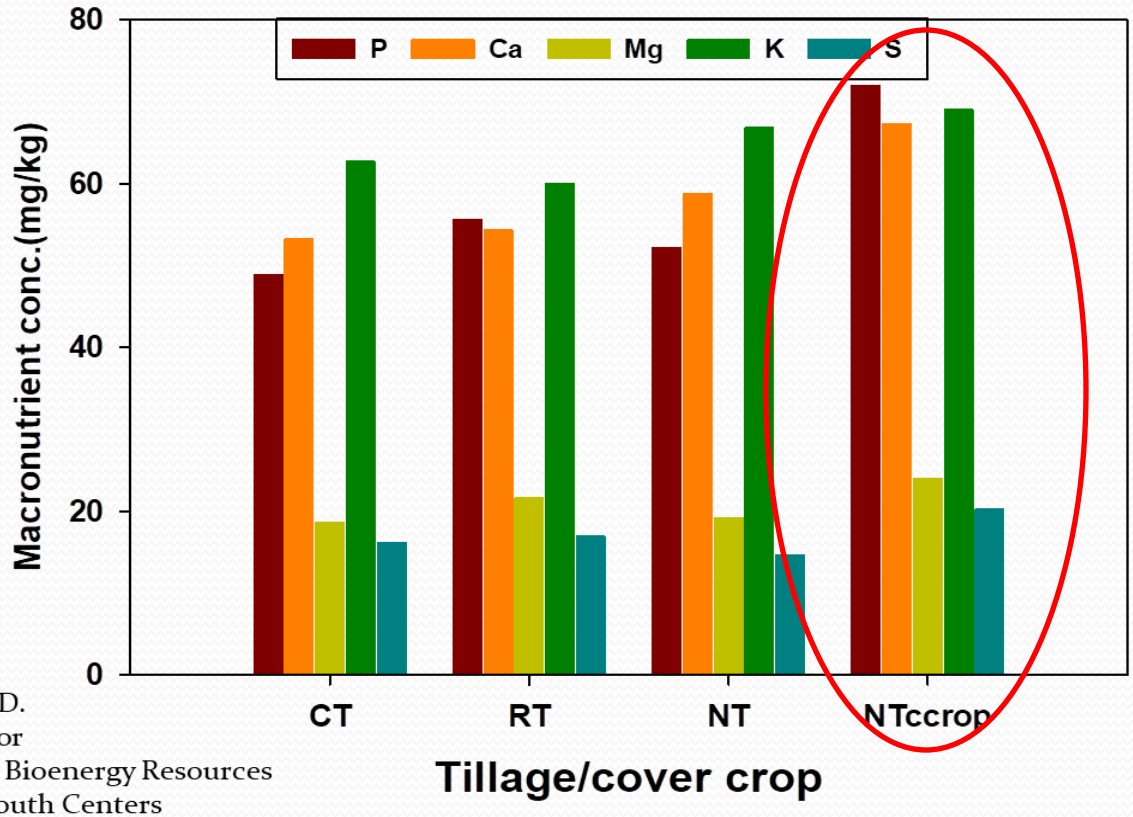
Cover Crops for Soil Health

Ann Brandt

Walnut Creek Seeds, LLC.
SIMPLE. SUSTAINABLE.

Organic NoTill/Regenerative
Peak Nutrient Density

Fig. 4: Tillage and cover crops effect on **macronutrient density** of corn grain (based on 2018 data)



Rafiq Islam, Ph.D.
Program Director
Soil, Water, and Bioenergy Resources
OARDC-OSU South Centers

OSU has found that Cover crop/no till corn and soybeans have higher amino acid, crude protein, micro and macronutrient levels than conventional tillage.

This is Penn State + Academics + Admission + Tuition and Aid Research Athletics News + HOTLINE GIVE APPLY MORE

Soil tillage reduces availability of 'longevity vitamin' ergothioneine in crops

The study is among the first to demonstrate that soil disturbance can directly impact a key dietary factor associated with long-term human health.

PMC
US National Library of Medicine
National Institutes of Health

PMC

Advanced Journal list

Journal List > Microorganisms > v.7(9); 2019 Sep > PMC6780873

microorganisms MDPI

Microorganisms. 2019 Sep; 7(9): 287.
Published online 2019 Aug 23. doi: 10.3390/microorganisms7090287

PMCID: PMC6780873
PMID: 31450753

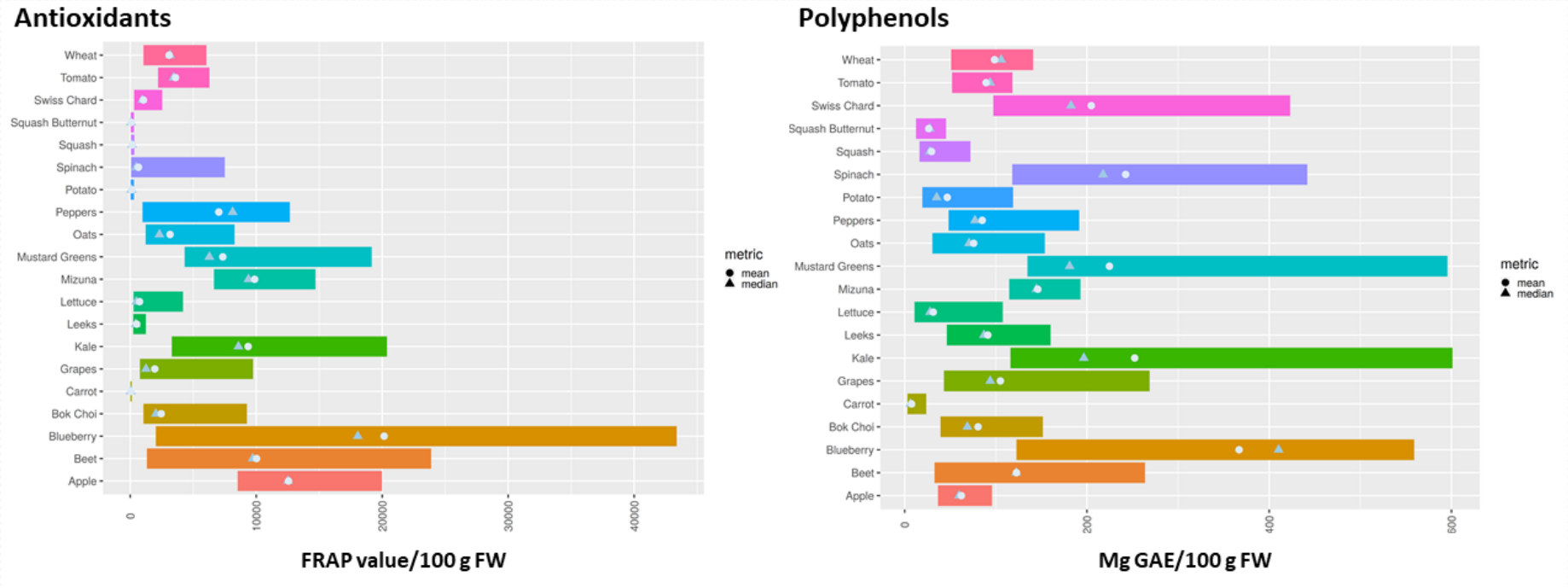
Does Soil Contribute to the Human Gut Microbiome?

