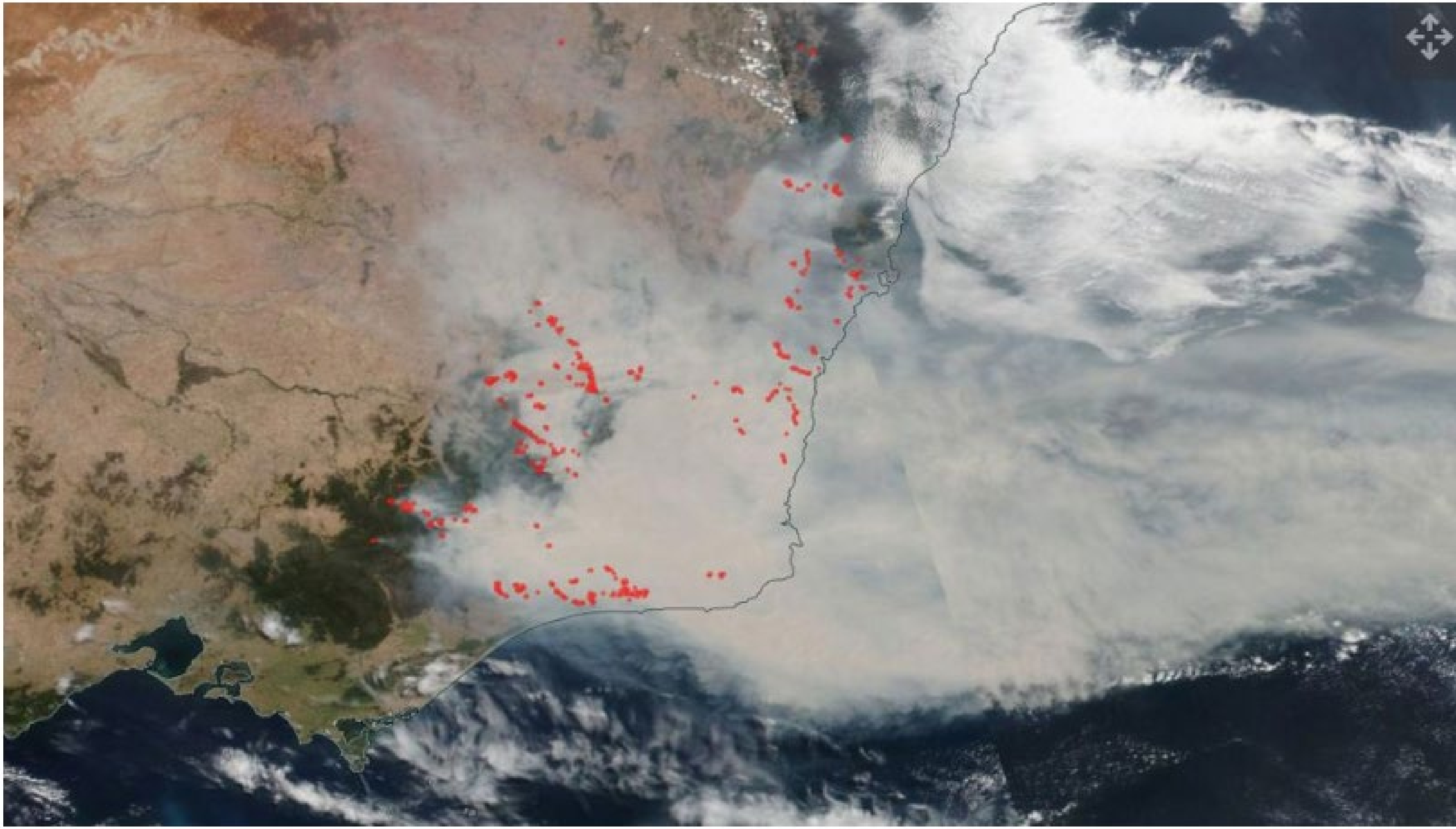
Bottom Line Benefits of Building Resilience



(Image credit: NASA EOSDIS)

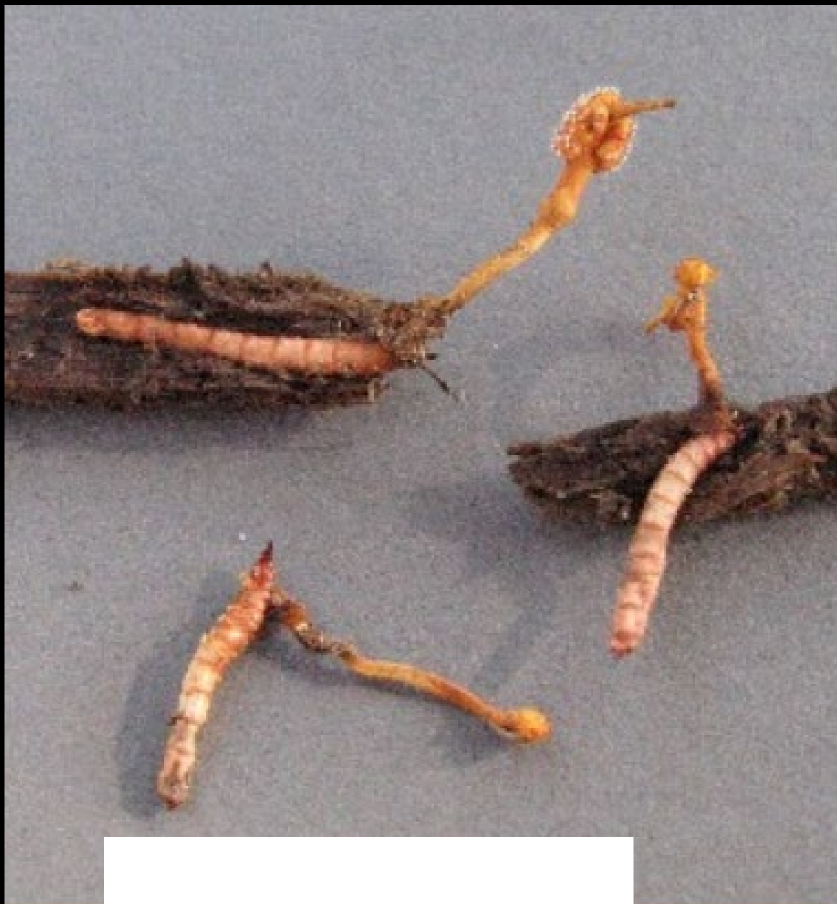
- Natural sequence farming (Peter Andrews)
- Keyline Contours (Yeoman)
- Compost in contours
- Leaky weirs
- Adaptive grazing

20 Dec 2019, 3:30 p.m. News

Martin Royds, Jillamatong, Braidwood, in front of one of his weirs, with the hills that were burnt out by the recent bushfires in the background. Helicopters fighting the fires, filled up from the weirs every 40 seconds.

Cordyceps gunnii

Entomopathagenic Fungi



Cordyceps variabilis.
Credit Roger Heidt.

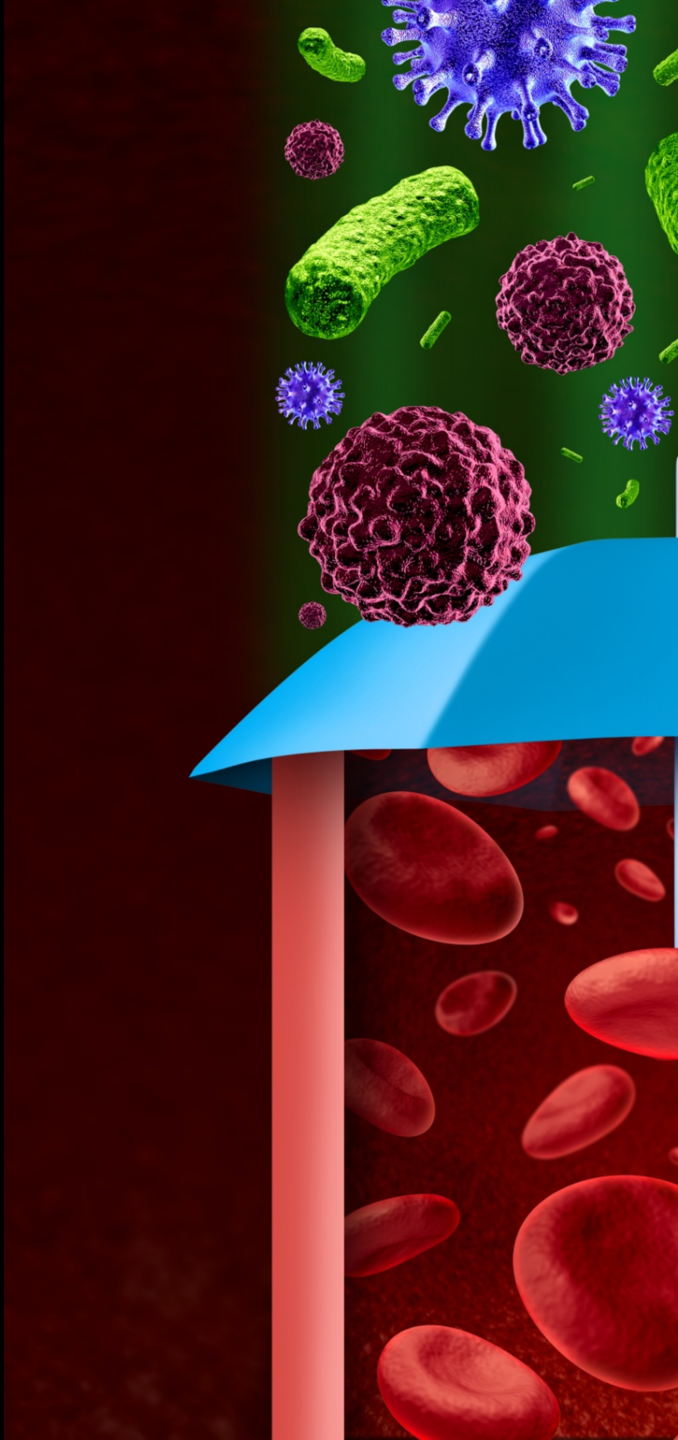
Beauvaria bassiana
White muscardine disease

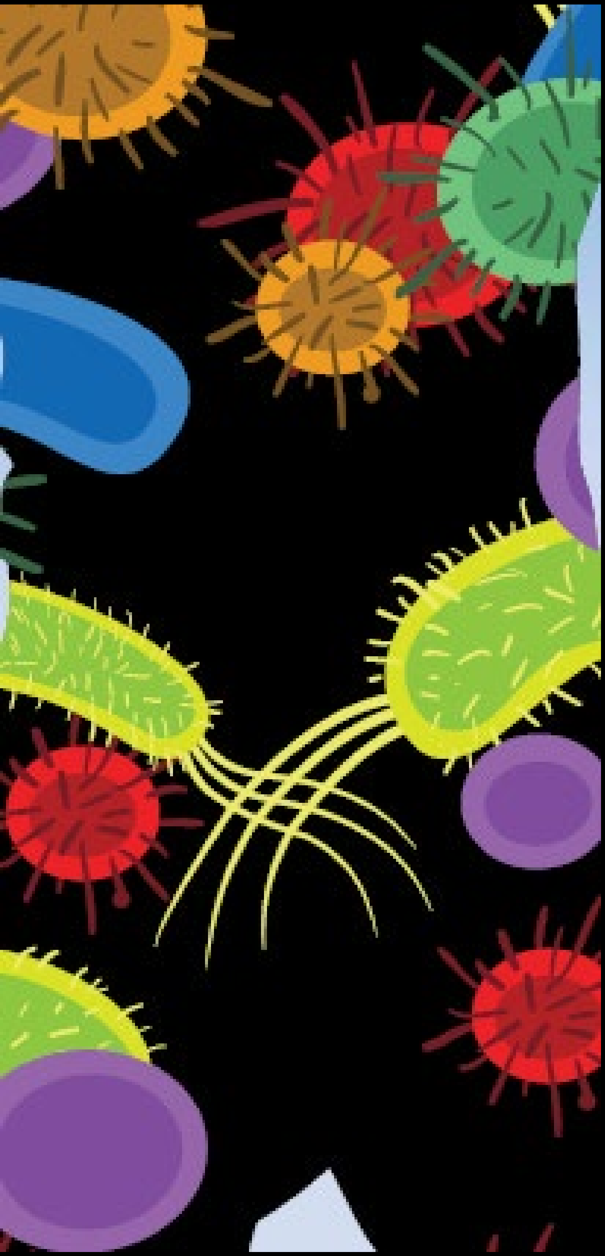
Metarhyzium spp
Green muscadine disease


Kim Deans

Gut microbes:

- Make us grow
- Regulate our health
- Provide vitamins, enzymes etc
- Help our whole body to function
- Disruption of gut flora linked to disease





