Regenerative Agriculture & Soil Health

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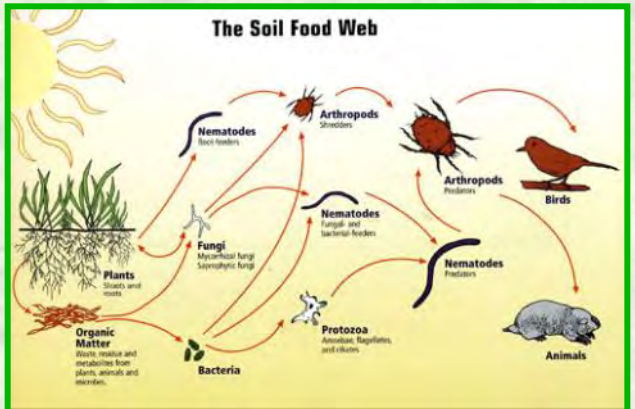
SOIL HEALTH
is a function of:

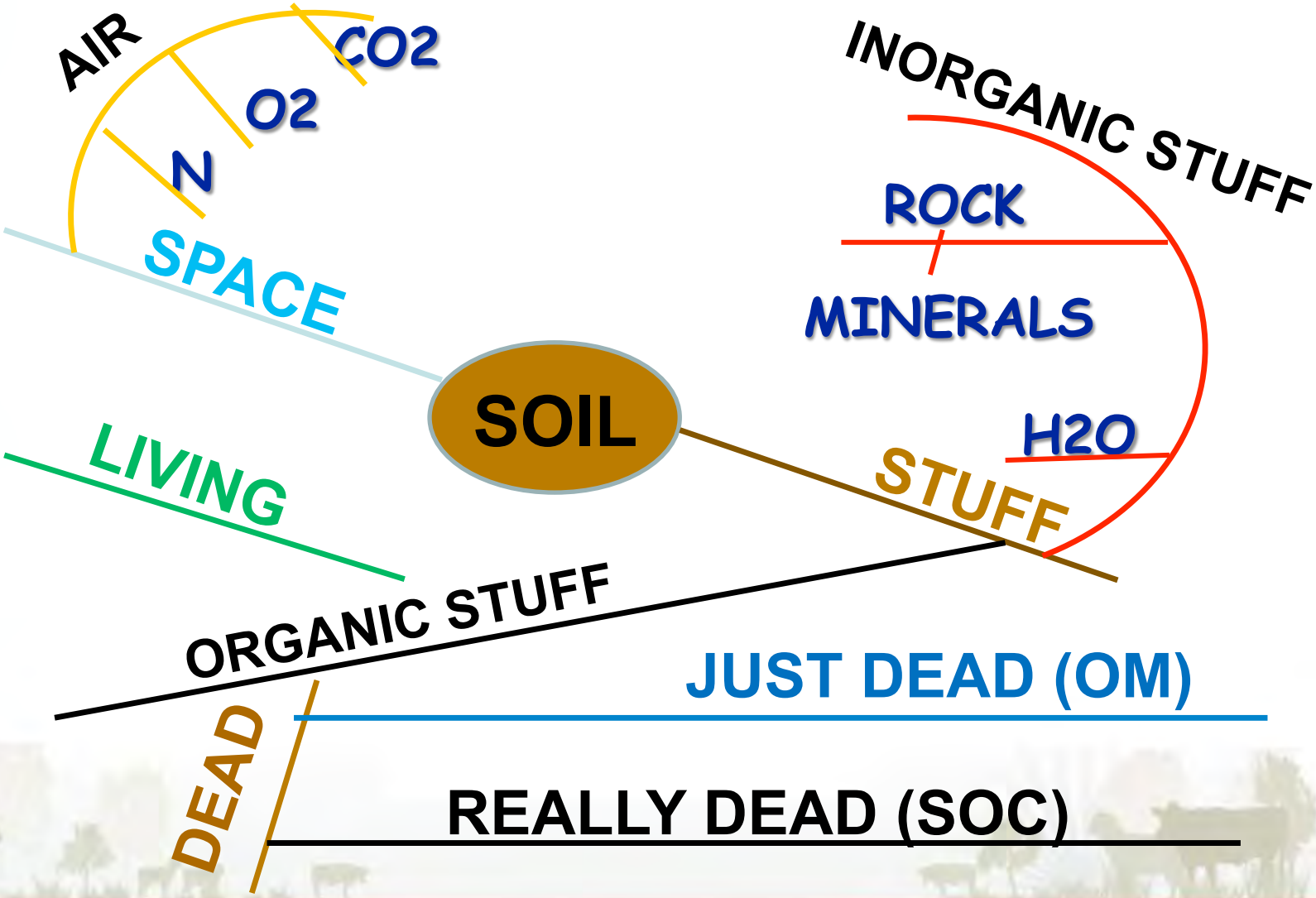
Physical Attributes

Chemical Balance

Biological Activity & Balance

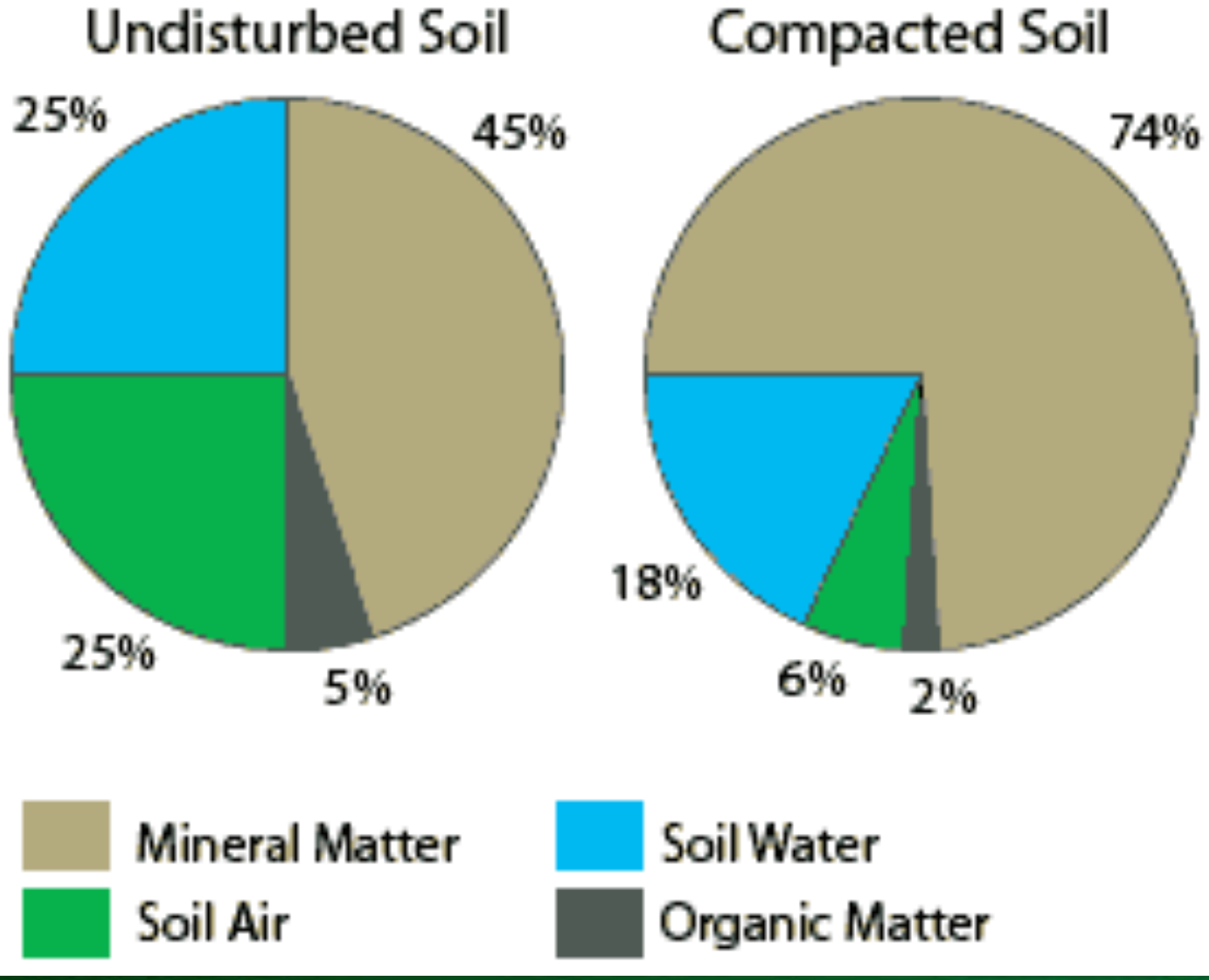


SOILS 101


AIR
CO2
O2
N
SPACE
INORGANIC STUFF
ROCK
MINERALS
SOIL
H2O
STUFF
LIVING
ORGANIC STUFF
JUST DEAD (OM)
DEAD
REALLY DEAD (SOC)