Winfried E.H. Blum, Sophie Zechmeister-Boltenstern, and Katharina M. Keiblinger*

Author information Article notes Copyright and License information Disclaimer

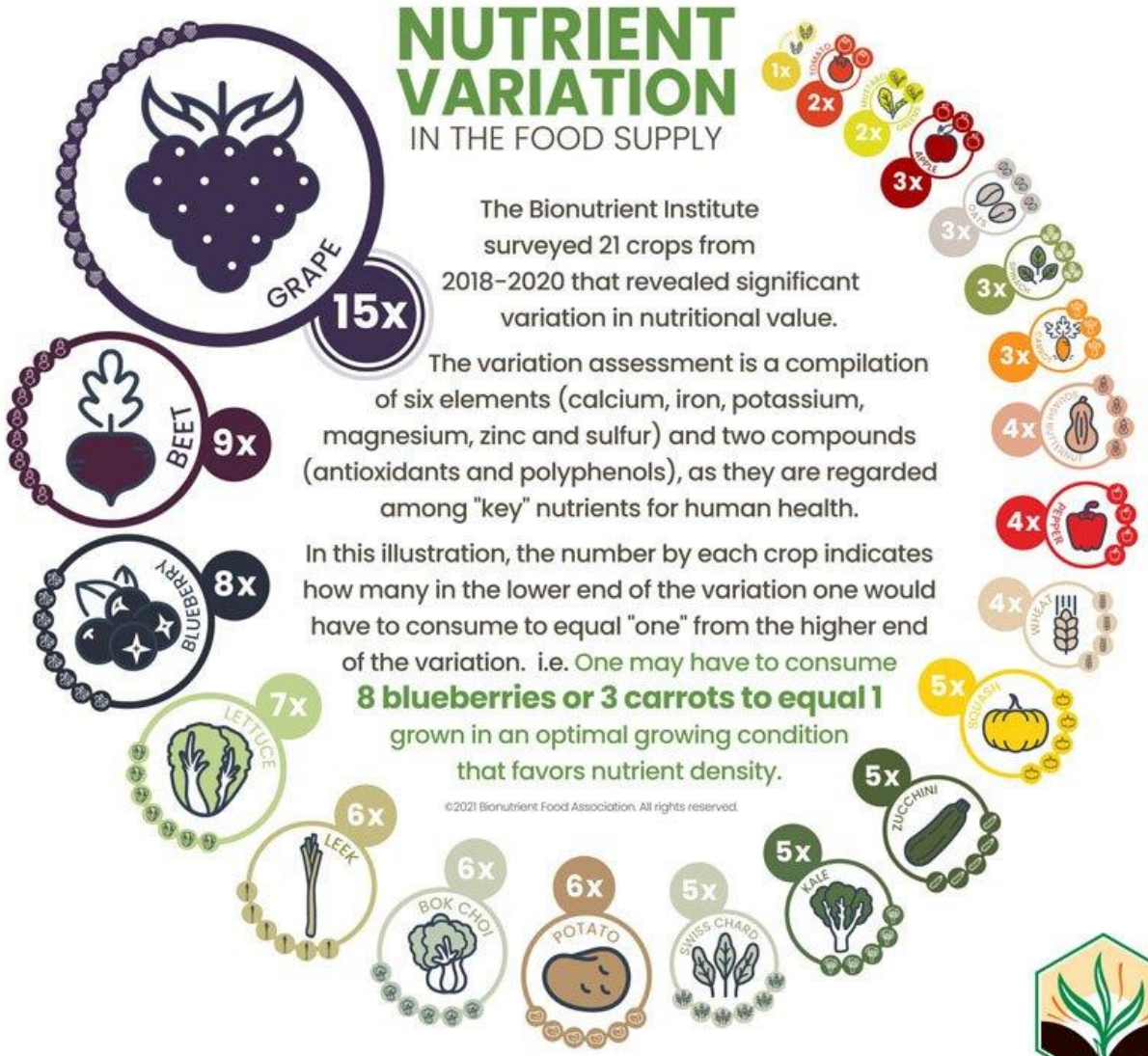
Micro

What are we getting (or not)?



Results from Bionutrient Insitute – 2020 Report Understanding the Science from Field to Plate

Bionutrient Food Association

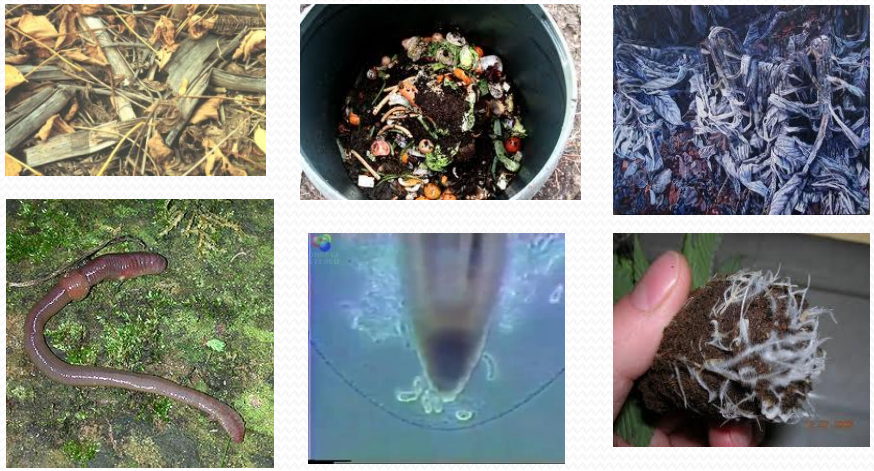


Do we really need more food?
Or just *better* food?

www.BionutrientInstitute.org

What is Soil?