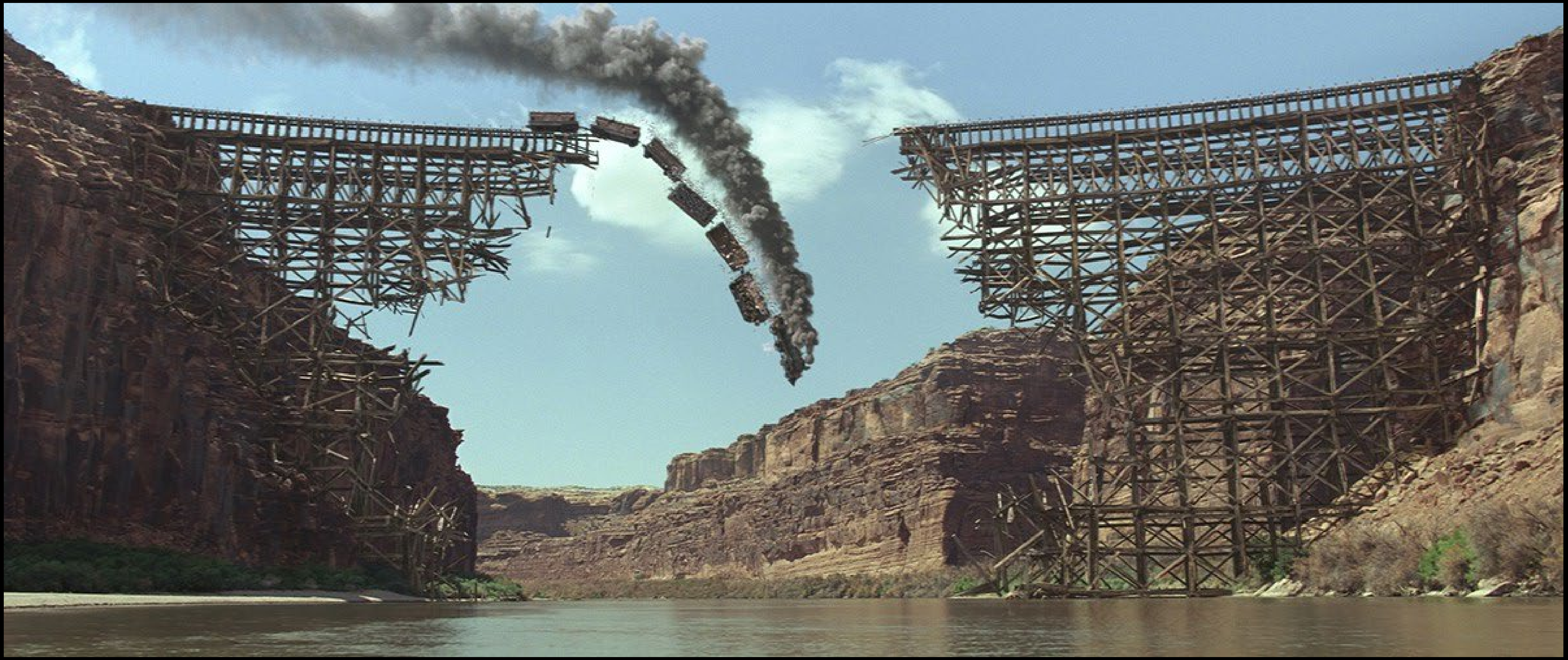
Gut microbiome & health

Acne, Asthma/Allergies, Anxiety and PTSD, Arthritis, Autism, Autoimmune diseases, Cancer, Crone’s, Depression, Diabetes, Eczema, Inflammation, Longevity

Motor Neuron, MS, Obesity, Parkinsons, Sleep issues, Tooth Cavities….and more….


ANTACIDS
LAXATIVES

We’ve blown the microbial bridge

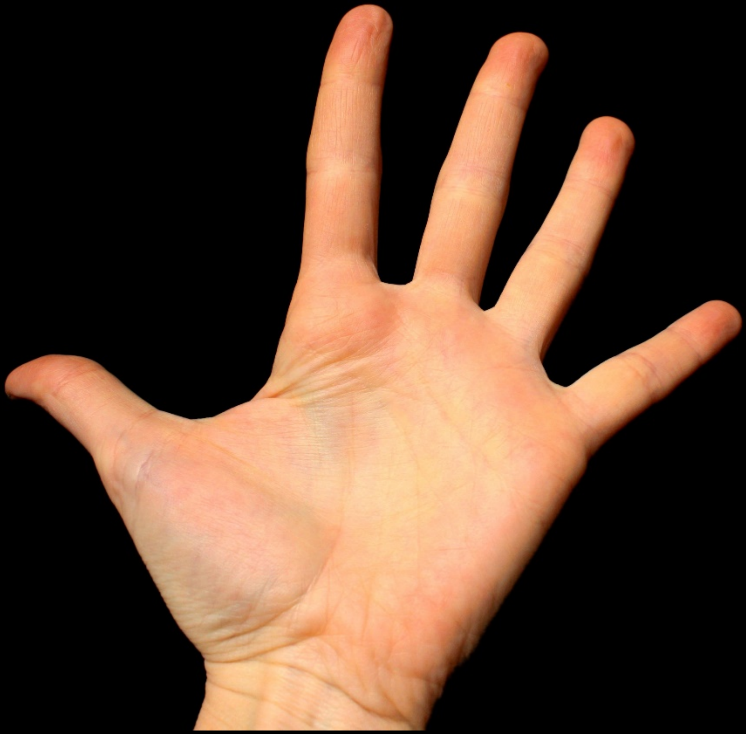


We're doing the same to our soils

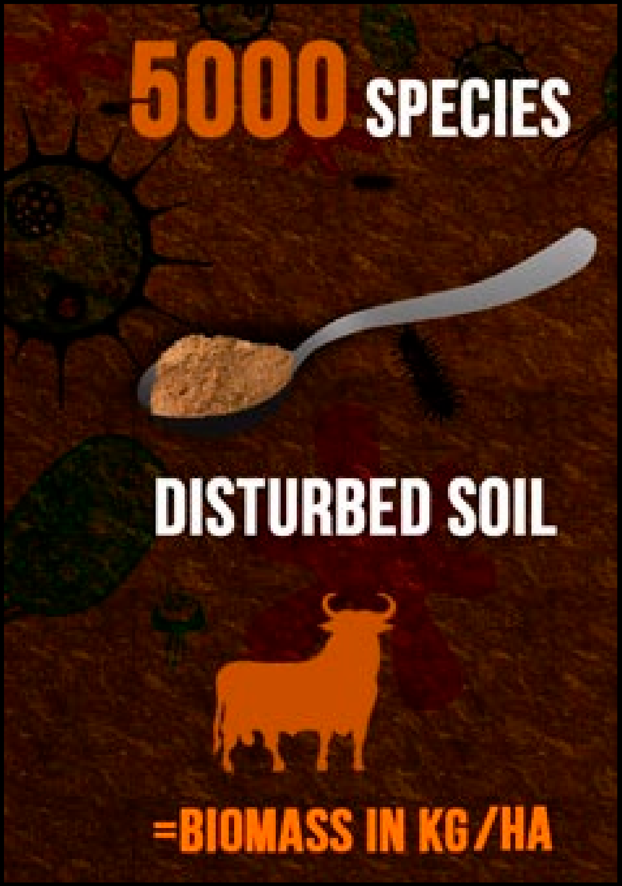
They have indigestion, constipation, gas, dehydration and diarrhoea

The US loses 6.9 billion tonnes of soil each year (Pimentel, 2000)

Microbes are everywhere!

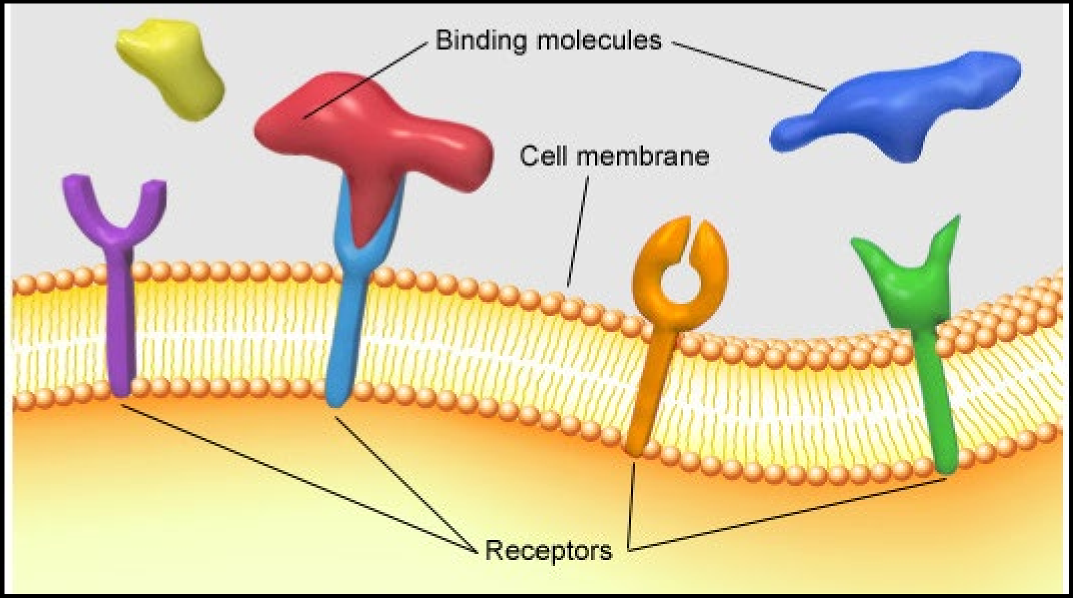


Disturbed vs Healthy Soils



10's of thousands of signalling molecules in soil

- Proteins, hormones, enzymes, elicitors
- Plant defence molecules;
  - salicylic, jasmonic acids chitinase, proteinase



Quorum Sensing

- Bioluminescence
- Insects; ants and honeybees
- Quorum quenching –switches biology off

- A little goes a long way…parts per trillion

New discoveries between plants and bacteria

- Aromatics, exudates, hormones, pheromones, enzymes, vitamins, sugars, amino acids & proteins…

Quorum sensing

~80% of plant health and nutrition is driven by biological functions

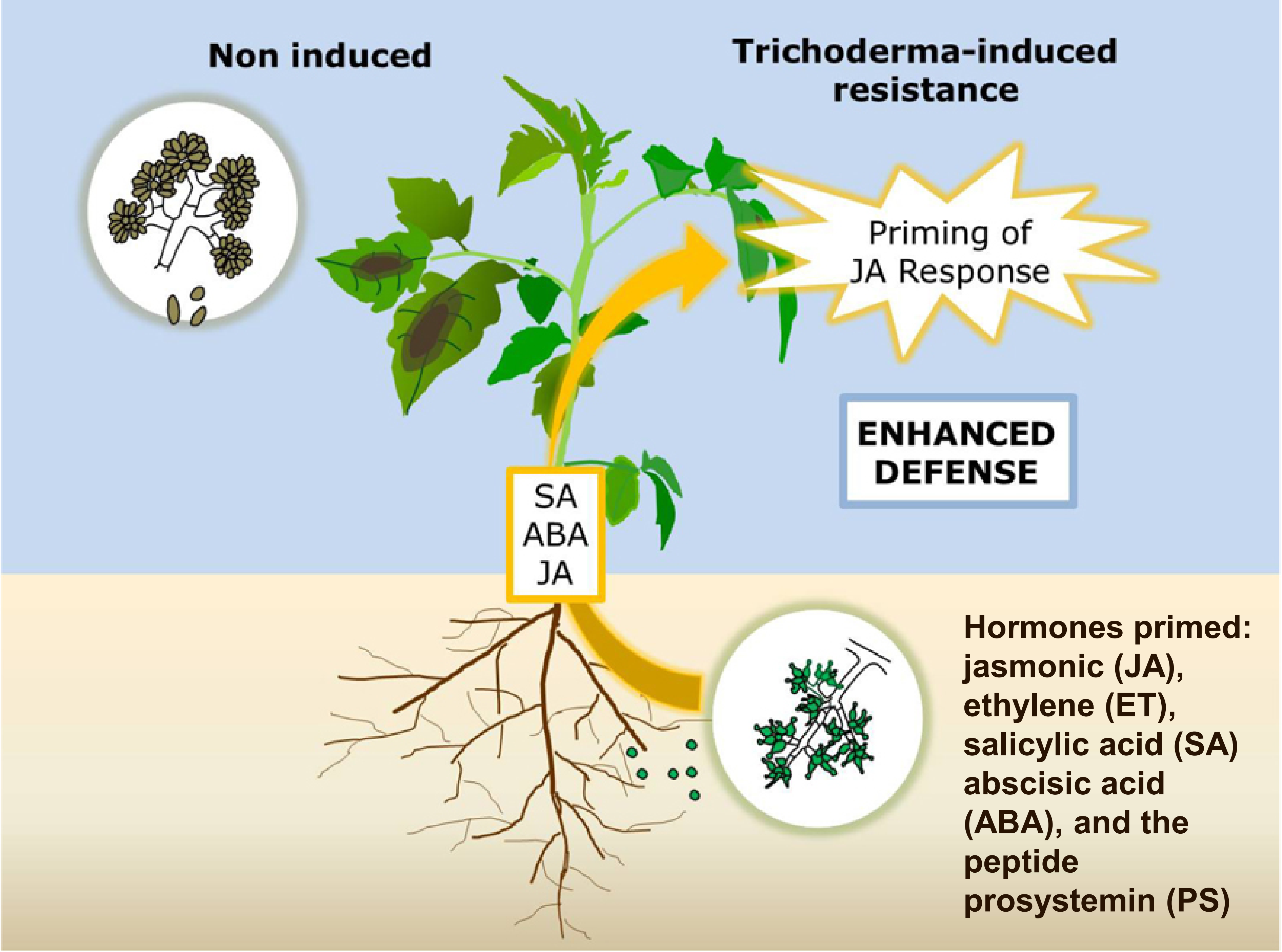
Diverse communities

= more signals

= increased resilience to stress

= crop health and quality

Optimising biological diversity and biomass is CRITICAL


Non induced
Trichoderma-induced resistance
Priming of JA Response
ENHANCED DEFENSE
SA
ABA
JA
Hormones primed: jasmonic (JA), ethylene (ET), salicylic acid (SA) abscisic acid (ABA), and the peptide prosystemin (PS)

