



Soil Health Success

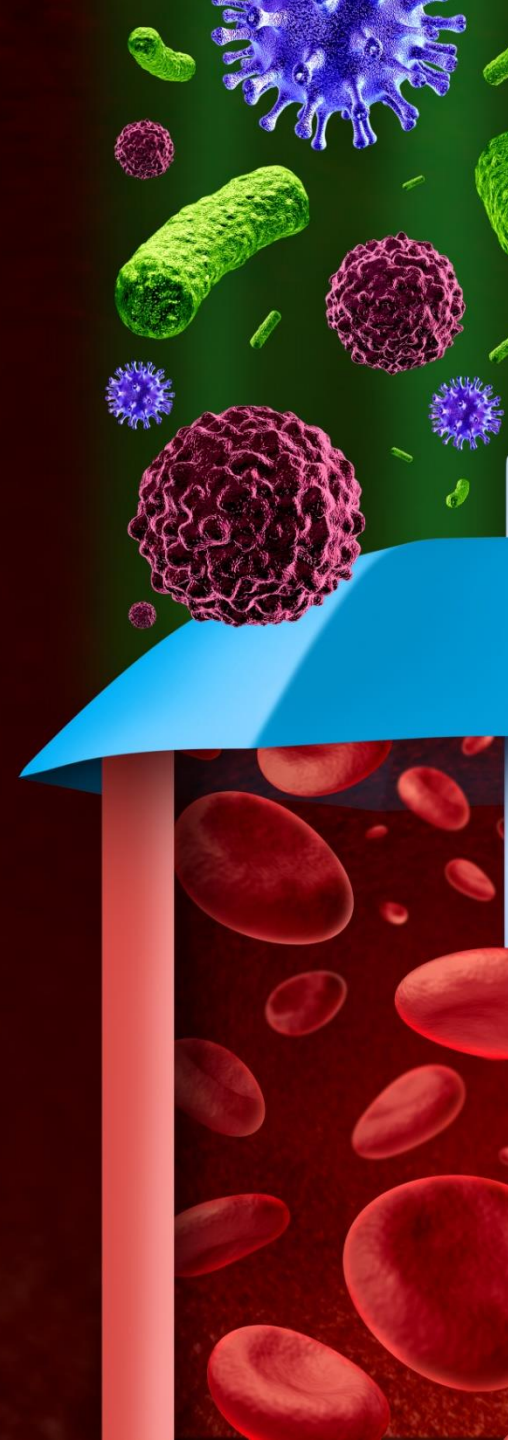
with Nicole Masters





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....



We've blown the microbial bridge



We're doing the same to our soils

They have indigestion, constipation, gas and diarrhoea



Canada loses 1-2 T topsoil
per T of grain

Healthy Soils

- Hold onto and release nutrients
- Hold onto and release water
- Have great structure
- Are full of life
- Protect against pests & disease

Healthy soils contd...

- Decompose and detoxify
- Buffer to changeable climate
- Are full of secondary metabolites, plant growth hormones and enzymes
- Grow healthy, nutrient dense crops



Which all means...

Resilience

Productivity

Animal health

Reduced need for inputs

Reduced costs \$\$

= PROFIT!



Kenny, G. (2011). Adaptation in agriculture: lessons for resilience from eastern regions of New Zealand. Climatic Change, 106(3), 441-462.

Microbiology

Management

Chemistry;
nutrient ratios,
pH

Soil texture,
CEC, BS

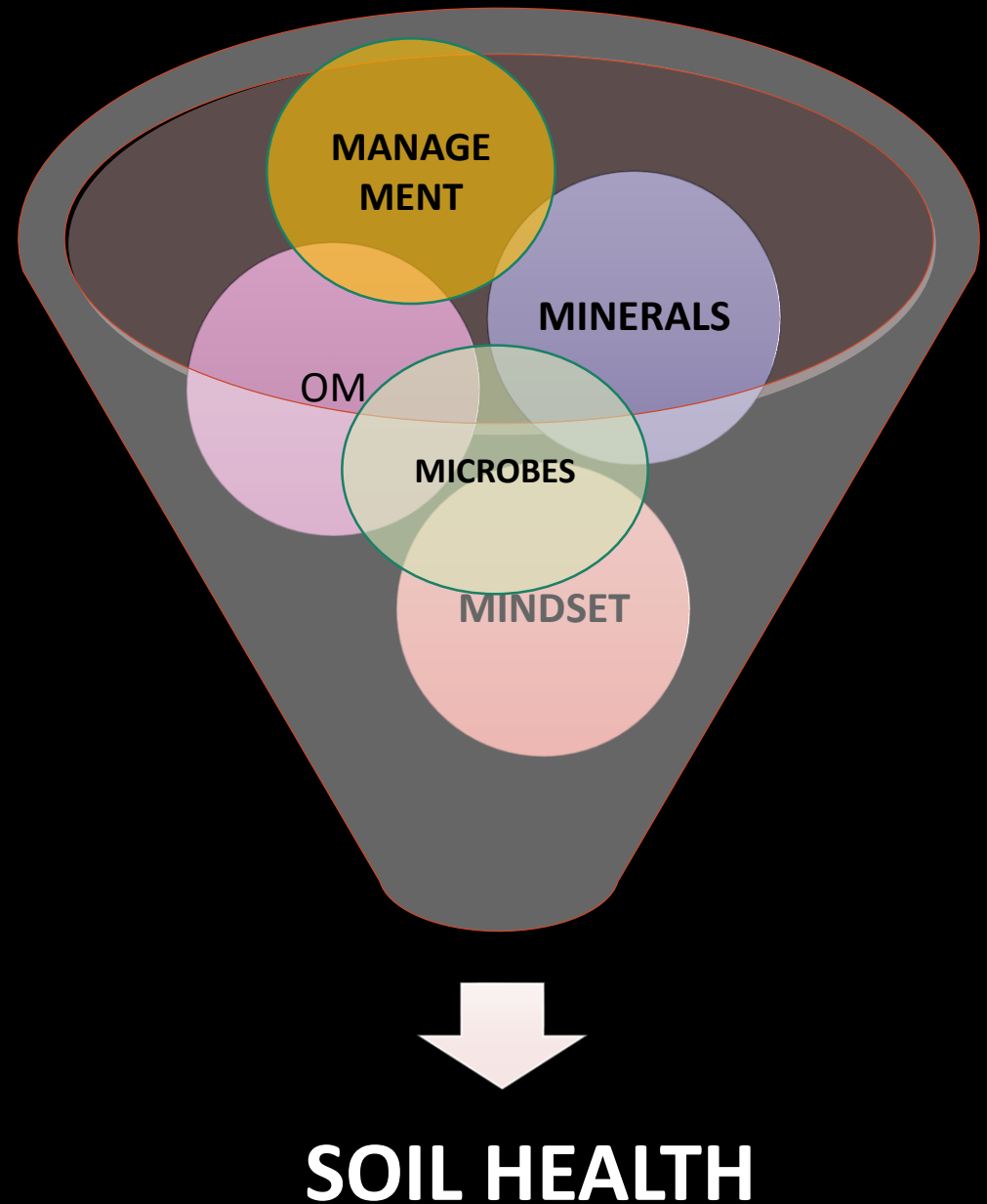
Physics and
Energy

These elements do not stand in
isolation: they are intimately linked

What is putting a drag on your ranching system?

The 5 M's

What is putting
a drag on your
production
business?



EMERGENCY



TRIAGE NURSE

*Being the worst
makes you first.*

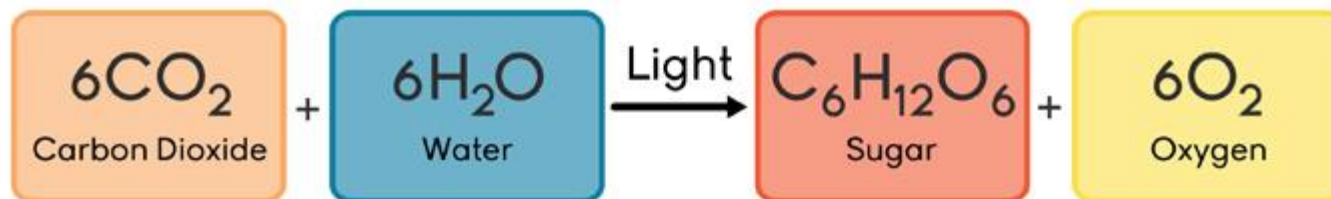
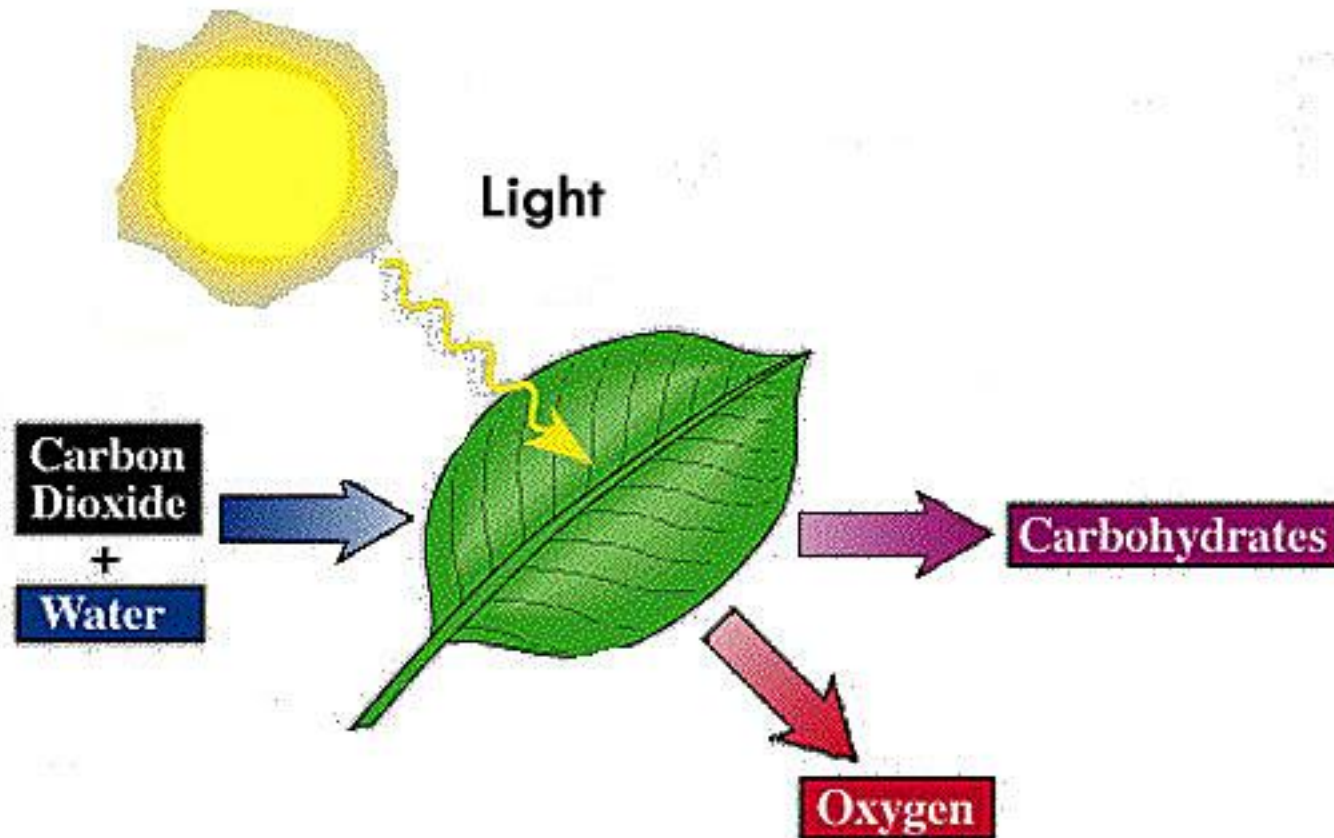
THE
SARCASM
SHOP