Minerals ~45%



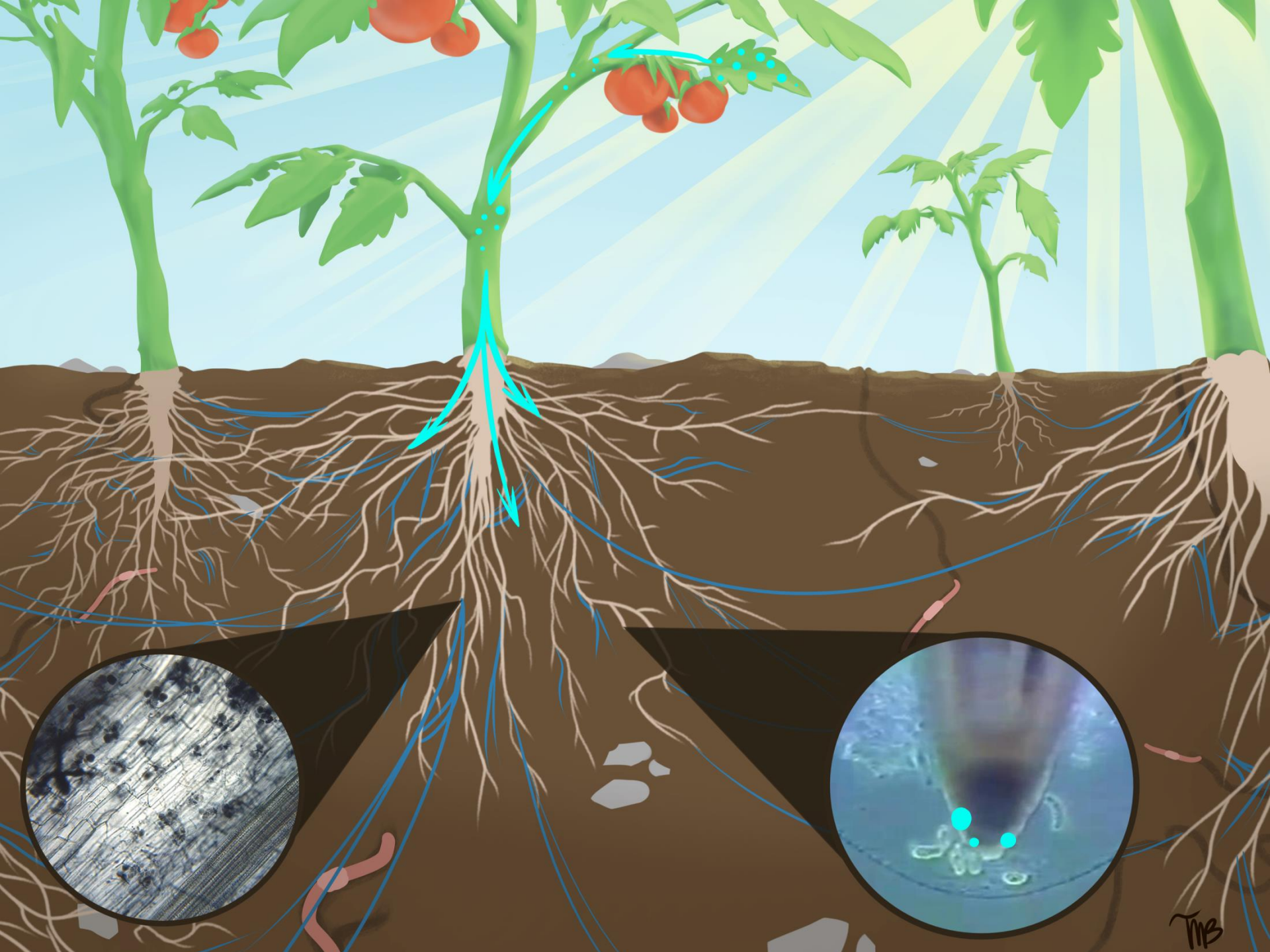
Organic Matter ~5%

Air ~25%

Water ~25%

Soil health is the continued capacity of soil to function as a *vital living ecosystem* that sustains plants, animals, and humans.

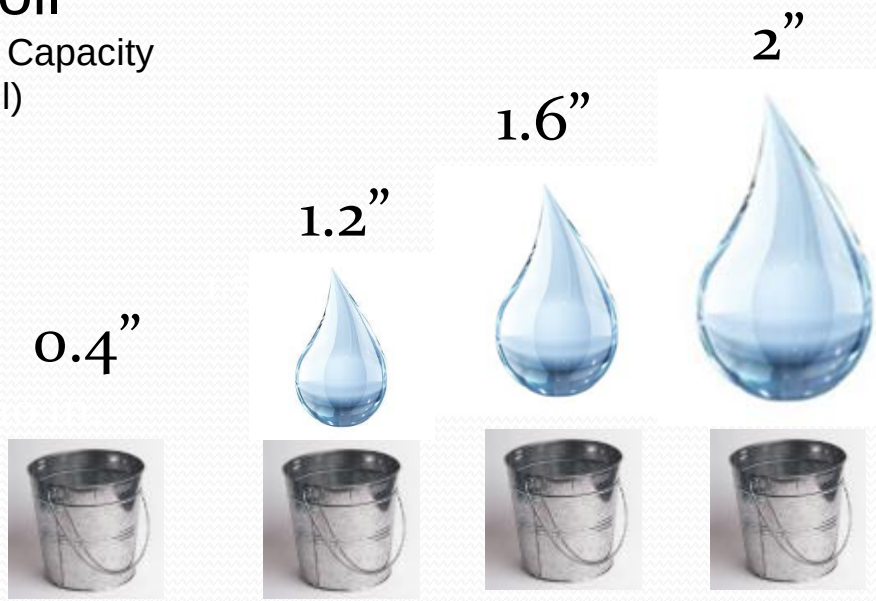
In just one teaspoon of healthy soil more microbial life exists than the current global population.


TMB

Soil Organic Matter and Water Holding Capacity

Silt loam soil

Available Water holding Capacity
(in H2O/ 10” soil)



SOM = 0% 1% 2% 3%

Source: Berman Hudson, 1994. JSWC 49:189-194.