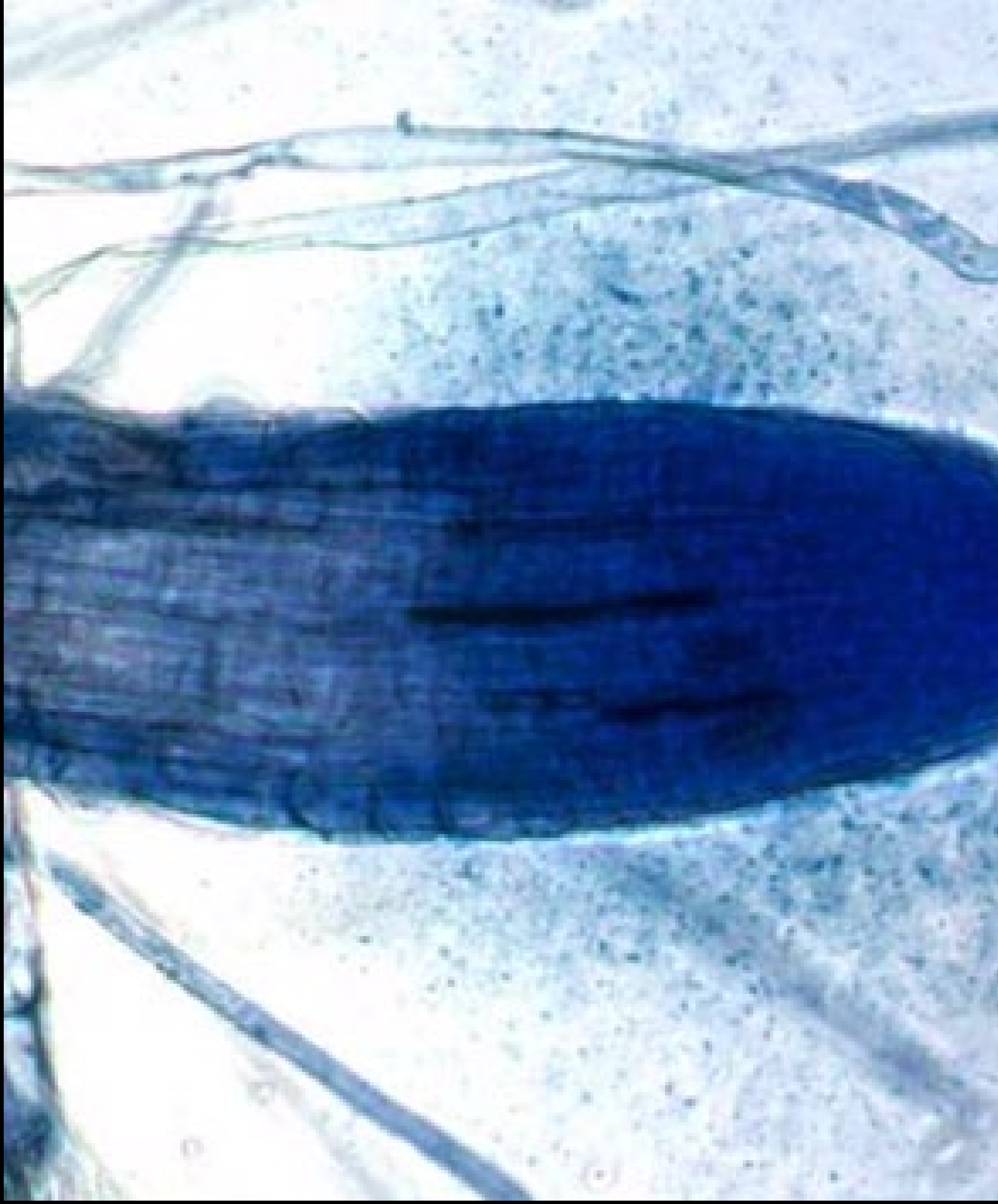
Healthy rhizosphere

- Plant protection
- Nutrient uptake
- Plant growth
- Feeds microbes
- Carbon building
- Resilience
- Buffer – temp, pH

SEED DRESSING - Encourage root development and thick rhizosheath

Rhizophagy

30% of nutrients to a seedling come from the absorption of bacteria.



Two neighbouring orchards

Integrated system

No compost application,
herbicided rows, irrigation,

→ 5.3 # C/y^2 (top 4”)

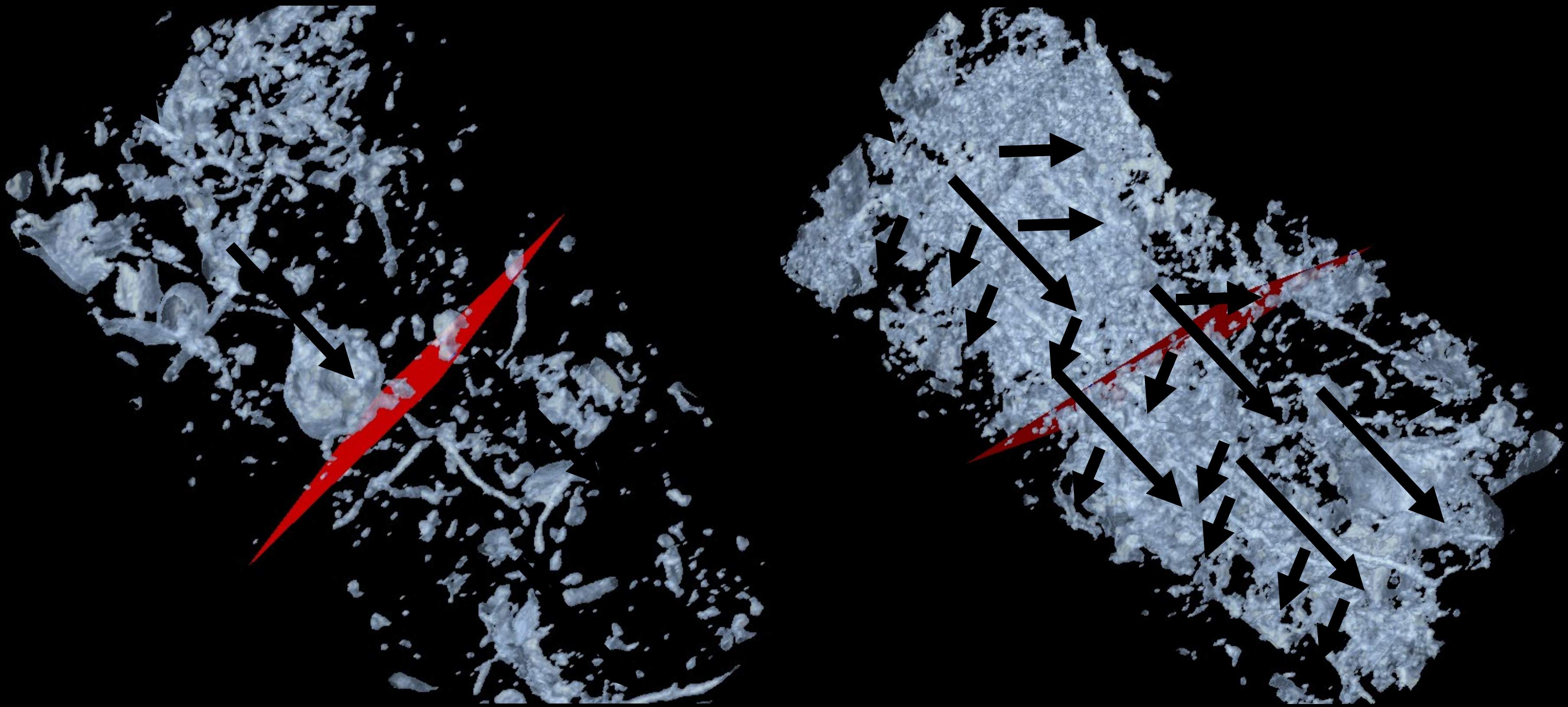
Biological system

Compost application,
pasture in rows, no irrigation,

→ 8.4 # C/y^2 (top 4”)

Plant & Food
RESEARCH
RANGAHAU AHUMĀRA KAI

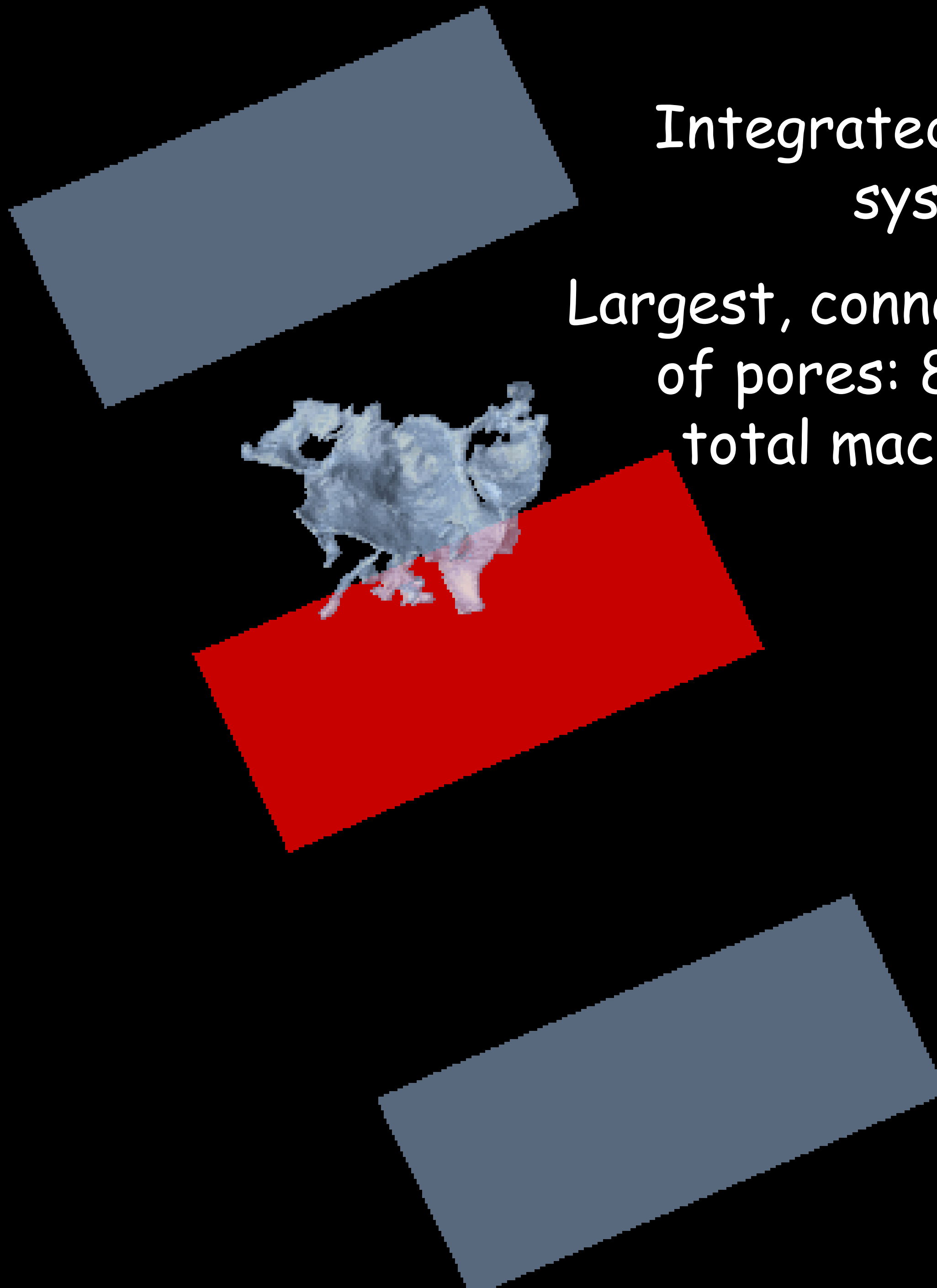
Macro-pores enhance the mixing of nutrients and contaminants