Physical

Typical Composition of Soils



Soil Structure

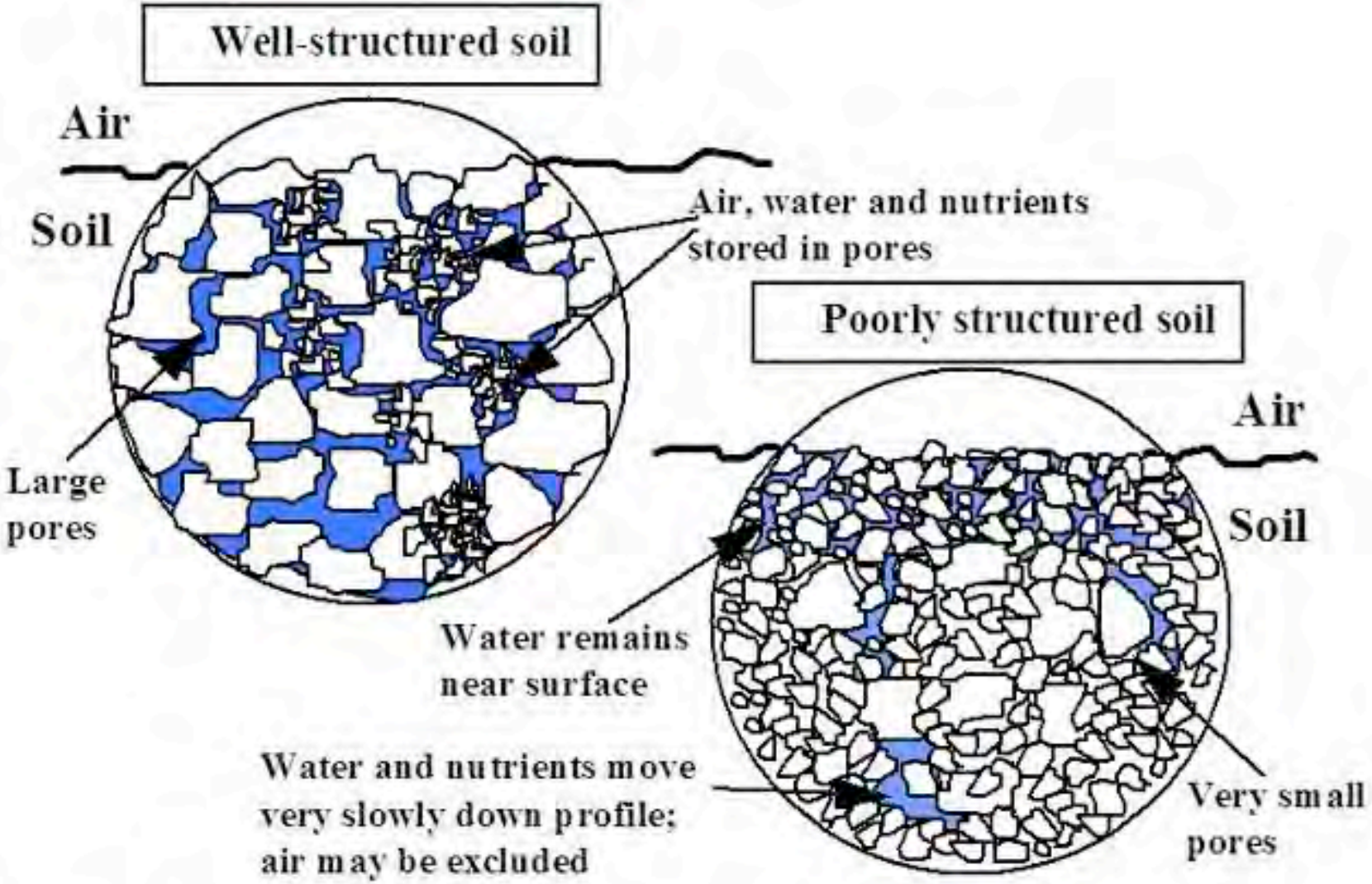


Figure 1. A diagrammatic representation of well structure and poorly structured soils.
Source: Victorian Department of Agriculture.

Indicators of poor physical structure

- Low infiltration rate
- Waterlogging
- Hardpans
- Cloddy, hard soil
- Poor root systems

Chemistry

Indicators of poor chemical composition

- Weed problems
- Poor root systems
- Low brix level in plants
- Unhealthy plants
- Poor animal & Human health

Biology

There is a critical relationship between calcium and fungi.