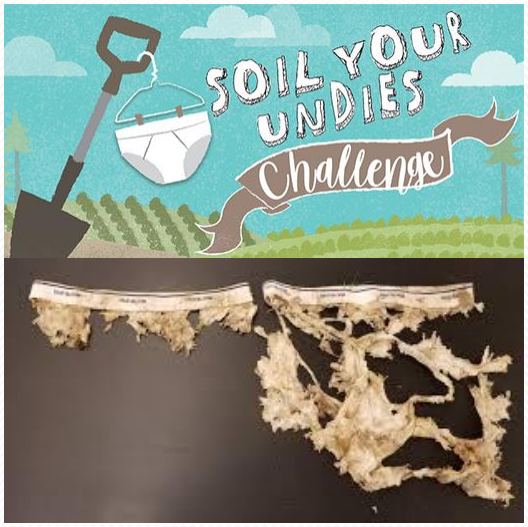
DIY Soil Health Evaluation

Slake Test

Water Infiltration

Surface Crusting

Biology, Sight, Smell, Root Health



Microbial Health

NRCS Soil Health Best Practices

- Keep the Soil covered as much as possible
- Disturb the soil as little as possible
- Keep plants growing throughout the year to feed the soil
- Diversify as much as possible using crop rotation and cover crops

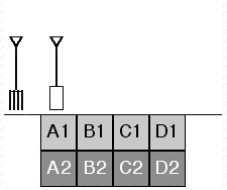
Source: Natural Resource Conservation Service Core Practices Soil Health Checklist

Keep the soil covered…

Disturb the soil as little as possible

Tillage is relative…

Total Inversion



Undisturbed

8 in +

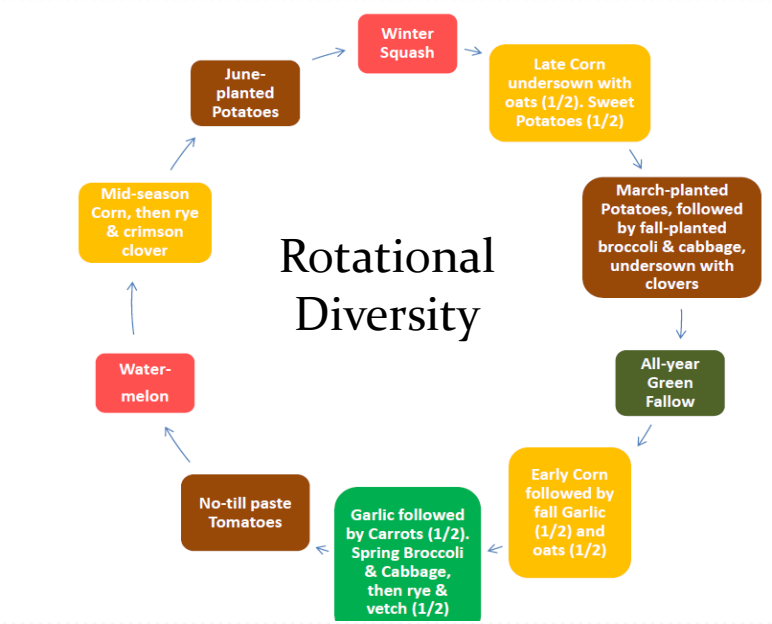
4 in - 2 in

2 in - 1 in

>1 in

Keep plants growing all year…

Diversify.. crop rotation and cover crops



Fallow period cover crop diversity

Dense interplanting including cover crops, companion crops

Cover Crop Defined

A cover crop is not harvested but is grown to benefit the soil and/or other crops in a number of ways.

Picture from http://grasslandscience10.weebly.com/temperate-grassland.html

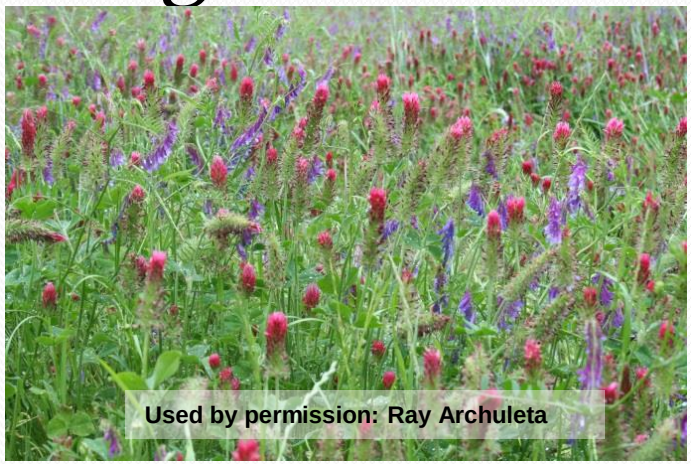
- ✓Rain/Wind Erosion
- ✓ Weed Suppression
- ✓ Forage for bees/beneficials
- ✓ Moderate Soil temp
- ✓ Moderate Soil Moisture

- ✓ Nitrogen Production
- ✓ Increase Organic Matter
- ✓ Feed Soil Microbes
- ✓ Reduce disease pressure
- ✓ Nutrient Scavenging
- ✓ Improve Water Infiltration

General Types of Cover Crops

Grasses/Grains

Legumes



Brassicas

Broadleaf

Grasses & Grains

Barley, Oats, Ryegrass, Cereal Rye, Millets

Generally Used to:

- Scavenge nutrients, especially N
- Reduce or prevent erosion
- High surface mulch
- Thick fibrous roots, some deep to bring up nutrients
- Suppress weeds (allelopathy in cereal rye)

Oats

Cool Season, ***Frost kills***
Fibrous roots
Great for ***short windows*** 4-6wks
Promotes ***mycorrhizal fungi***
Great prep for perennial crops
Plant March-June, Aug-early Oct
Economical

Cereal Rye

Cool Season, ***Over winters***
Suppresses Weeds
Fibrous roots
Remains active to 34F
Plant mid July – Nov, Mar-April
Economical

Sorghum Sudan

Warm Season, Winter Kills
Promotes ***mycorrhizal fungi***
Very Deep Fibrous roots
Plant Mid June - Aug
Very Drought, Heat Tolerant
Prussic Acid Concerns for Grazing
Great prep for perennial crops

Legumes

Peas, Vetch, Clovers, Alfalfa, Sunn hemp

Generally Used to:

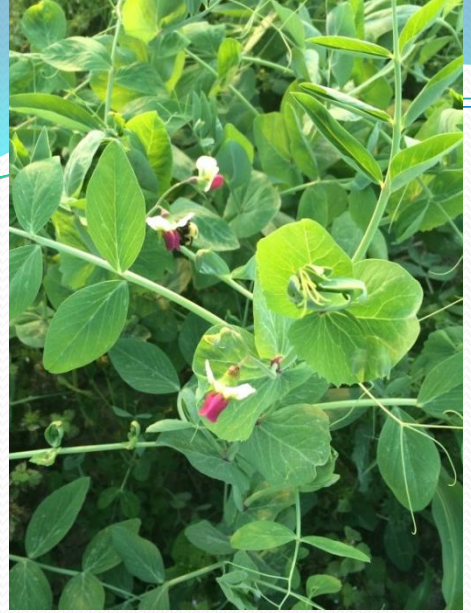
- Fix Atmospheric Nitrogen
- Reduce or prevent erosion
- Provide short-term N to crops
- Suppress weeds

Notes:

Clovers, vetch may have hard seed

Require Rhizobia bacteria to fix efficiently

Hairy Vetch, Crimson Clover green manures suppress Fusarium wilt in watermelon



Winter Pea

Cool Season, May winter kill
Great for short windows 4-6 wks
Plant March-June, Aug-early Oct
Economical
Will climb if possible
No hard seed

Hairy Vetch

Cool Season, Over winters
Forms Thick Mat
Long and viny
Plant March – April, Aug-mid Oct
Usually about 5% Hard Seed
When in full bloom-cut or crimp

Crimson Clover

Cool Season, Over winters
Grows to 2” tall
Plant May – mid Sept
Usually about 5% Hard Seed
When in full bloom-cut or crimp
Gorgeous!