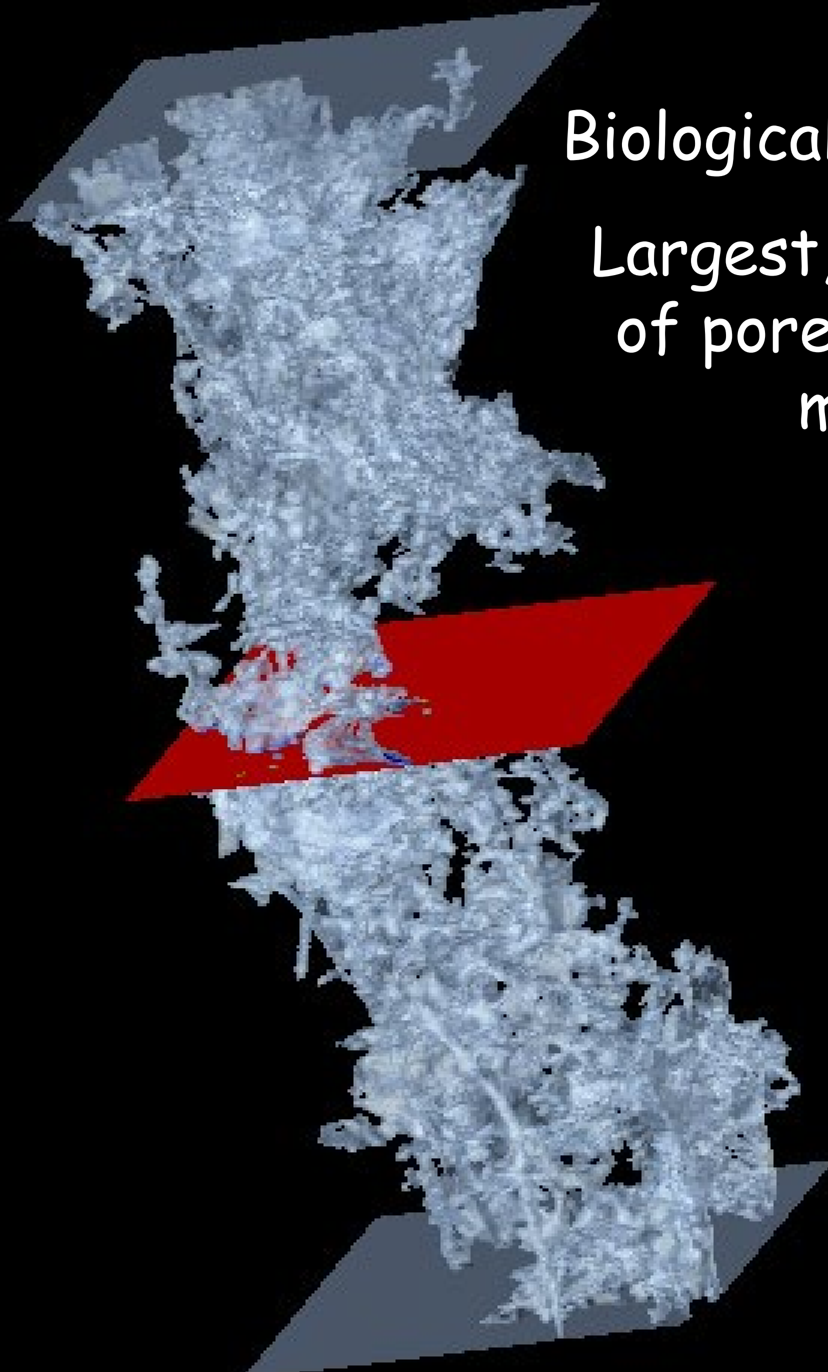


= better buffering of nutrients and filtering of contaminants

Integrated managed system

Largest, connected system of pores: 8.8% of the total macroporosity





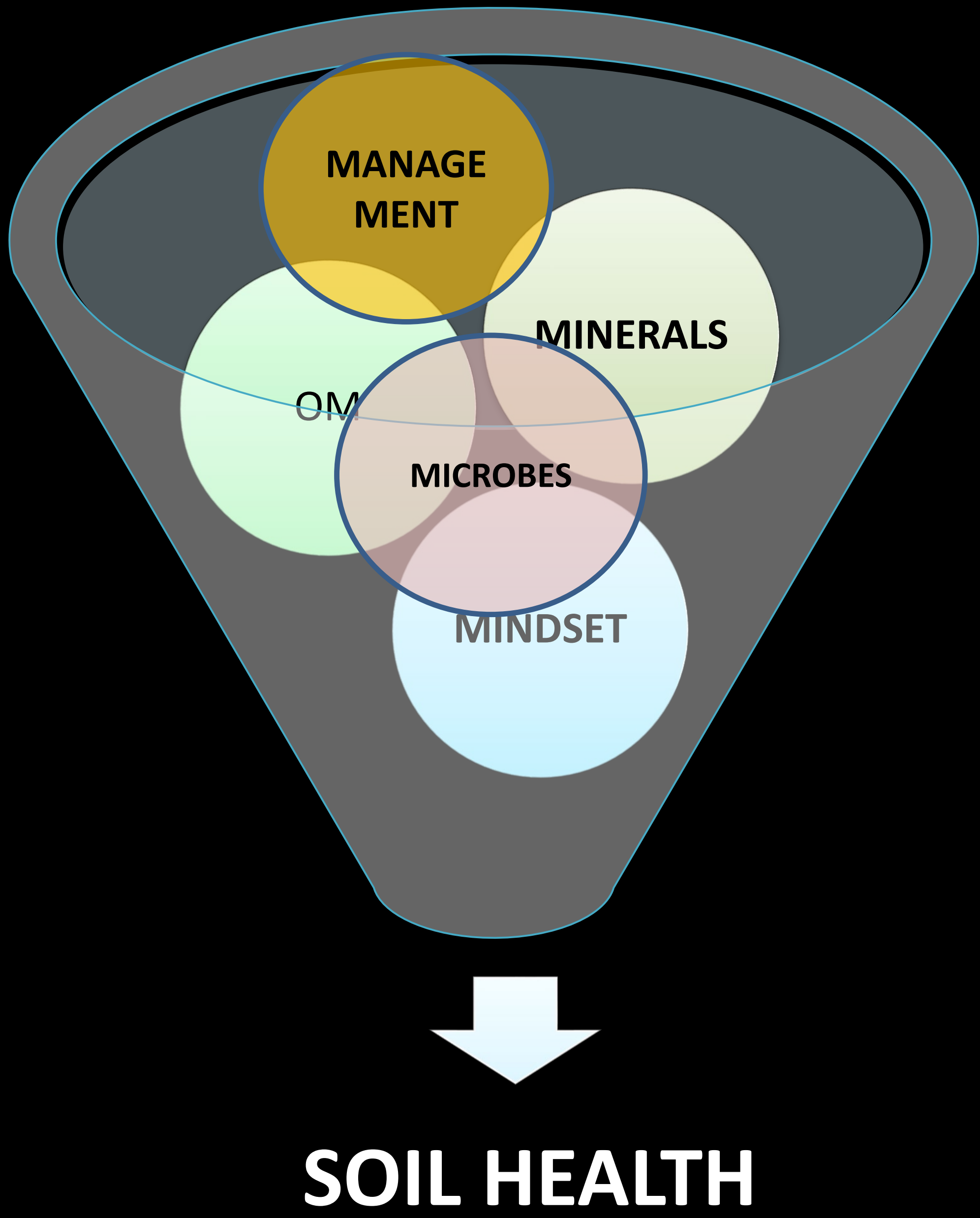
Biologically managed orchard

Largest, connected system of pores: 79% of the total macroporosity


NPK
168° F at 1/5” depth
Worm extracts
90° F

What is putting a drag on your farming system?

The 5 M's



Bacteria and archaea

- Oldest, simplest, most numerous organisms
- Involved in: disease suppression, nutrient retention, form soil micro-aggregates

Bacteria are essential. However,

- Bacterial dominance can lead to compaction
- High bacteria and low predators tie up nutrients
  - Increases nitrates in plants
- Germination signal for many “weeds”

What (who) makes it rain?

- 40-100% of ice crystals contain bacteria
- Pseudomonas syringae
  - ice nucleating bacteria
  - frost

Reducing the frost factors

- ***Reduce free nitrates***
- ***Higher sugar (brix)***
- ***Biological activity on leaves & in soil***
- ***Pseudomonas fluorescens***

Protect from frost damage as low as -6 °C for up to two months.

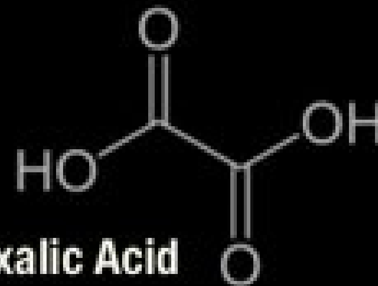
Frost and biology

Fungi

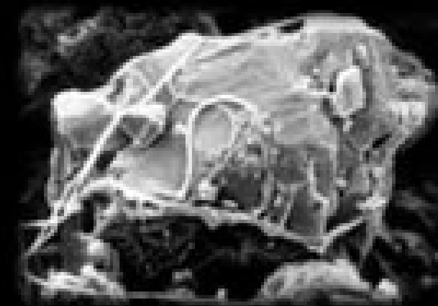
- Disease suppression
- Retain nutrients
- Decomposers
- Form soil <u>macro</u>aggregates
- Hold soils together
- Yield

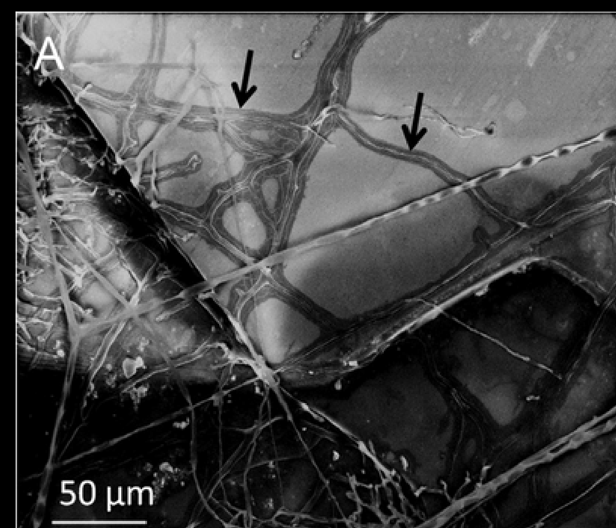
Geomycology

Fungi release nutrients bound on rocks



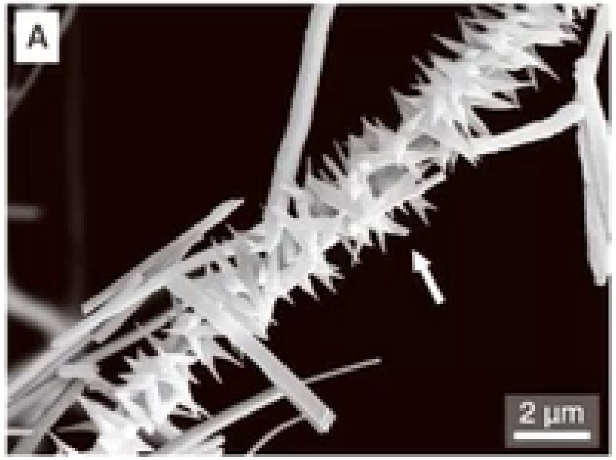
Oxalic Acid





Pinzari, F et al (2016). Routes of phlogopite weathering by three fungal strains. Fungal Biology. 120.

Fungal Biomineralization



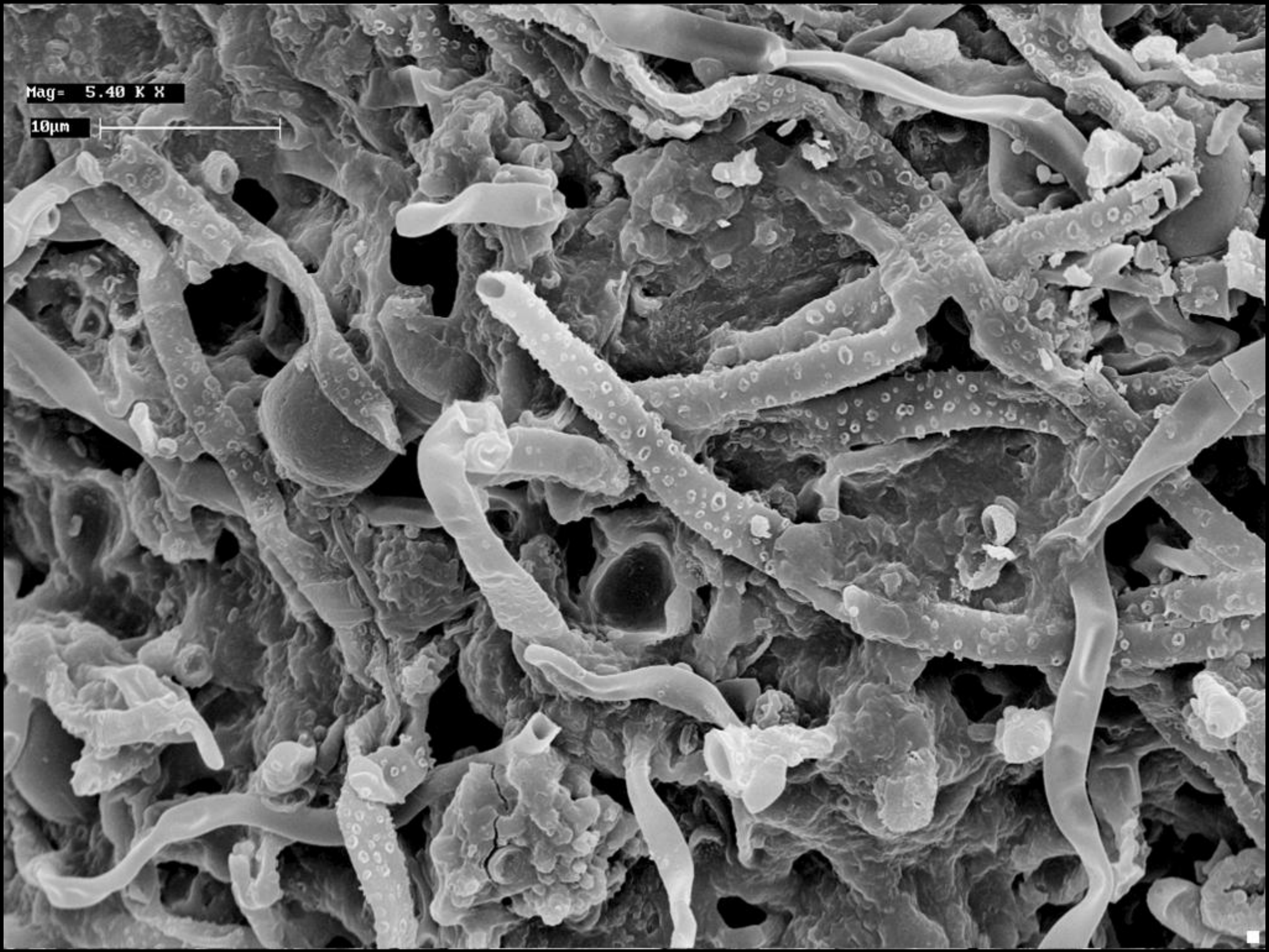
Weddelite ($CaC_2O_4 \cdot 2H_2O$)

Calcite ($CaCO_3$)

Recombine minerals to create new elements

Carbon sink

Calcium oxalate



Fungi:Bacteria ratios

- As F:B ratio increase, C accumulation increase
- NMSU showing F:B ratios are more closely related to production than NPK
- Low F:B ratios increases low quality ‘weed’ species

Fungal Foods

Fungi require more **complex carbons** “brown materials” e.g. ‘brown’ grass, cellulose, lignin, chitin, stubble, straw, fish hydrolysate, humates, biochar, wood chip…

Case Study Canada

35,000 acres growing wheat, barley, canola & peas.

