REGENERATIVE AGRI-CULTURE:

BUILDING PROFITABILITY & RESILIENCE THROUGH HEALTHY, FUNCTIONING SOILS

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Presentation to
NT Soil Symposium

Katherine
August 1st, 2019

(Image: Trish Dixon)

Regenerative Agriculture

Key Message

HEALTHY LANDSCAPES & SOILS → **HEALTHY FOOD/FIBRE** → **HEALTHY PROFITS, PEOPLE + HEALTHY PLANET**

Regenerative Agriculture

Ecological Grazing

Biological Agric.

Agroforestry

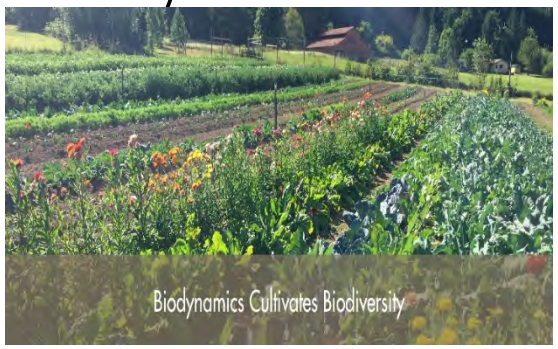
Keyline

Edible Shrubs

Permaculture

New Cropping

Biodynamics



Agricultural practices that enable landscapes/systems to self-organize back to open-ended health – to self-heal

THE BIG CONTEXT

HOW WE GOT INTO OUR EXISTENTIAL CRISIS # 1

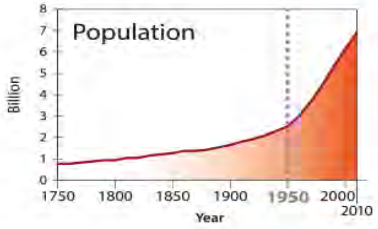
OUR PLANET IN THE ANTHROPOCENE

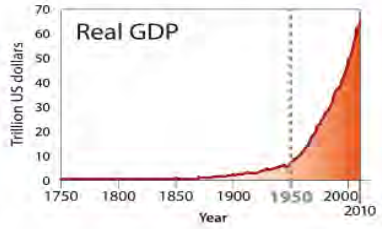
THE ANTHROPOCENE

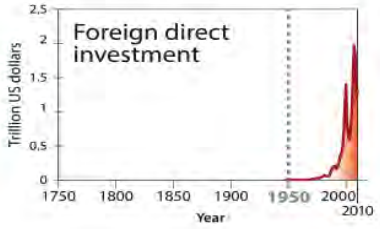
The greatest crisis that humanity has ever faced in its entire history

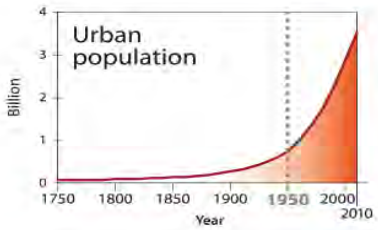
THE GREAT ACCELERATION

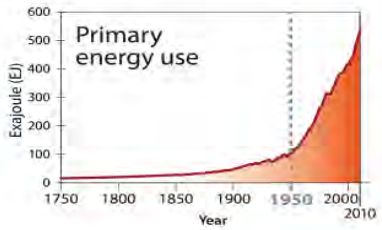
Socio-economic trends

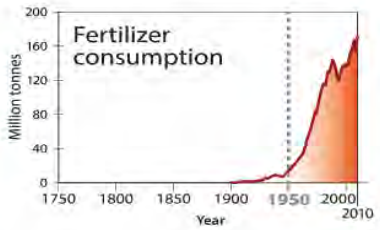


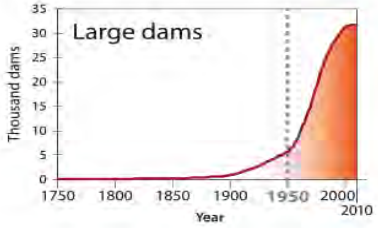


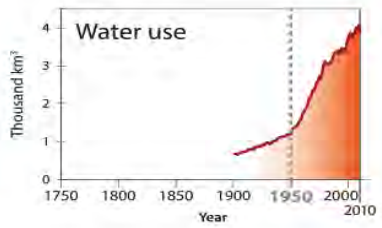


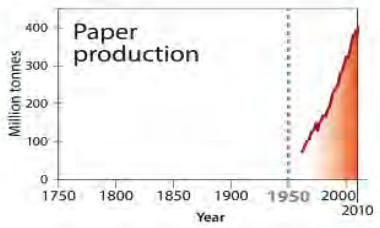


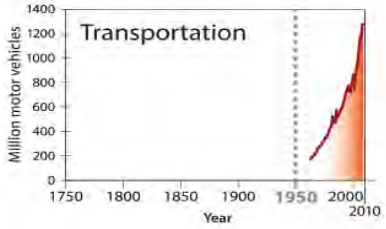


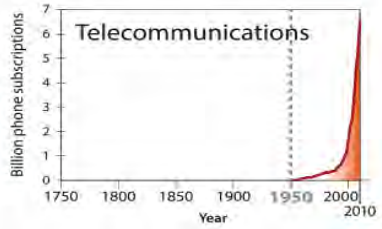


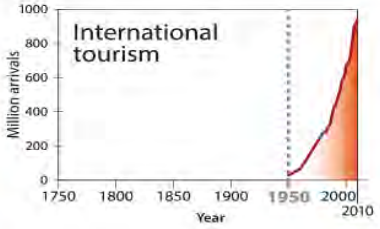




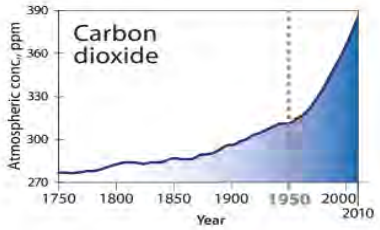


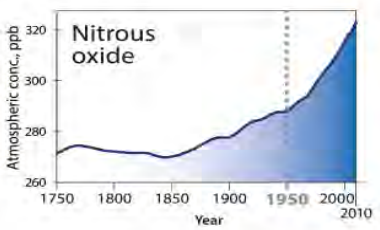


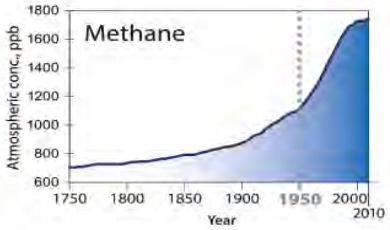


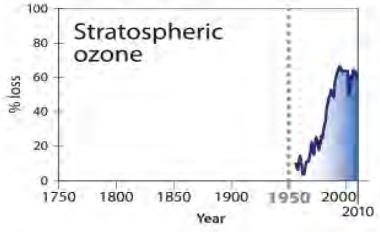


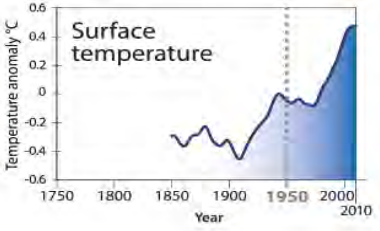
Earth system trends

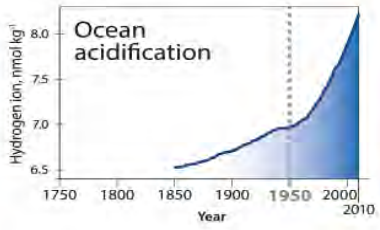


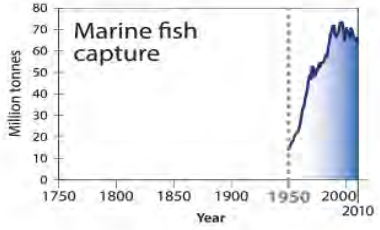


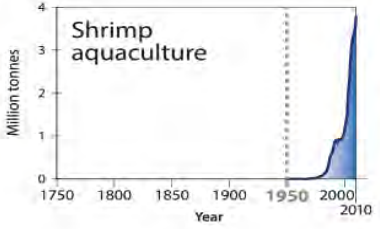


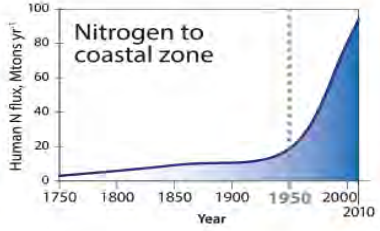


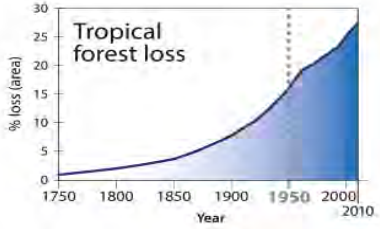


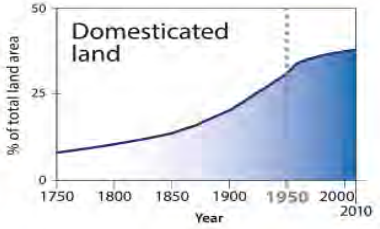


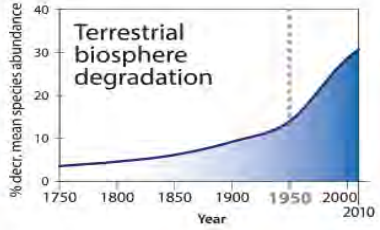










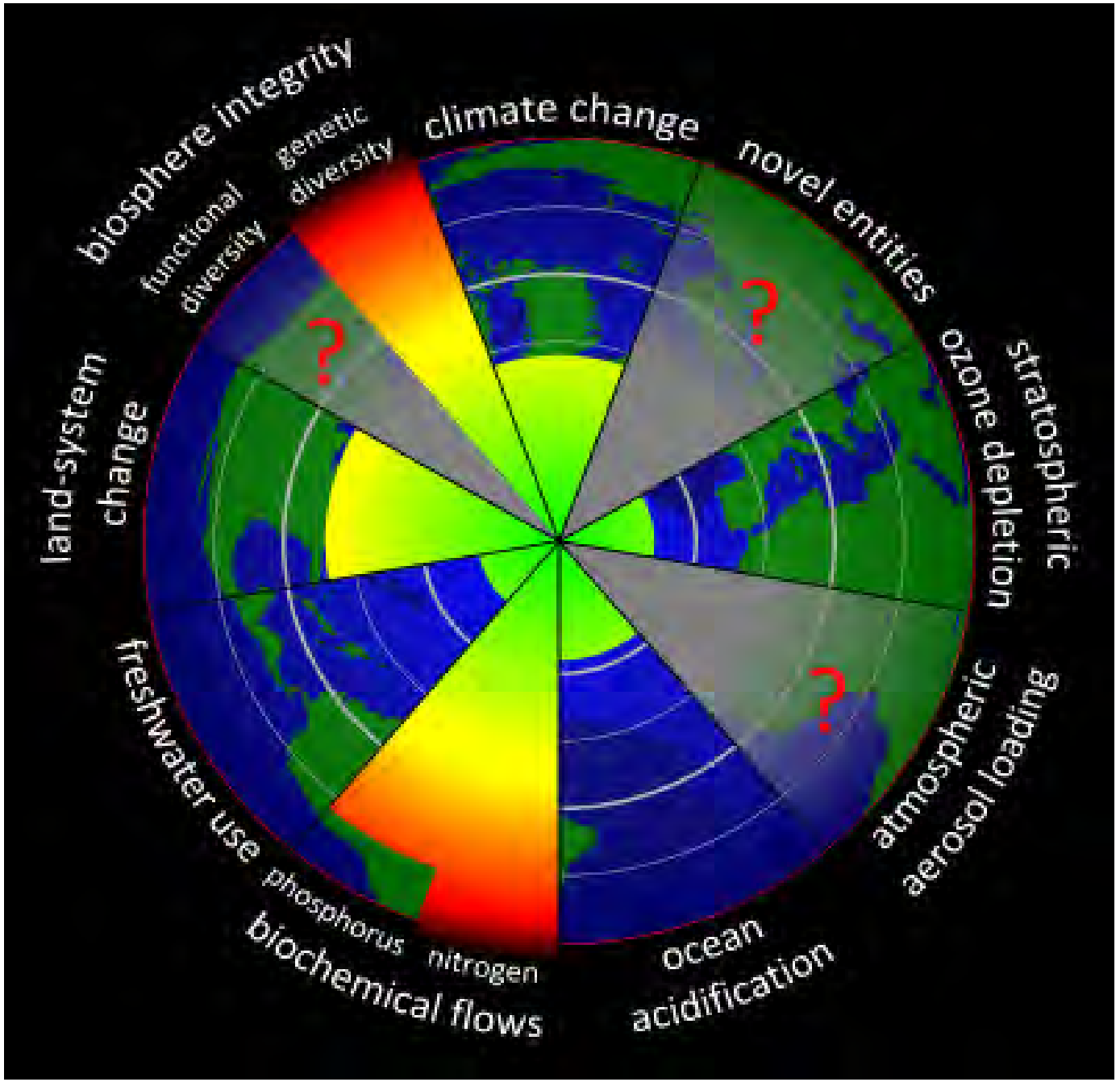


FRESH-WATER OVER-USE

The Aral Sea
(between Uzbekistan & Khazakhstan)

270 miles [435 km) X
180 miles [290 km)

- Once the world's 4th largest lake – effectively dried-up in 2014
- Soviet era cotton irrigation
  (on drying-up, pesticides, herbicides were released to atmosphere)