Principles to harness solar harvest

- Principle 1: Let 'em breathe
- Principle 2: Just add water
- Principle 3: Digestion

- Principle 4: Feed your microbes
- Principle 5: Tickle the system with balanced nutrition

Solar Ranchers



Refractometers

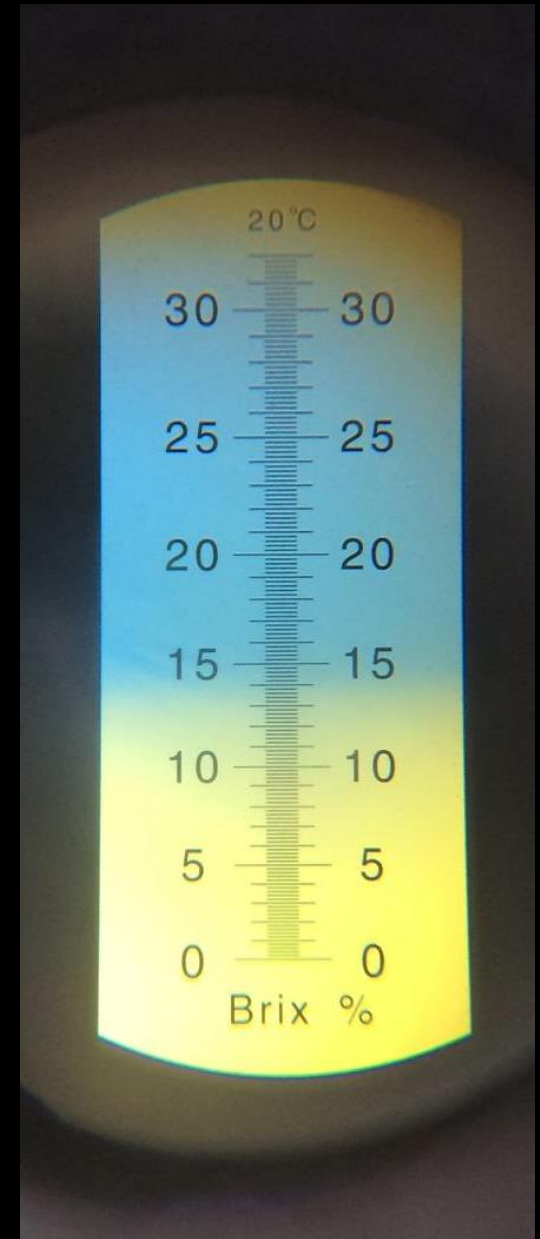
- The function of plants is to produce sugar which lead to the manufacture what goes out the farm gate!

= PROFIT



Brix

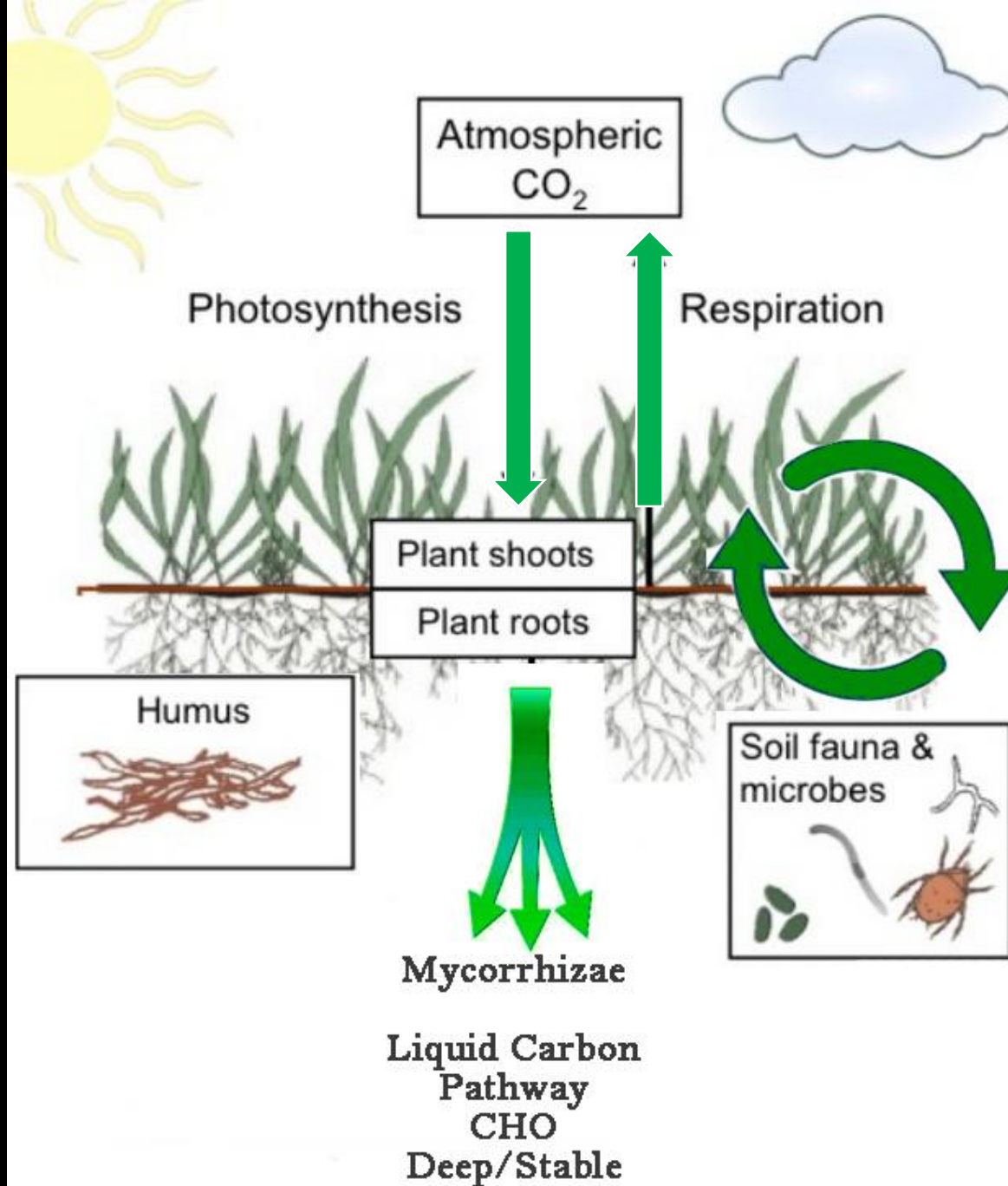
- A measure of sugars & dissolved solids
- Optimal photosynthesis and plant health occurs when the brix is 12 and over



- Chicory trial
- 4 gal/milk/ac
- Brix in chicory from 3 to 8
- Brix in nightshade 18 to 6

What is the main pathway for stable organic carbon into soil?

- A. Trampling grass
- B. Organic matter
- C. Worms
- D. Root exudates
- E. Dead roots



Without
AM



With
AM

C

N

C

C

H₂O

P

C

Zn

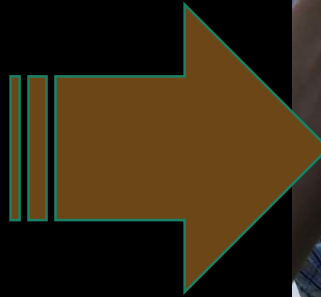
C



Regenerative farming
captures sunlight...