CALCIUM RETENTION AND FUNGI

Elaine Ingham's Classic Experiment

Sterilised Potting Mix

No Calcium Retention

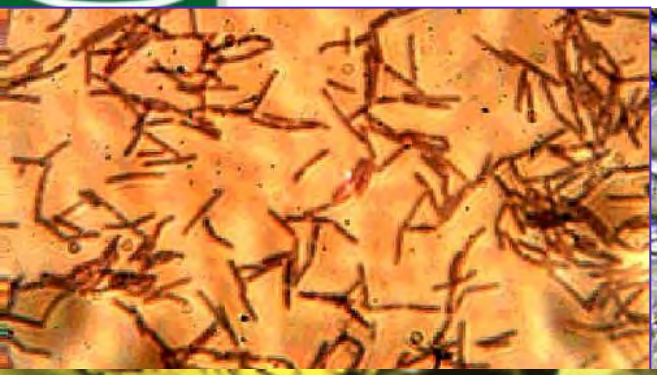
Added Bacteria-Dominated Compost

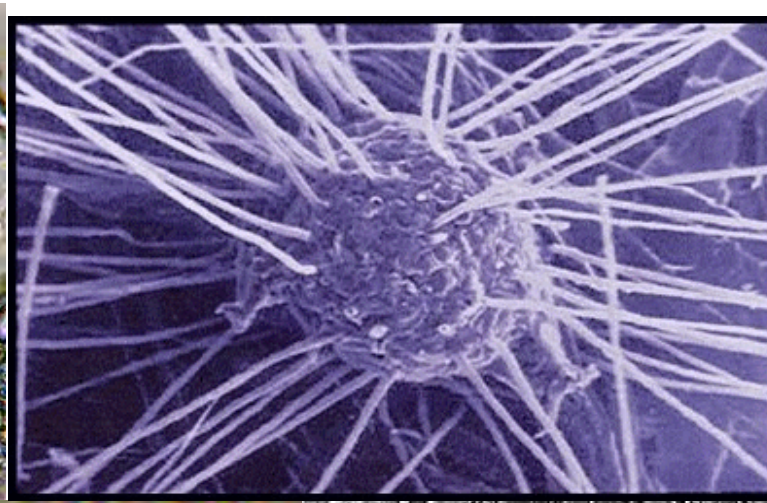
2% Calcium Retention

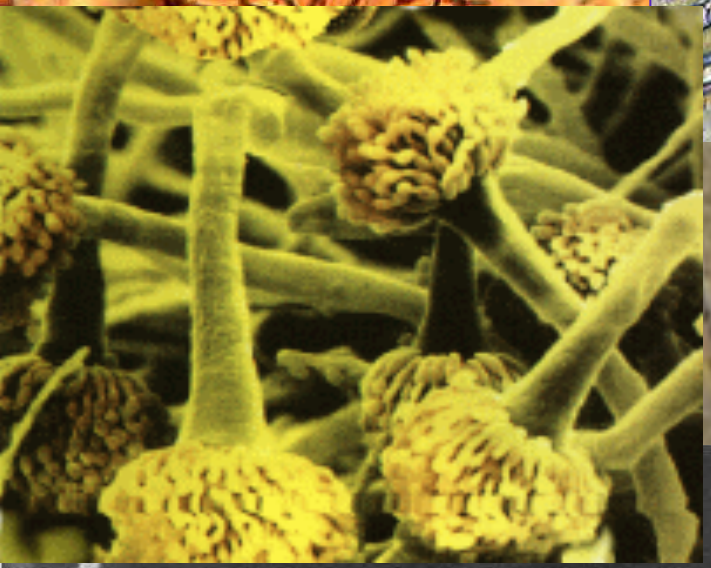
Added Fungi-Dominated Compost

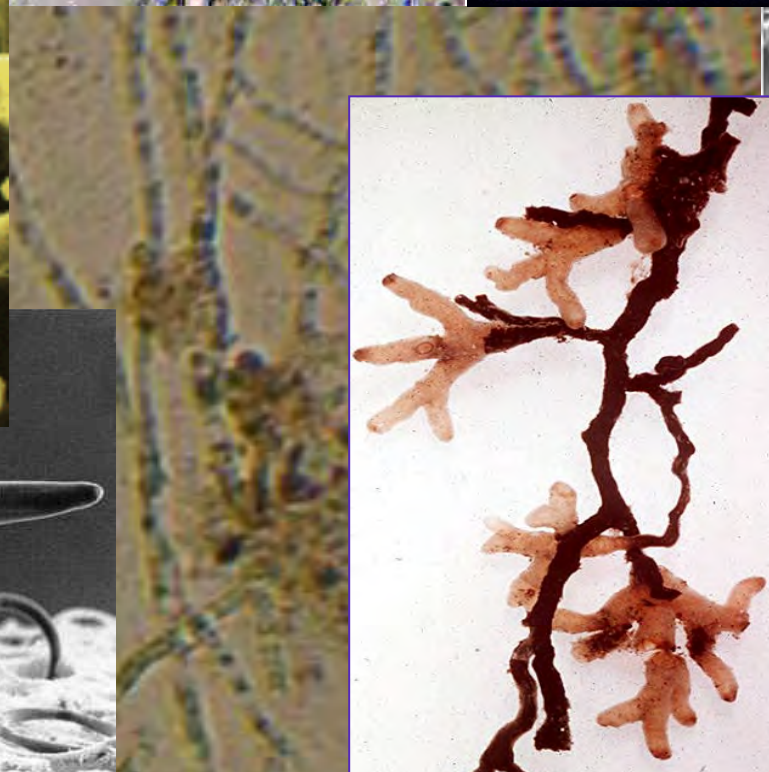
98% Calcium retained

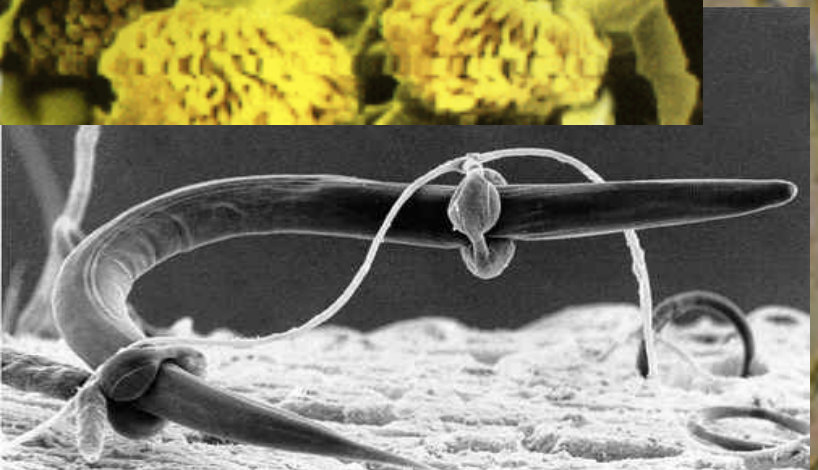
Biology we CAN'T see











Biology we CAN see

RCS

At the Dung Beetle Bar.

Empowering People

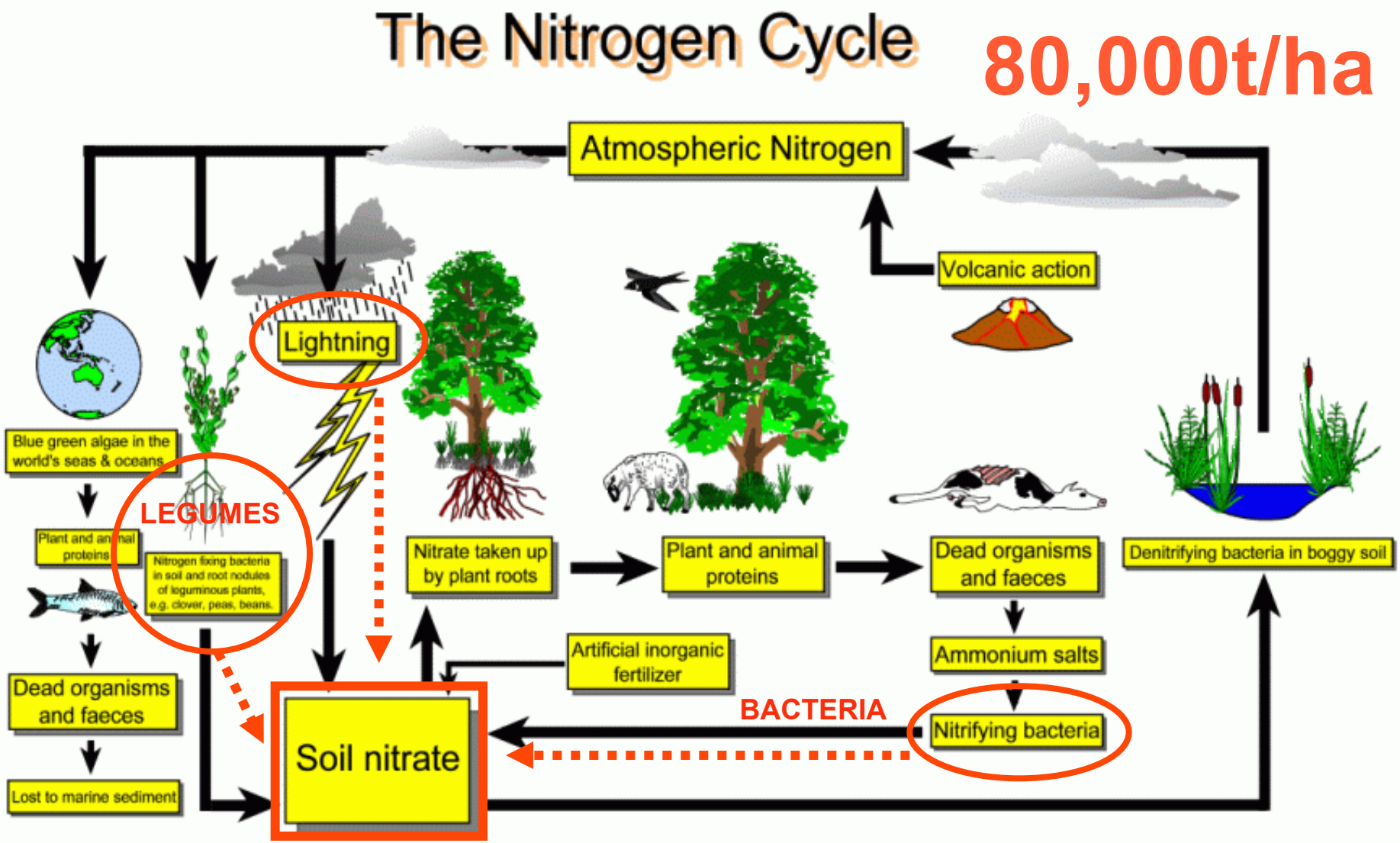
The Soil Food Web

First trophic level:	Second trophic level:	Third trophic level:	Fourth trophic level:	Fifth & higher trophic level:
Photosynthesizers	Decomposing Mutualists Pathogens, Parasites Root-feeders	Shredders Predators Grazers	Higher level predators	Higher level predators