Earth's threatened planetary boundaries

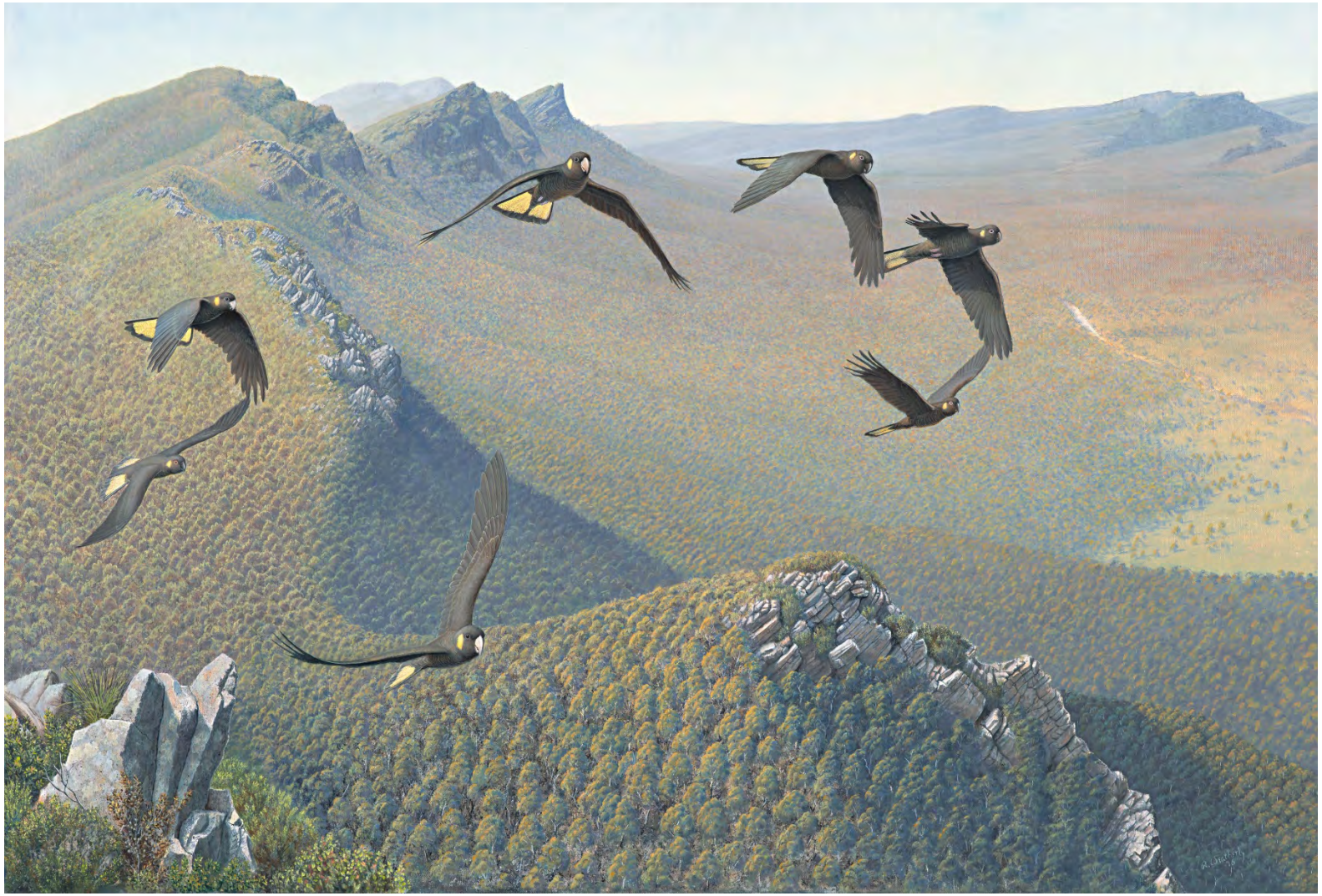
Industrial Agriculture is a/the major player in causing damage to the 6 key biophysical Earth systems:

1. **Climate Change**
2. **Biodiversity Loss**
3. **Land-system Change**
4. **Freshwater use**

5/6. **Biochemical phosphorus/nitrogen flow**

(graphic Wikipedia)


AHAJOKES.COM



(Image: painting by Richard Weatherly)

But -

This is grounds for hope…

If industrial agriculture = a major causal factor - then

Regenerative agriculture = a key solution

THE BIG CONTEXT # 2

HOW WE GOT INTO OUR EXISTENTIAL CRISIS # 2

AGRI-CULTURE

HISTORICAL DESERTIFICATION: The Fertile Crescent

The eroded hills of Attica are like the *"skeleton of a sick man, all the fat and soft earth having been wasted away."*

(Plato, 360 B.C.)

But in Australia, we too
Are creating
DEAD SOILS

We need to overthrow 10,000 years of agricultural Tradition – based on the plough, poor mechanical & chemical intervention & poor grazing management

SO, HOW DID WE COME TO DO THIS ?

Rise of the Mechanical Mind

ORGANIC MIND

MECHANICAL MIND

‘A nation that destroys its soils destroys itself’

President F.D. Roosevelt: ‘Letter to all State Governors on a Uniform Soil Conservation Law’, 26th Feb. 1937

USA ‘Dustbowl’, Prairie states, 1935

Agriculture has degraded 5 of 13.4 billion ha. available for agriculture globally = 37 %

(UN FAO)

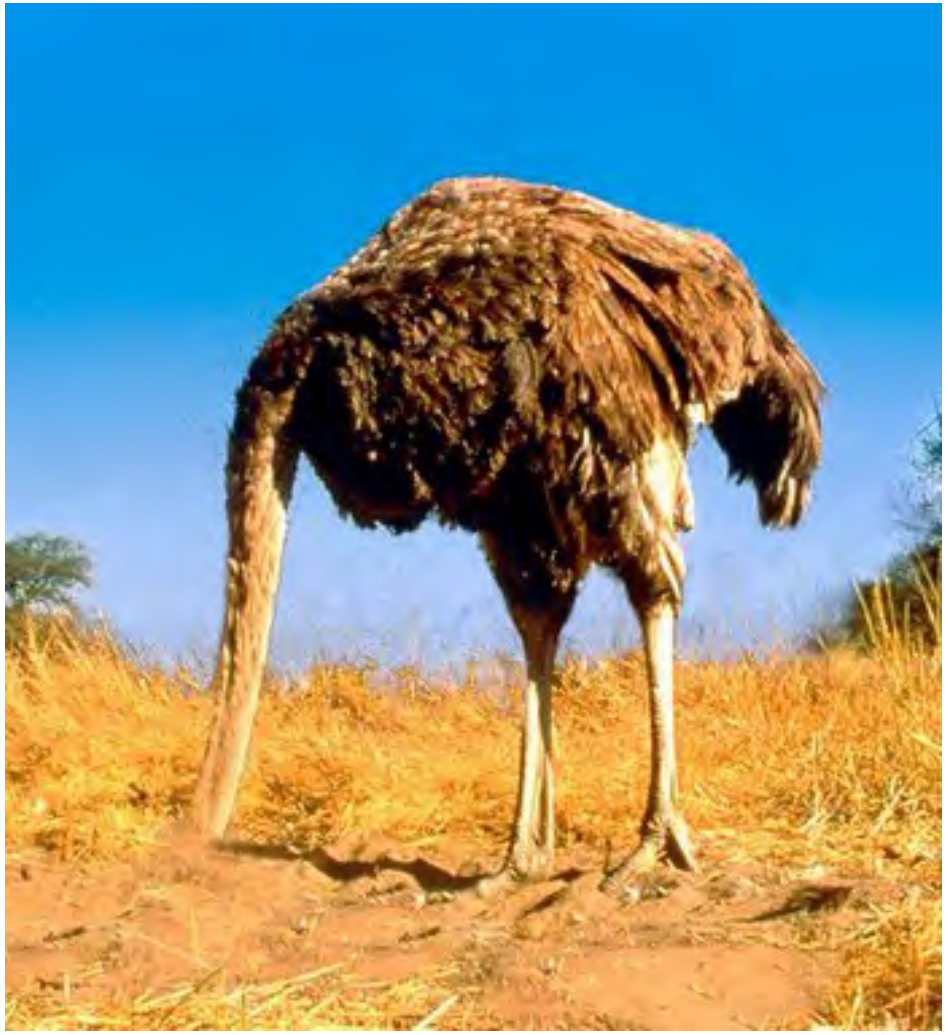
1930s Mallee Drought Australia

The Dust-Bowl we pretend we didn't have

ONLY IN THE PAST ?

Melbourne *Herald Sun* Cover: May 8 2019

From *facebook: Swan Hill Guardian* 28 Feb. 2015
'The BOM has issued a severe weather warning of strong winds up to 90 km.'



Are We
in denial re.
desertification &
planetary
consequences ?

BUT, THERE IS ANOTHER PATHWAY

The Key? Healthy, biologically-rich & active Soil

Plants, with animals, can restore our farms and soils, our ecosystems and profits

<u>Not</u> Monocultures of plants, <u>not</u> the plough, <u>nor</u> industrial inputs - BUT

1. Multi- species cover crops, etc. &

2. Richly Diverse grasslands

& All holistically grazed, plus with a large diversity of plant species

TURNING THINGS AROUND

1. Regeneration via Gaining Ecological Literacy

(Image: Elaine Ingham; plant seedlings)

Current industrial paradigm?

Nature = enemy !!

- To be simplified, dominated &, if necessary, killed.

1. Mounting, massive unsustainable environmental & social costs
2. Increasing toll on human health
3. Escalating separation of humans from natural environment

This leads to Landscape Illiteracy

My own journey?

Landscape Illiteracy or Blindness

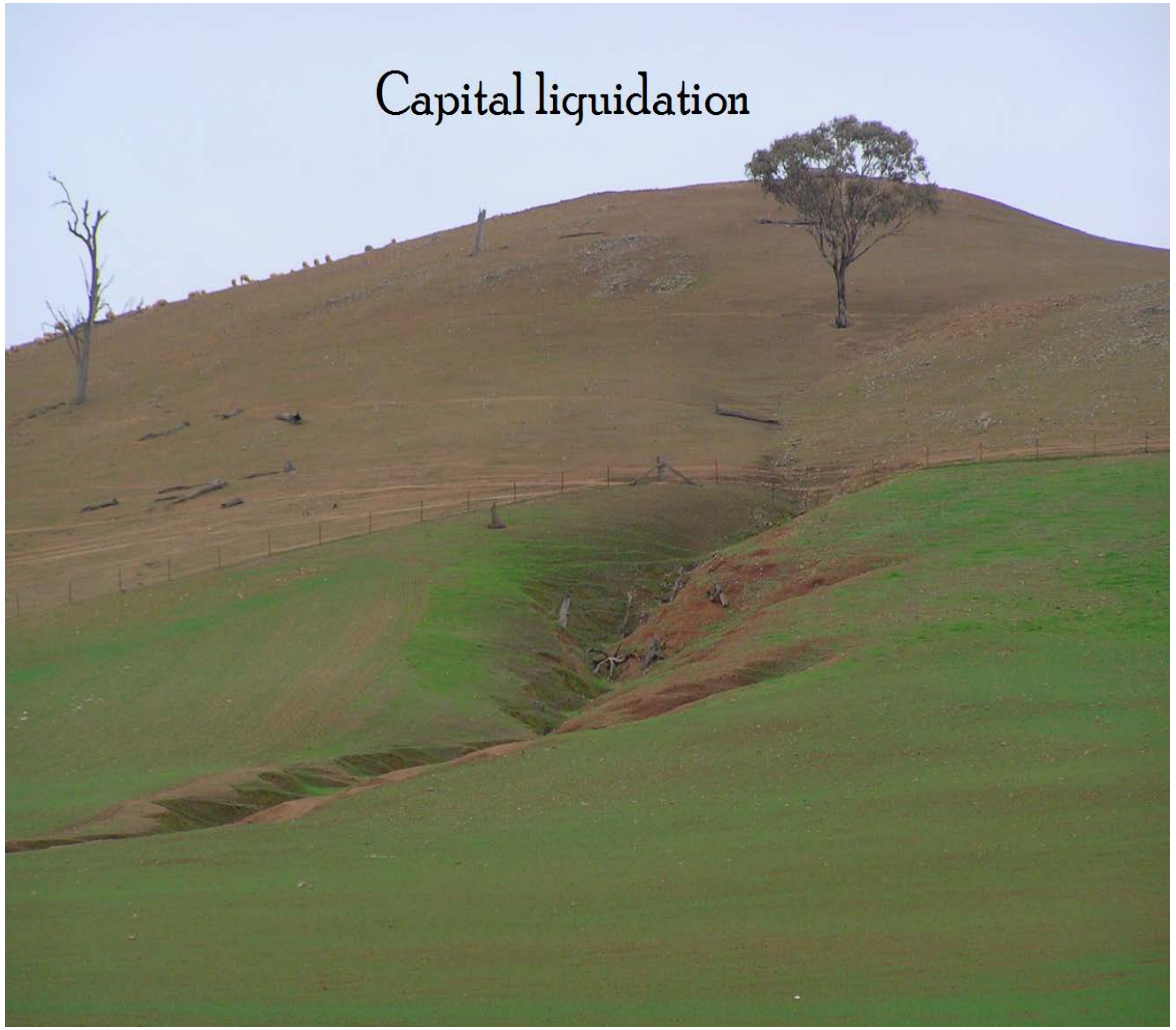


Photo: David Marsh

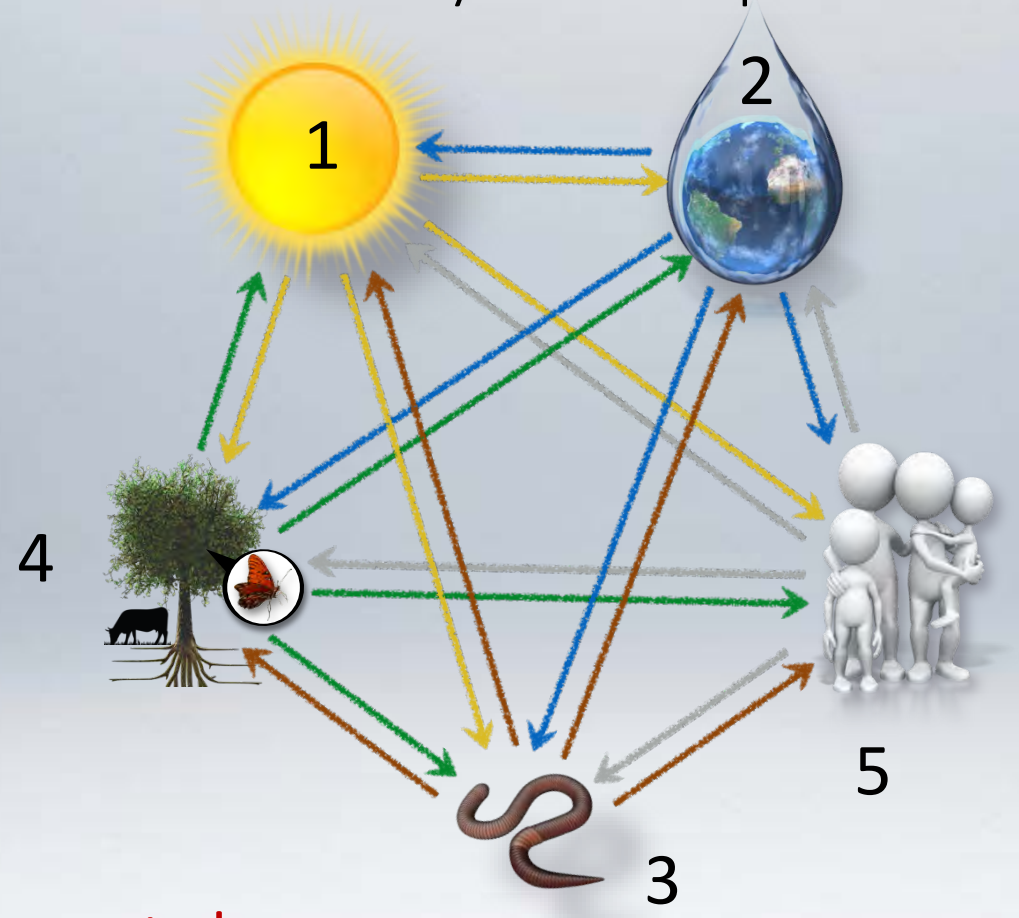
Is Paradigm-Induced Blindness

A Monaro Fence-line ca. 2009

(Lindsay Morgan)