...and turns
it into soil

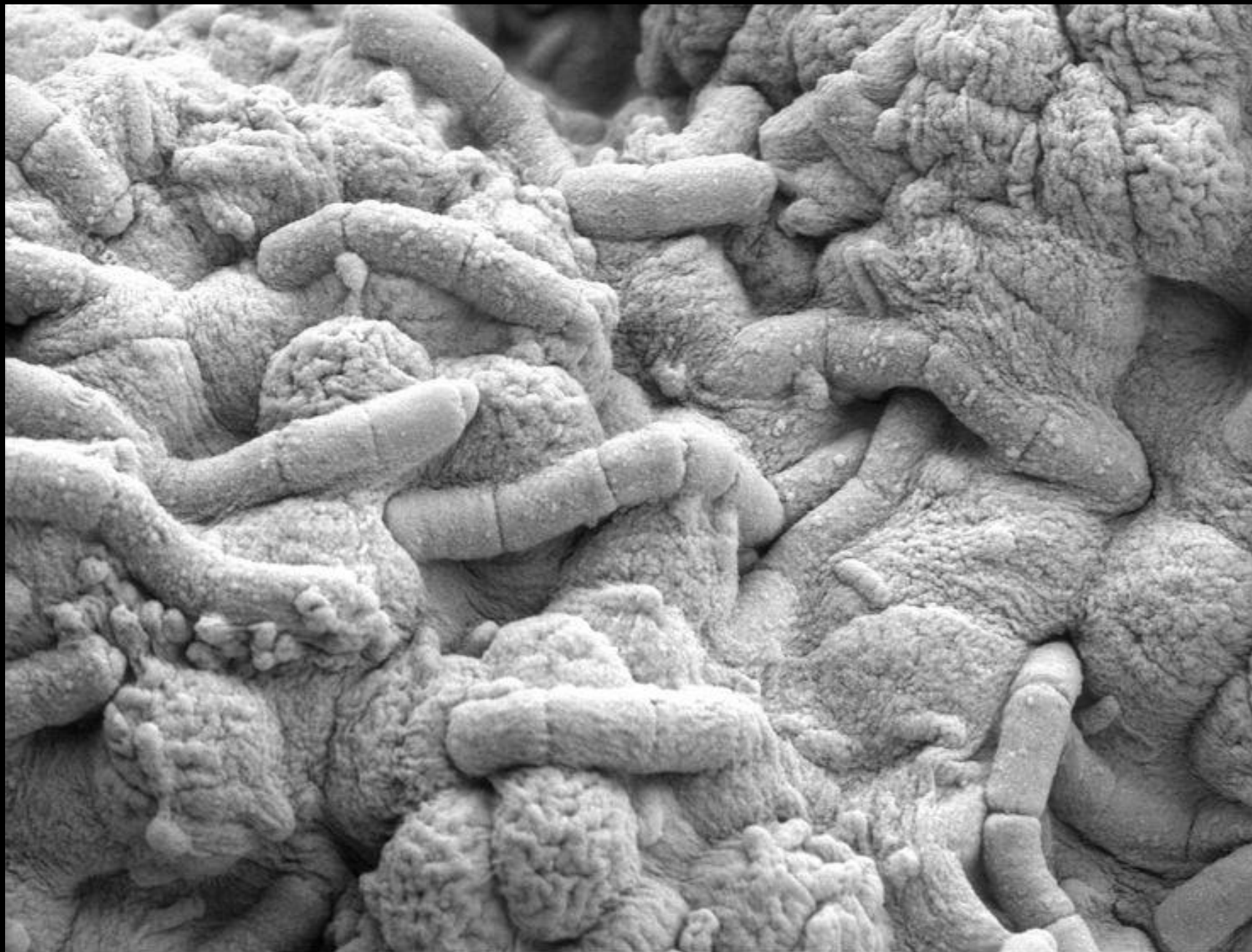


The key players...

- Bacteria
- Archaea
- Fungi
- Flagellates
- Amoebae
- Ciliates
- Nematodes
- Algae

} Collectively called
Protozoa





x5000

5 μ m

5kV

8mm

Bacteria and archaea

- Oldest, simplest, most numerous organisms

- Involved in:

disease suppression, nutrient retention, N cycle, decomposers

- Make fine Microaggregates

- Consume simple sugars

Bacteria multiplying and consuming organic matter

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*

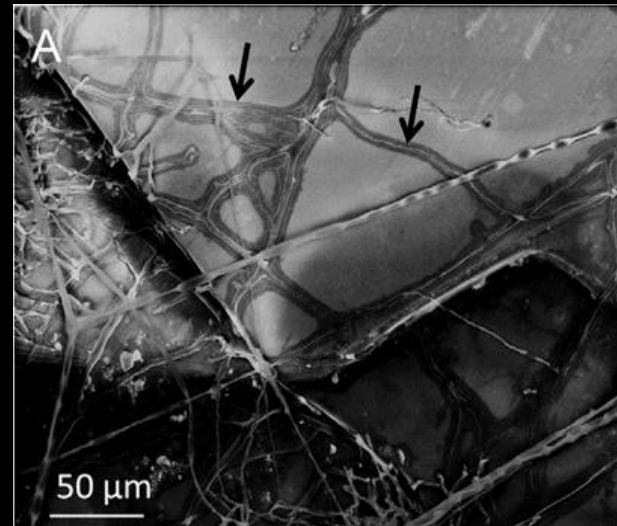
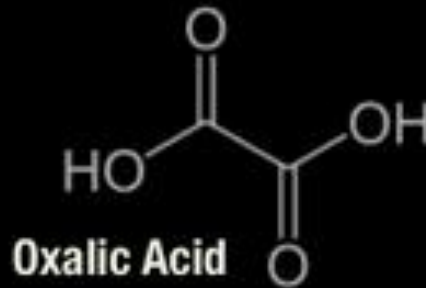
Protect from frost damage as low as -6 °C for up to two months.

Fungi

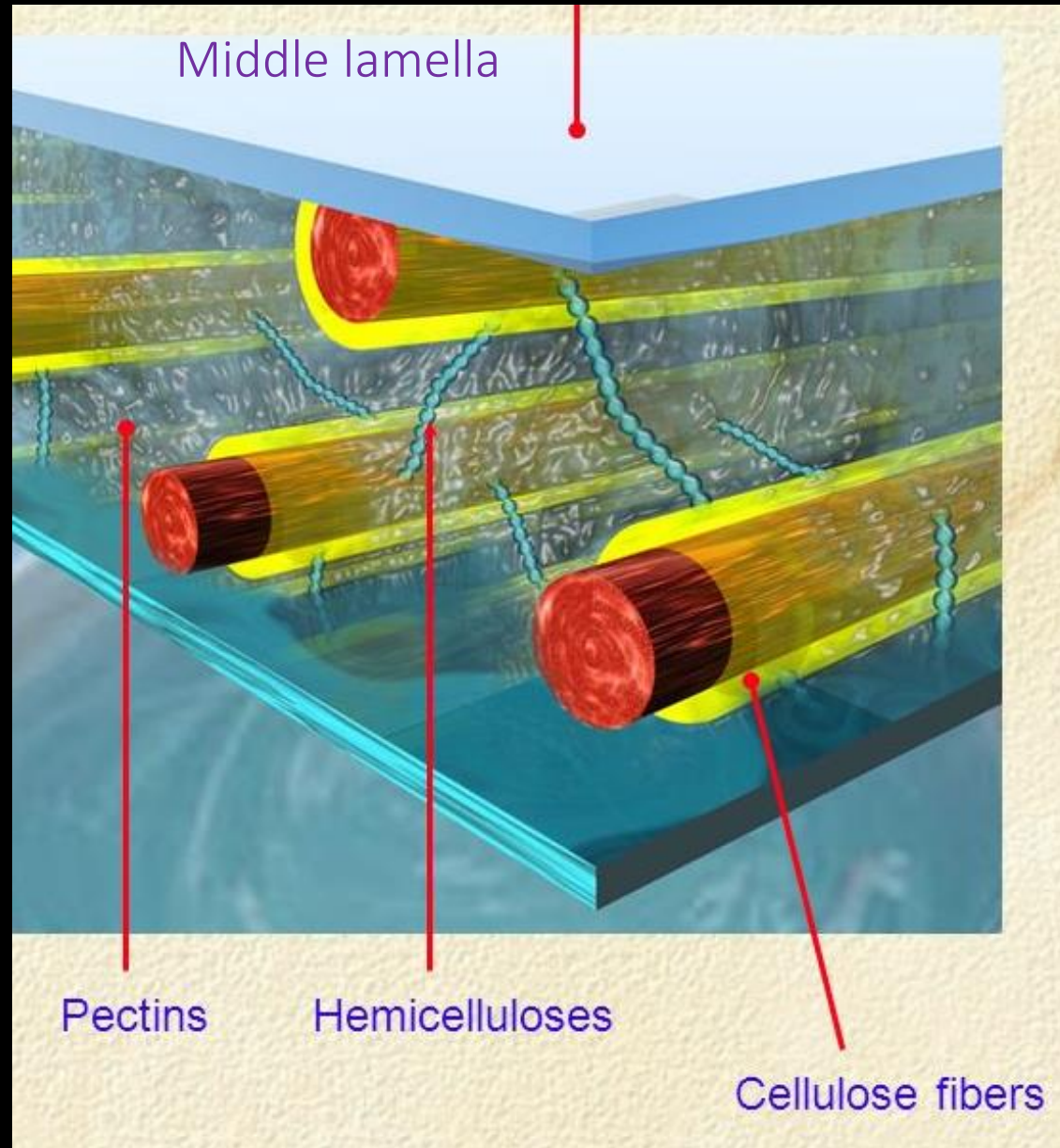
- Disease suppression
- Retain nutrients
- Decomposers
- Form soil macroaggregates
- Hold soils together
- Yield

Geomycology

Fungi
release
nutrients
bound on
rocks



Plant nutrition;
vitamins, enzymes,
quality have direct
relationships to soil
microbial activity



Calcium pectate

= quality forage.

- High brix, high ME, weight gains and milk
- Low fungal activity produces Mg pectate compounds which are inferior (rank)
 - Low brix, low ME, low RFV
 - Poor storability
 - Diseases and pests

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

Fungi make water. Literally

- When breaking down organic matter, 20% of what fungi produce is WATER

Fungal Foods

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

Review

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
- exudates, aromatics -
hormones, pheromones,
enzymes, vitamins, sugars,
amino acids & proteins...

Quorum sensing



Optimising biological diversity
and biomass is CRITICAL

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

Diverse communities

= more signals

= increased resilience to
stress

= crop health and quality



Ian & Di Haggarty, WA
“Prospect Farms”
Natural Intelligence Farming
Sheep and cropping
8” av rainfall

Program: Post grazing-
seed drilled with vermi-
liquid, compost extracts
10 litres/Ha

Nutrition

- Reduced frost damage
- Improved wool quality
- Zero chem-residue crops
- Increased storage
- Increase quality



What signal are you sending?

Program on degraded lands:

5 litres worm extract

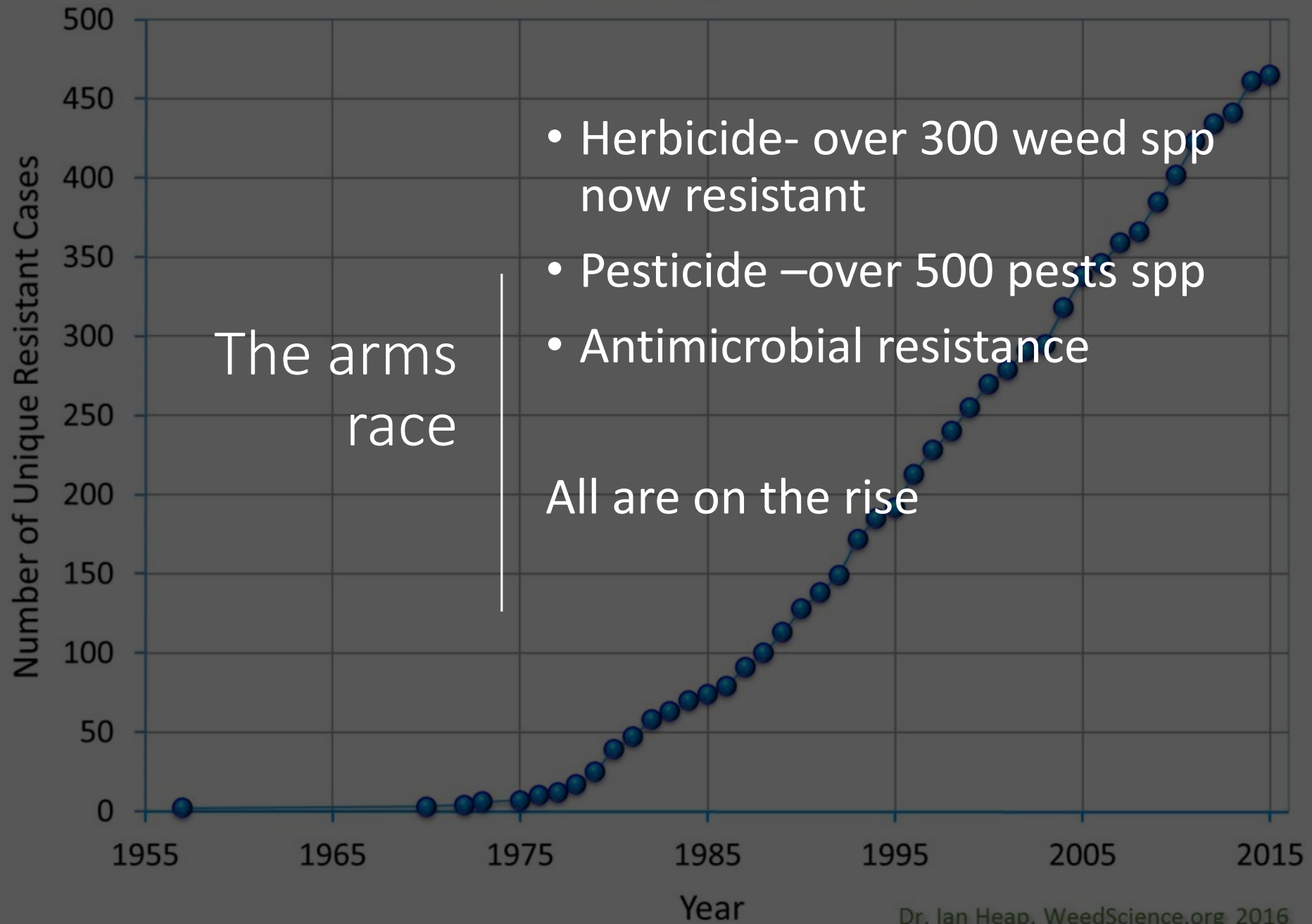
100 litres compost extract

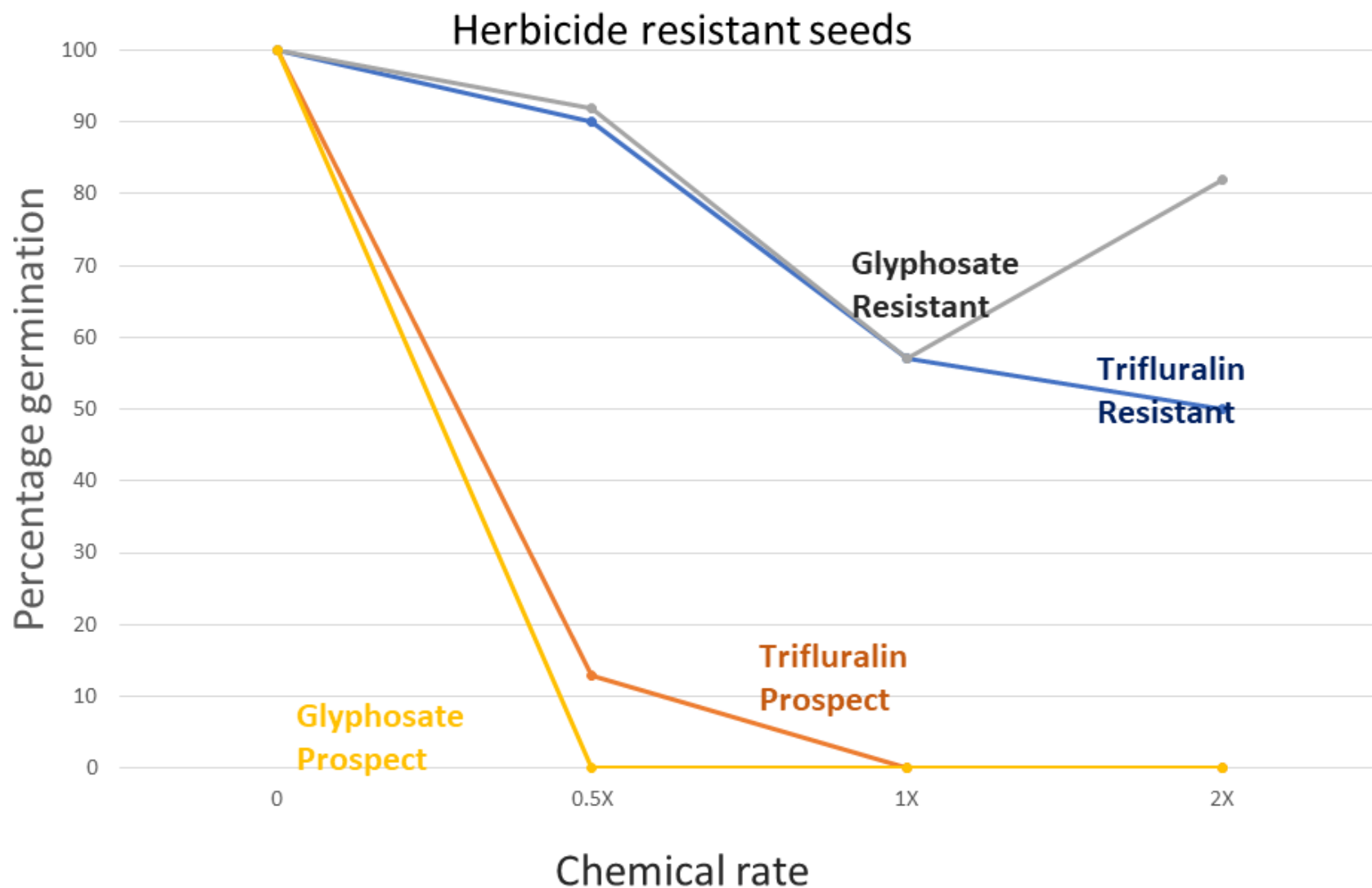
1st year, button,
kerosene and
windmill grasses

2nd year Paspalidium



Global Increase in Unique Resistant Cases





Indreland Angus

Montana Stockgrowers
Association 2011



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 /ac
 - 8 litres fish hydrolysate
 - 10 Lbs trace element (based on soil/forage test)
 - 20 oz humic
 - Beauvaria

- Conv fertility



Forage tests

DM Basis	'Supreme'	Bio Alfalfa	Control Alfalfa
Crude Protein	>22%	29.7	21.9
ADF	<27	26.7	33.9
NDF	<34	28.5	37.5
TDN	>62	70.1	62.4
RFQ	>180	222	155

Forage testing

DM Basis	Bio Alfalfa	Control Alfalfa
Calcium (1.3-1.8%)	1.77	1.99
Phosphorus (0.25-0.69%)	0.4	0.29
Potassium (2-3.4%)	1.84	1.21

10 lbs vermicast

2 lb seaweed

down drill, with winter rye and vetch

What are the ingredients for poor soil health?

- Set stocking, over-grazing
- 'Icides
- High soluble fertilizer
- Waterlogging
- No green living plant roots

SEED DRESSING - Encourage root development and thick rhizosheath

Weeds: doctors of the soil

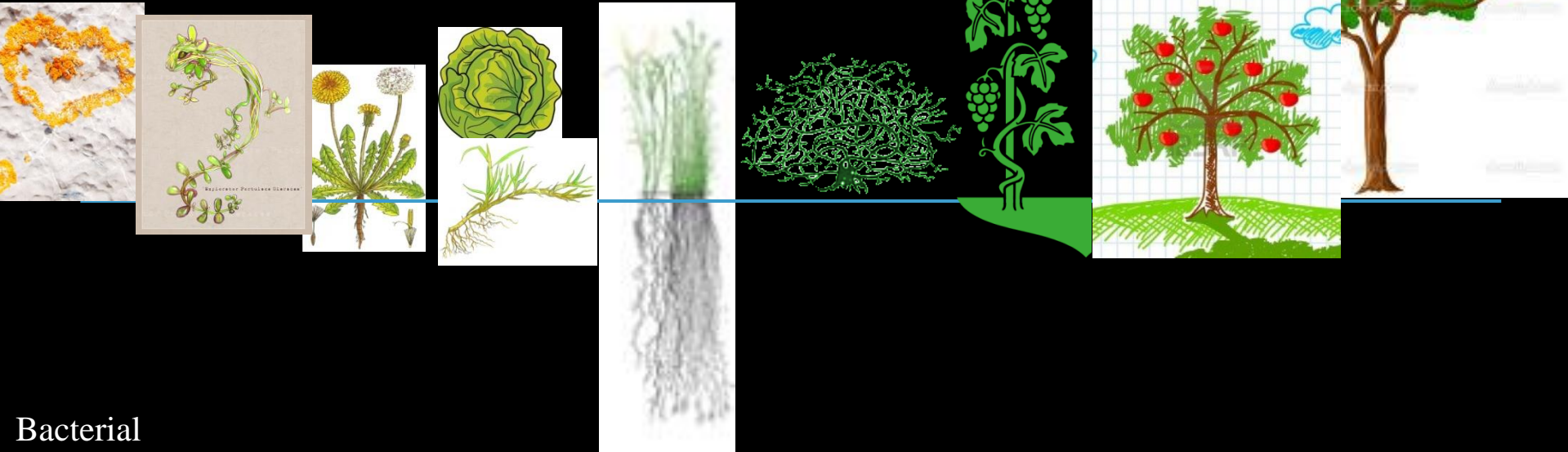
What is their role?

- 1. To quickly protect bare/disturbed soil
- 2. Low organic matter
- 3. Balance minerals
- 4. Microbial imbalances and
- 5. As a safety valve for toxins.