Brassicas

Oilseed Radish, Mustards, Ethiopian Cabbage

Generally Used to:

- Scavenging nutrients, especially N, from deep profile
- Reduce or prevent erosion
- Alleviate soil compaction (tap root)
- Nematode suppression
- Suppress weeds

Notes:

Generally very quick to establish

Can host flea beetle, slugs (trap crop)

Don't rotate with other brassicas/cole crops

Most winter kill

Brassica Comparison

Winfred

Daikon Radish

Scavengers, Compaction Reduction, Nematode Suppression

Purple Top Turnip

Rapeseed/Canola

Yellow Mustard

Broadleaf

Sunflowers, Flax, Phacelia, Buckwheat

Mixed bag of uses, plant specific:

- Some scavenge nutrients
- Variable organic matter contribution
- Most suppress weeds

Notes:

Sunflowers: deep tap root, variable allelopathy

Buckwheat: Makes P more available

Phacelia: excellent for honey bee forage

Flax

Rapid growth
Mobilizes phosphorus
Promotes Mycorrhizal fungi
Attracts beneficials
Good companion cover
Plant March-June, Aug-early Sept

Phacelia

Cool Season, germs below 54F
Dense fibrous roots
High value bee forage
Native forb, 2' high
Plant Mar-April

Buckwheat

Warm Season, Frost kills
Fibrous, acid roots
Makes Phosphorus available
Reseeds freely (45 to 60 days)
Great for short windows
Honey bee forage/beneficials
Plant after frost up to 30 days before first frost

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service
Idaho

Cover Crop Periodic Table

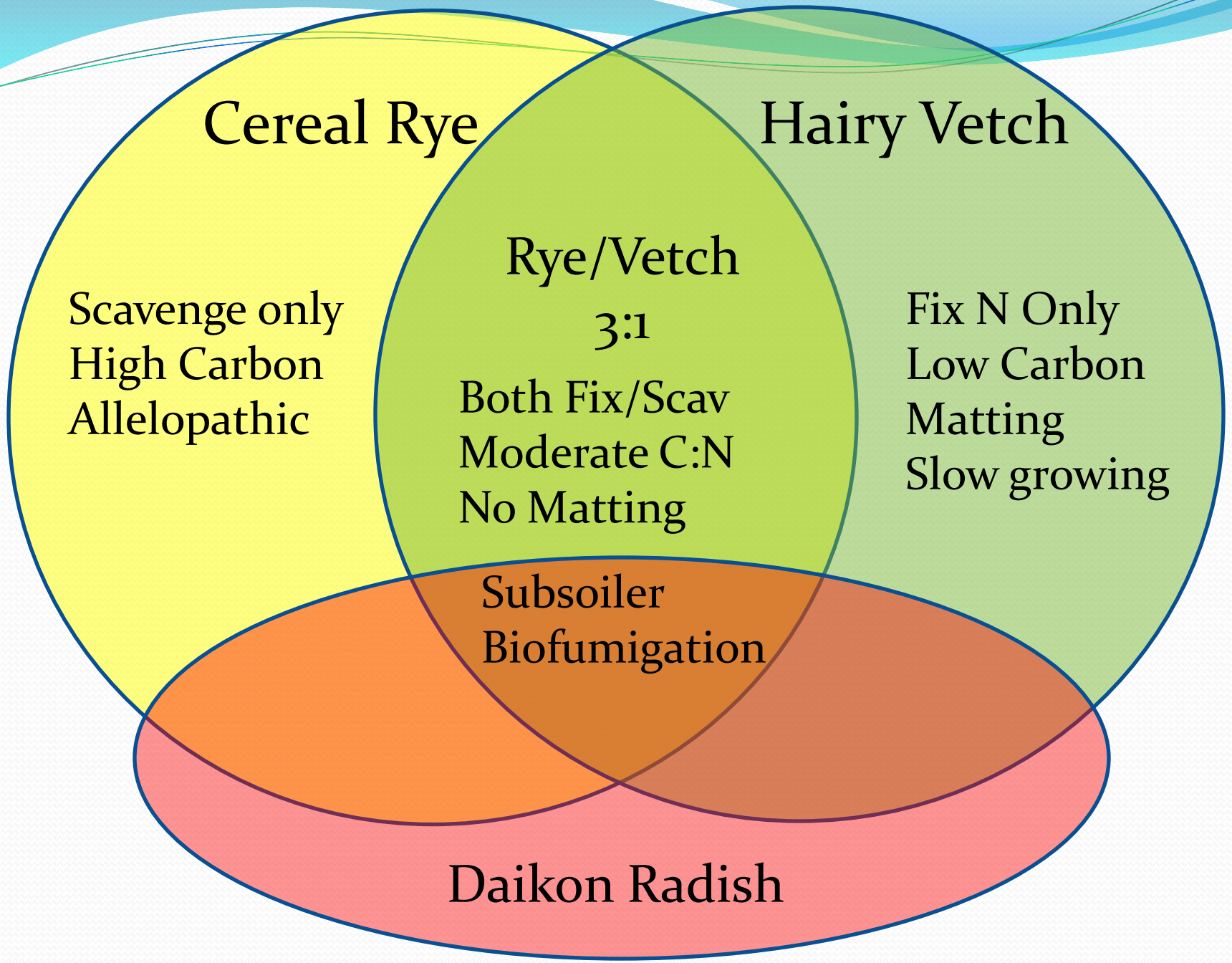
Cool Season Plants						Warm Season Plants		
Grass								Grass
Barley	Broadleaf Plants							Pearl Millet (wk)
Oat (wk)	Arugula						Amaranth (wk)	Foxtail Millet (wk)
Ryegrass	Flax (wk)		Legumes				Buckwheat (wk)	Proso Millet (wk)
Wheat	Rape	Turnip (wk)	Field Pea	Chickling vetch (wk)	Medic	Chickpea (wk)	Sunflower (wk)	Sudan grass (wk)
Cereal rye	Kale	Radish (wk)	Lentil	Red Clover	Ladino clover	Cowpea (wk)	Safflower (wk)	Teff (wk)
Triticale	Canola	Beet	Spring Pea (wk)	Crimson clover	Bean (wk)	Soybean (wk)	Chicory	Grain Sorghum (wk)
Annual Fescue (wk)	Mustard	Tyfon (wk)	Vetch	Sweetclover	Alfalfa	Sun Hemp (wk)	Squash (wk)	Corn (wk)