HEALTHY LANDSCAPES = A JOURNEY IN ECOLOGICAL LITERACY

Built around the 5 key landscape functions



1. Solar Function
2. Water cycle
3. Soil Mineral cycle
4. Dynamic Ecosystem Communities
5. Human-Social

Key: All are interconnected;

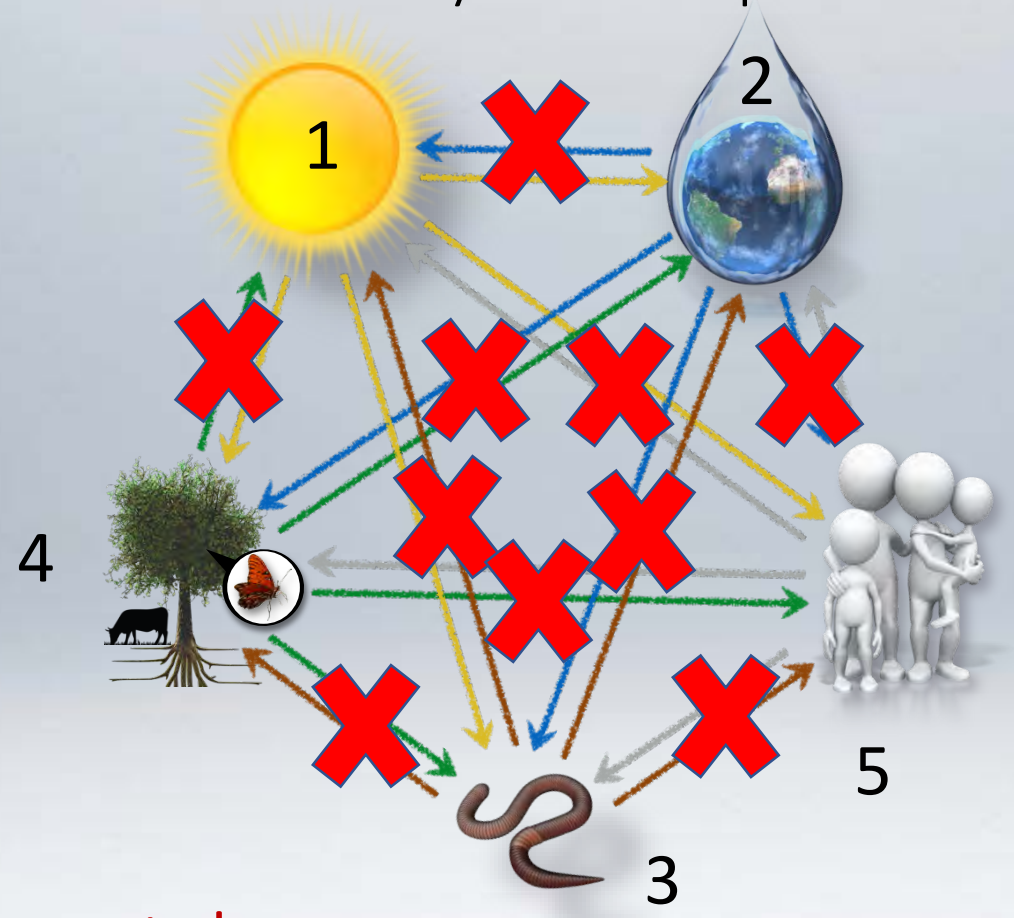
Indivisible; Dynamically in Feedbacks –

They undergird ecosystems & human civilisation

Impact on Ecological Function ??

A JOURNEY IN ECOLOGICAL LITERACY

Built around the 5 key landscape functions



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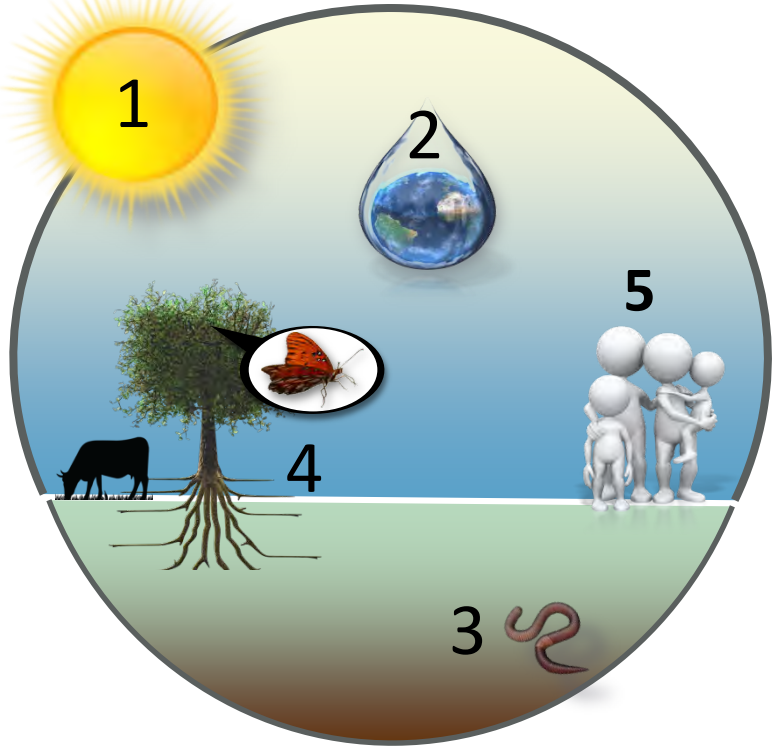
Function # 1: The Solar Energy Cycle

Green plants = the foundation:
So, to increase energy flow/capture,
we need to expand the primary trophic base

(i.e. > number
solar panels
year round)



The 5 Landscape Functions

n.b. The solar function impacts all other functions in a virtuous circle

Regenerative Grazing Management

2,000+ cows, Holbrook, NSW, one mob

Maximising the Solar energy cycle:

Stacked, multi-species COVER-cropping for multi-function

Nature has long provided a template, & through holistic grazing we too can inject energy by bunching cattle/sheep & provide long rest periods

Solar Cycle: Resilience in Grazing

Holistic grazing management

Set-Stocking regime

Greater Karoo region South Africa - 7” (175mm) rainfall

- Livestock carrying and production tripled after 40 years
- Water Retention tripled after 3 years

(Norman Kroon)

Mt. Pleasant Station, NW Queensland, after 100 years of set-stocking – Oct. 2004 (per. Garlone Moulin & RCS)

Mt. Pleasant Station, Oct. 2014, 10 years on

Active Gully erosion healing after 10 yrs on Mt. Pleasant

One paddock at a time !!

August 2006 (Dry S.)

September 2007 (Dry S.)

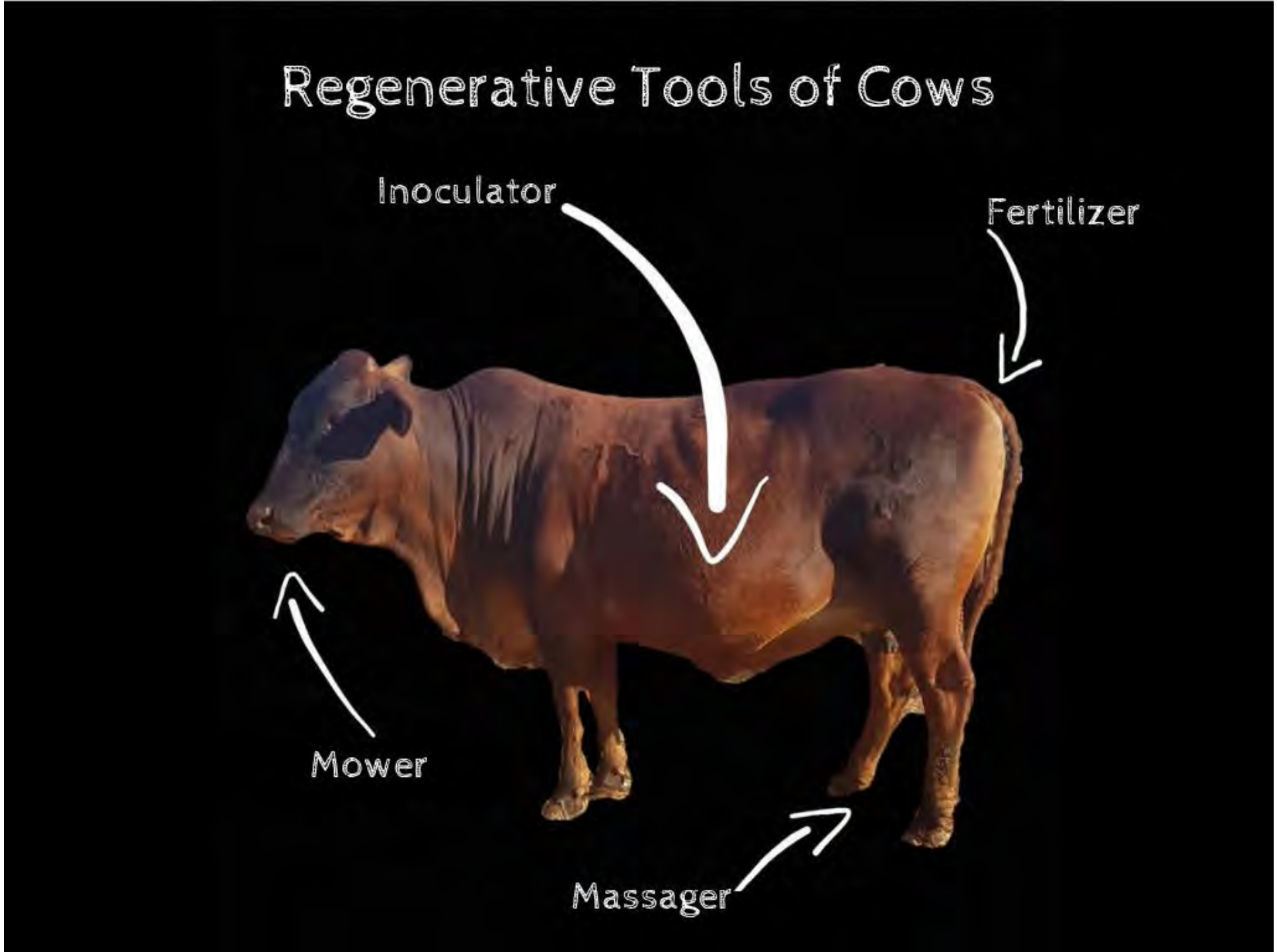
Pearce Family's 'Bannockburn' station, Rockhampton, Queensland
After 150 years continuous grazing & burning (Catriona Pearce)

November 2008 (Dry S.)

October 2012 (Dry S.)

March 2013 (Wet Season)

Regenerative Tools of Cows



THE MIRACLE OF COW MANURE …

LET NATURE DO THE HEAVY LIFTING …

Research shows 2/3 manure is buried

→ **feeds carbon & soil biology**

THE IMPORTANCE OF OBSERVATION

Solar Cycle: Regeneration in Cropping (1)

Conventional dryland cropping involves replacing all aboveground vegetation with the crop, in this case wheat.

A no-kill crop of oats that yielded 1.6 tonnes/ha in a redgrass pasture paddock. (Photo courtesy of Bruce Maynard)

Pasture-Cropping & its Originator:
Colin Seis, Gulgong NSW

No-Kill Cropping & its Originator:
Bruce Maynard, Narromine, NSW

(per Norton & Reid 2013)

SOLAR CYCLE: REGENERATION IN CROPPING (2)

Multi-Species Cover Cropping

Grazing and cropping are combined and managed in a way where each one benefits the other.

1. Cover Cropping uses a diverse crop/planting to create mulch, control weeds and improve soil health.
2. i.e. to cover the ground & build fertility for the next crop

   or pasture

3. But to maximize soil health, animals in rotation = essential

Maximising sugars & other exudates into the soil

Grasslands & grazed croplands are like liquid carbon pumps

By using high-density, Holistically-grazed livestock in cropping/grazing systems:

- Industrial inputs = eliminated
- Spongy soils return
- Soil is covered i.e. protected
- A tipping-point in soil health = triggered
  (*Quorum Sensing*)
- This in turn leads to rapid soil-building
  (rapid increase soil carbon)

Function # 2: Water Cycle

Regenerating desertified land in Mexico after 30+ years
Coahuila, Las Pilas Ranch - (the latter > 27 years Holistic grazing Management)

Before - 1980

After – 2007 (per Guillermo Osuna Saenz)

Function # 2: The Water Cycle

(82mm in 2 hours – per. Nigel Kerin)