Plant: Biology Relationships

Annual
grasses



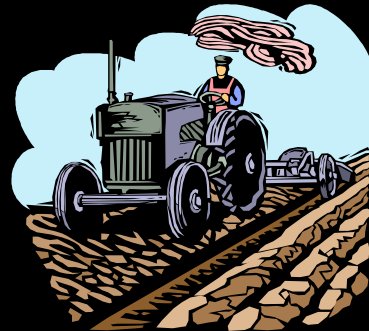
Bact:Fungal
1:1

Fungal
1000:1

Bacterial Dominated



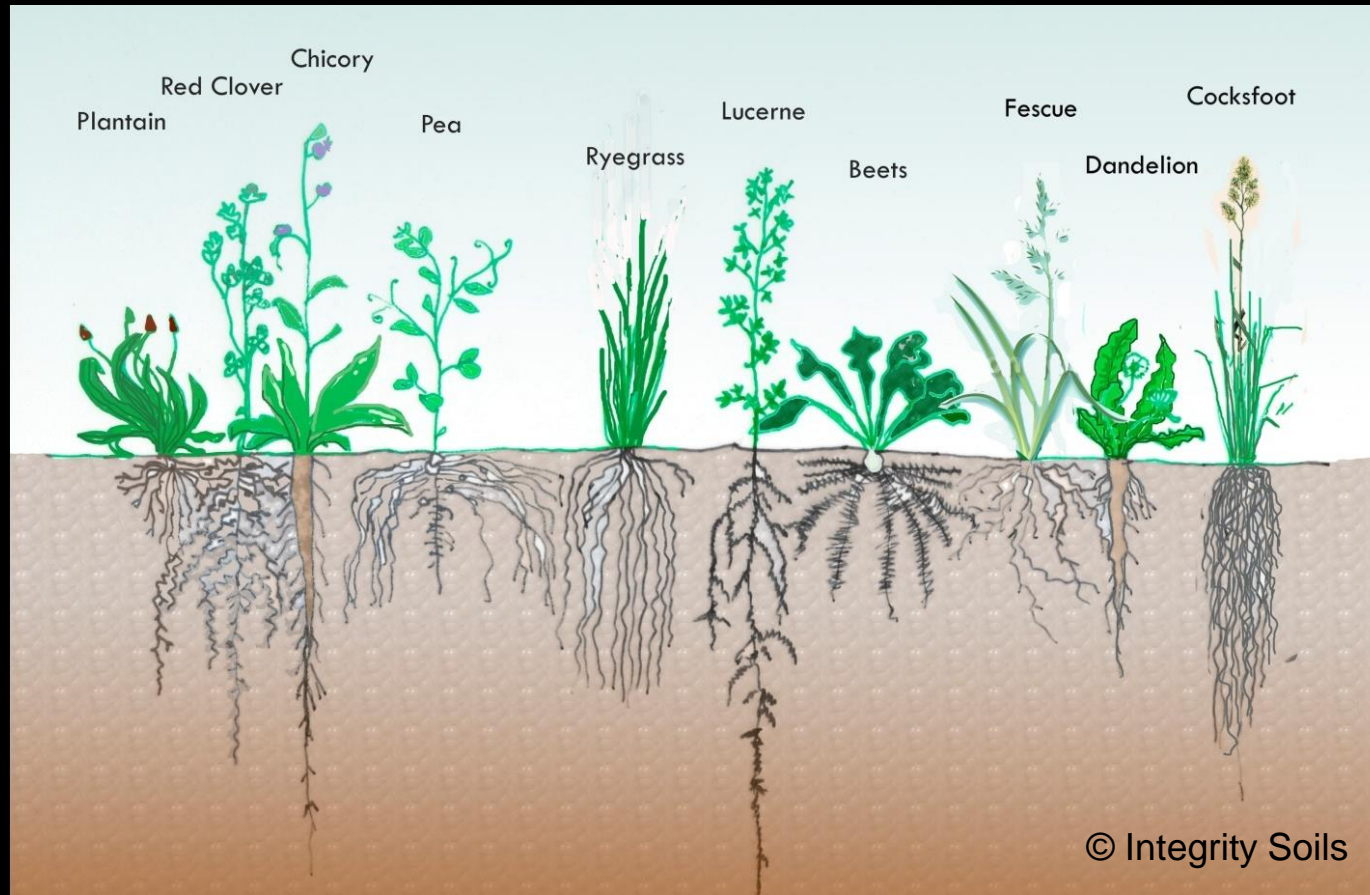
Pasture ploughed;
Slicing and dicing
Fungi.
1:1 reduces to 0.75
Perfect ratio for Kale



Kale ploughed;
Slicing and dicing
Fungi.
0.75 reduces to 0.5
Perfect for early
succession weeds.



Diversity is key



Fostering diversity provides multitude of benefits...
secondary metabolites, health properties, beneficial insects/
animals, weed competition, mycorrhizal guilds, access to
water, soil microbes, nutrient exchange, humus...etc etc etc



Root system



**Native fescue -
18,500 to 36,600
kg/ha**



**Spring wheat -2000
to 2900 kg/ha**



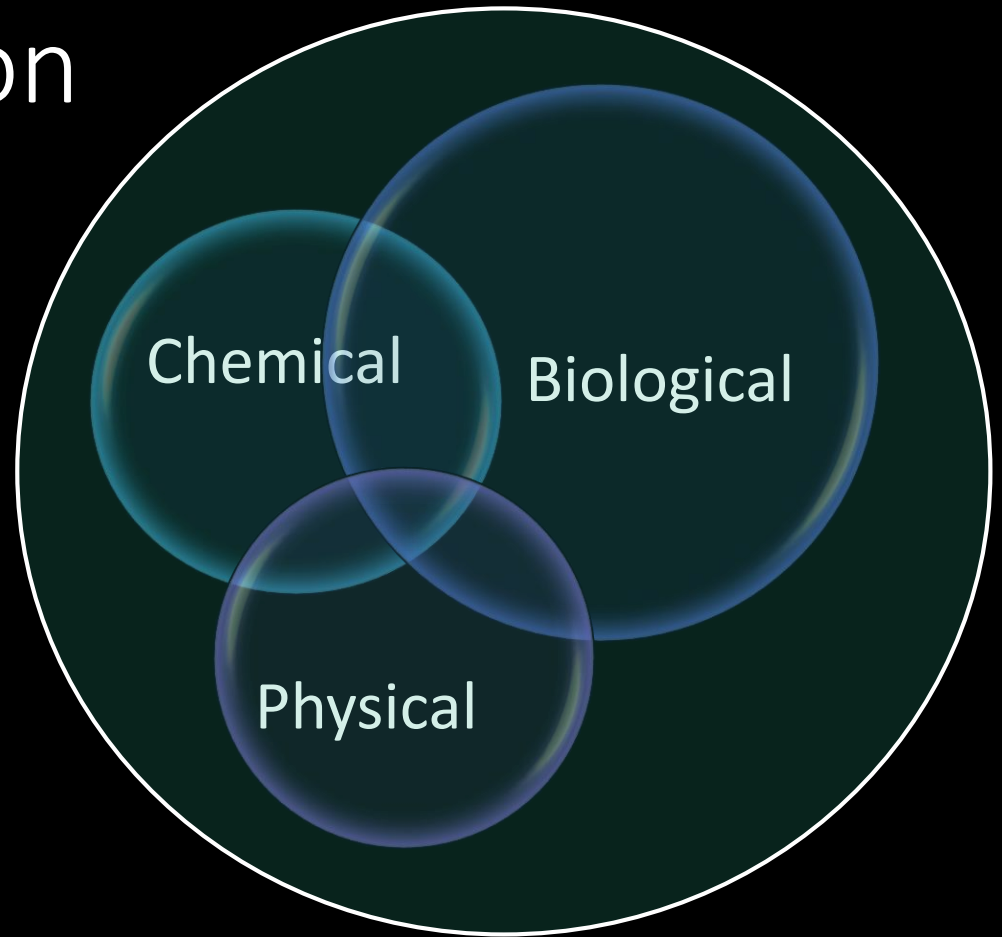
Diversity is key

What is the #1 factor which limits yield?

AIR

Soil compaction

- Physical
- Minerals
- Microbes



Management

Two neighbouring orchards



Biological system

Compost application,
pasture in rows, no irrigation,

→ 3.8 kg C/m² (top 0.1 m)

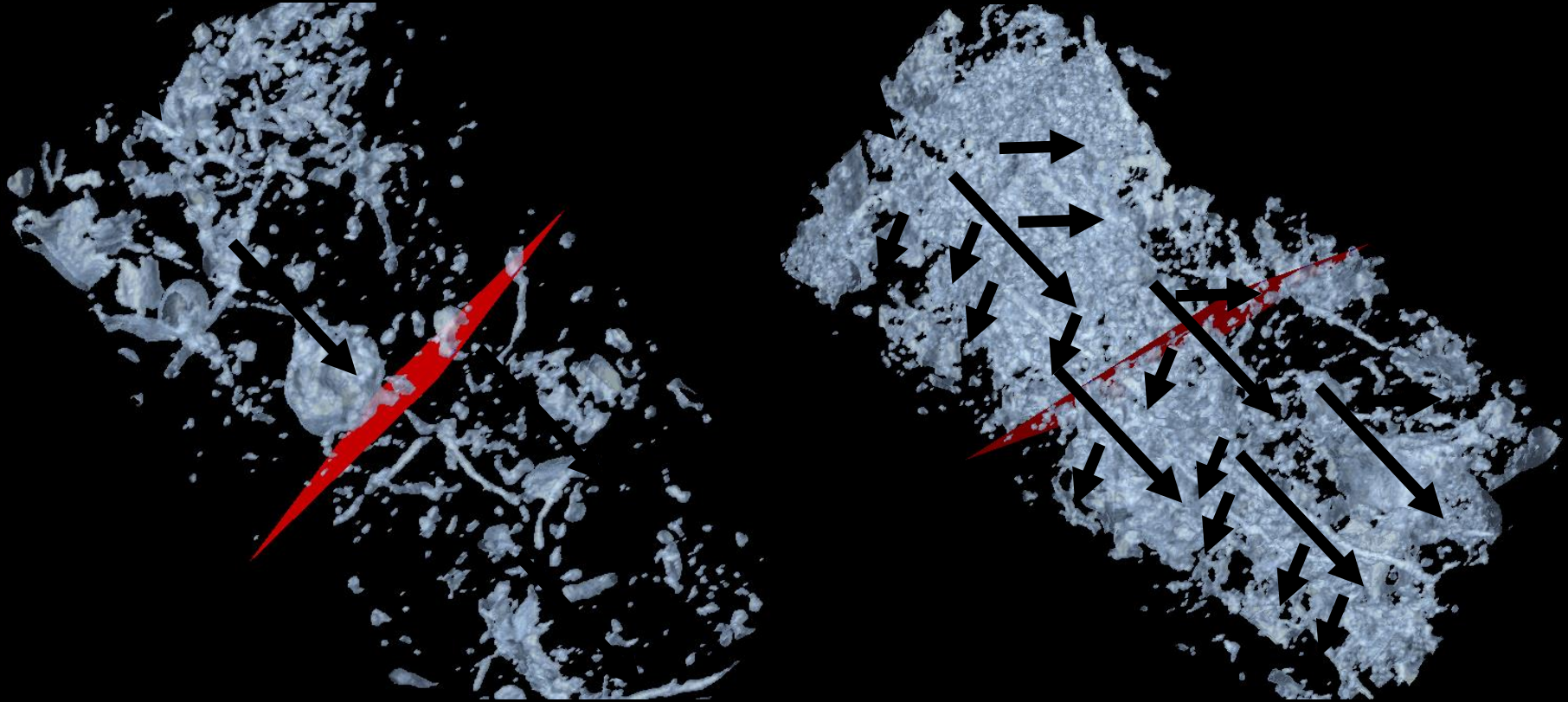
Integrated system

No compost application,
herbicide rows, irrigation,

→ 2.6 kg C/m² (top 0.1 m)