Av precip 12 to 19” (incl snow)

Why change?

- Top 1% of producers in region
- Market signals
- Declining soil health
- Want to be the best!

Soil Concerns

- Tight compacted, poor soil structure
- Water logging /drought
- Low functional humus,
- Low biological activity, low AMF,
- high Mg, low trace elements,
- low sodium

1st year program Wheat

<u>Down the slot</u>

- Gypsum 35 #
- Humate 25 #
- Sea minerals 4 #
- Boron 0.6 #
- Zinc 0.35 #
- Copper 0.5 #

<u>Seed treatment</u>

- AMF, Trichoderma
- P-solubilising bacteria

<u>Foliar</u>

- 2.4 litres 10 10 10 (NPK)
- 300mls Fulvic acid

(1 kg 21% B in peas)


Buffer chemicals with Carbon

- Fulvic/humic lift cell wall permeability by 30%
- Fulvic acid (600mls/ha) with glyphosate
- Reduce herbicide use by 30%

Year One results

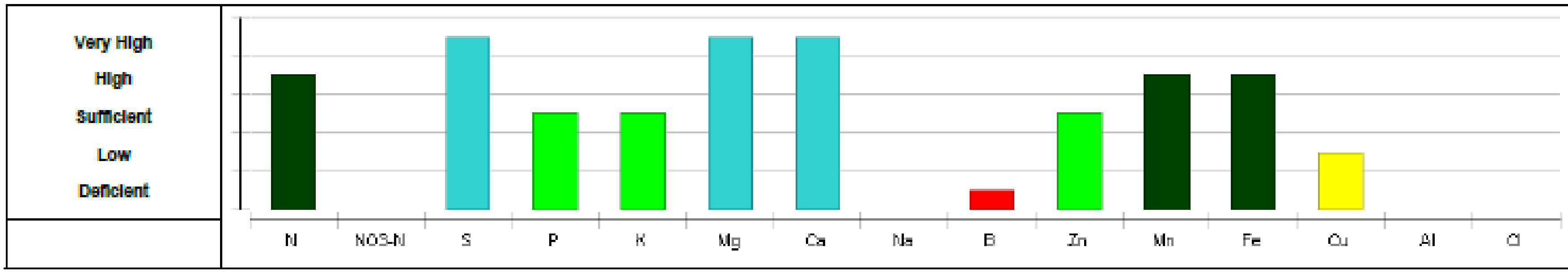
- Only 34mm rainfall!
- Roots through hardpan
- Awesome healthy crop and good yield

2016

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2016-08-04	2210017	4.25		0.62	0.22	2.42	0.76	0.85	0.08	3	24	225	125	4	54	
Normal Range		2.00 3.00		0.16 0.40	0.20 0.50	1.50 3.00	0.17 0.50	0.20 0.50		6 30	15 70	35 200	25 100	5 25		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	6.9	1.8	0.4	91	3.2	107	0.6	2443
Expected Ratio	8.9	1.1	1.3	88	7.2	460	1.3	194

Nutrient Sufficiency Ratings

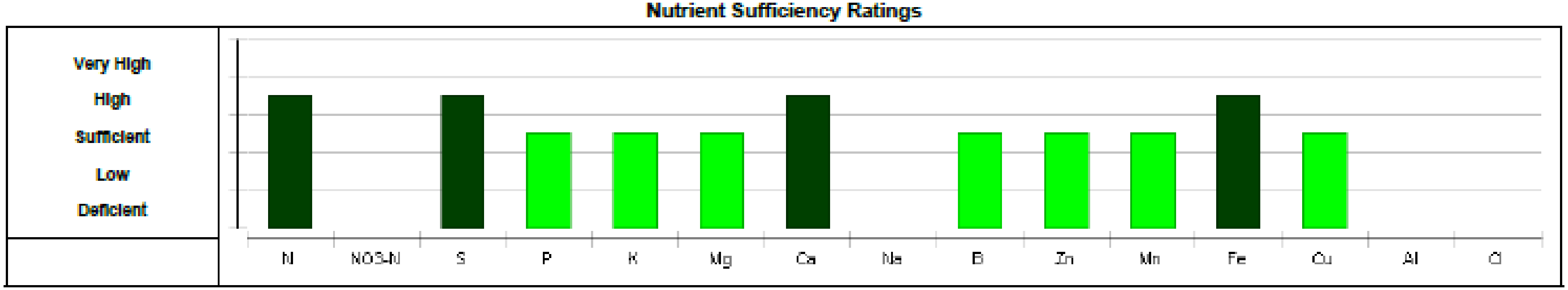


2017

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2017-08-01	2230055	3.54		0.41	0.23	1.86	0.28	0.56	0.02	9	19	44	123	12	51	
Normal Range		2.00 3.00		0.16 0.40	0.20 0.50	1.50 3.00	0.17 0.50	0.20 0.50		6 30	15 70	35 200	25 100	5 25		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.7	1.9	0.6	118	6.7	426	2.8	637
Expected Ratio	8.9	1.1	1.3	88	7.2	460	1.3	194

Nutrient Sufficiency Ratings



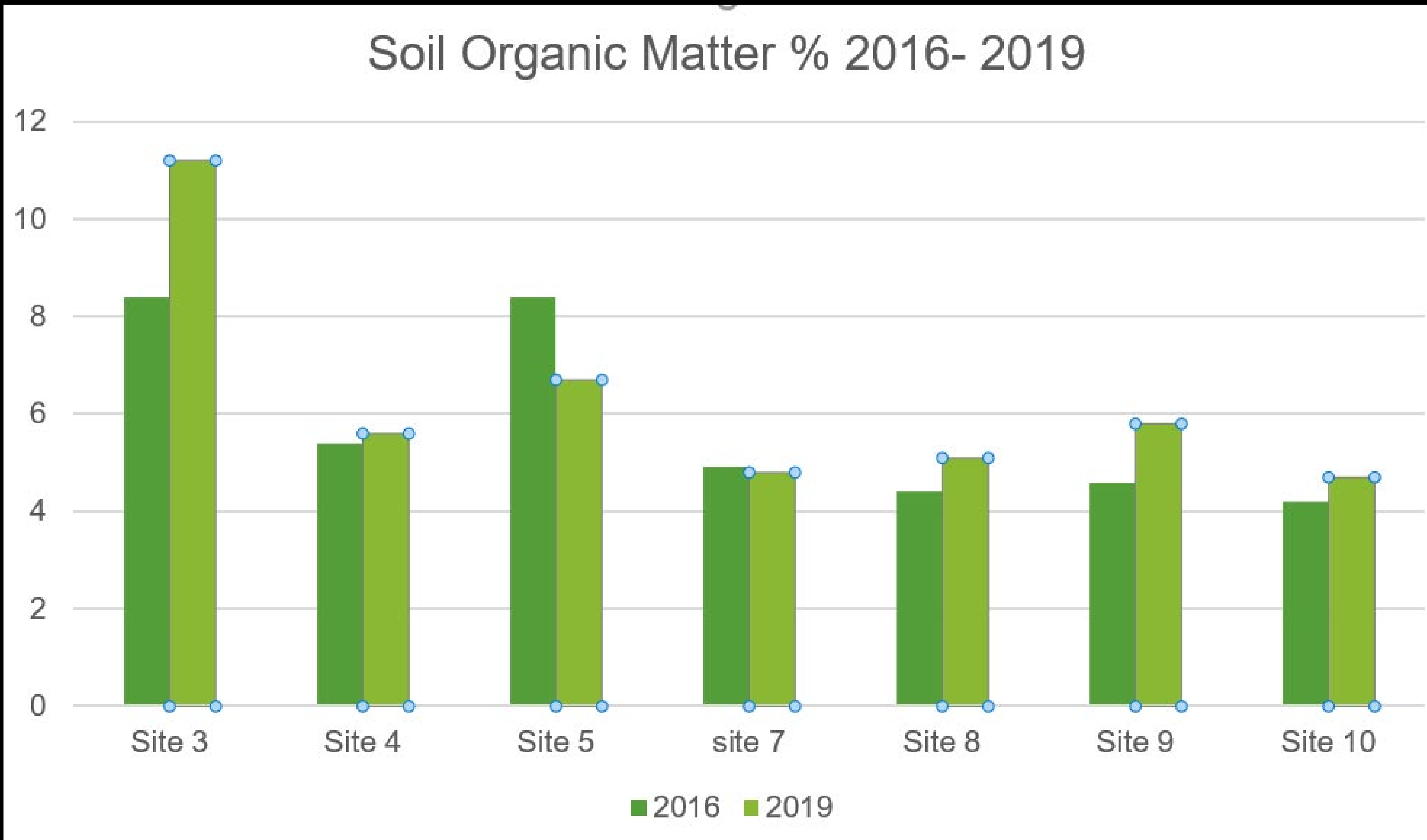
Year One results

- 60% reduction spend
- Roots through hardpan
- Awesome healthy crop and good yield
  - Wheat 70 bushels/acre

  – All on only 5” rainfall!

  – Cover crop failures

- Maintaining yield
- Decreasing costs
- Water infiltration increase 5-10x


Soil Organic Matter % 2016- 2019
12
10
8
6
4
2
0
Site 3
Site 4
Site 5
site 7
Site 8
Site 9
Site 10
2016
2019

Increases in Profitability

Passes	Savings
• Pesticides	• 95%
• Herbicides	• 40%
• Fuel	~ 20%
• Fertilizer/inputs	• $50/ac (year 1-3)

Ian & Di Haggarty

44,000 ac, sheep and cropping

5 properties in WA, 8 inches “average” annual rainfall

Program

Post grazing- seed drilled with vermi-liquid @ 0.5 gal/ac.

On new rehab land - 12 gal compost extract

Low rate glyphosate pre-emergent

Year round ground cover

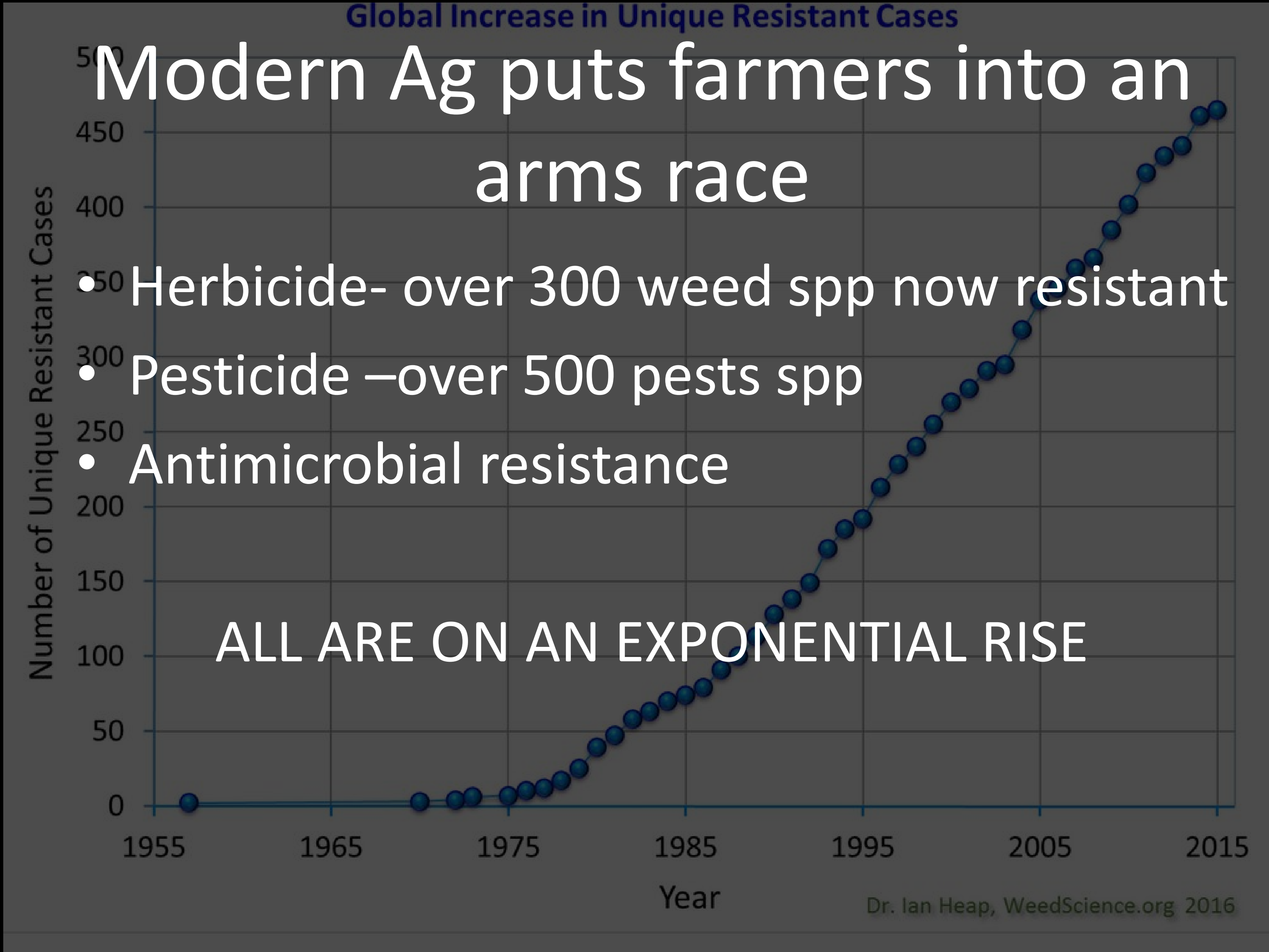
Year 1: Buttongrasses
Kerosene grass
Windmill grasses
(Early sucessional grasses)