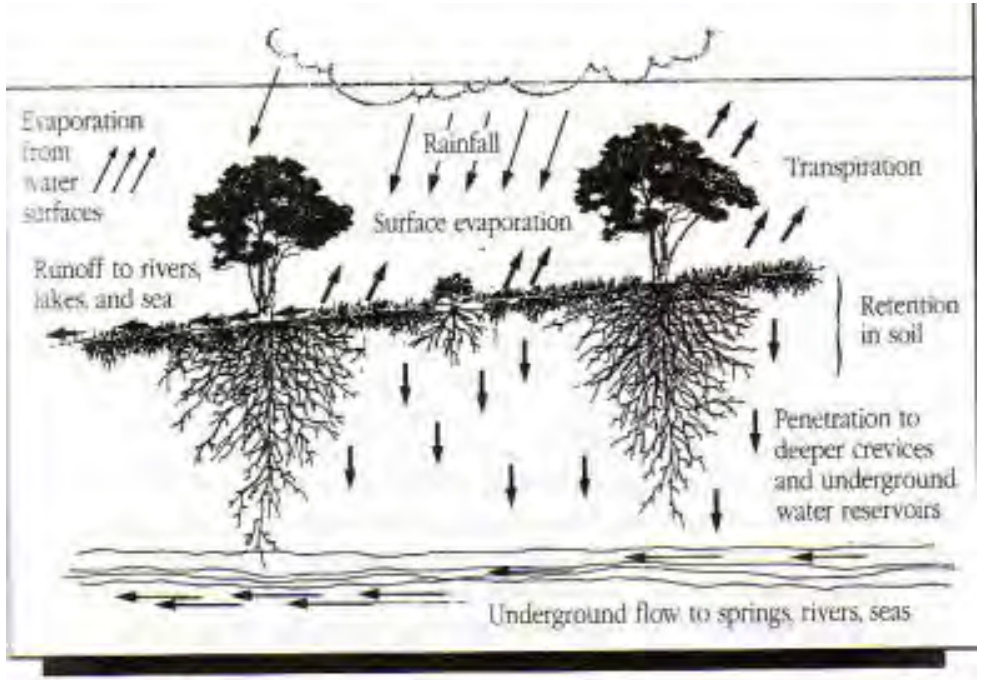


Figure 12-1 *The water cycle.*

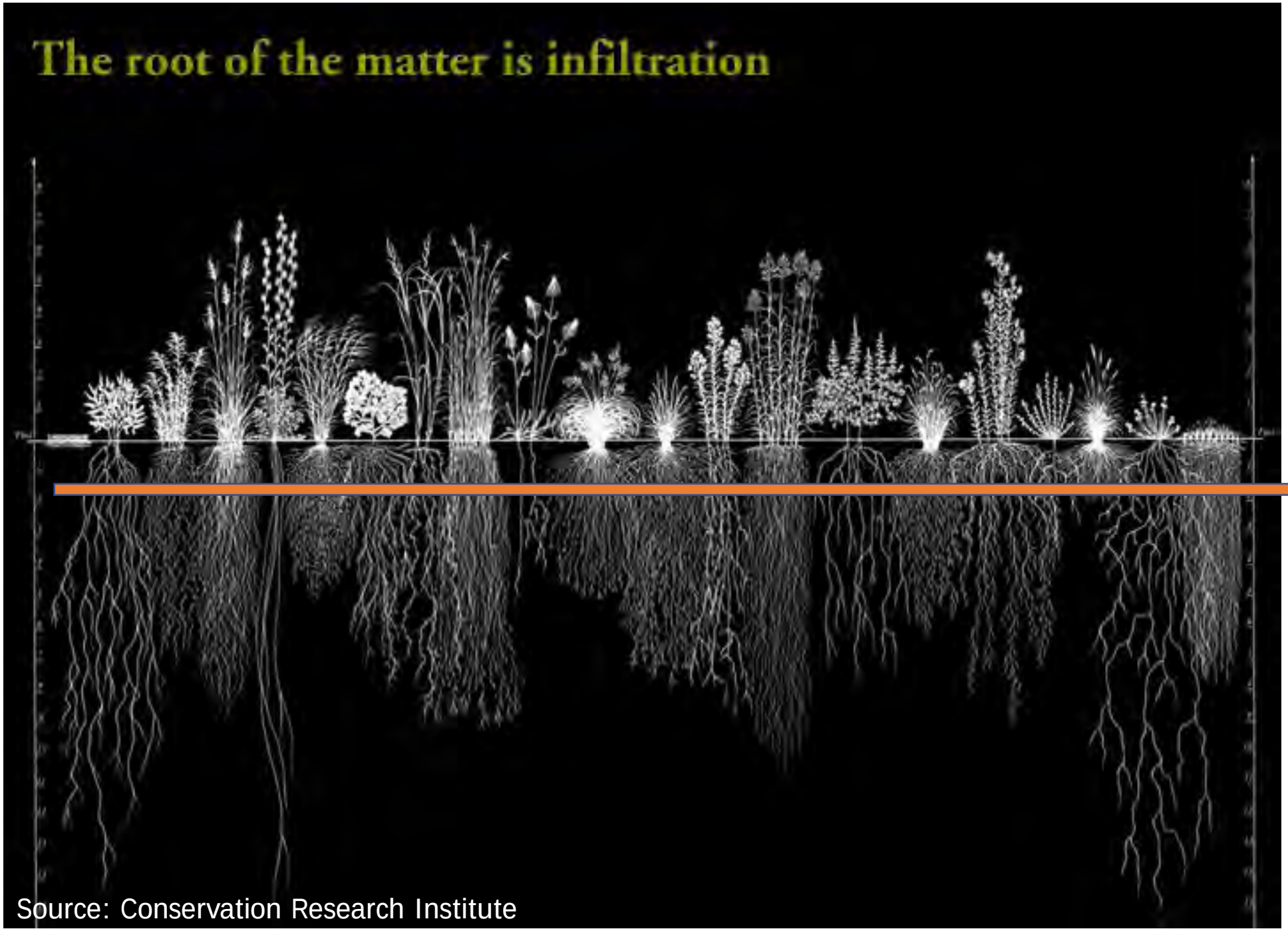
(Savory/Butterfield 1999)

An effective water cycle

REQUIRES ACTIVE MANAGEMENT

Destruction of cover by tillage &/or over-grazing = main cause of desertification; ensuing compaction; erosion etc.

e.g. splash erosion on bare soil delivers more compaction than tillage



Source: Conservation Research Institute

Modern industrial Crop-Lands' Hard-Pan

OVERGRAZING

Overgrazing happens when animals linger too long among rapidly growing plants – or if they return too soon when growth is slow.

Rough fescue plants after 16 weeks of clipping treatments. Sods from an ungrazed area (12 yr) were placed in a greenhouse and clipped once, then not clipped or clipped every 4 weeks to a stubble height of 1.5, 3, or 5 in.

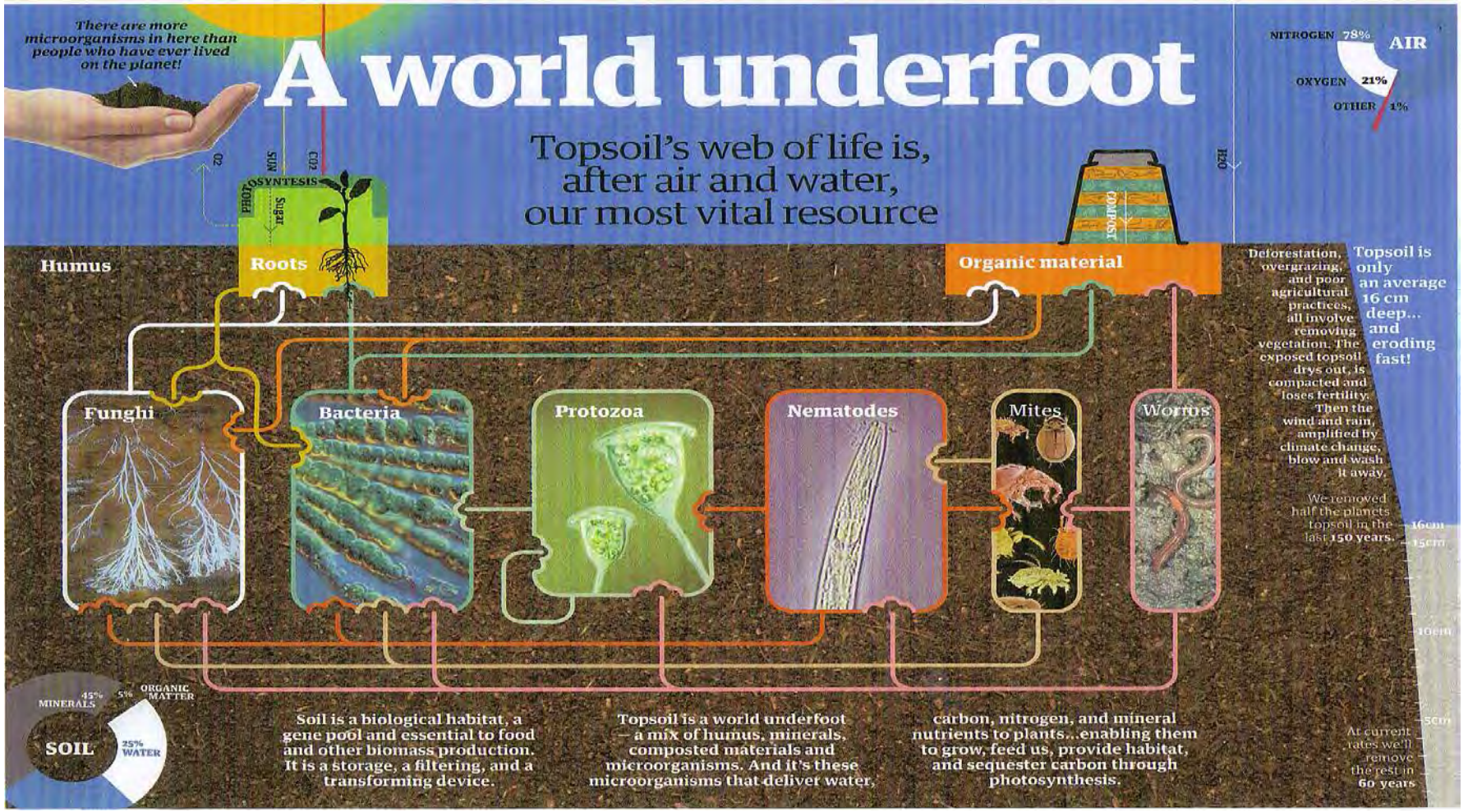
Clip ht.	Tops	Roots	Tiller no.	
-- in --	-- g DM --		initial	final
Not	20.2	15.0	87	431
1.5	1.8	0.7	73	53
3	5.9	3.0	81	192
5	16.0	7.8	77	427

FIGURE 2. Plants of *Festuca scabrella* unclipped and clipped to stubble heights of 5 inches, 3 inches, and 1½ inches at 4-week intervals.

A. Johnston. 1961. Can. J. Plant Sci. 41:615-622.

Function # 3: The Soil-Mineral Cycle

An Effective Soil-Mineral Cycle: Key = biologically active living soil



(Image: U.N.)

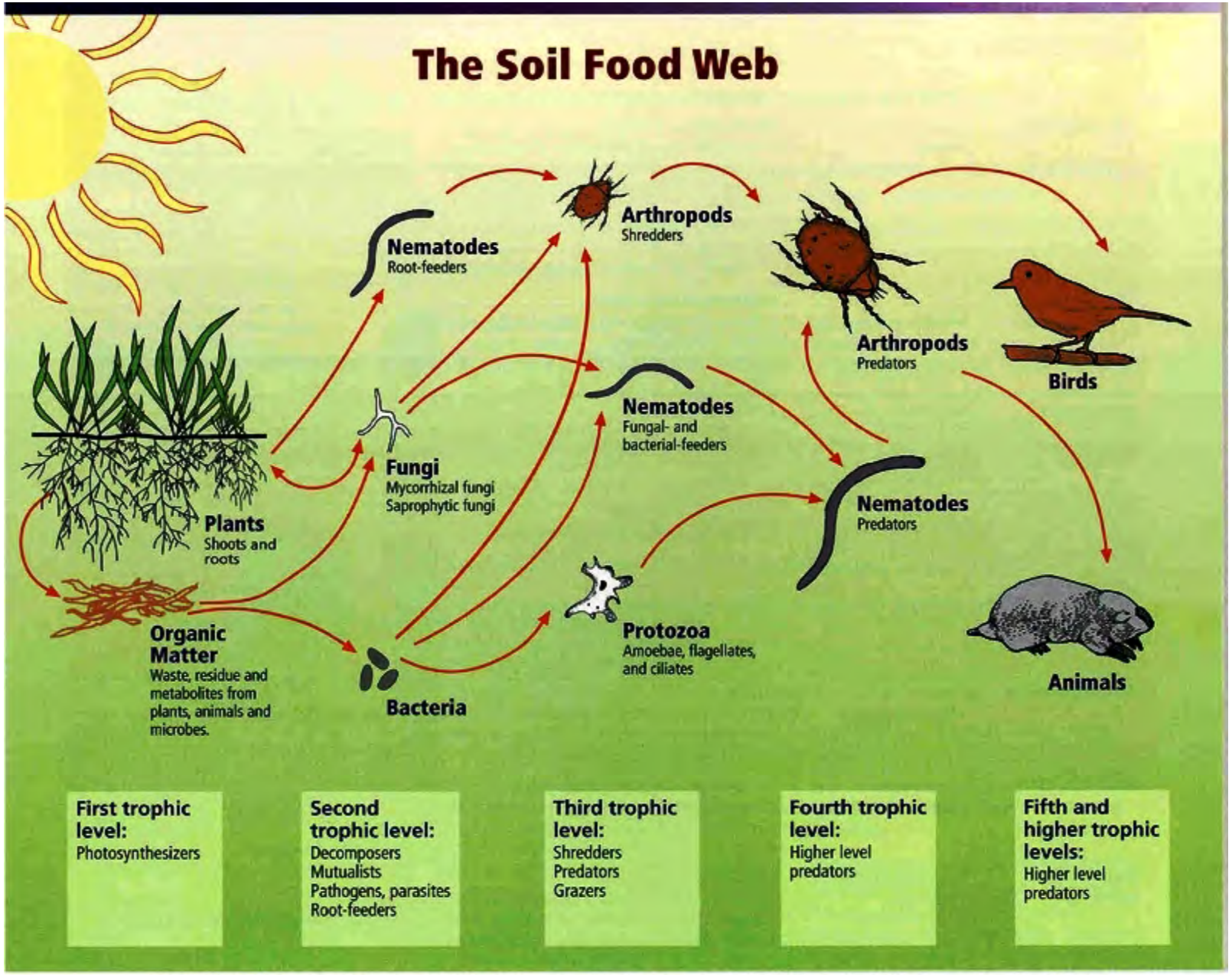
- Soil microbes & other soil life require plants for food.

- **The natural world is composed of inter-dependent communities of organisms**

  (& 93% non-plant organisms = microbes)

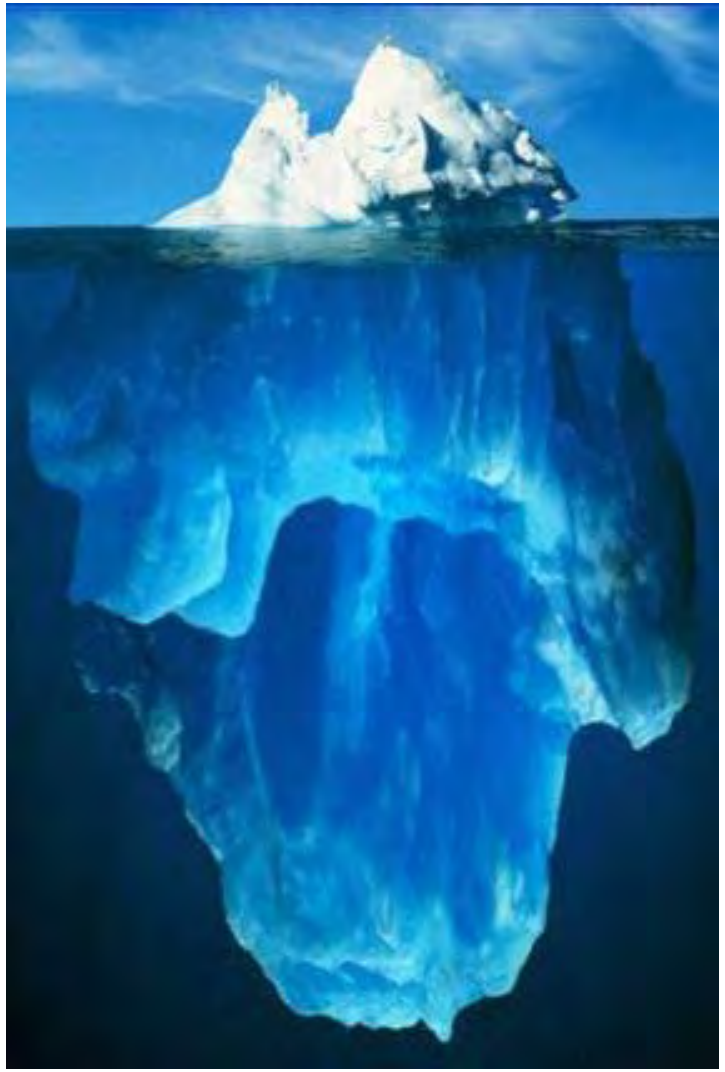
- Plants release root exudates, and decaying plant organic matter, to soil microbes, fungi etc. --

and in return this life supplies nutrients to plants.



Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html.

Soil bacteria



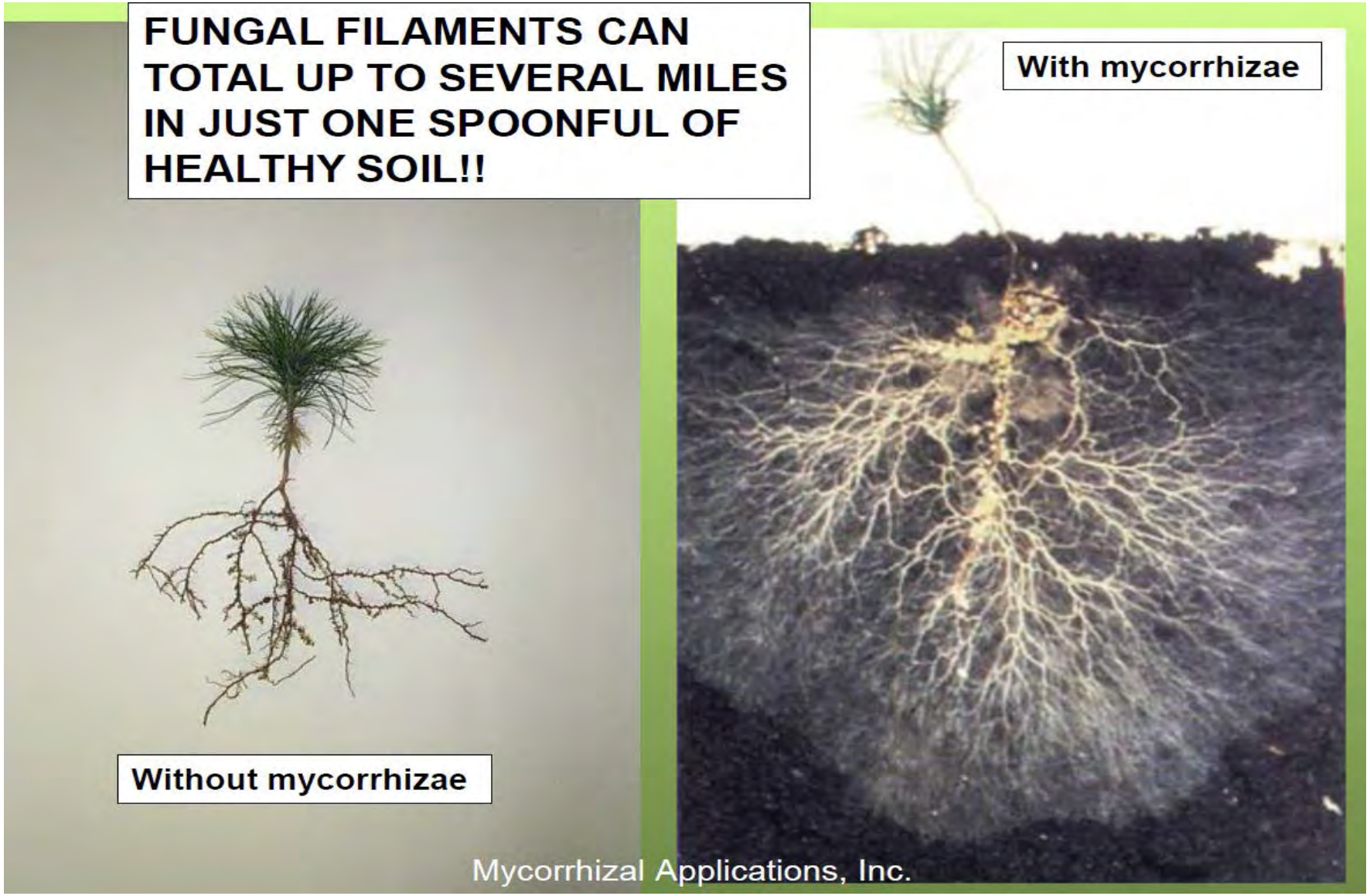
The Iceberg Impact

In a healthy Agricultural soil there is vastly more life under-ground than above

& thus more carbon

& water

(n.b. industrial agriculture destroys all this)



No Fungi

only 1/1,000 of surface area for Mineral/nutrient absorption

INDUSTRIAL **REGENERATIVE**

Australia's best soils - dead from industrial agriculture

In a dry season:
8mm rain, but
12 hours previously

IF NO COVER:

At 41 c air temp (108.5 F):

- Huge evaporative loss
  (= little/no moisture)
- Only 0.4 cm down --
  soil temp. = 60.6 c (160.7 F)
- This kills all soil life

1930s
Dust-Bowl
U.S.A.

Wes Jackson in
Nature as Measure (p.4)*:*

“The ploughshare may well have destroyed more options for future generations than the sword.”

‘NATURAL INTELLIGENCE AGRICULTURE’

Ian & Di Haggerty, W.A. – Resilient Cropping (on 6 to 14” rain)

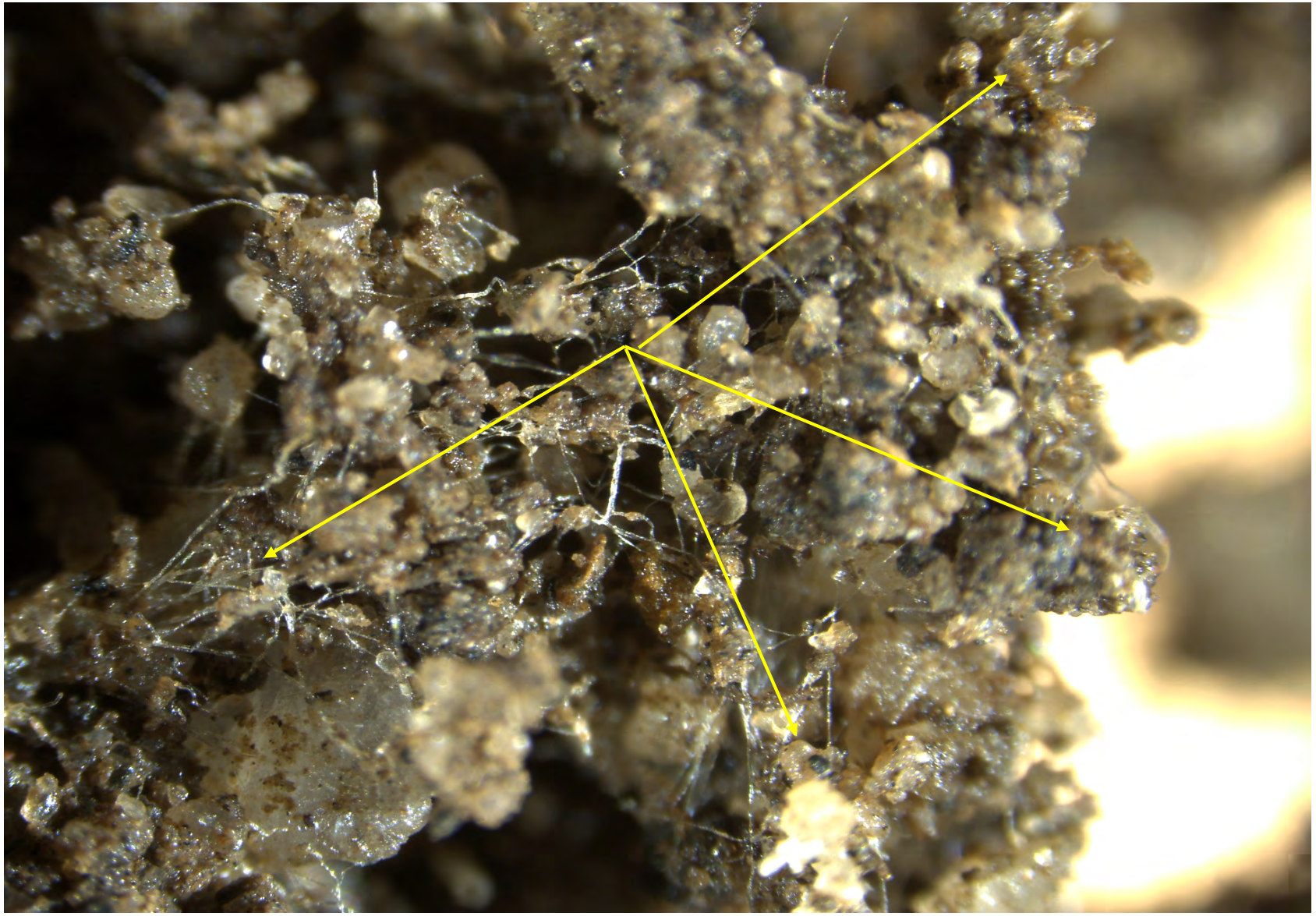
Fence-line Comparison between Haggertys and neighbour – post-harvest 2015

(photos, per Di Haggerty)

Neighbour's paddock

Strong healthy soil aggregation

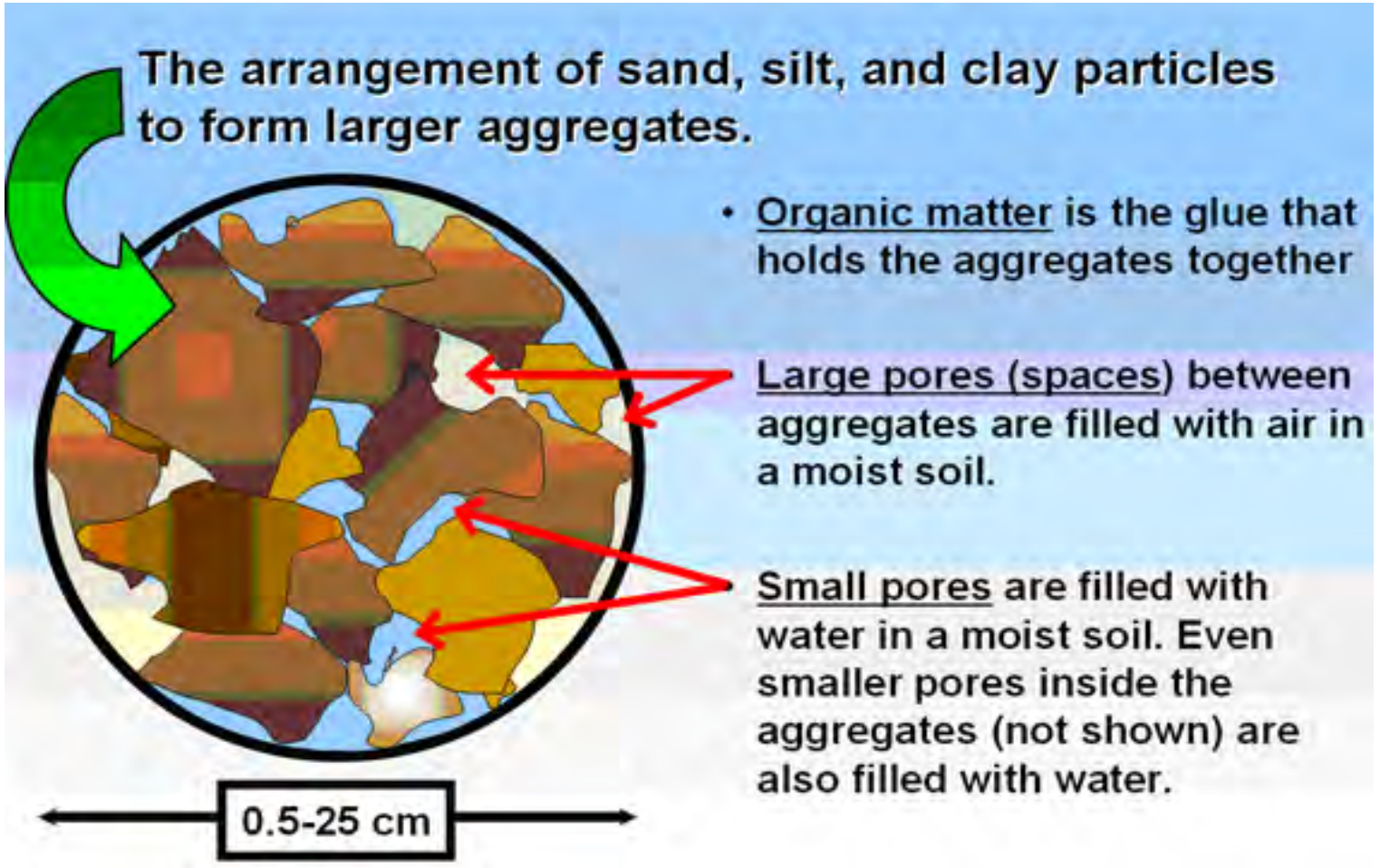
Haggerty's Paddock



(Image,Phill Lee)

Healthy soils look like this, with little sticky networks gluing the soil together to form soil aggregations

(fungal hyphae, glomalin etc.)



Good Soil Aggregation

- Healthy soil biology fed by plant sugars/exudates
  (fungi = crucial)
- Glomalin (superglue) delivers stable aggregatn.
- Well-aggregated soil can have 50% space (air & water storage = health)

- **Cathedral stones = mineral particles**
- **The cement = Soil Organic Matter**

Healthy, aggregated Soil is up to 50 + % air.