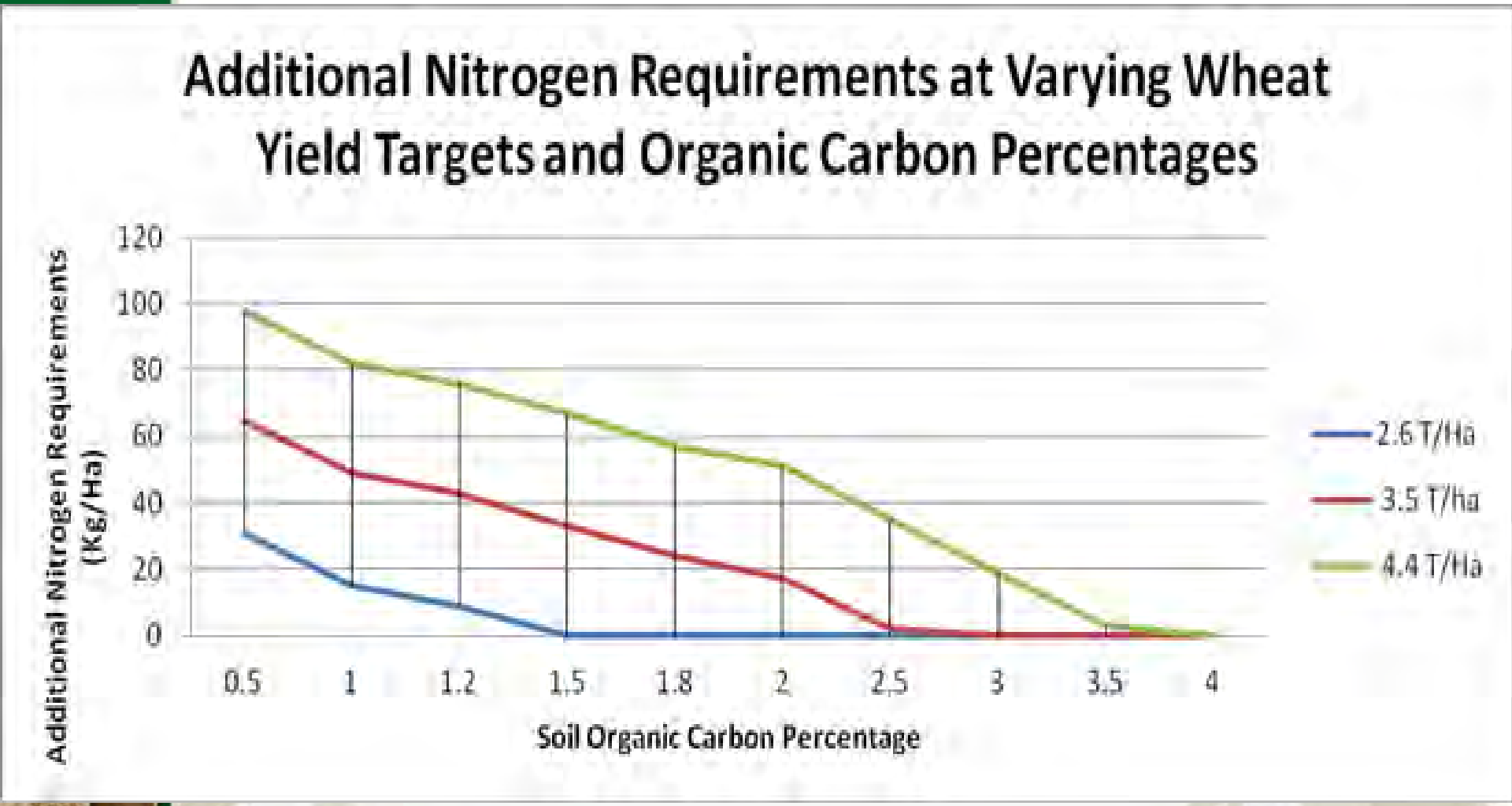
The C:N Ratio

Group	Form	pH	Foodsource	C:N
Bacteria	Decomposer Mutualists Pathogens	Alkali	Proteins, Nitrogen Low MW carbon	5:1
Fungi	Mycorrhizal Saprophytic Pathogen/Predator	Acidic	Carbon	10-20:1
Protozoa	Grazers		Bacteria	50:1
Nematodes	Grazers Predators		Bacteria, Fungi, Protozoa, Nematodes Roots	100:1

NITROGEN from the AIR



Carbon v Nitrogen



Produced by Guy Webb

Indicators of poor biological balance

- Slow OM breakdown
- Poor root systems
- Low brix level in plants
- Insect & disease issues
- Low nutrient density

6 PRINCIPLES of REGENERATIVE FARMING

1. PLAN, MONITOR & MANAGE SOIL HEALTH
2. MAXIMIZE LIVING PLANT PRODUCTION
3. A FOCUS on BIOLOGY will REPAIR SOIL HEALTH
4. INTRODUCE BIODIVERSITY
5. MAXIMUM THICKNESS and AVAILABILITY of GROUND COVER
6. LIVESTOCK are NATURE's RECYCLERS

Modern paradigm

Our ability to change the earth increases at a faster rate than our ability to foresee the consequence of change.

The Conventional approach and Result

Empowering People

The essential Components of a regenerative Ecosystem are:

1. Biodiversity
2. Healthy Soil
3. Healthy Plants
4. Healthy Animals
5. Healthy Food Production
6. Healthy People

Principle 1.
Plan, Monitor & Manage Soil Health

GOAL:

"To profitably leave our land in better condition"

The Linkages

Gross Margin = (f) Plant Productivity

Plant productivity = (f) plant available water and nutrients

Plant available water and nutrients = (f) CeC

CeC = (f) Soil organic carbon (incl Humus)

Soil organic carbon = (f) biological activity

Biological activity = (f) food, shelter, water & air

Food, shelter, water & air = (f) PLANT PRODUCTIVITY

Plant productivity = (f) plant available water and nutrients

Spiral up

Spiral down

WAYS to INCREASE SOIL HEALTH

Biodiversity

CATALYTIC INPUTS

BIOLOGY

MANAGEMENT

(eg grazing/cover cropping)

COMBINATIONS

Management

- Grazing
- Cover/Green manure Crops
- Crop rotations
- Continuous cropping
- Aeration
- Landscape Hydration

+ Biology

- Compost & Compost Extract (BEAM)

+ Fertilizer & Catalysts

+ Perennial Legumes

Compost Extract & Worm Juice on Wheat & Barley - WA

Ian & Di Haggerty

The Underpants underground test

Catalytic fertilizer

- **Boron (Solubor)**
- **Sulphur (Gypsum)**
- **Calcium (Calsap or micro fine lime)**
- **Silica (BD501)**

As foliar applications

Multi Species cover crops

Images by Gabe Brown

Aeration & Rehydration - Keyline

Hydration

Mulloon Institute

Swales

Leaky Weir

Gully Repair

Principle 2.
MAXIMIZE LIVING PLANT PRODUCTION

http://www.soil-carbon-regeneration.co.uk/glomalin/attachment/amf-symbiosis/

Gabe Brown stock grazing a cover crop

High Density grazing

Cover Crops and Yield

0.8% SOC – Legume Cover Crop
YIELD = 1t/ha DM

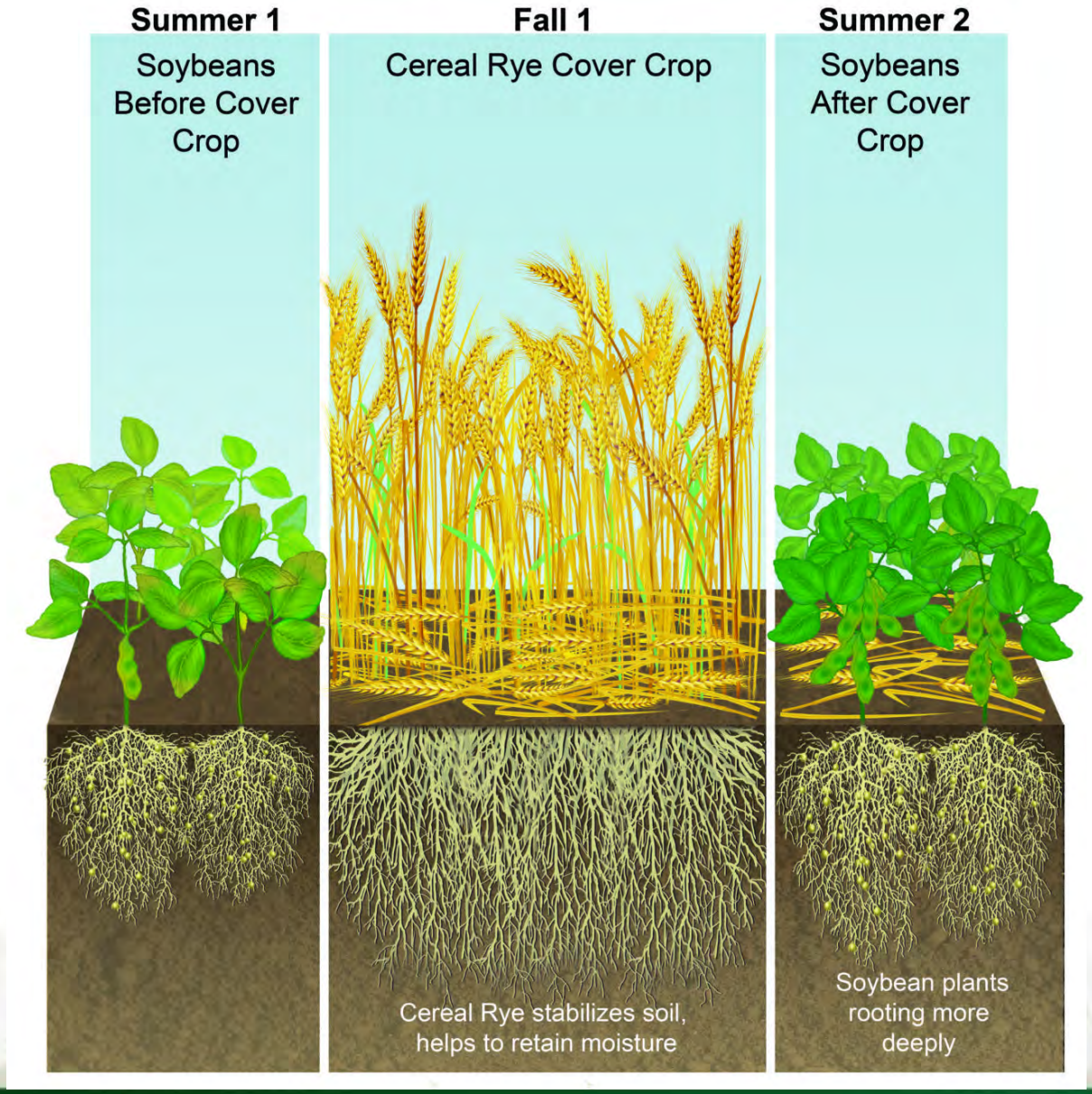
Johnson, D, Ellington, D and Eaton, W (2013) Institute for Sustainable Ag Research.