Year 2:
Serratia spp
Native C4 palatable grass

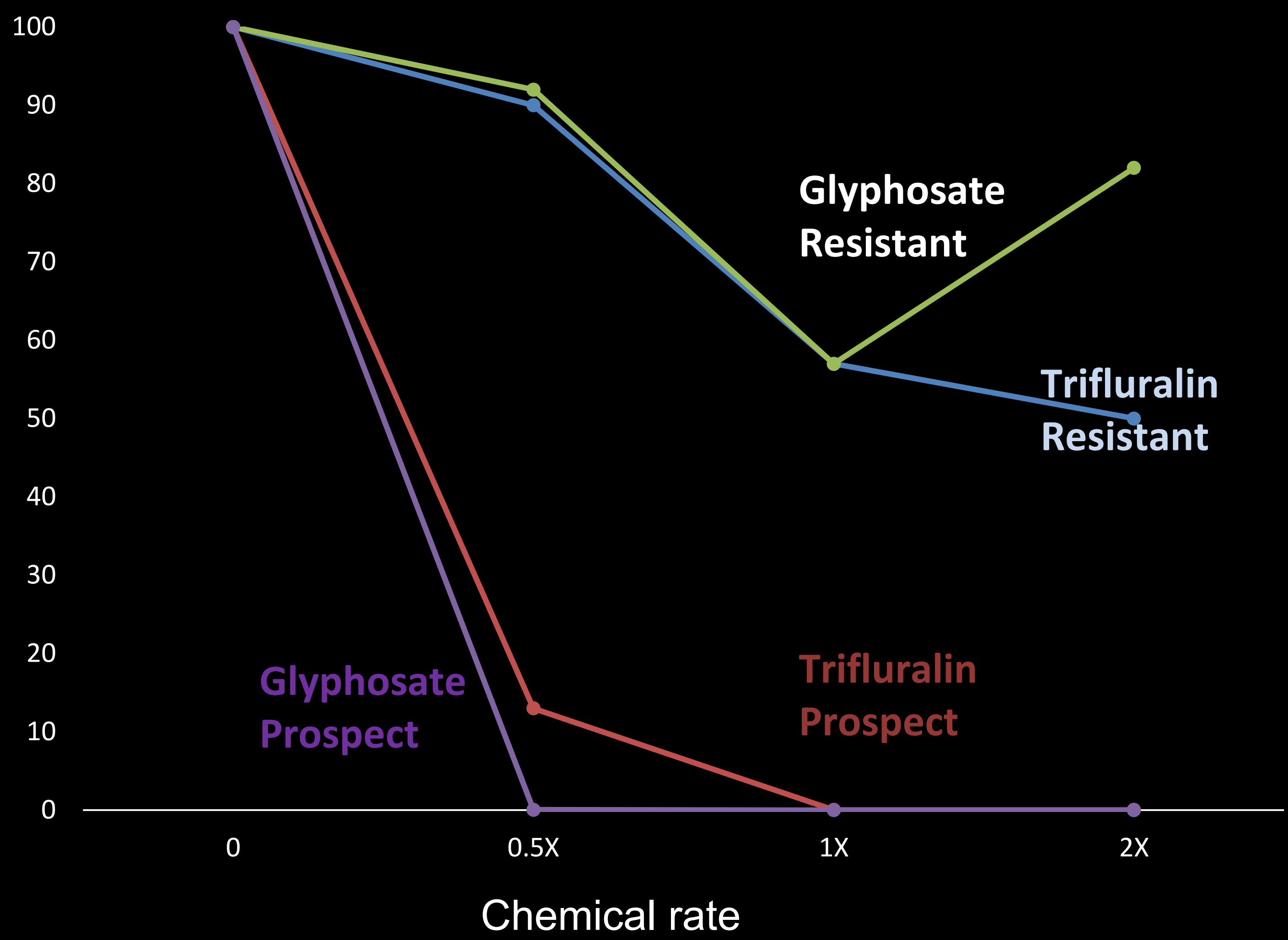
Modern Ag puts farmers into an arms race

- Herbicide- over 300 weed spp now resistant
- Pesticide –over 500 pests spp
- Antimicrobial resistance

ALL ARE ON AN EXPONENTIAL RISE



Herbicide resistance in ryegrass



What signal are you sending?

- Optimise plant brix (photosynthesis)
- Ensure year round cover
- Increase root mass
- Lift above/below diversity & biomass
- Address limiting factors
  - air, water, decomposition?

Image Credit: Kayla Sargent, Western Ag Reporter

"Regenerative Agriculture is the way of the future; indeed without it there is no future for Western Australia"

Alannah Mactiernan,

WA Minister for Ag and Food

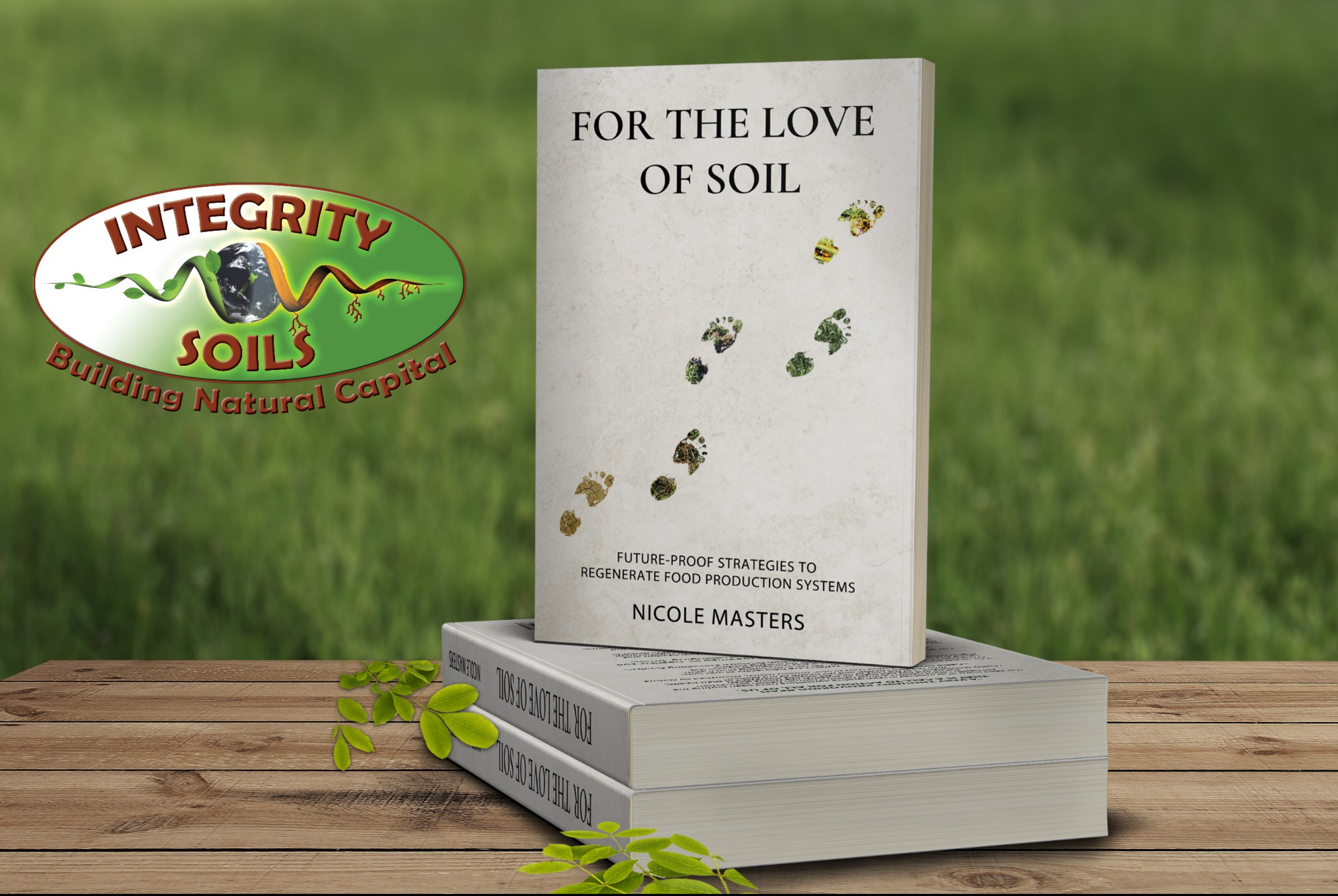
An Enriched Future

Getting fit for a better world is key.

We have identified five elements that are crucial to making that happen.

1. A regenerative mindset: thinking about what we can regenerate in our ecosystems.
2. A Taiao approach, and we talk about that in more detail below.
3. Our commitment to ethical production systems.
4. Delivering outstanding products for discerning consumers around the world.
5. We need to make the most of our New Zealandness in everything we do.

In 2005, Barry Marshall and Robin Warren were awarded the Nobel prize in Physiology


INTEGRITY
SOILS
Building Natural Capital
FOR THE LOVE OF SOIL
FUTURE-PROOF STRATEGIES TO REGENERATE FOOD PRODUCTION SYSTEMS
NICOLE MASTERS

Where do you see for the future Agriculture?

- Complicated, mechanical fixes?
- Deep, ecological, complex and adaptive solutions that address root causes?

How do we transition profitably?

By repairing and regenerating the microbial bridge

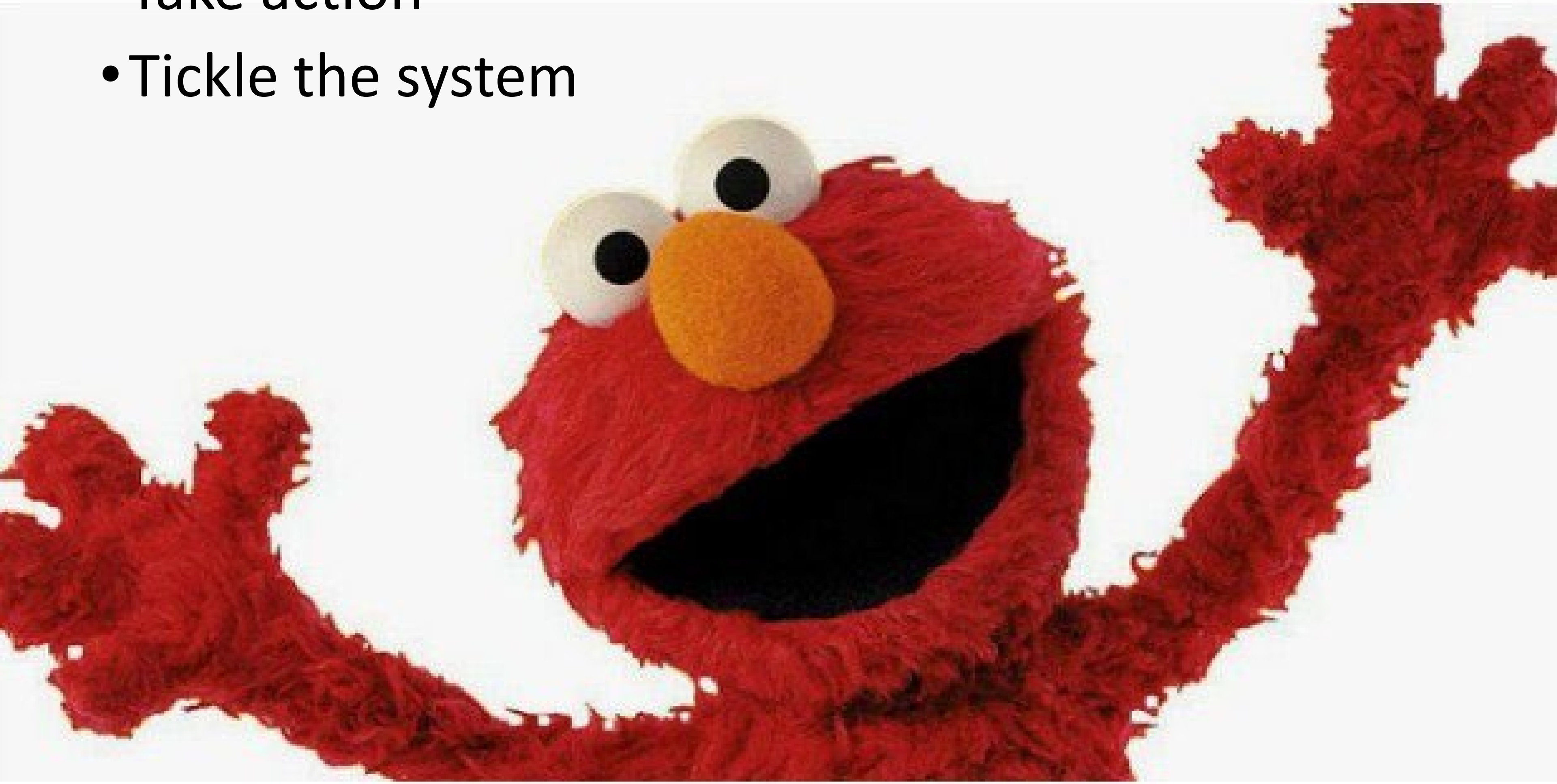
Feed your underground workforce

- Lift plant brix (photosynthesis)
- Is there a trace element or mineral holding you back?