(wk) = winter killed

USDA is an equal opportunity provider and employer

Cover Crop Use Chart

Beneficial Insects	Honey/Wild Bees	Soil Builder	Compaction Control	Erosion Control	Nitrogen Fixation	Nitrogen Scavenger	Tolerates Some Shade	Low PH	High pH
Buckwheat	Alfalfa ❄	Alfalfa ❄	Alfalfa ❄	Alfalfa ❄	Clovers ❄	Cereal Rye ❄	Annual Ryegrass ❄	Buckwheat 5.0	Barley 8.5 ❄
Canola	Buckwheat	Canola	Annual Ryegrass ❄	Barley ❄	Cowpea	Radish	Berseem Clover	Canola 5.5	Canola 8.0
Cowpea	Canola	Chicory	Cereal Rye ❄	Clovers ❄	Faba Bean	Sorghum Sudan	Cereal Rye ❄	Cereal Rye 5.0 ❄	Hairy Vetch 7.5 ❄
Hairy Vetch ❄	Cowpea	Clover ❄	Radish	Cowpea	Hairy Vetch ❄		Crimson Clover ❄	Cowpea 5.5	Mustards 7.5
Partridge Pea ❄	Crimson Clover ❄	Cowpea	Sorghum Sudan	Oats	Mung Bean		White Clover ❄	Crimson 5.5 ❄	Oats 7.5
Phacelia	Phacelia	Flax	Sweet Clover ❄		Sunn Hemp			Hairy Vetch 5.5 ❄	Radish 7.5
Radish	Red Clover ❄	Forage Pea			Winter Pea			Mustards 5.5	
Sunflower	Sunflower	Hairy Vetch ❄						Oats 4.5	
Turnip ❄	Sunn Hemp	Turnip ❄							
	Sweet Clover ❄								
	White Clover ❄								


Cereal Rye
Hairy Vetch
Scavenge only
High Carbon
Allelopathic
Rye/Vetch
3:1
Both Fix/Scav
Moderate C:N
No Matting
Fix N Only
Low Carbon
Matting
Slow growing
Subsoiler
Biofumigation
Daikon Radish

Winter Kill vs Spring Growth (Cool Season VS Warm Season Veg)

Oats
Winter Peas

vs

Cereal Rye
Hairy Vetch

Opportunities for Garden Cover Crops

- Sow under fruiting vegetables or after fall harvest
- Frost-seeding of small seeded clovers, usually medium red clover
- Year round fallow, soil rehab
- Replace a crop failure
- Mid March thru May, 6 weeks before food crop planting
- April thru September, 4 weeks or more between crops
- Pathways, seasonal border strips for beneficials, trap crops

General Seasonal Planting Windows

Frost Seeding	Early Spring	Spring	Summer	Late Summer	Fall
Mid Feb- Mid March	March-April	Late March- Mid May	May-July	Late Aug- Mid Oct	Sept- Mid Nov
Red clover	Ryegrass Barley Oats Forage Peas Hairy Vetch	Oats Field Peas Clovers Turnip Phacelia	Millets Sorghum Sorg-Sudan Berseem Sunflower Buckwheat Cow Pea Soybean	Ryegrass Barley Oats Hairy Vetch Winter Pea Brassicas Rye	Rye Triticale

Exceptions: Interseeding, Hoop House, Trap Crops

Things to keep in mind

Have cover crop goals determine your choice

Short window cover crops (30 to 45 days): **Buckwheat, Oats, Peas**

Winter kill cover crops (worry free):
Buckwheat, Oats, Cow Pea, Millets, Radish, Sunflower

How do I kill overwintering covers:
For cool season veg: Spray, Till, Mulch or Weed whip aggressively and hope…
For warm season veg: All of the above or if mature-Cut, Mow or Crimp

Avoid Radish covers in rotations with cole crops (Broccoli, Kale, etc)

Avoid leguminous covers in rotations with Peas, Green beans

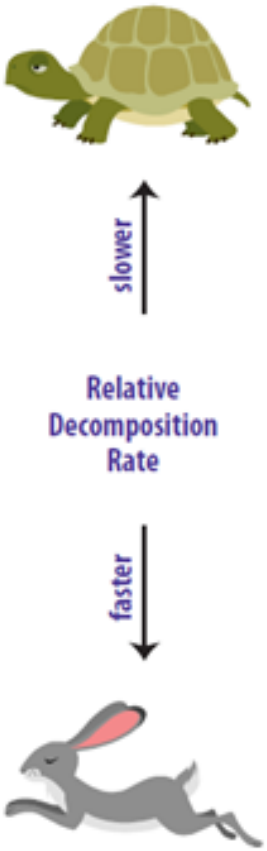
Clovers and Vetch will have hard seed and Buckwheat reseeds quickly

The earlier you plant in the fall, the more soil benefits

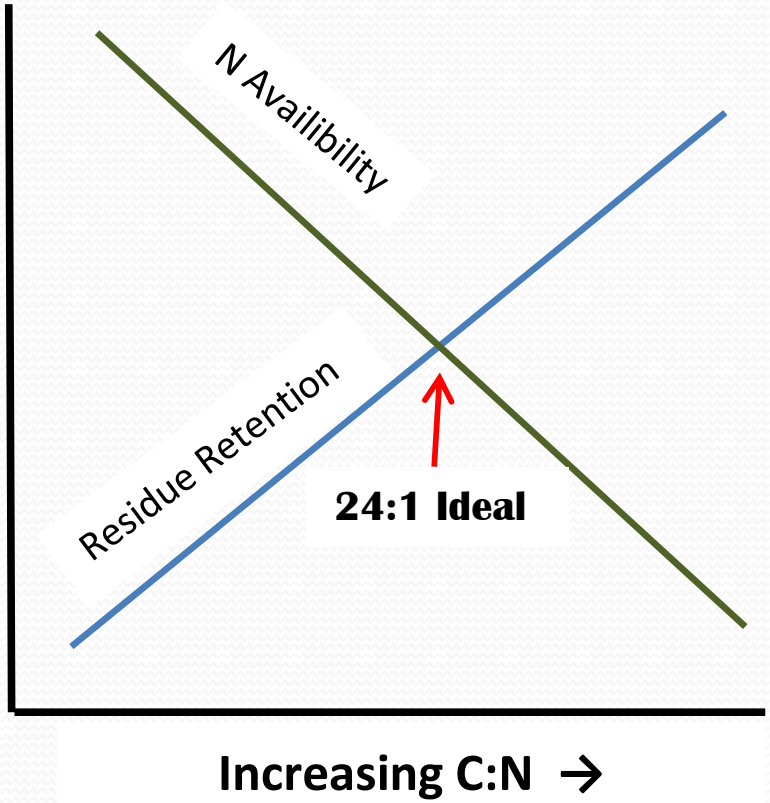
The more overwintering covers, the more soil benefits-KEEP LIVING ROOTS 24/7/365

Be Aware/Beware Carbon:Nitrogen!