Cover Crops and Yield

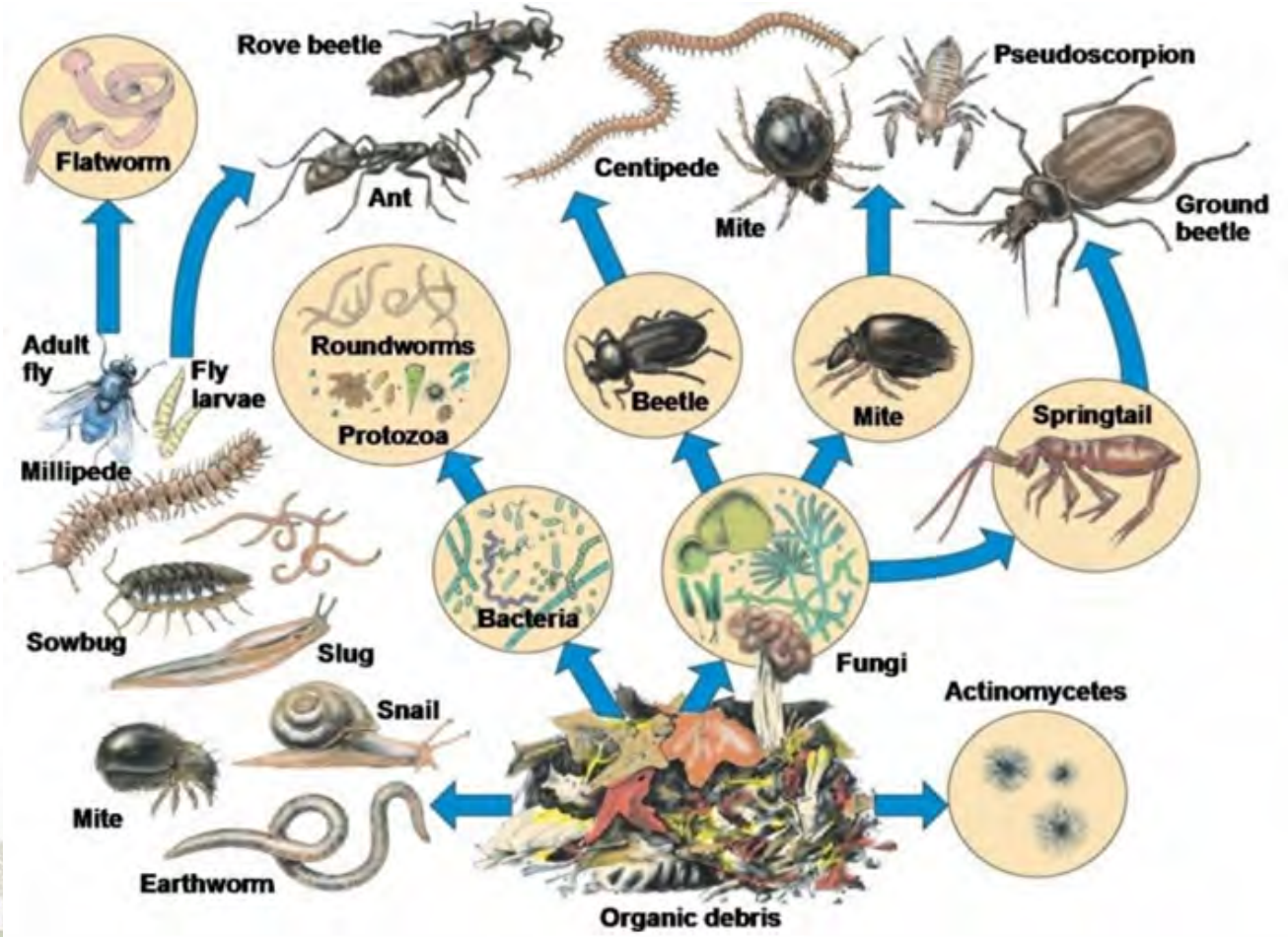
9.5% SOC – Legume Cover Crop
YIELD = 7.5t/ha DM

Johnson, D, Ellington, D and Eaton, W (2013) Institute for Sustainable Ag Research.

Iowa corn belt



Principle 3.
A FOCUS on BIOLOGY will repair soil health



Biology is the ENGINE

Gross Margin = (f) Plant Productivity

Plant productivity = (f) plant available water and nutrients

Plant available water and nutrients = (f) CeC

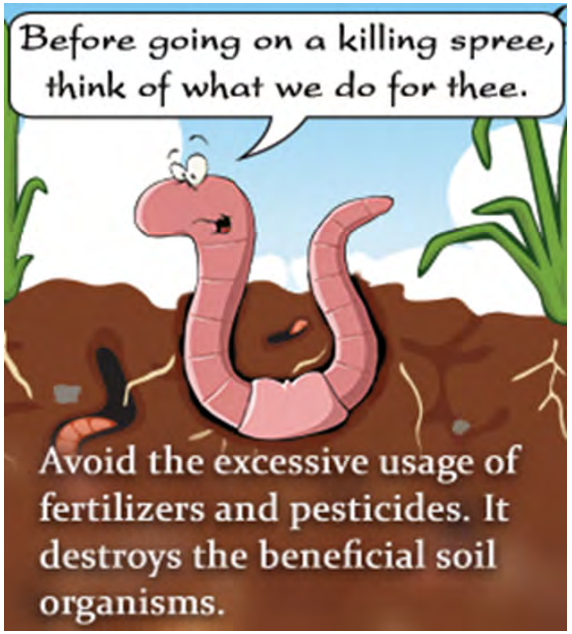
CeC = (f) Soil organic carbon

Soil organic carbon = (f) biological activity

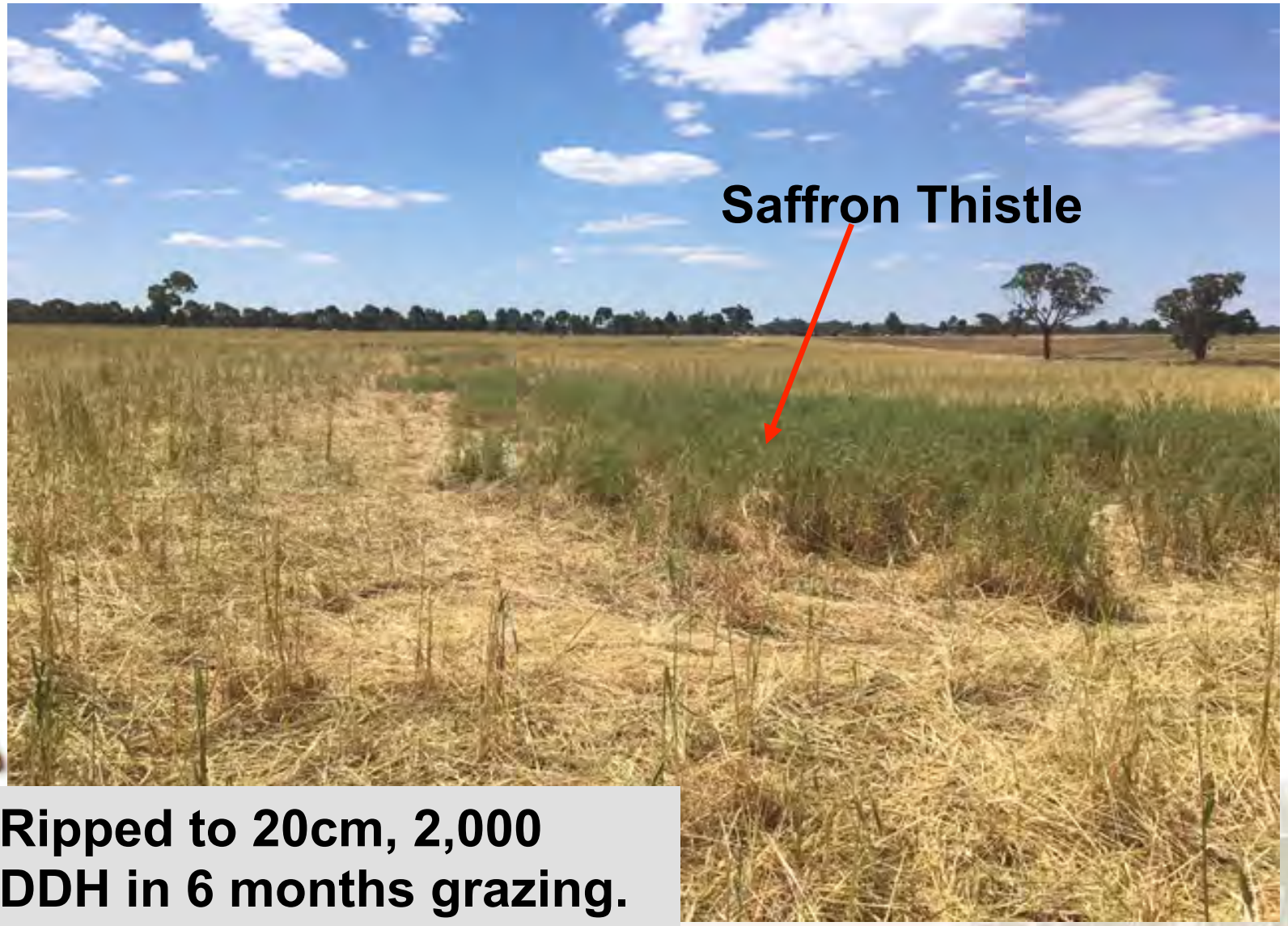
Biological activity = (f) food, shelter, H_2O & air