- Avoid bare ground and overgrazing at any cost
- Improve plant root systems through species selection and above-ground management

Keys for success

- Identify major limiting factors
- Take action
- Tickle the system



Indreland Angus

Concerns:

- Low Brix (13) , Brix same thru day
- Low N, P, low trace elements; B and Mn
- High insect pressure

2 alfalfa treatments

- Bio Block
  - 2 gal fish hydrolysate
  - 10 Lbs trace element (based on soil/forage test)
  - 8 oz humic acid

  Cost $20/ac

- Conv fertility


Hillsboro

Hillsboro

Forage tests

DM Basis	'Supreme'	Bio Alfalfa	Control Alfalfa
Crude Protein	>22%	29.7	**21.9**
NDF	<34	28.5	**37.5**
TDN	>62	70.1	**62.4**
RFQ	>180	222	**155**

Results

- Brix lifted to 20
- Faster recover after grazing/hay
- Minimal insect damage
- Crop yield improvements
- 1 T/ac crop

A tale of 2 soils


On Pasture

120 years of management

South Side

- 120 years under degrading irrigation system
- Cut for hay
- Horse grazing

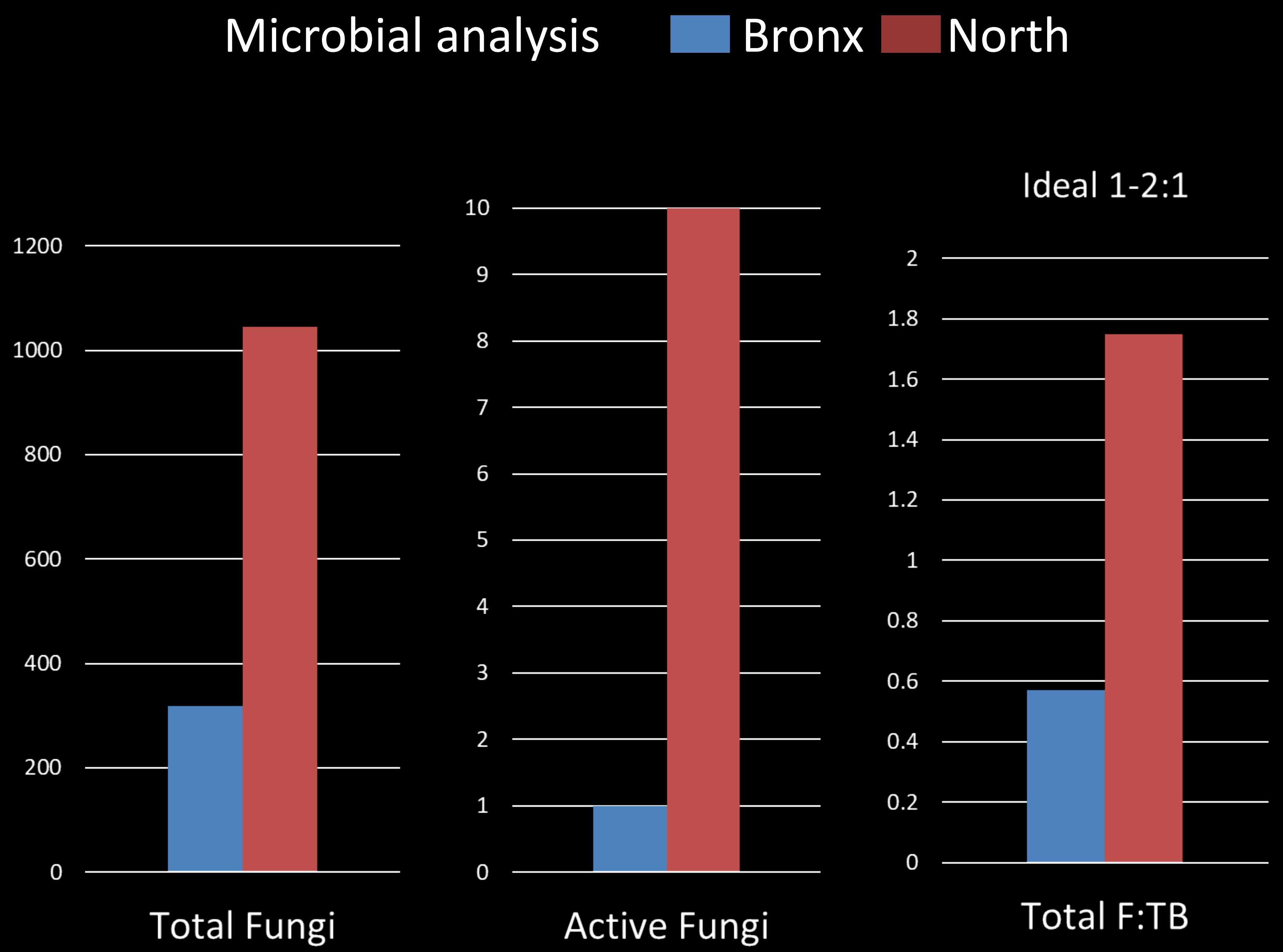
North Side

- Under tall sage >30years
- 30 years Holistic management
- Good irrigation practices

24 mins 1” water infiltration
80% unpalatable plants, 80% non-mycorrhizal


1 min 2” water infiltration
<5% unpalatable species

10x humus
Humus holds 7 X weight in water= 70x more water holding capacity


Microbial analysis
Bronx
North
1200
1000
800
600
400
200
0
Total Fungi
10
9
8
7
6
5
4
3
2
1
0
Active Fungi
Ideal 1-2:1
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Total F:TB

South Side

- Flagellates **297** > 10,000
- N potential: 100 lbs/acre
- AMF **9**% > 10%
- 16% root feeding nematodes

North Side

- Flagellates **16,441** > 10,000
- N potential: **300+** lbs/acre
- AMF **14** % > 10%
- 5% root feeding nematodes

2018 program

- Direct drill 7 spp mix

With 30kg vermicast

Foliar application:

- fish hydrolysate, molasses, humic, redmonds salt

2 lazy 2 Ranch, Billings, MT

- 12 “ rainfall, 40” pan evaporation
- 3200 – 3800’ elevation
- Started Holistic Management in early 1990’s
- Early success- lifting stock numbers. <5 day moves

Concerns

- Animal health
- Bare ground
- Poor diversity
  - Sage and crested wheat
- In 1993 25 years of holistic management




NEW HOLLAND


2 lb vermicast as extract/acre

- 1 lb vermicast as extract/acre

What is the purpose of Ag?

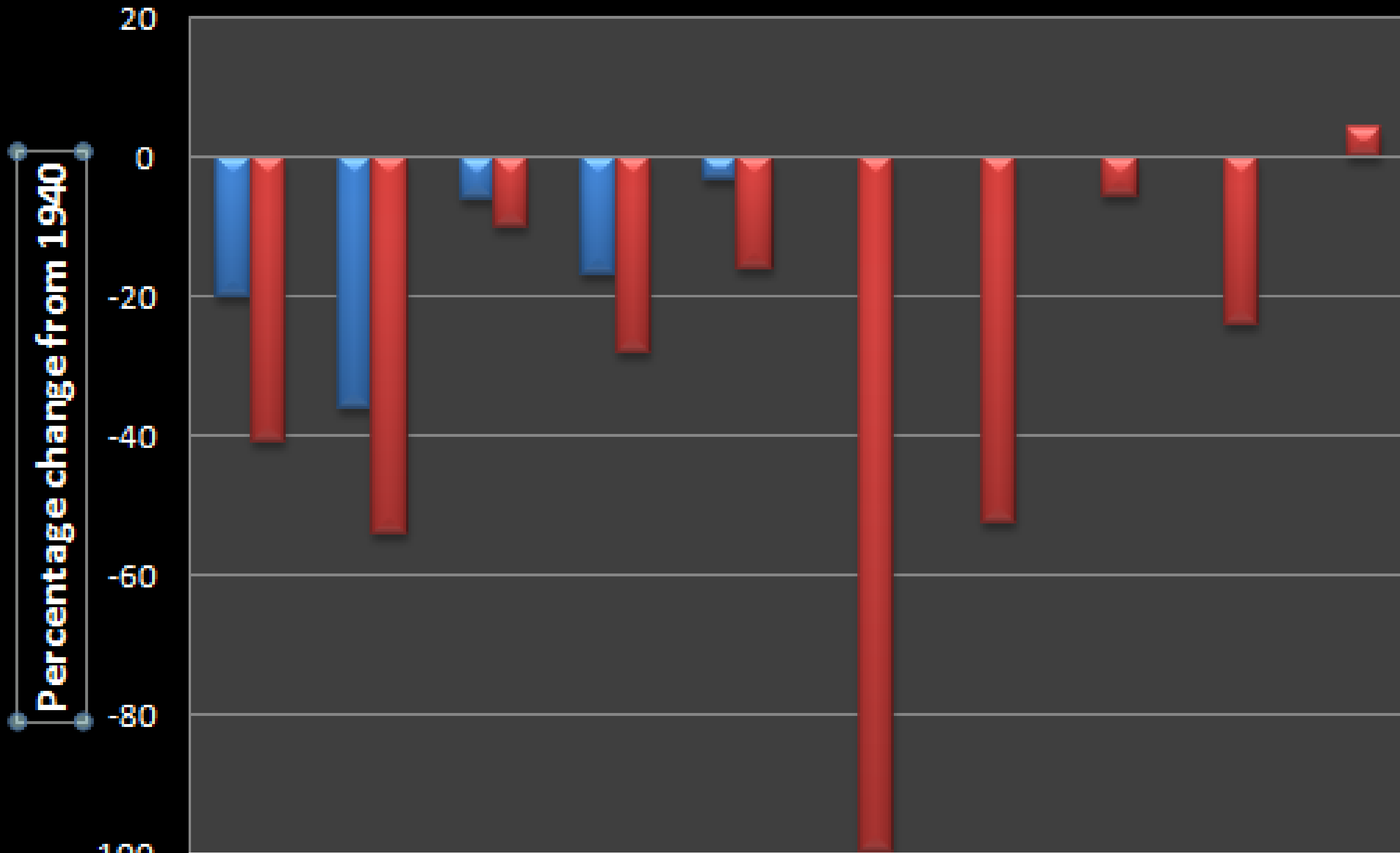
Many agricultural scientists deny that there is any link between human health and what happens on-farm, however…

70 YEARS OF SOIL DEPLETION

The reduction in average mineral content of fruits and vegetables since 1940.†

MINERAL	VEGETABLES	FRUITS
Sodium	-49%	-29%
Potassium	-16%	-19%
Magnesium	-24%	-16%
Calcium	-46%	-16%
Iron	-27%	-24%
Copper	-76%	-20%
Zinc	-59%	-27%

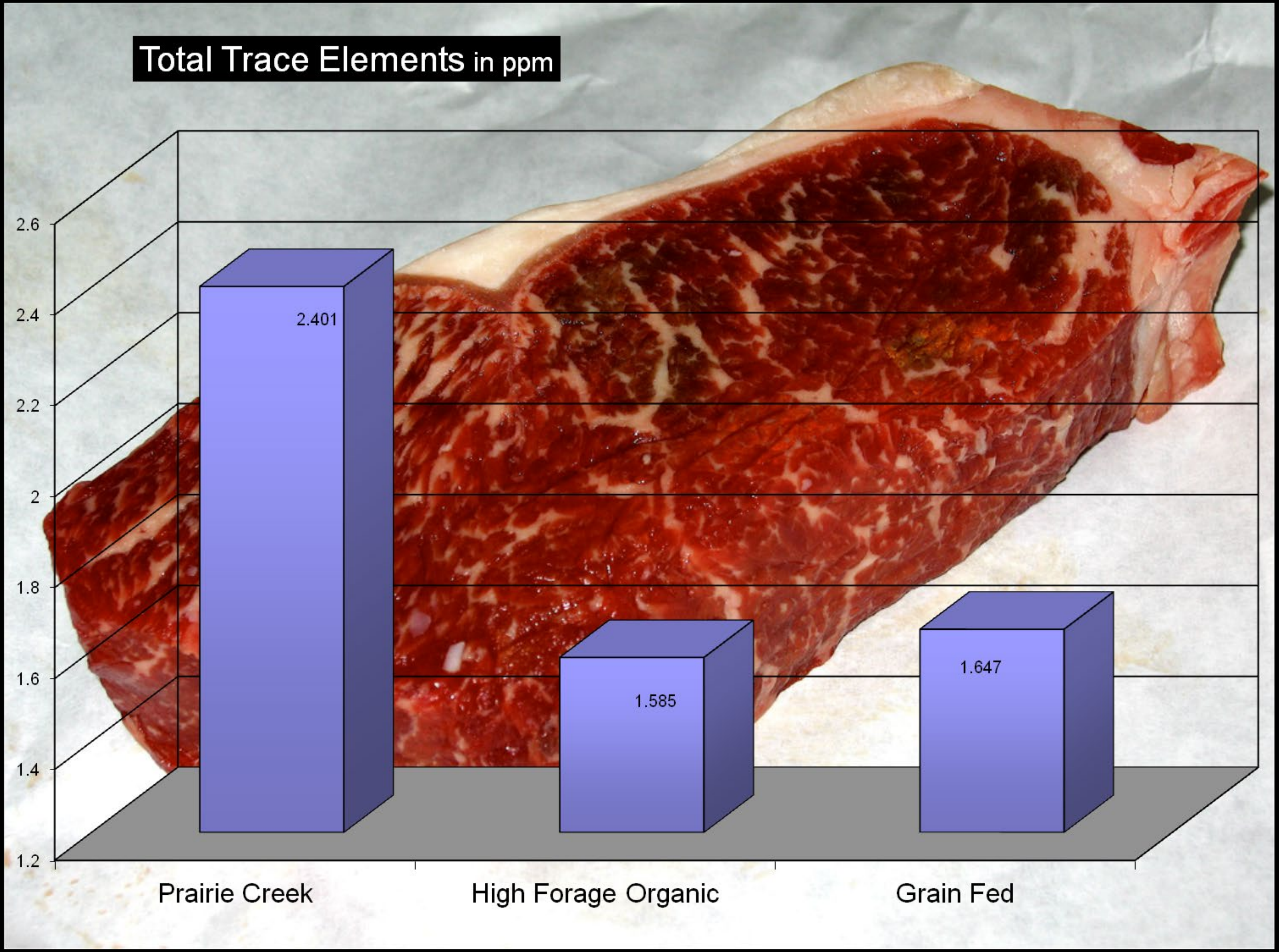
% Changes in beef nutrient density 1940-1991