Its voids and ethereal spaces are like cathedrals – where much else is going on:

- **Water storage**
- **Nutrient exchange**
- **Protection from disease & harmful elements**

i.e. Healthy soil has intelligent, selective interfaces

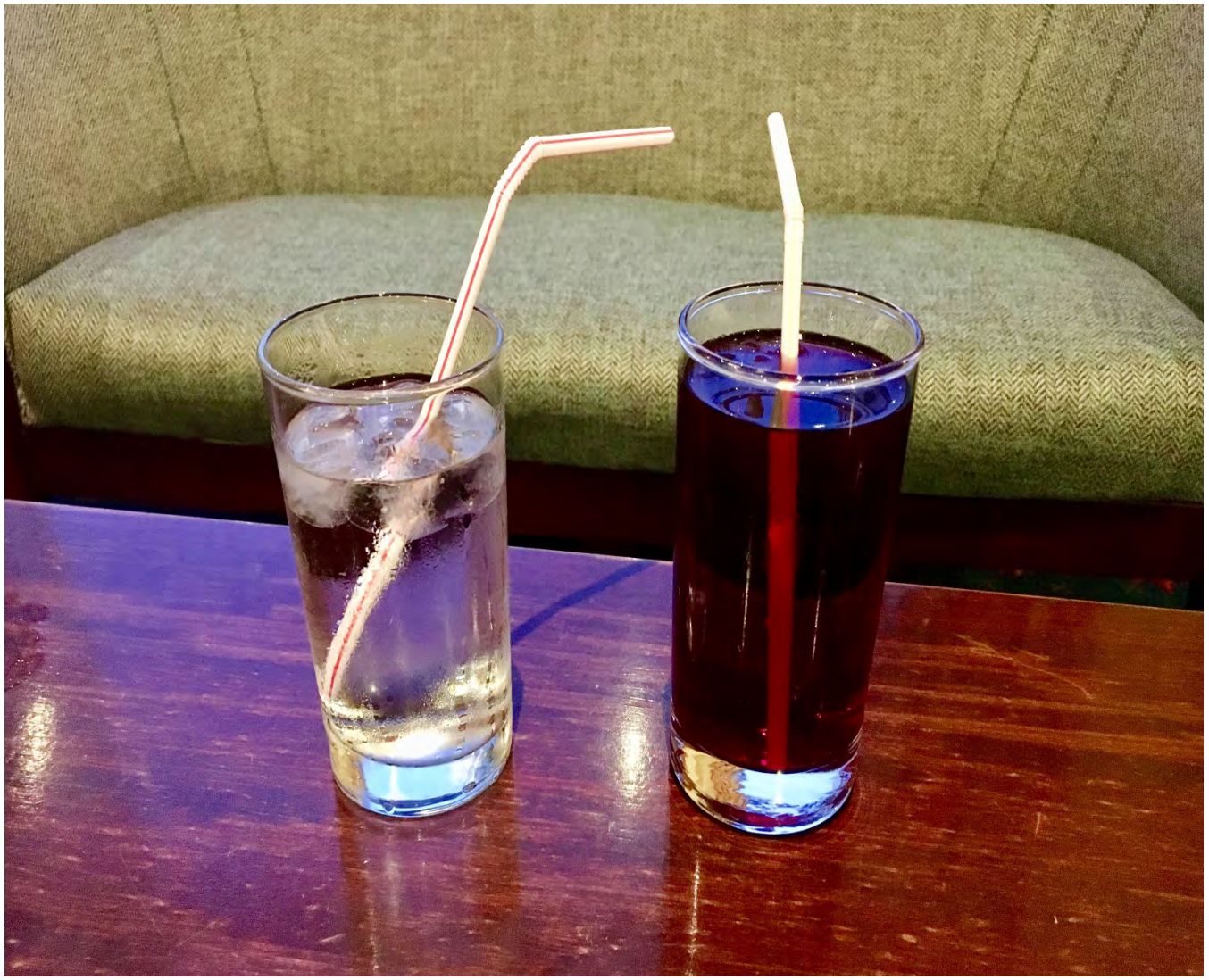
Excellent Cation Exchange Potential

The cathedral-like spaces and voids of healthy soil provide huge surface area for the attachment of important

cations +

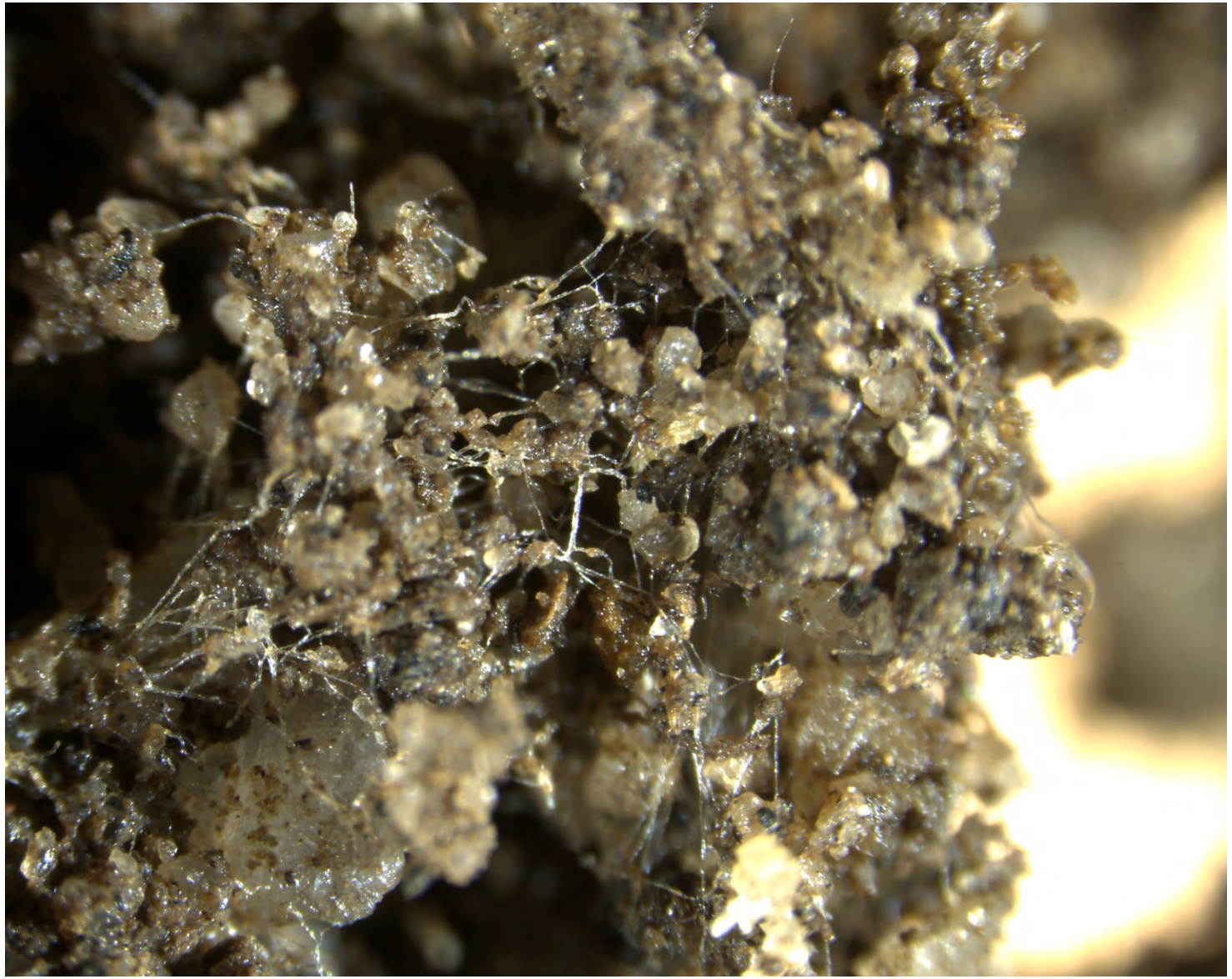
→ **uptake of essential minerals, trace elements etc. like onto velcro**

Poor landscape management destroys the crucial cathedral-like spaces of soil and its structure



Without fungal-driven healthy soil structure,
plant roots can only indiscriminately suck-up soil-water solution – like via straws

- i.e. no discrimination between toxins, disease agents etc. & nutrients
- and contains only a fraction of the good cation trace elements, essential minerals etc.
- **i.e. no different to hydroponics**

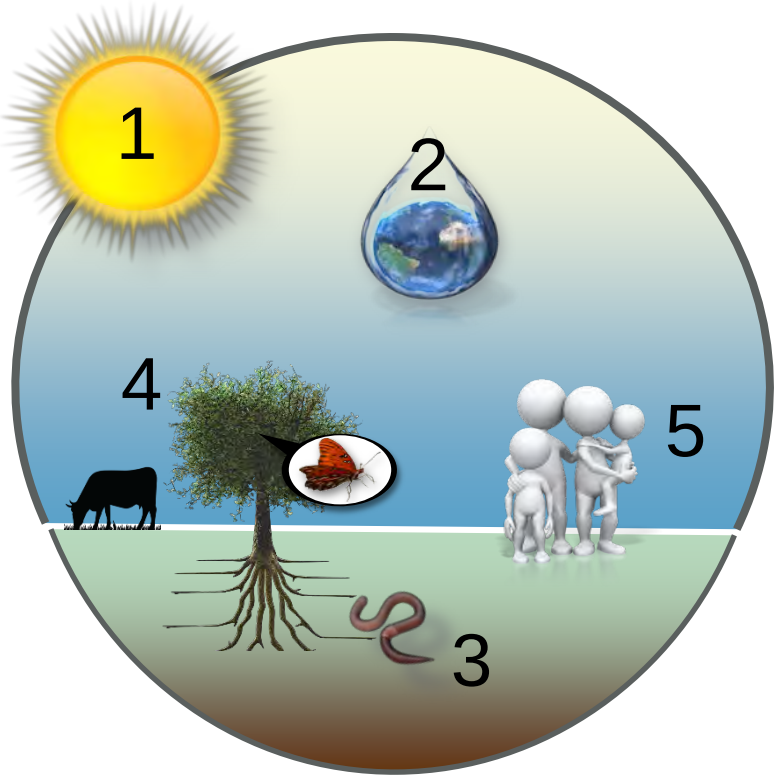


That is, 80 % of a soil's bio-fertility depends on surface exposure, cation exchange etc. –
NOT the quantity of nutrients
(especially via industrial over-doses)

The correct balance of Minerals and primary & secondary nutrients are essential for human & animal health.

Mountain goat down-climbing for salt minerals

Function # 3: The Soil-Mineral Cycle (Cont.)



The 5 Landscape Functions

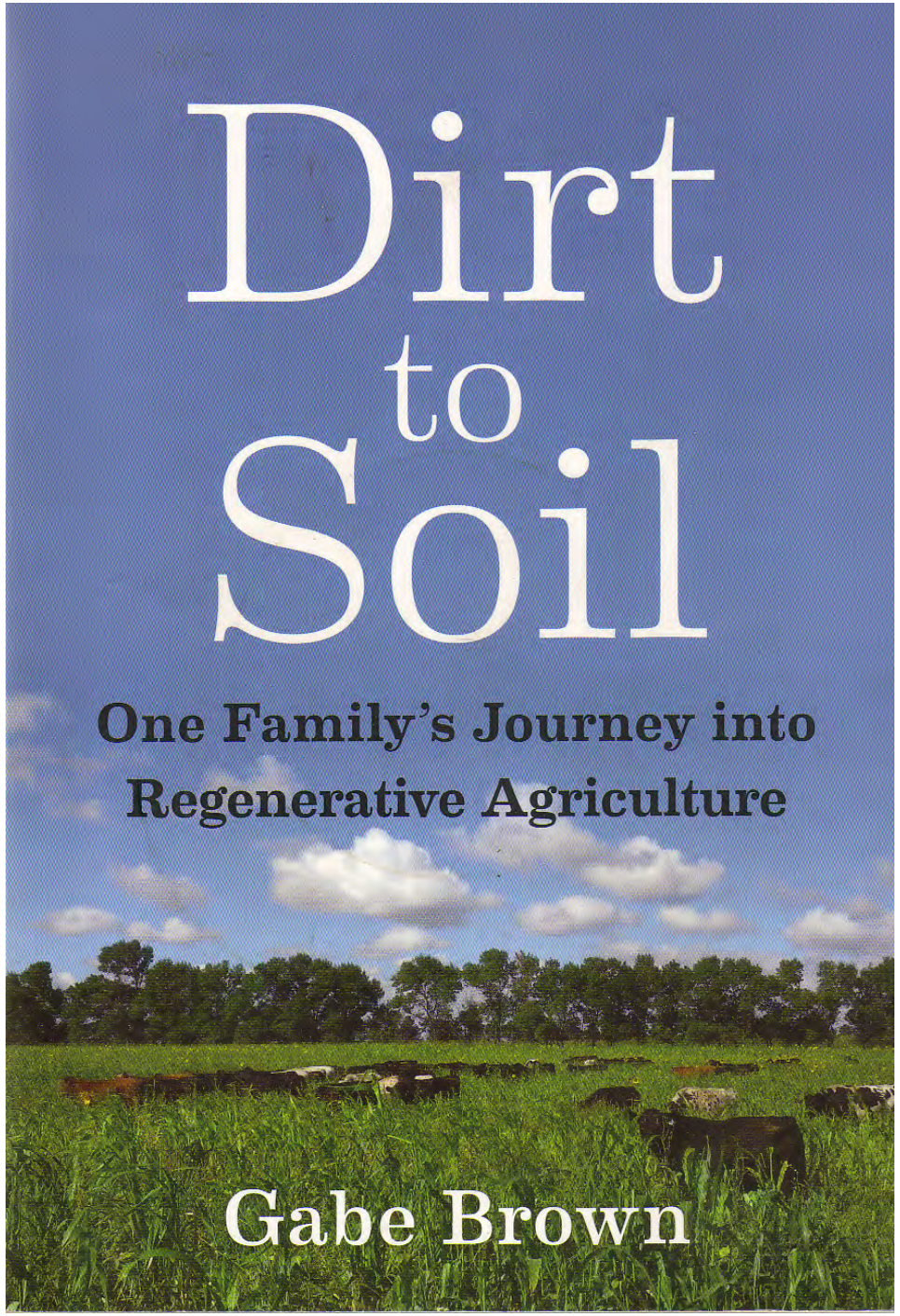
(Per Fred Provenza)

What's next in re-creating soil health?

Multi-Species Pasture- & Cover- Cropping

(per Colin Seis)

Harvest multi-species crop for grain



His Secret?