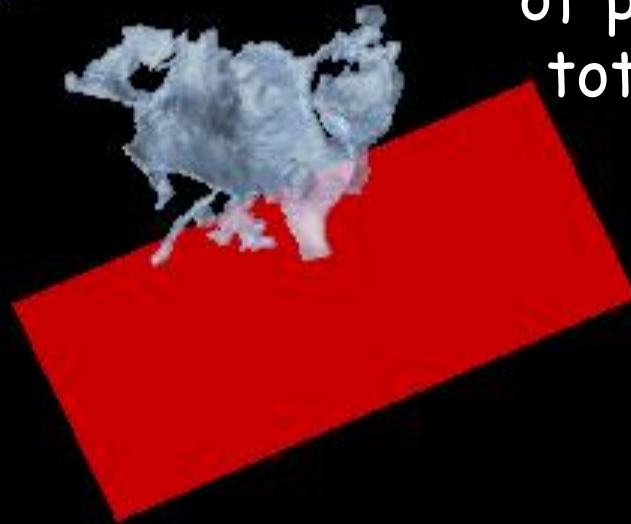
Macro-pores enhance the mixing of nutrients and contaminants



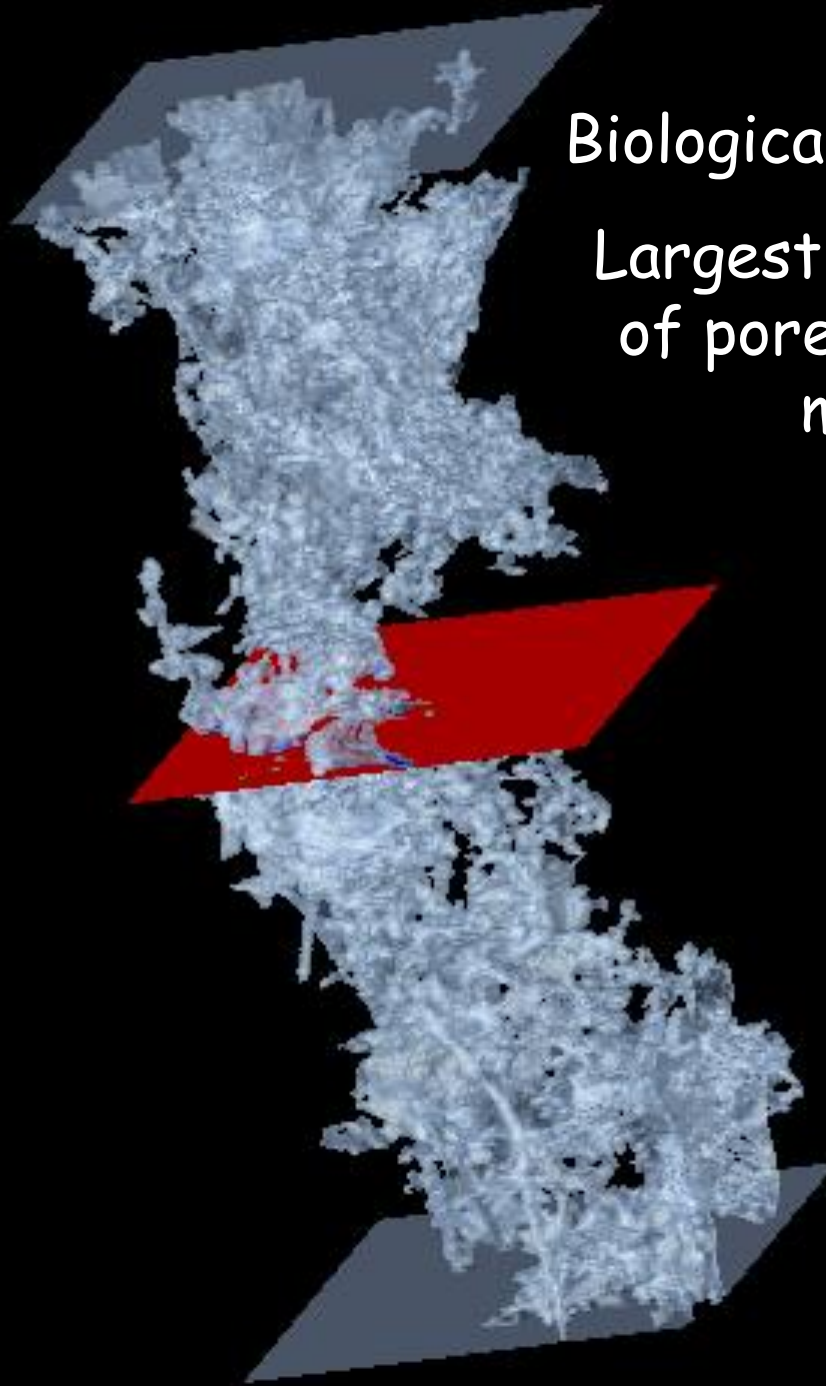
= better buffering of nutrients and filtering of contaminants

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



What stops N-fixation?

Temperature

No inoculation

Lack of Co, Mo

High soluble N

Compaction




Ways to increase N efficiencies

- Address compaction

is it due to - mineral/microbes/management/OM?

- Diversity of plant species (rooting depths)
- Crop rotation, legumes
- ALWAYS ALWAYS ALWAYS add carbon to fertiliser



Cut N with no yield drop!

- Manage residue to recycle nutrients
- Biological inoculums to recycle/hold nutrients
- Stimulate/inoculate N-fixers, mycorrhizae

- Apply N closer to crop needs
- Soil test before N applications
- Anchor N with carbon (humates, molasses)
- Foliar feed

Case Study Canada

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

Av precip 300 to 482 mm (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
- low functional humus,
- low biological activity, low AMF,
- high Mg, low trace elements,
- low sodium

1st year program Wheat

Down the slot

- Gypsum 35 kg
- Humate 25kg
- Sea minerals 4kg
- Boron 600gm
- Zinc 350gm
- Copper 500 gm

Seed treatment

- AMF Trichoderma
- P-solubilising bacteria

Foliar

- 2.4 litres 10 10 10
- 300mls Fulvic acid
(1 kg 21% B in peas)

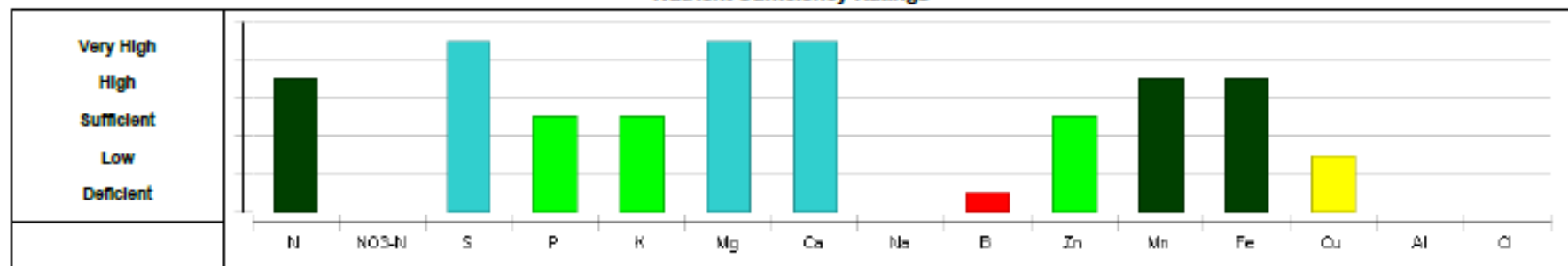
Nitrogen

- 2016 – 110 kg actual N
- 2017 - 30 kg actual N
- With no yield drop!
- 2018 – 25 kg actual

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		0.16	0.20	1.50	0.17	0.20		6	15	35	25	5		
		3.00		0.40	0.50	3.00	0.50	0.50		30	70	200	100	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							

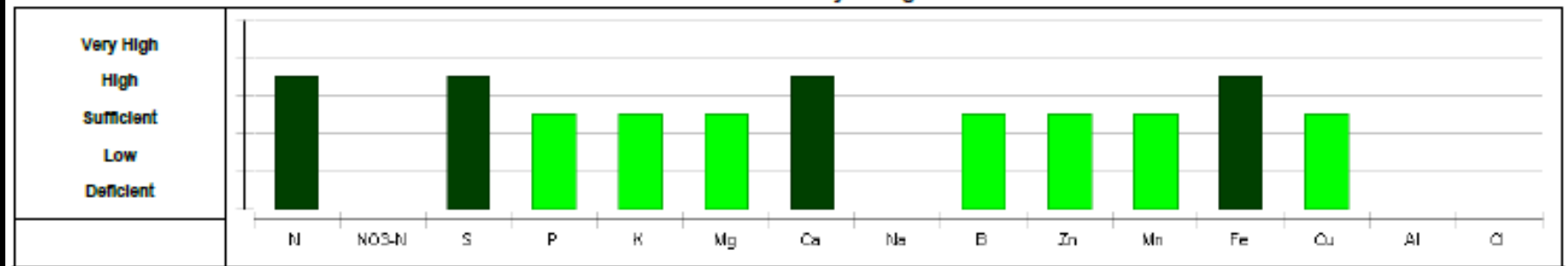
Nutrient Sufficiency Ratings



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		0.16	0.20	1.50	0.17	0.20		6	15	35	25	5		
		3.00		0.40	0.50	3.00	0.50	0.50		30	70	200	100	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