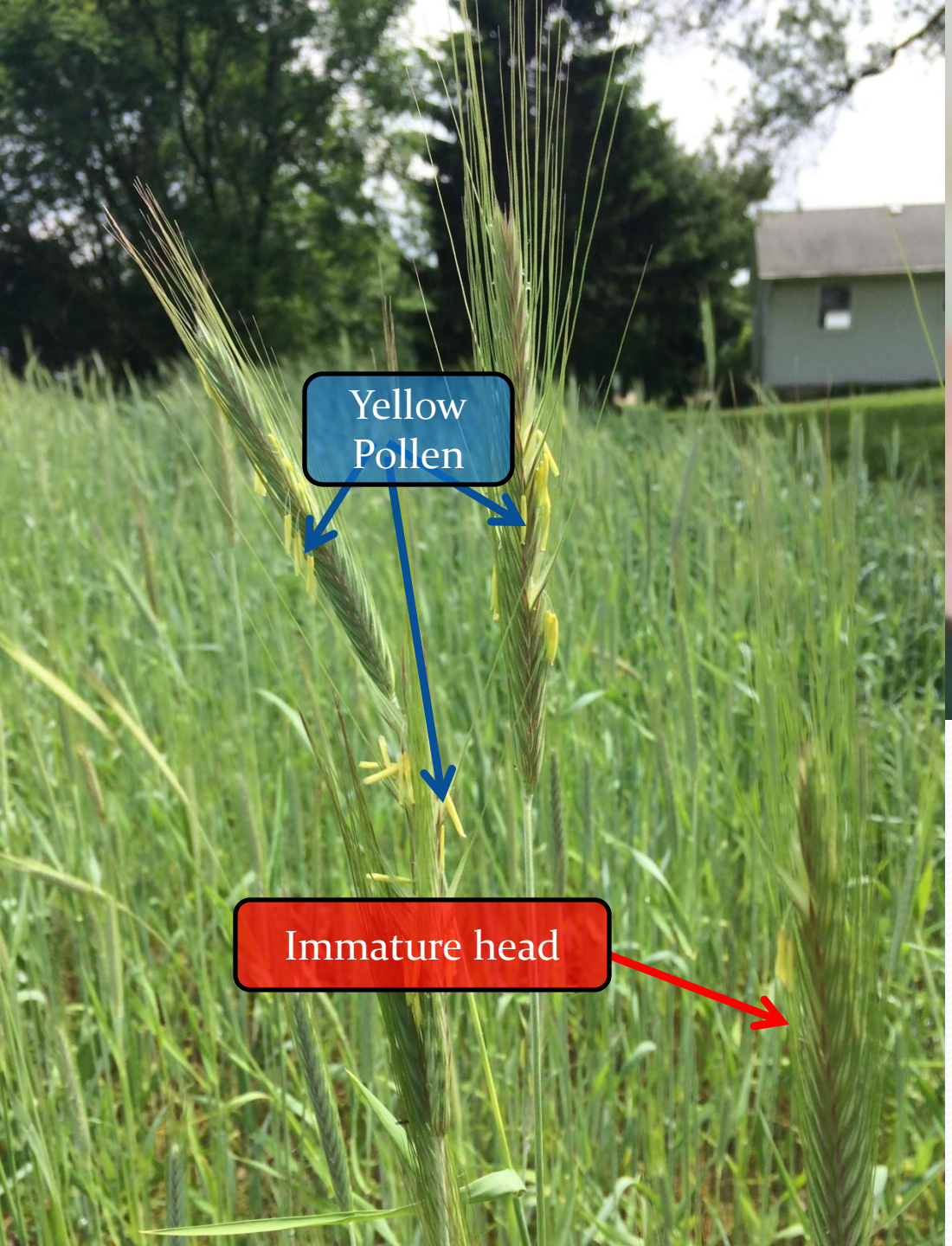
Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	**24:1**
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



From:NRCS, "Carbon to Nitrogen Ratios in Cropping Systems"



Legume – Brassica – Grass/Grain



Left: Beginning anthesis (pollination) in cereal rye, rolling marginally successful.

Above: Milk –stage in sorghum sudangrass. This can now be successfully rolled to terminate.