13 to 20+ diverse-functioning cropping &/or pasture species, laid down as cover by livestock

Better Soil Health = Better Water Cycle

Gabe Brown's low bulk density soil > 12 yrs

(rainfall penetration: 1st inch, 9 secs;

2nd inch, 16 secs)

Across the fence, neighbour's high bulk density soil - under industrial agriculture

(rainfall penetration: an inch/2 hours)

(Gabe Brown; Christine Jones)

One of Gabe Brown's tools

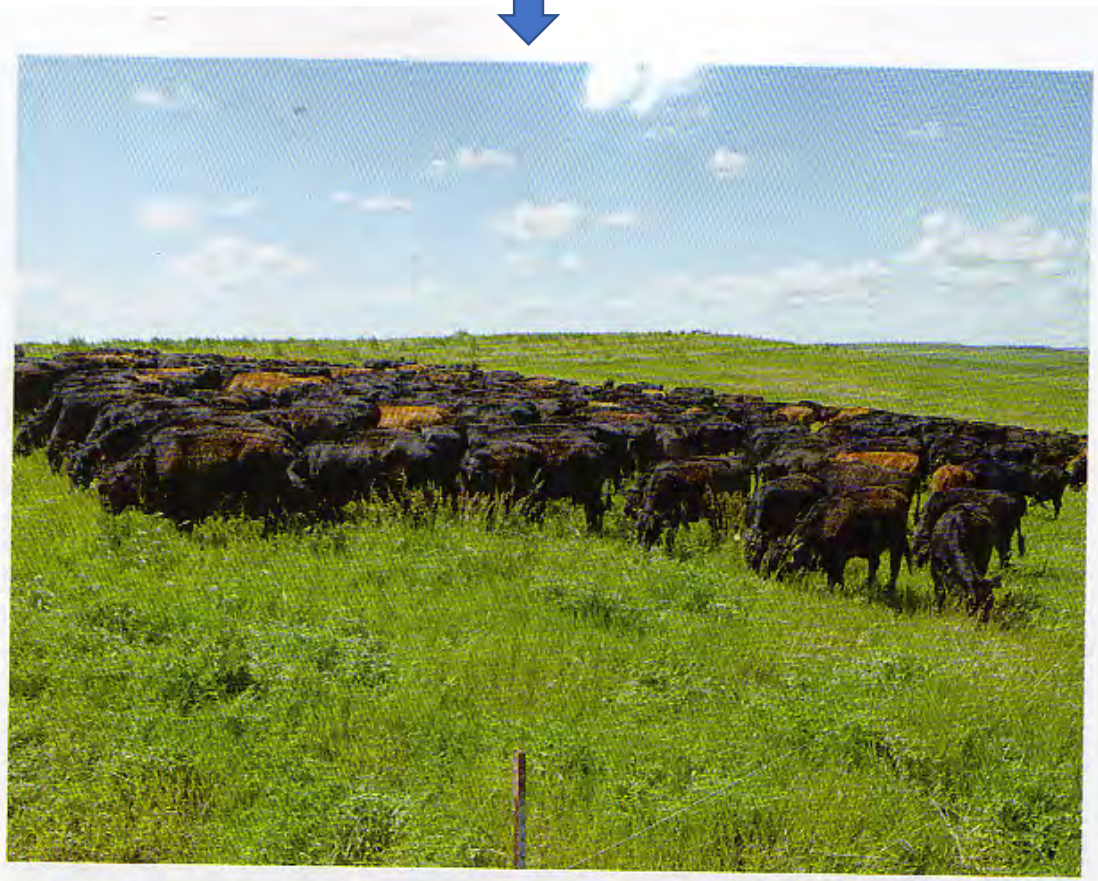


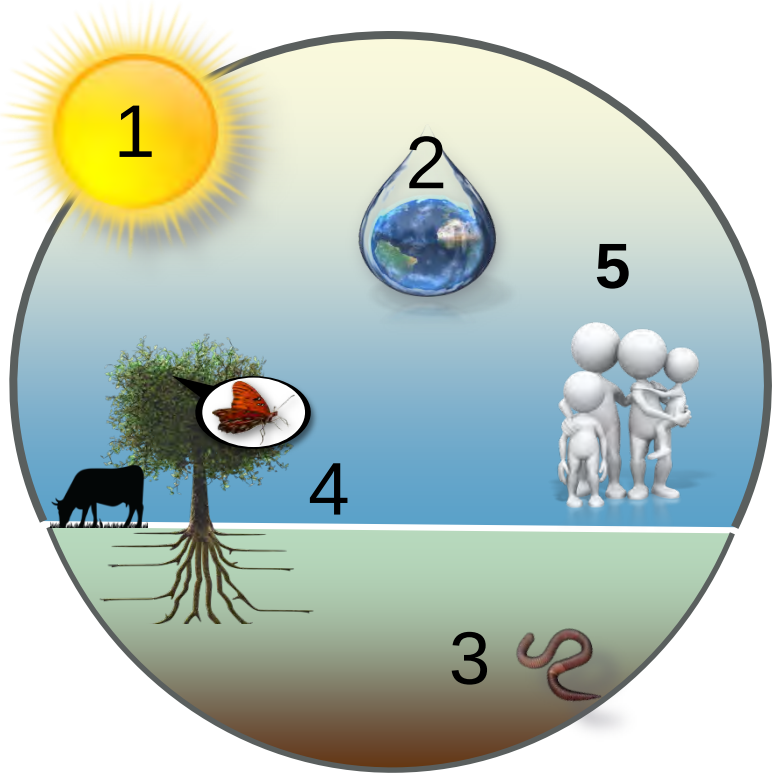
Plate 12. Here is what 700,000 pounds live weight per acre looks like grazing on diverse perennial forage.

Gabe Brown's 5 Principles of SOIL HEALTH

1. Limited Disturbance
   (mechanical, chemical, physical)
2. 100 % Soil Cover or Armour
3. Diversity (plants & animals)
4. Living Roots (as long as possible)
5. Integrated animals in system

Combining The Functions

Bonus Extra



Only healthy soil biology can put long-term Carbon in the soil

Through getting all 5 landscape functions properly working, just with 1% > Soil carbon, up to 144,000 extra litres of water can be stored per hectare

THE CATHEDRAL EFFECT (Morris, 2004)

SOIL ORGANIC CARBON (S.O.C.) = THE KEY DRIVER OF FARMER'S PROFITABILITY (GRAZING & CROPPING)

When we generate high S.O.C. in biologically rich soil:

We get remarkable **self-organization**
and thus a tipping-point:

→ rapid soil building

BUT WHAT IS REALLY HAPPENING?

Complex communities
= the normal situation in nature

- Species-rich, diverse
- Abundance & interaction

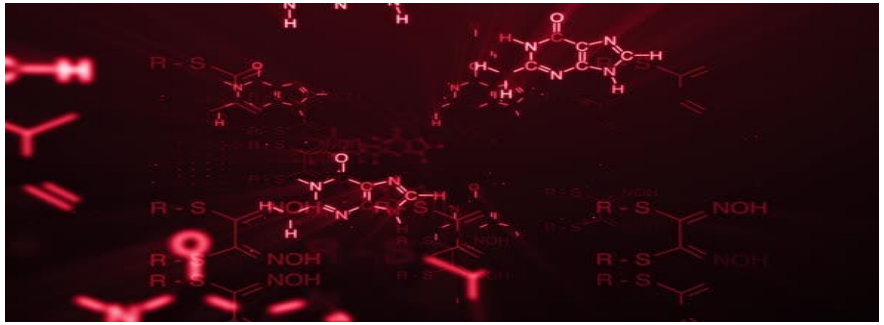
So (1) why do we think that underground – the soil –
is any different to above ground ? &
(2) why do we destroy & simplify this complexity
so as to grow simple monoculture pastures & crops ?
(& at great $$ expense & environmental cost)

So, what else is going on?

1. Great plant-microbe (soil life) communication

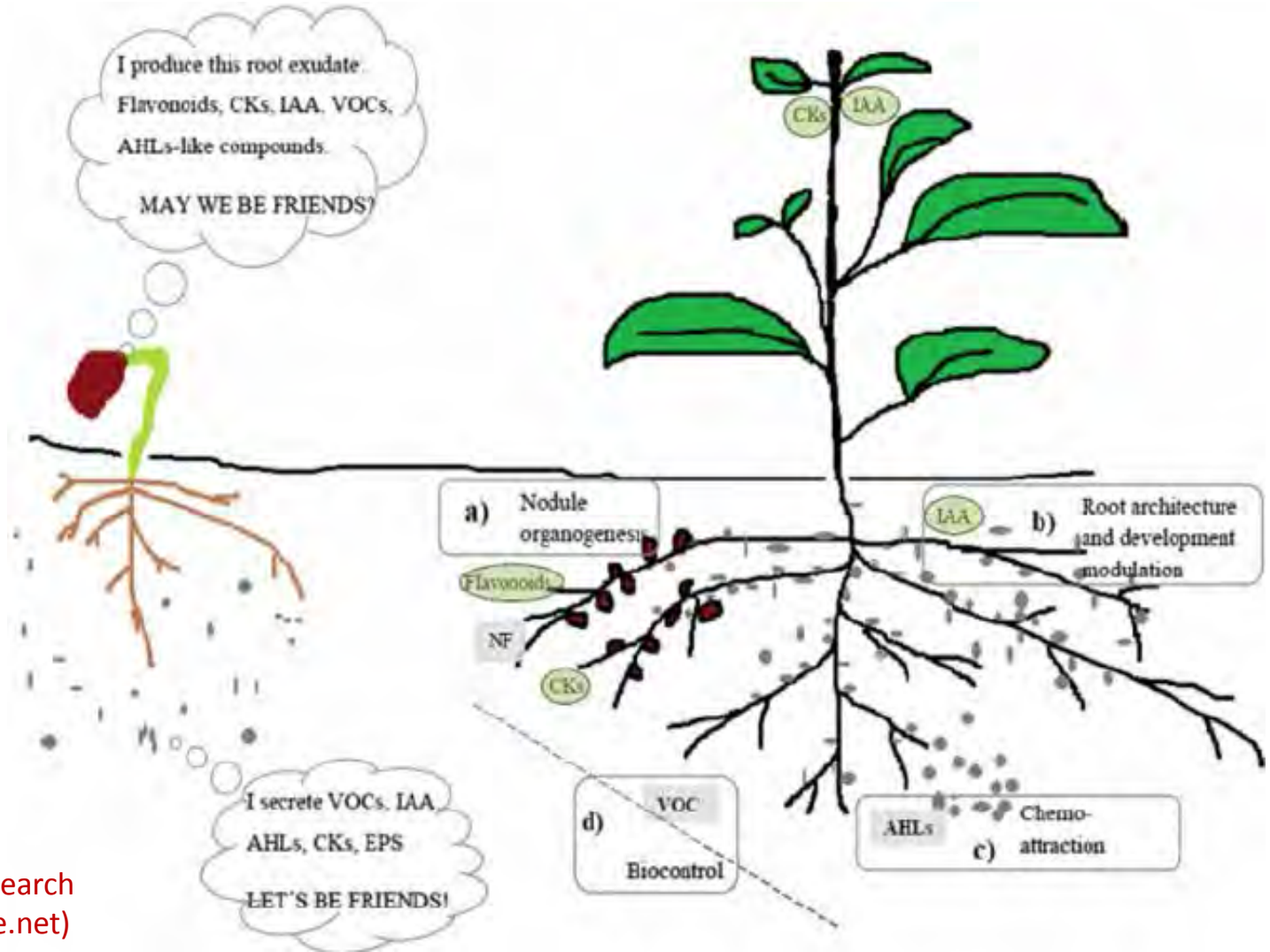
   Communication is across animal/plant kingdoms, phyla, genera, species (e.g. between plants, a range of soil biology forms & humans)

   - Using a common chemical vocabulary



2. QUORUM SENSING (Q.S.)

Communication & Tipping-Points in a Healthy Soil → Q.S.



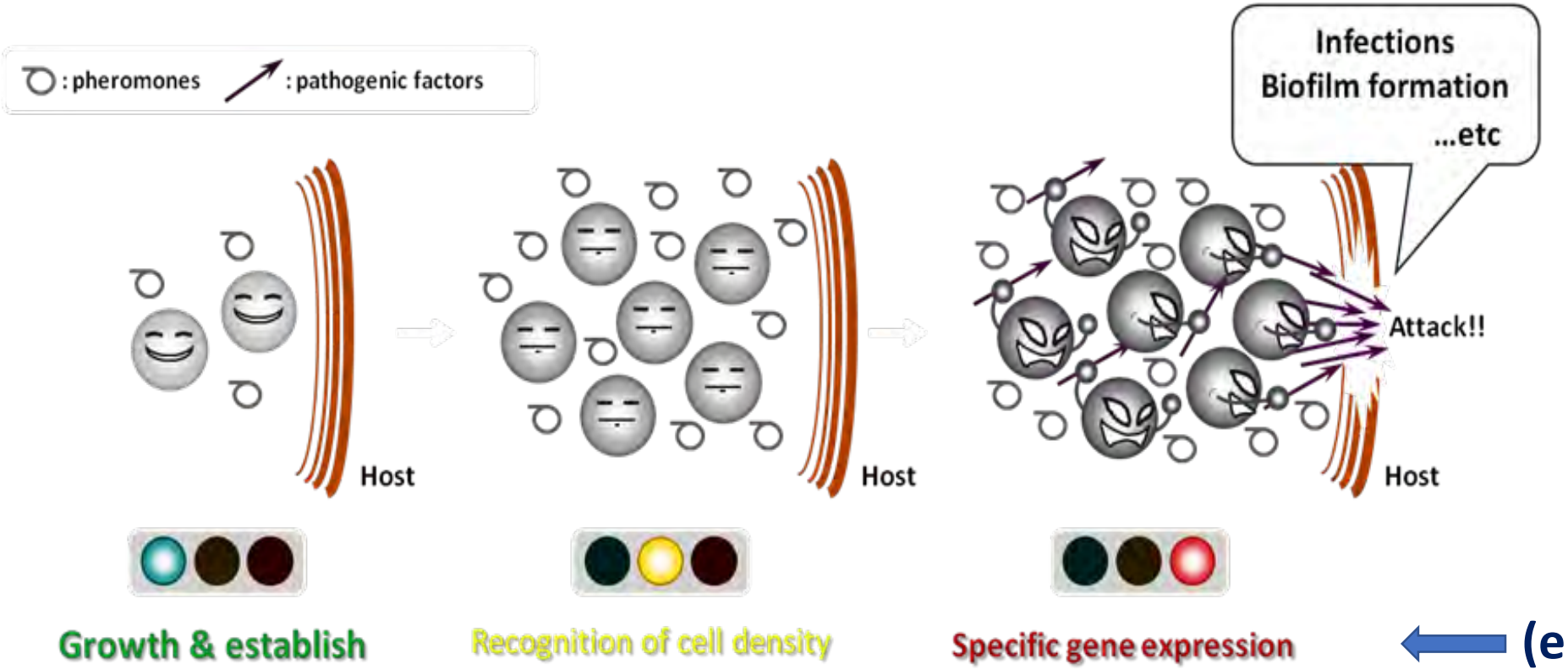
(research gate.net)

Example of plant-microbe communication/interaction

1. Plant realises soil is nitrogen poor
2. It releases chemical messages in root exudates (in this case *flavonoids*)
3. Rhizobia bacteria then respond, & form nodules & begin fixing nitrogen

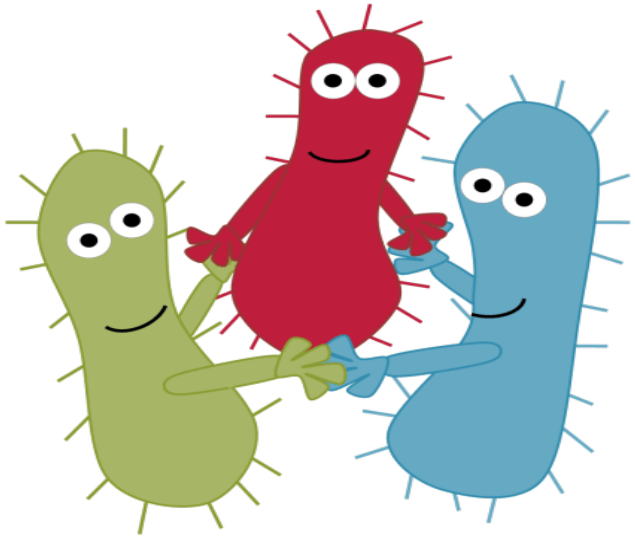
n.b. But the 2 only happens when you get to a tipping point for QS