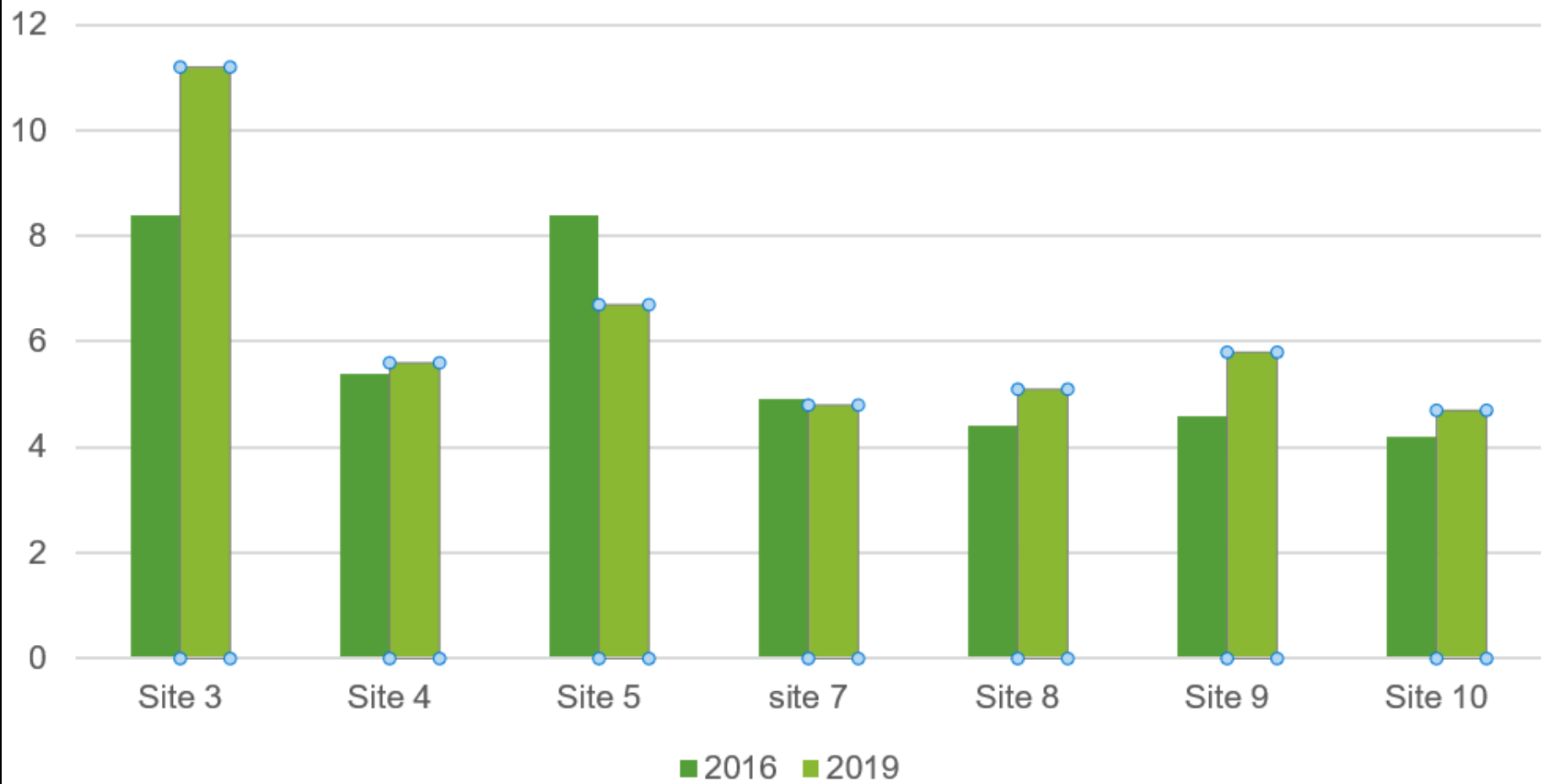
Year One results

- 60% reduction spend
- Roots through hardpan
- Awesome healthy crop and good yield
 - Wheat 70 bushels/acre
- All on only 130 mm rainfall!
- Cover crop failures

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

Year 3

Soil Organic Matter % 2016- 2019



Labs

- Biological testing
 - www.Earthfort.com USA (direct count)
 - www.ciaaf.com.au AUS (PLFA)
 - www.wardlabs.com (USA Haney and PLFA)
- Mineral
 - Ward labs www.wardlabs.com
 - www.alcanada.com

Forage

- www.alcanada.com

What actions can we take?

1. Actions that you will do in the next week
2. Actions that you can talk with other people about

What signal are you sending?

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

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



- We are inextricably linked in with nature's cycles
- Working with biology supports efficient functional systems
 - That are profitable
 - Productive
 - And fun!



1

How long has your soil
resource been
degraded?

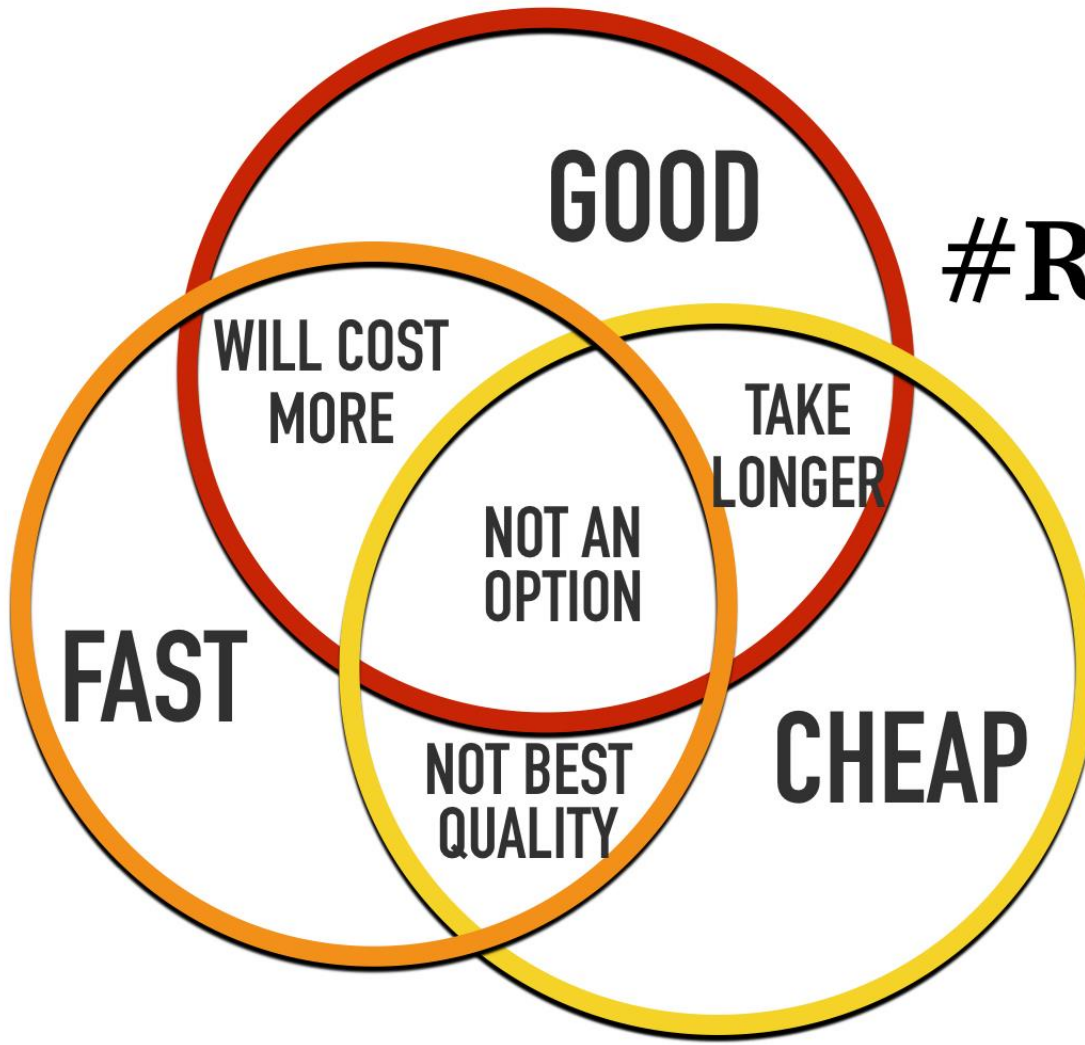


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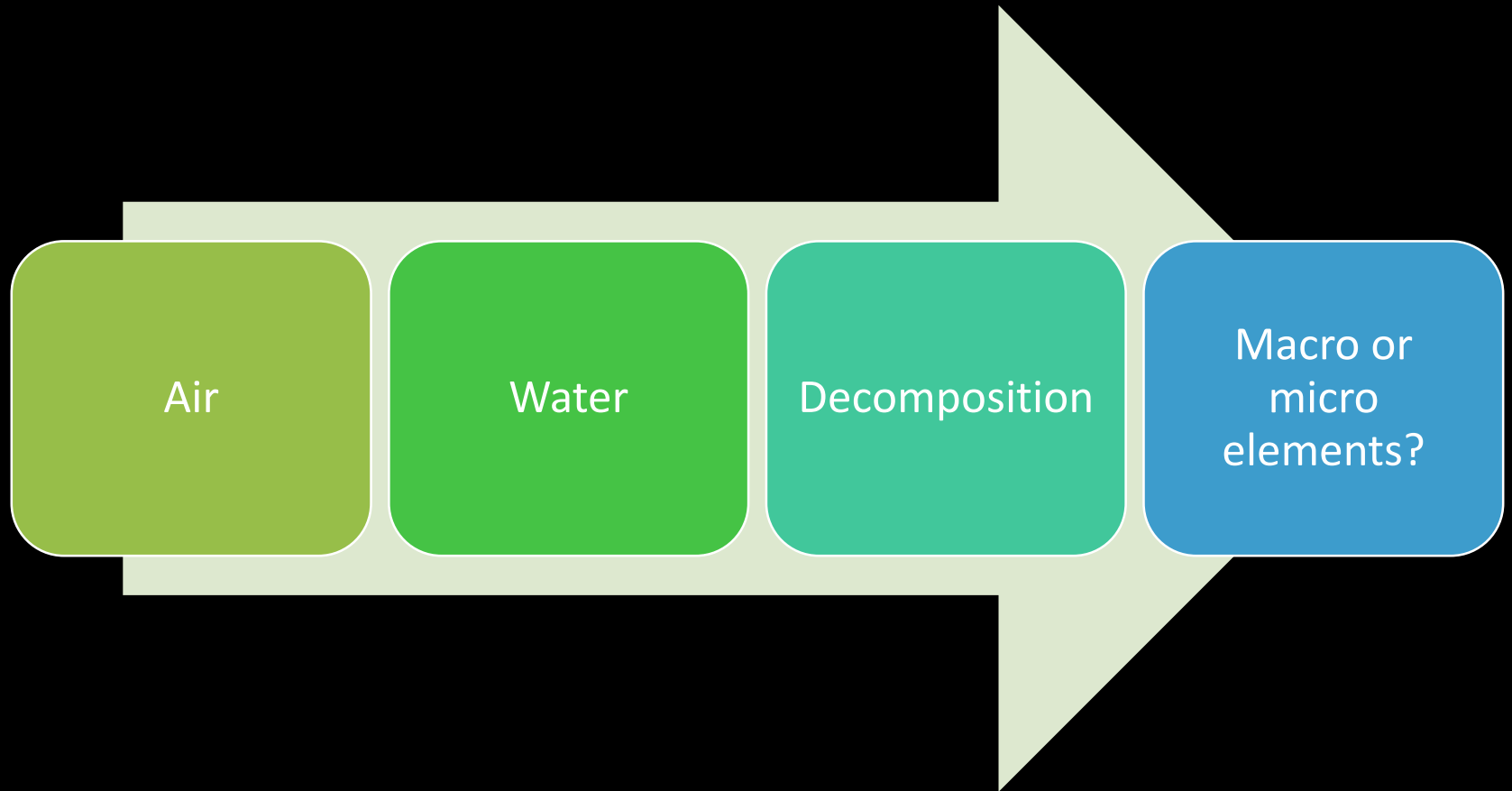
How much
money/time do you
have?