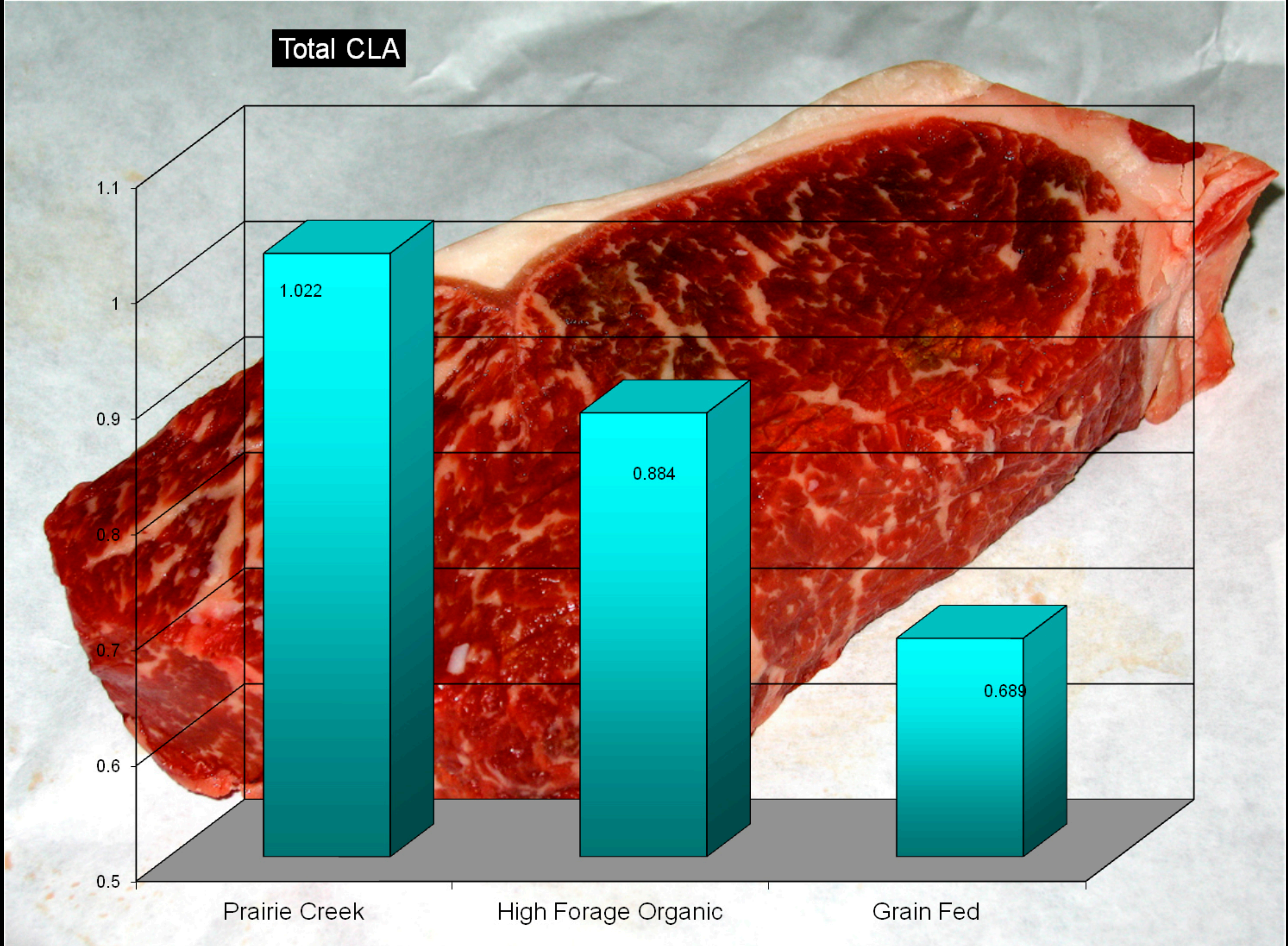
	Ca	Fe	Mg	P	K	Vit A	Thiamine	Riboflavin	Cu	Niacin
1963	-20	-36	-5.9	-16.7	-3.4	0	0	0	0	0
1991	-41	-54	-10	-28	-16	-100	-52.5	-5.63	-24	4.19

3 cattle operations

1. Low rates: composted chicken litter, gypsum, rock phosphate and a trace mineral blend. Diverse pastures, adaptive grazing.
2. Certified organic grassfed, nil inputs
3. Feedlot, grain fed, balanced ration

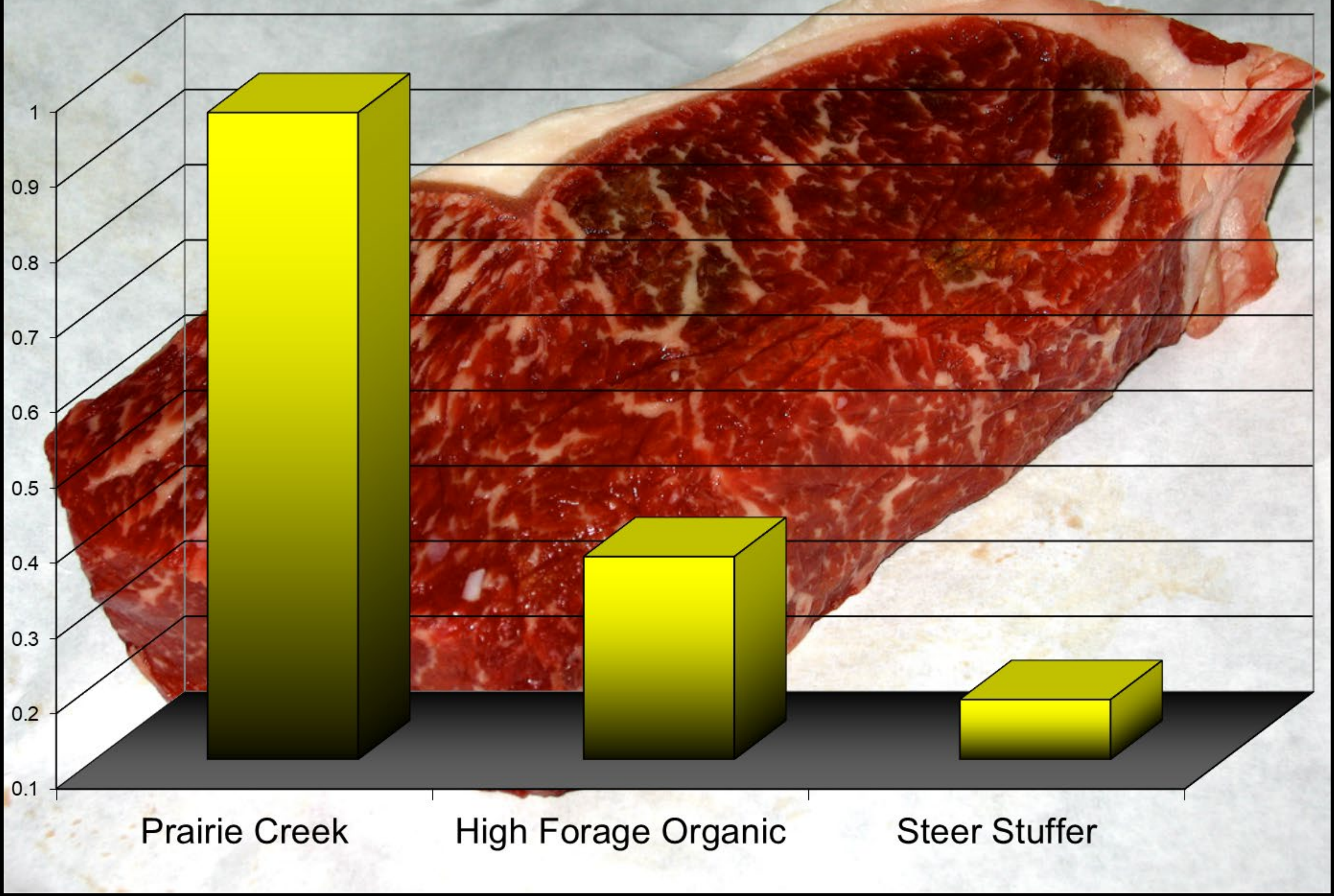


Beef with different feeding regimes and trace elements (US data)

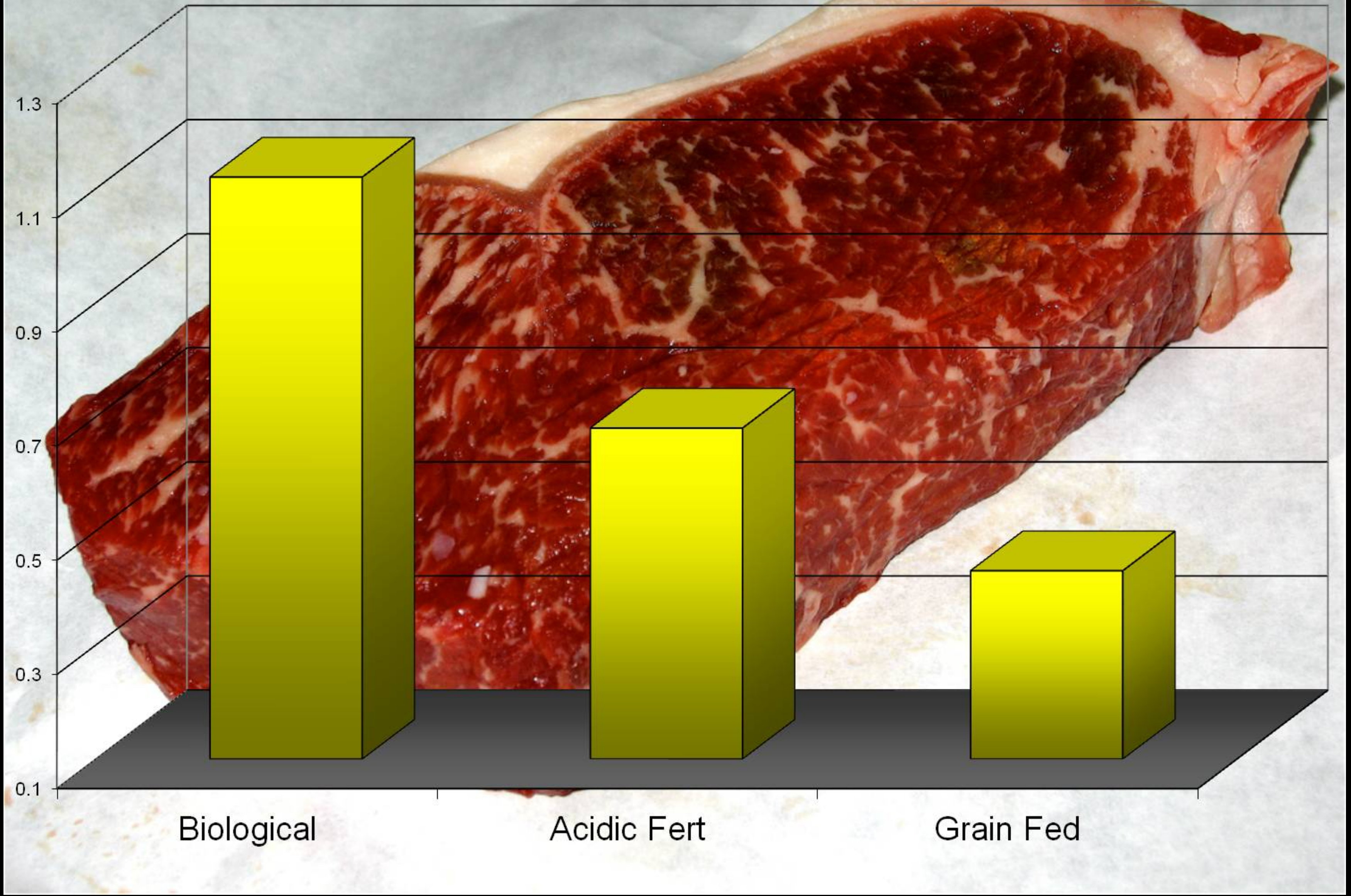


Beef with different feeding regimes and CLA (US data)

Omega 3 to Omega 6 Ratio



Omega 3 to Omega 6 Ratio



NZ data comparing beef under different fertilizer/ feeding regimes www.integritysoils.co.nz

INTEGRITY SOILS

Biological Education Specialists