The Essentials of life

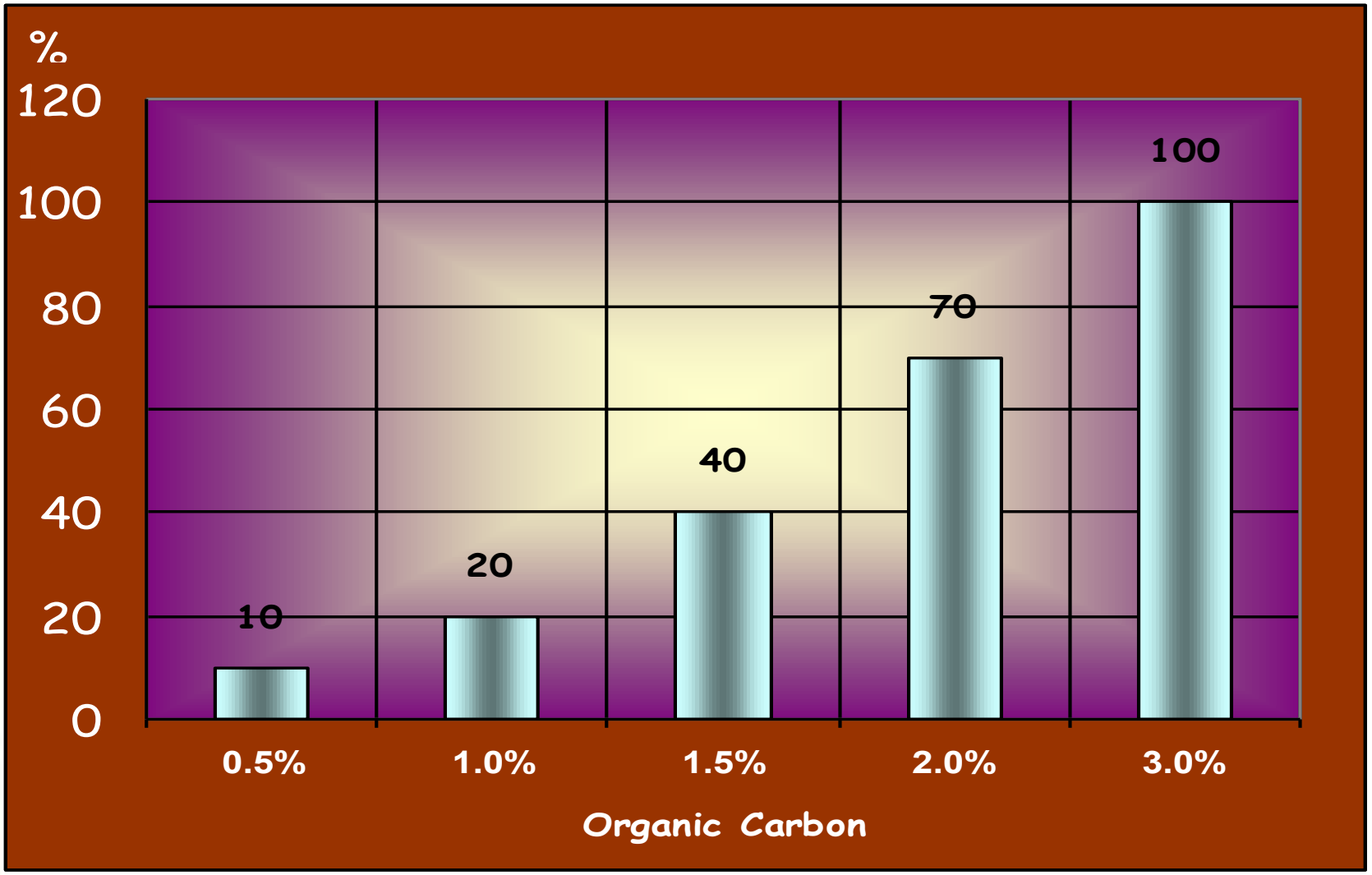
- ✓ AIR – especially oxygen and nitrogen
- ✓ WATER
- ✓ FOOD – esp ENERGY
- ✓ SHELTER – eg litter, living species



Aeration (Yeomans 20cm)



Ripped to 20cm, 2,000 DDH in 6 months grazing.
James Morse, 2016



Relative water holding capacity (litres per 50 kg of soil)

BEAM

BIOLOGICALLY ENHANCED AGRICULTURAL MANAGEMENT

Dr David Johnson, New Mexico

Johnson-Su **No-Turn** Composting Bioreactor

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New Mexico State University

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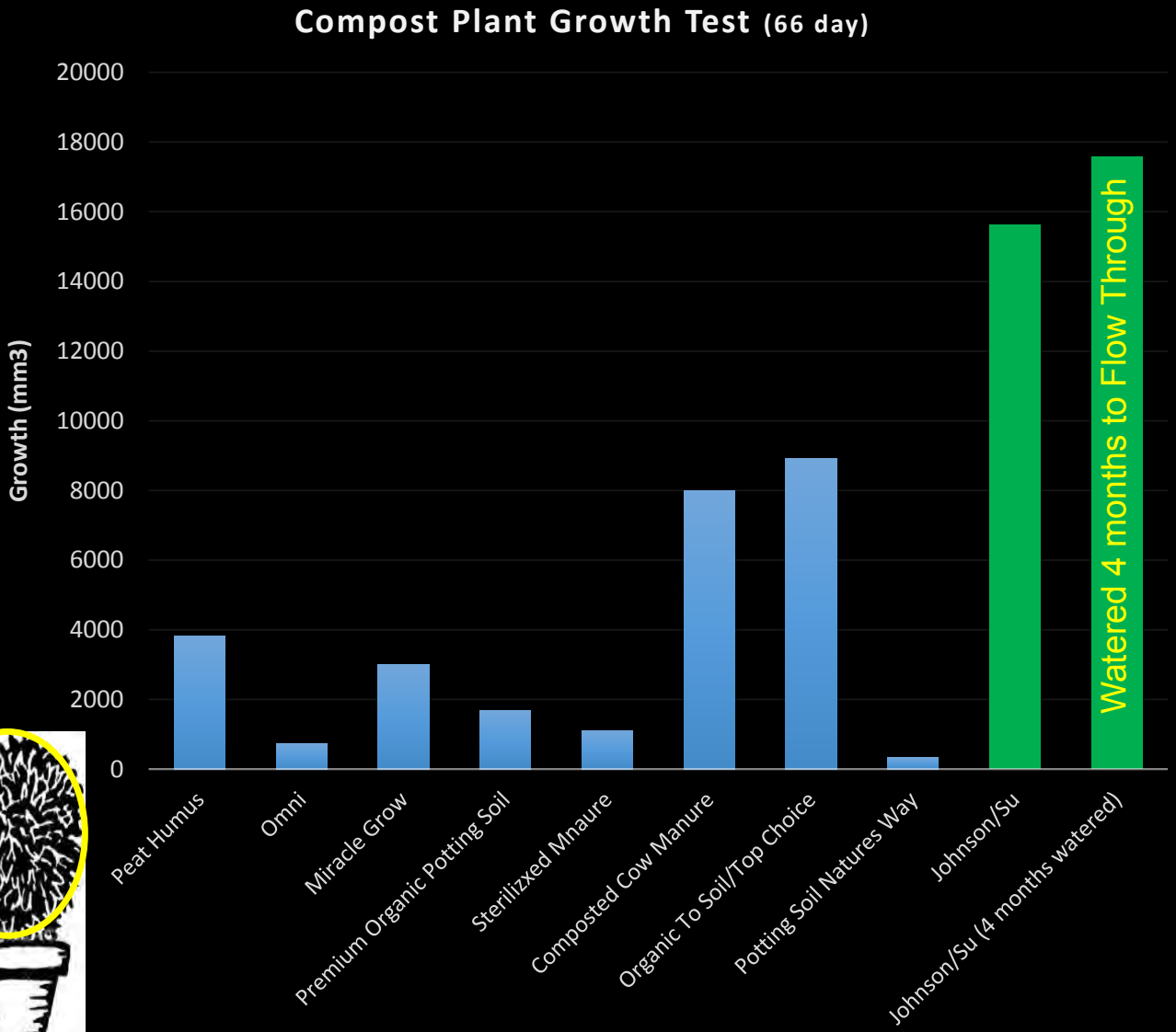

Not All Composts Are Equal!