How long will it take?

#RealityCheck



Identify limiting factors



Managing expectations

- Many changes happen under the soil first
 - Look to root structures and soil changes
- Benchmark and follow trends
- Commit to a program for at least 3 years in the same field

FOR THE LOVE OF SOIL



STRATEGIES TO REGENERATE
OUR FOOD PRODUCTION SYSTEMS

NICOLE MASTERS

www.integritysoils.co.nz

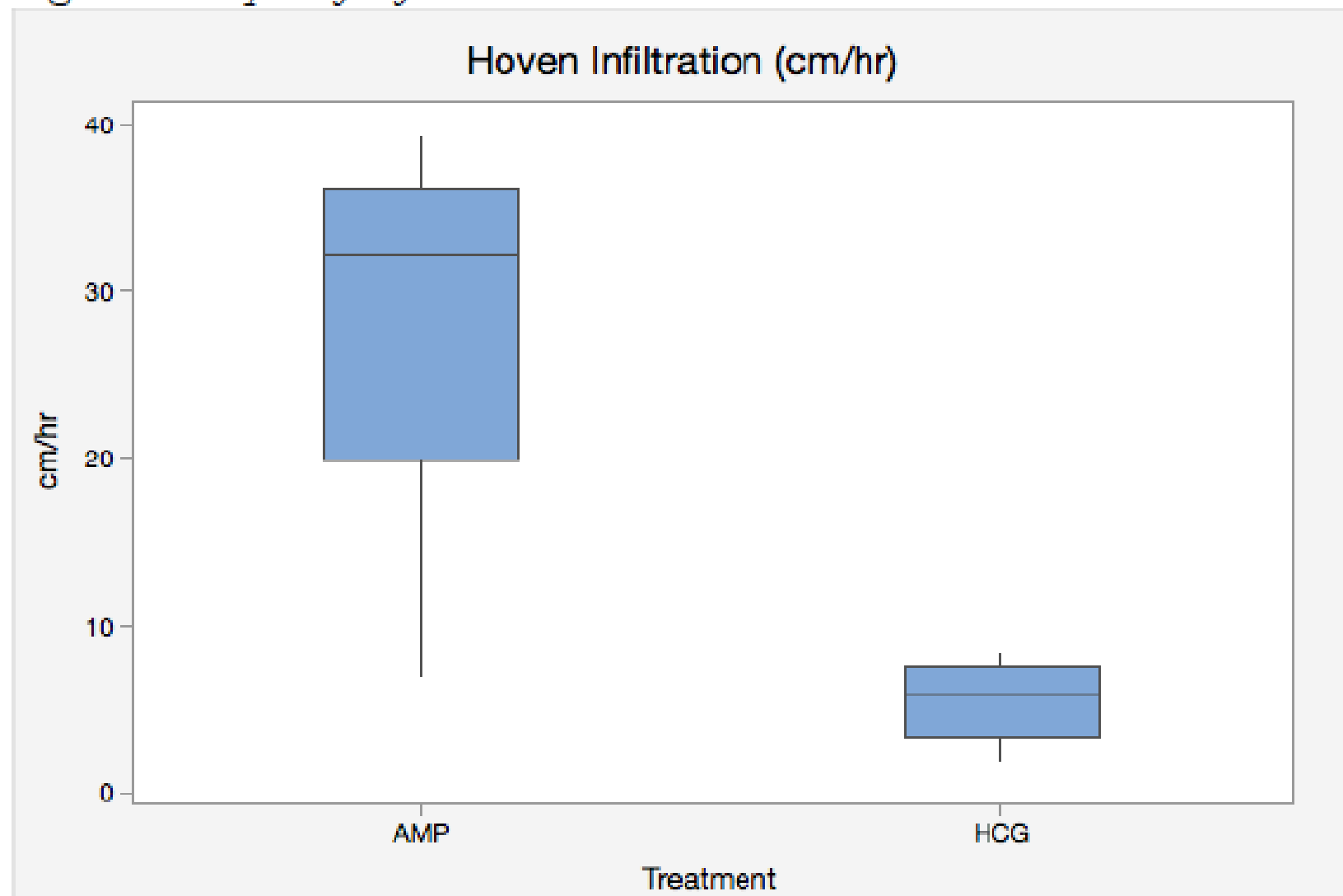


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What we offer:
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Workshops
Extraordinary outcomes!

Is your water effective?

Figure 2. Boxplot of Infiltration Rates at Hoven Ranch





Hoven farm AMP field indicating the high biomass of totally green vegetation broad leaves and high litter cover
relatively deep soils on all landscape positions



Hoven farm neighbor field indicating less vegetation biomass and lighter green, narrower leaves and low litter cover
relatively deep soils on all landscape positions

Hamish Bielski

Concerns:

- Major insect pests
- Soils hydrophobic
- Not growing much!

First year

- Infiltration went from 40 mins/inch water
 - To 10 secs for first inch
 - 26 secs for 2nd inch!
- AND
 - Minimal insect pests
 - Root penetration
 - YIELD!

Open up tight soils

- Deep rooted cover crops; chicory, brassicas, sunflower
- Fibrous root systems- oats, rye

Livestock and soil

- Grasslands have evolved to be grazed
- Benefits from livestock disturbance, manure, urine and microbial populations
- Many food production areas lacking livestock

Grazing and Roots

Grasses have evolved to flourish under periodic grazing pressures

Amount of plant grazed	Time for root recovery	Root growth on 33 rd day
90%	No root growth for 17 days	60%
60%	55% after 5 days	192%
30%	117% on 3 rd day	250%

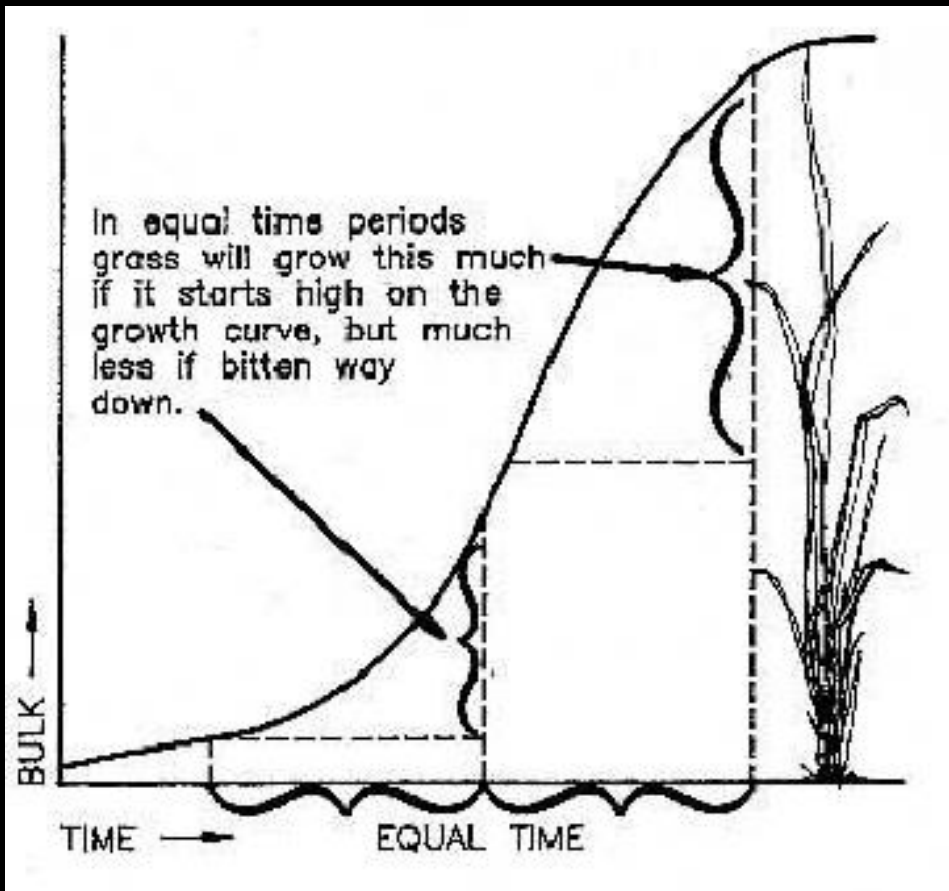
Graze between 3.5 leaf and the flowering stage

- Remove only 25% to 33%
- Carbon sink to root zone
- Increased microbial activity = increase in plant available nitrogen, phosphorus and sulfur

“Biologically effective Grazing Management”

Llewellyn Manske, NDSU Dickinson Research Extension Centre

Grazing for soils and profit



Livestock and biology

- Probiotics and healthy gut systems
- Use livestock to spread microbes and seeds
 - Use untreated seeds!
- Humate as free choice
 - Use raw humate for cattle (can mix with molasses)
 - Increases feed efficacy
 - binds to toxins (like ergot, alkaloids, etc)
 - Feeds beneficial soil critters- dung beetles

How can we assess health?

Soil indicators	Plant indicators
Soil structure/ porosity	Brix/EC/pH
Colour and # of mottles	Plant growth
Soil Colour/carbon	Legumes
Earthworms/dung beetles	Weeds/pests/disease
Soil smell/taste?	Plant colour and urine patches
Infiltration rates	Pasture utilisation
Surface relief	Root length and density
Temperature	Area of bare ground
Penetrometer, pH, EC	Drought stress
Soil mineral/biological testing	Input costs to maintain
Enzyme activity	Plant tissue tests
Extractable minerals	

Labs

- Biological testing

- www.Earthfort.com USA (direct count)
- www.ciaaf.com.au AUS (PLFA)
- www.wardlabs.com (USA Haney and PLFA)

- Mineral

- Ward labs www.wardlabs.com
- www.alcanada.com

Forage

- www.alcanada.com

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