5/24/15 Poor Man's Crimper
Winter Cereal Rye

06.06.2009

Pictures courtesy of Jon Branstrator, Branstrator Farms, Clarksville, OH

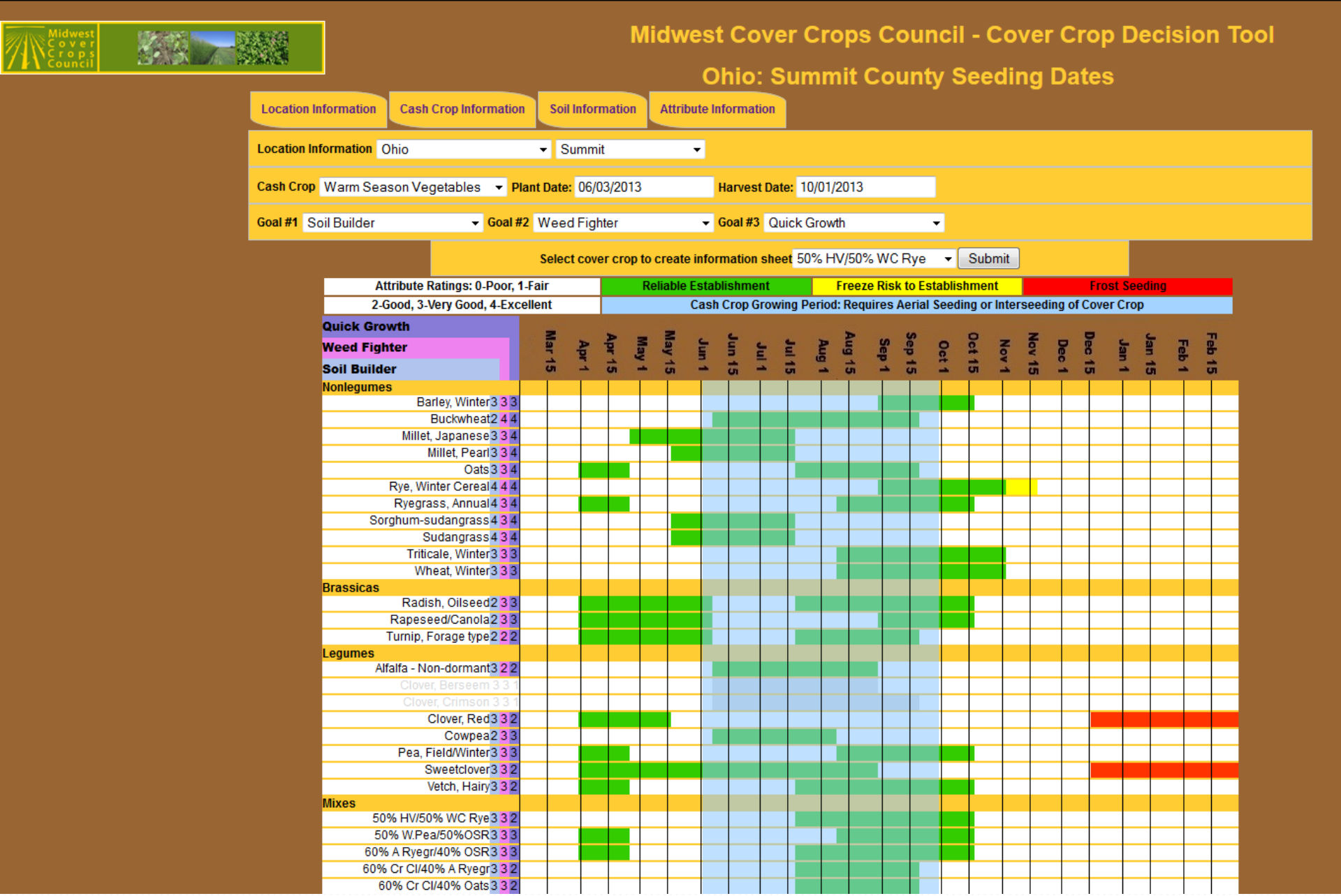
6/18/15 Crimped Cereal Rye and uncovered strips

Oats/Radish
Soil Protection, Early
Weed Suppression

Spring Mix for Slug trap crop around lettuce

True NO TILL Organic Vegetable Gardening with mulch for beginners 101. Pt 7

I AM ORGANIC
GARDENING



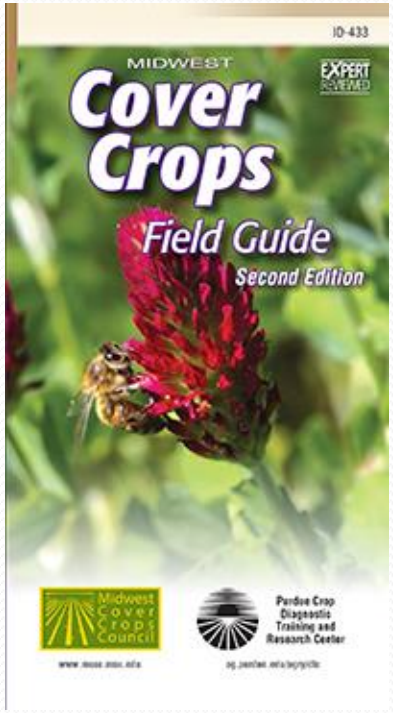
http://www.mccc.msu.edu/selectorINTRO.html

Good Books

Google Search

"Midwest Cover Crop Field Guide"

https://ag.purdue.edu/agry/dtc/Pages/CCFG.aspx



"Managing Cover Crops Profitably", 3rd Edition, Published by SARE, 2007

Chart 2 **PERFORMANCE AND ROLES**

	Species	Legume N Source	Total N (lb./A)[1]	Dry Matter (lb./A/yr.)	N Scavenger[2]	Soil Builder[3]	Erosion Fighter[4]	Weed Fighter	Good Grazing[5]	Quick Growth
NONLEGUMES	Annual ryegrass *p. 74*			2,000–9,000	◕	◕	◕	◕	◕	◕
	Barley *p. 77*			2,000–10,000	◕	◕	●	◕	◕	◕
	Oats *p. 93*			2,000–10,000	◕	◑	◕	●	◑	●
	Rye *p. 98*			3,000–10,000	●	●	●	●	◑	●
	Wheat *p. 111*			3,000–8,000	◕	◕	◕	◕	◕	◕
	Buckwheat *p. 90*			2,000–4,000	○	◑	◔	●	○	●
	Sorghum–sudan. *p. 106*			8,000–10,000	●	●	●	◕	◕	●
BRASSICAS	Mustards *p.81*		30–120	3,000–9,000	◑	◕	◕	◕	◑	◕
	Radish *p. 81*		50–200	4,000–7,000	●	◕	◕	●	◑	◕
	Rapeseed *p. 81*		40–160	2,000–5,000	◕	◑	◕	◕	◑	◕
LEGUMES	Berseem clover *p. 118*	●	75–220	6,000–10,000	◕	◕	◕	●	●	●
	Cowpeas *p. 125*	●	100–150	2,500–4,500	◔	◑	●	●	◑	◕
	Crimson clover *p. 130*	◕	70–130	3,500–5,500	◑	◕	◕	◕	●	◑
	Field peas *p. 135*	●	90–150	4,000–5,000	◔	◑	◕	◑	◕	◕
	Hairy vetch *p. 142*	●	90–200	2,300–5,000	◔	◕	◑	◑	◑	◔
	Medics *p. 152*	◑	50–120	1,500–4,000	◔	◑	◑	◕	◕	●
	Red clover *p. 159*	◕	70–150	2,000–5,000	◑	◕	◑	◕	●	◔
	Subterranean clovers *p. 164*	●	75–200	3,000–8,500	◔	◕	◕	●	◕	◑
	Sweetclovers *p. 171*	●	90–170	3,000–5,000	◔	●	◕	◕	◕	◑
	White clover *p. 179*	●	80–200	2,000–6,000	◔	◑	◕	◕	●	◔
	Woollypod vetch *p. 185*	●	100–250	4,000–8,000	◑	●	◑	●	◑	◕

[1]**Total N**—Total N from all plant. Grasses not considered N source. [2]**N Scavenger**—Ability to take up/store excess nitrogen.
[3]**Soil Builder**—Organic matter yield and soil structure improvement. [4]**Erosion Fighter**—Soil-holding ability of roots and total plant.
[5]**Good Grazing**—Production, nutritional quality and palatability. Feeding pure legumes can cause bloat.

○=Poor; ◔=Fair; ◑=Good; ◕=Very Good; ●=Excellent

REFERENCES

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Books/Papers

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