_6$

Respiration

Nutrient Balance and Carbon Sequestration.



Net carbon sequestration requires other nutrients.

7 – 10 units of C per unit of N

50 –60 units of C per unit of P

70 – 80 units of C per unit of S

Balanced fertilization is needed for both crop uptake and carbon sequestration!

Rattan Lal, 27 Jan., 2000

“C”over
“C”rop
“C”ocktails

SOM is 58% Carbon!

SOM

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** that simulates how a mimics plant uptake

CO_2-C 24 hr burst test (Respiration)

- Estimate of Microbial Biomass and Activity

CO_2-C 24 hr. Respiration test

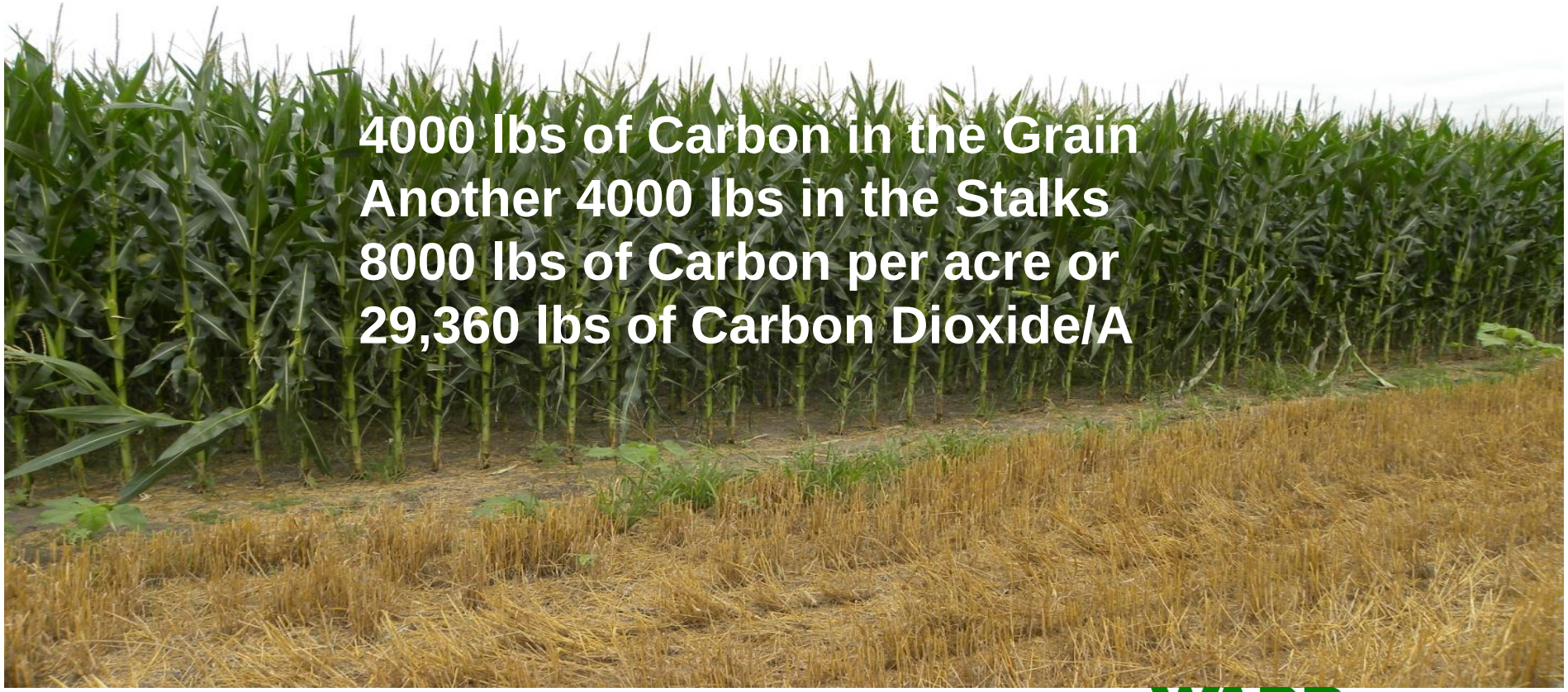
Good number = 60 to 120 ppm CO_2-C

Depends on water soluble organic C.

Can be 300 or more.

How Much Carbon Comes from the Soil?

200 Bushel per Acre Corn



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Water Extract

Measures the amount of food (carbon and nitrogen) in the soil water film that surrounds soil particles.

Haney Water Extract

- **Total Organic Carbon (WEOC)**
- It is soluble in water and the food for microbes.
  - Good number is 120 to 250 ppm C depending on CO2-C burst test.

MAC Calculation

- **Microbial Active Carbon (% MAC)**
  - **(24 hr CO_2-C / WEOC) * 100**

    WEOC = water extractable organic carbon.
  - For example: (77.0 / 182) * 100 = 42.3 % MAC.
  - An ideal reading is 50 % MAC.
  - Good reading is above 20 % and below 80 %.

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.

WEON and Soil Ammonium are missed in regular nitrate soil tests.

Soil Health Calculation

- Good Number
- CO_2-C respiration 60 to 120
- C:N ratio 8 to 15
- WEOC 120 to 250
- WEON 12 to 25
- **Soil Health** = (CO_2-C/10) + WEOC/50 + WEON/10
- Good score for SE Nebraska is 10 or better

H3A Extract

- A soil extractant that mimics organic acids exuded by living plant roots to increase nutrient availability.
- Organic acid is excellent food for microbes and the soil pH soon returns to normal pH.
  - **Malic acid 1.2 g**
  - **Oxalic acid 0.6 g**
  - **Citric acid 1.0 g**
  - **Dissolved in 2000 g of distilled water (0.14 % concentration).**