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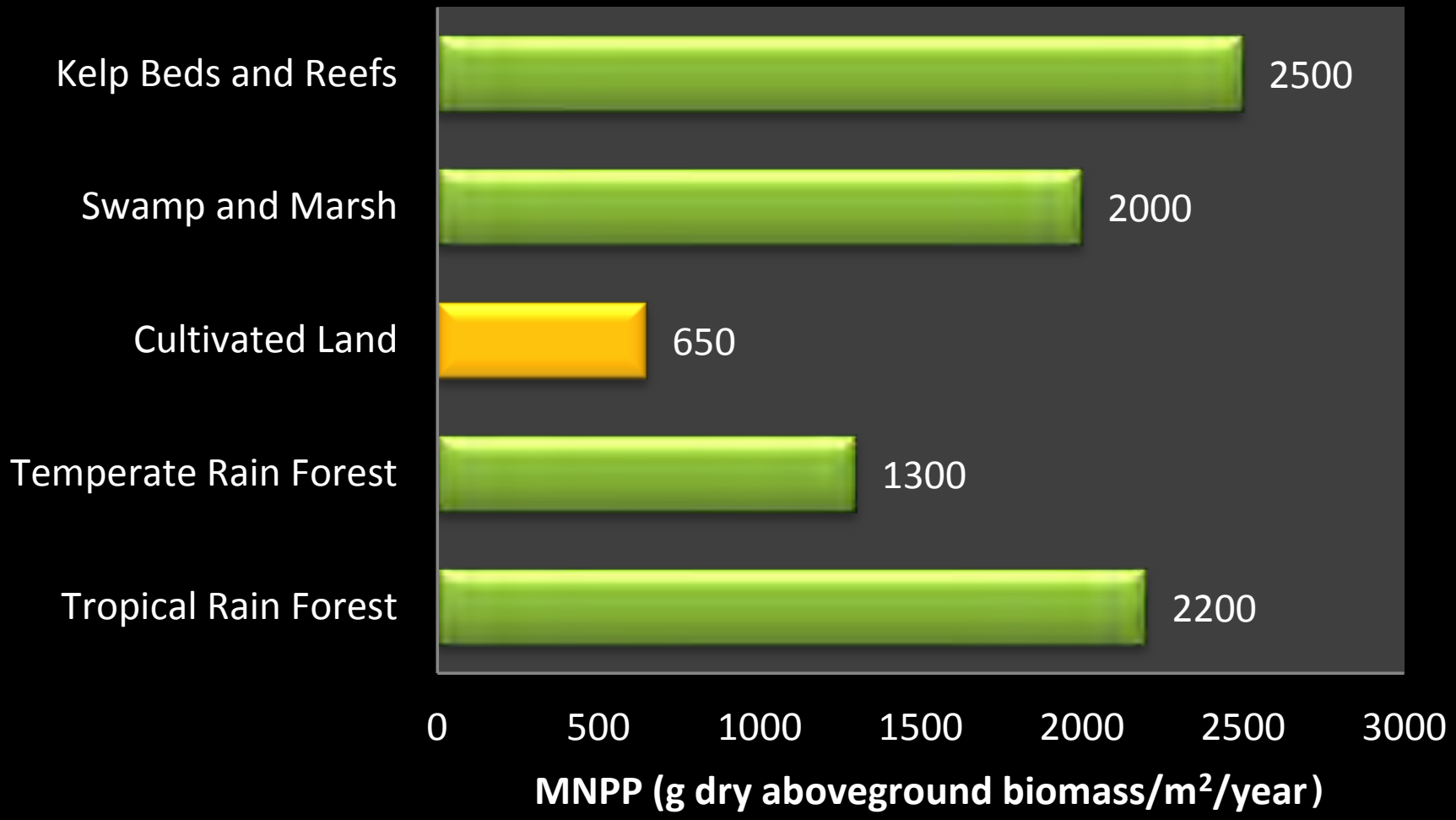
Most Productive Ecosystems



Whittaker, (1978)

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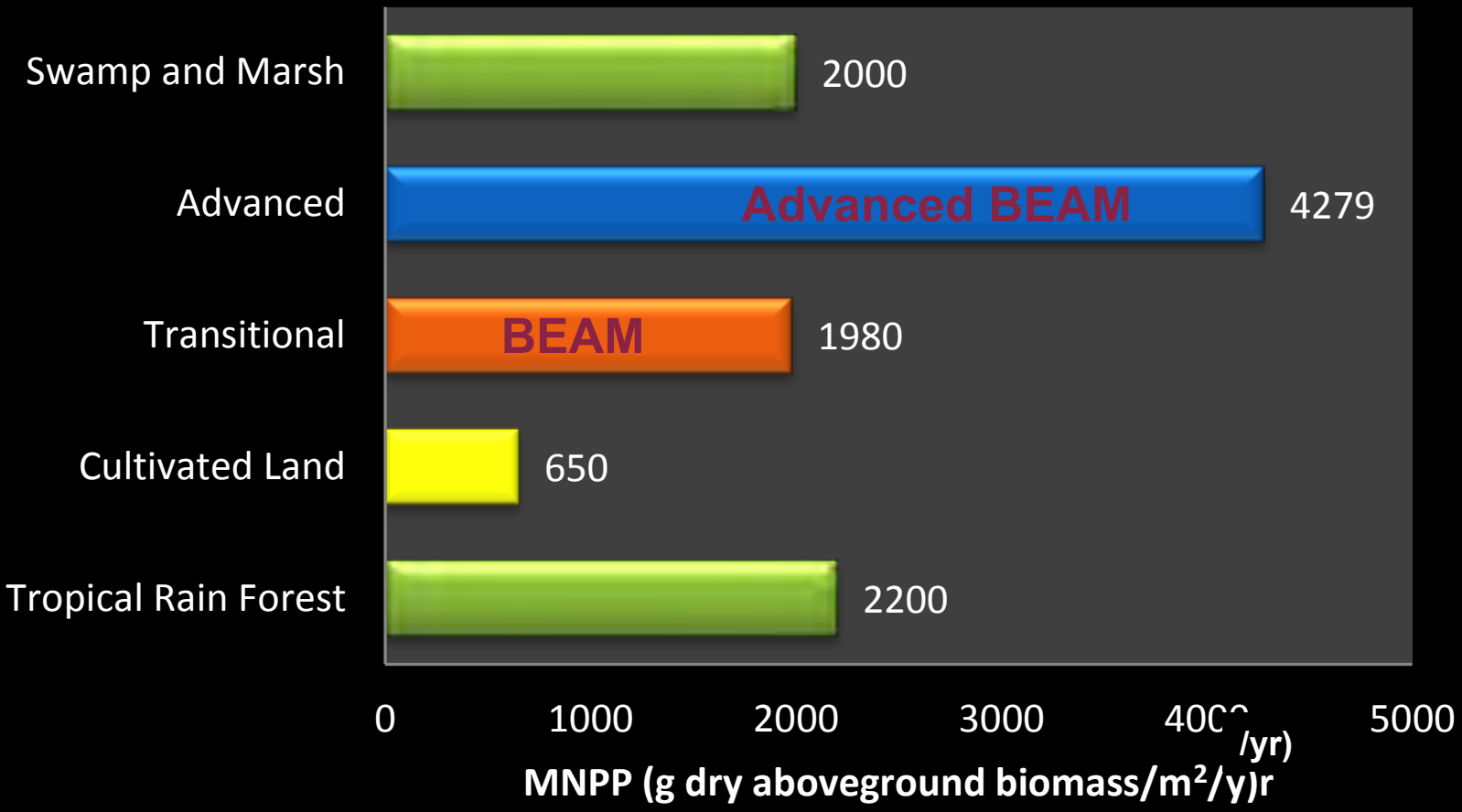
How Does a Biologically Enhanced Agricultural Management (BEAM) System Perform?



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Control (No Previous Covercrop Application) Total Dry Biomass Production = 1 ton/Acre

1 Year's Previous Covercrop Application Total Dry Biomass Production = 5 tons/Acre

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Sunflower yield as soils improve

..speed

Plus 29 days

Plus another 15 days

2015 Desert Sandy Soil Trial

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2016 Desert Sandy Soil Trial

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Changes in Soil Macro and Micro-Nutrients with "BEAM"

Months	0	6	8	15	19	Percent Increase	R^2	Regression
Manganese (mg/kg)	3.25	1.86	1.65	14.31	40.14	1135%	$R^2 = 0.969$	2nd Order
Iron (mg/kg)	4.89	4.12	2.66	27.01	59.19	1110%	$R^2 = 0.9892$	2nd Order
NO_3-N (mg/kg)	1.5	1.55	2.00	2.35	3.1	107%	$R^2 = 0.9847$	Linear
SOM (%)	0.75	1.25	1.22	1.49	1.41	88%	$R^2 = 0.7854$	Linear
Magnesium (mg/kg)	1.09	0.075	0.81	1.67	1.99	83%	$R^2 = 0.7954$	2nd Order
Calcium (meq/L)	4.09	2.82	3.00	6.07	7.19	76%	$R^2 = 0.6367$	Linear
Kjeldahl N (mg/kg)	633	719	739.00	752	1041	64%	$R^2 = 0.8244$	2nd Order
Phosphorus (mg/kg)	6.9	12.2	10.00	15.3	11.3	64%	$R^2 = 0.4624$	Linear
Zinc (mg/kg)	0.5	0.63	0.48	0.93	0.81	62%	$R^2 = 0.6652$	Linear
Copper (mg/kg)	1.17	1.1	1.04	1.74	1.64	40%	$R^2 = 0.6591$	Linear
Potassium (mg/kg)	30	33	32.00	42	41	37%	$R^2 = 0.8712$	Linear

20 month Study, 5 Sampling Periods

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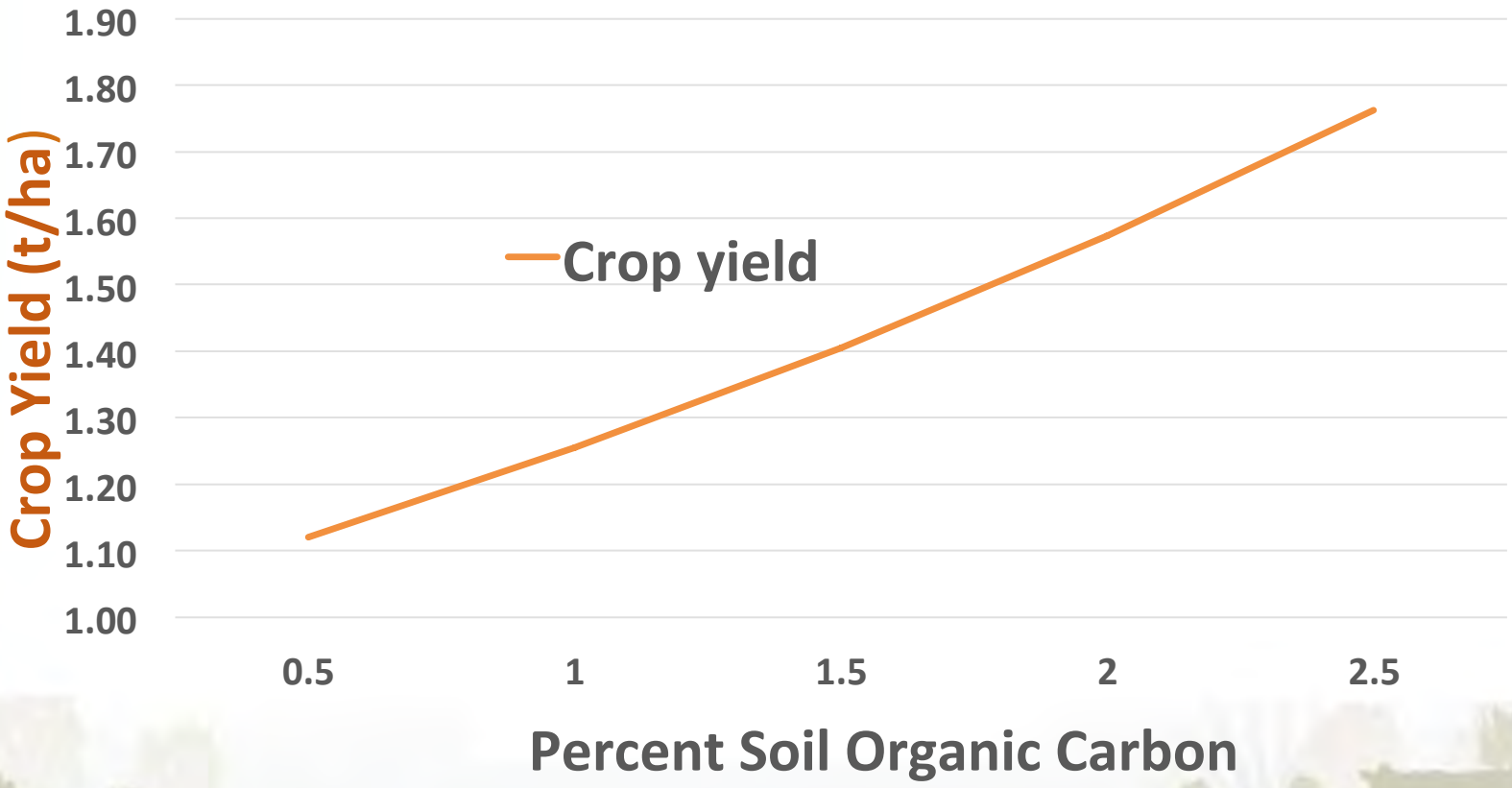
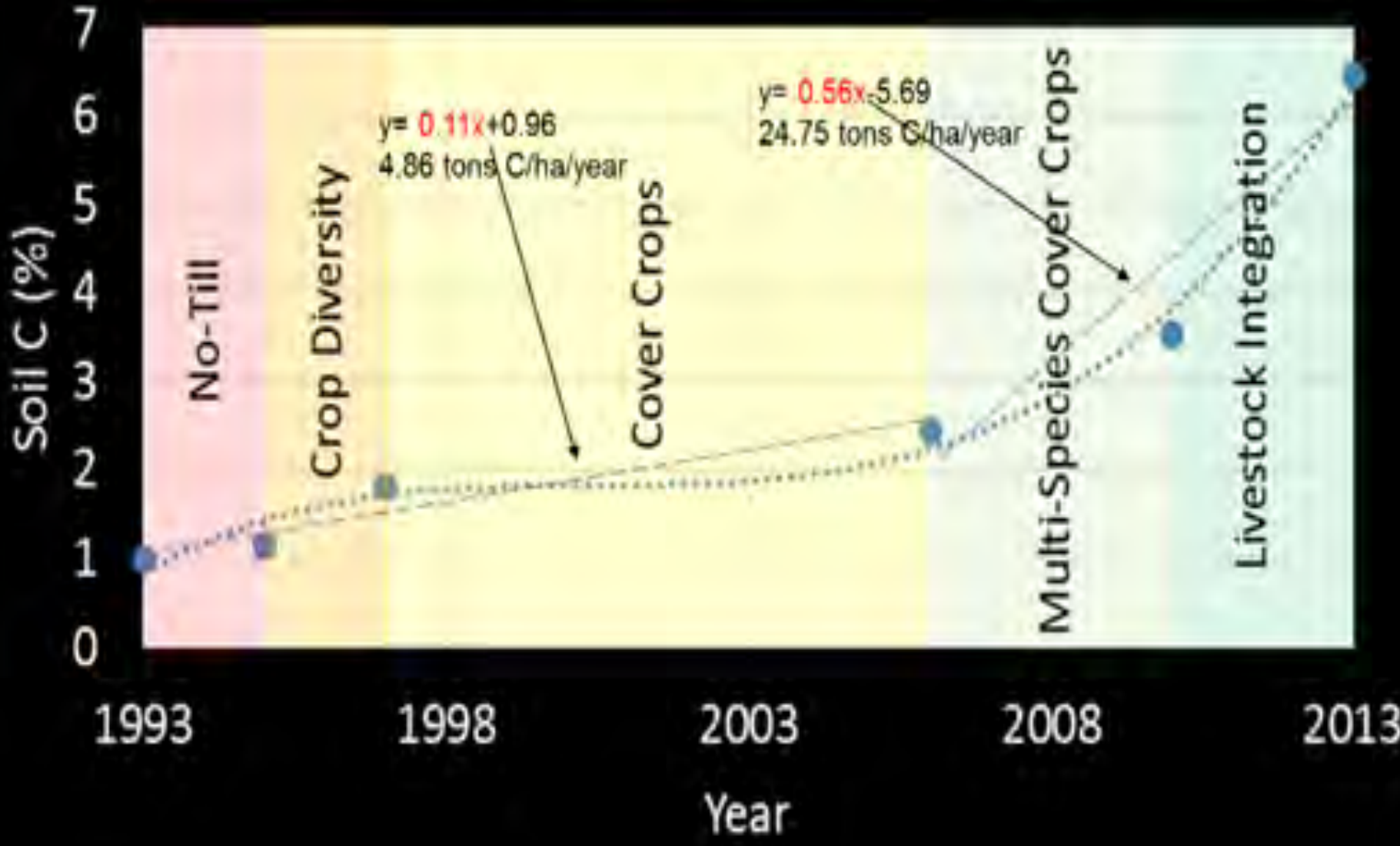
CROP YIELD INCREASES by 12% for each 0.5% change on soil carbon



Gabe Brown's Soil Carbon Data



Principle 4.
Introduce Biodiversity

Different root structures

Photos by Gabe Brown

Empowering People

The latest research from Europe demonstrates that RELATIONSHIPS what enhance ealth

BIODIVERSITY

Relationships between organisms drives the progress of all. However fungi are the extroverts that get it going.

Ally Cropping

Companion Cropping

Ley Cropping

Green Manuring

Fallow Efficiency

Bare Fallow	21%
Disc Tillage	25%
Blade Tillage	26%
Min/No Till	32%

"Improving fallow efficiency" 23 Feb 2016

Principle 5.
MAXIMUM THICKNESS & AVAILABILITY OF GROUND COVER

Iowa Secretary of Agriculture – Sonny Perdue

Empowering People

Improving groundcover

The effect of varying ground cover on water and soil loss in a 650 mm rainfall environment

20% ground cover	40% ground cover	70% ground cover
Runoff water loss = 160 mm/yr Soil loss = 85t/ha/yr	Runoff water loss = 90 mm/yr Soil loss = 40 t/ha/yr	Runoff water loss = 10 mm/yr Soil loss = 3 t/ha/yr
Poor plant production and poor animal production		Good plant production

Source: LeyGrain (2006)

Decaying & Living stubble

Principle 6.

LIVESTOCK are NATURE'S RECYCLERS

RECYCLING

Livestock functions

- Diversity of income
- Spread soil biology
- Feed soil biology
- Recycle waste products eg crop residue
- Animal waste is fertilizer & seeding
- Animal impact used to put crop residue on the ground