Example of Q.S.: Response to disease attack, plant-microbe communication, & genes switched on/off



Cell density dependent gene expression in quorum sensing
(e.g. virulence expression)

Quorum-Sensing (QS) & Plant Communication



1. Communication is across animal/plant kingdoms, phyla, genera, species (e.g. between plants, soil biology & humans) = complex

2. This communication → coordinated group behaviours → better fitness/ adaptation to the environment

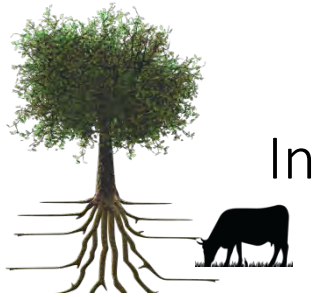
3. Quorum Sensing (QS) in farming is when we develop rich biodiversity above (e.g. plants) and below ground → magic

i.e. → a tipping-point & the system self-organizes into remarkable function and health

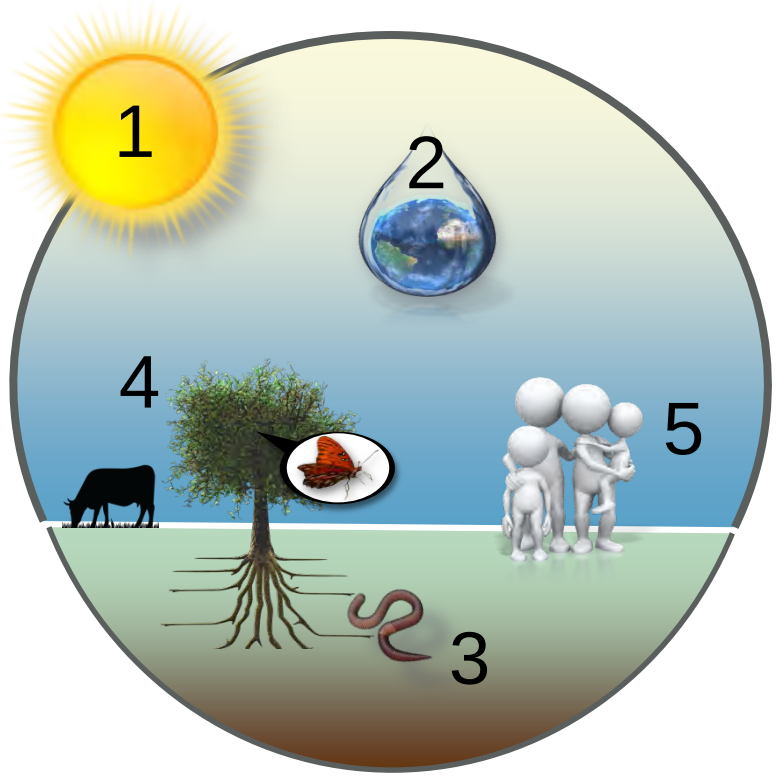
This = due to Quorum Sensing (QS)

BUT: WHAT CHANCE Q.S. & TIPPING POINTS IN THESE ENVIRONMENTS ??

Function # 4: Dynamic Ecosystem Communities/Biodiversity

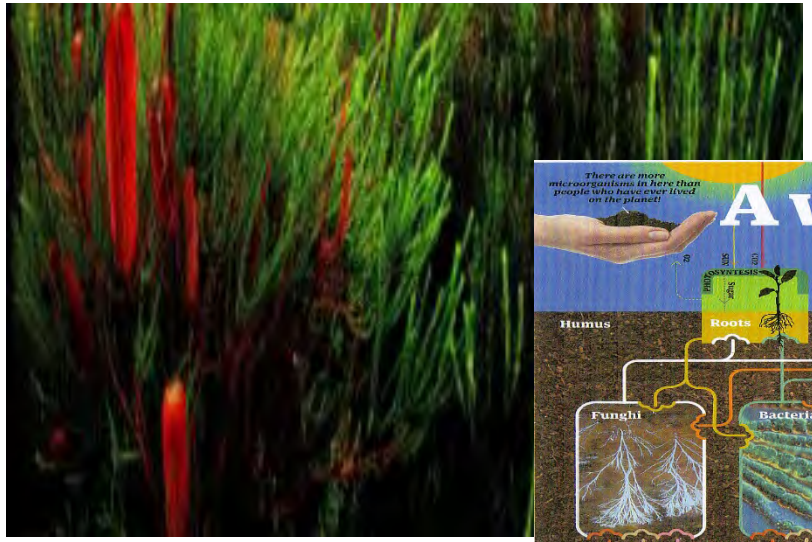


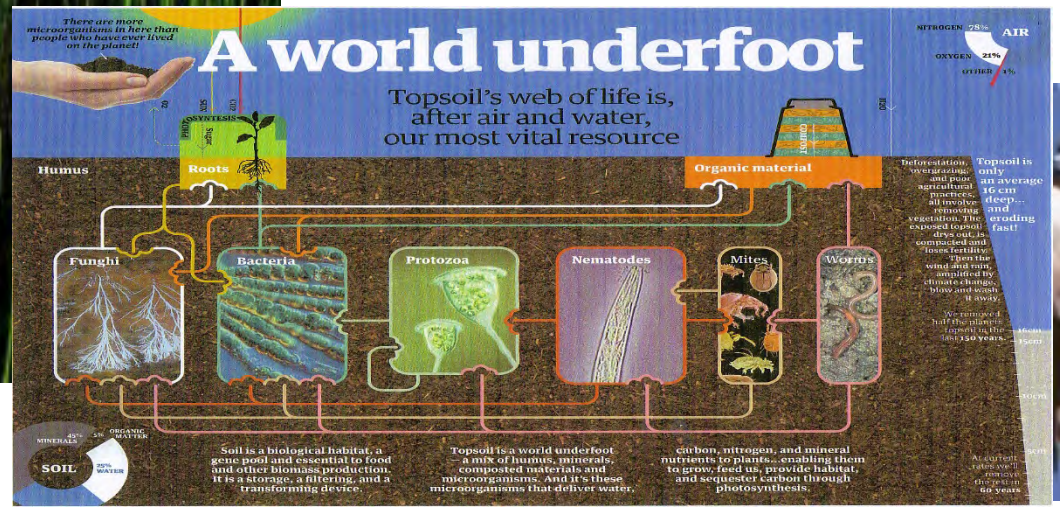
Involves diversity/networks/complexity/ mutualisms & symbioses, food-webs, networked communities



The 5 Landscape Functions

(above & below ground)





Solutions for Resilience:

Putting food trees + edible shrubs (the missing understorey layer) back into our landscapes: a vertical grazing layer with diverse nutrients **+ LOTS OF CARBON**

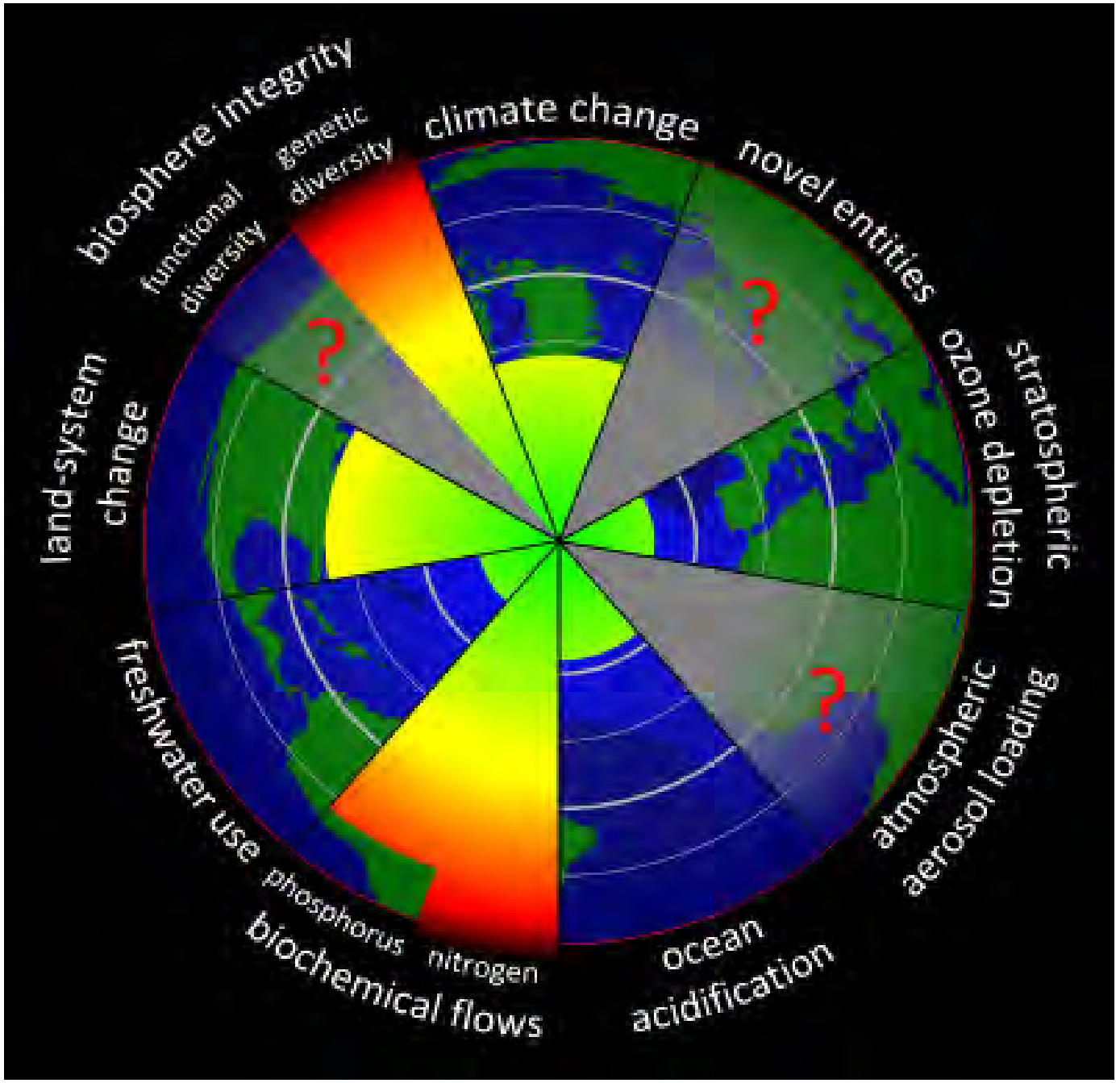
Tagasaste (Tree Lucerne)

Old Man Saltbush

TURNING THINGS AROUND

2. Addressing the Anthropocene

(Image: Elaine Ingham)



Earth's threatened planetary boundaries

Industrial Agriculture is a/the major player in causing damage to the 6 key biophysical Earth systems:

1. **Climate Change**
2. **Biodiversity Loss**
3. **Land-system Change**
4. **Freshwater use**

5/6. **Biogeochemical phosphorus/nitrogen flow**

BUT REGENERATIVE AGRIC. HAS THE SOLUTIONS !!

100 Top Carbon Draw-Down Techniques (Fully calculated by 70+ scientists)

- **Combined Regenerative Agriculture Practices: > 217 GT CO_2 Reduction**

i.e. combined regen. ag. = 240% > impact than # 1 (= refrigeration)

THE BIG CONTEXT # 3

HOW WE GOT INTO OUR EXISTENTIAL CRISIS # 3

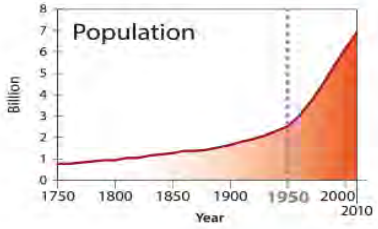
HUMAN ILL-HEALTH

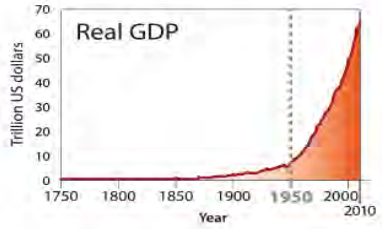
THE ANTHROPOCENE & HUMAN ILL-HEALTH ARE JOINED AT THE HIP

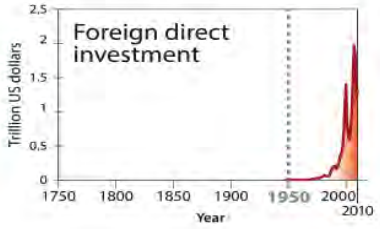
i.e. The ‘Great Acceleration’ also includes modern diseases

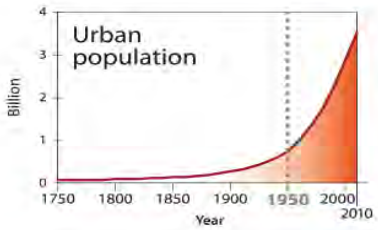
THE GREAT ACCELERATION

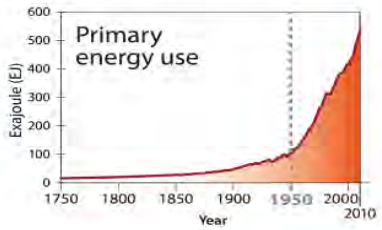
Socio-economic trends

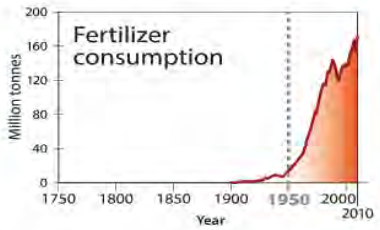


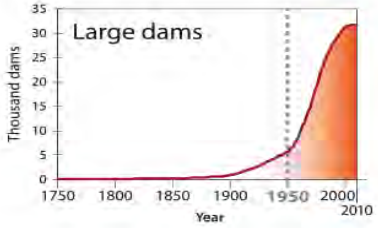


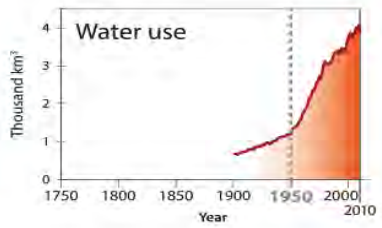


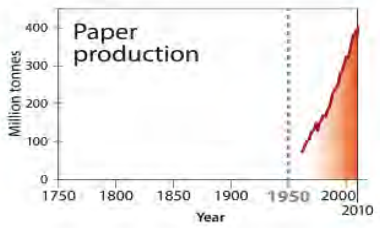


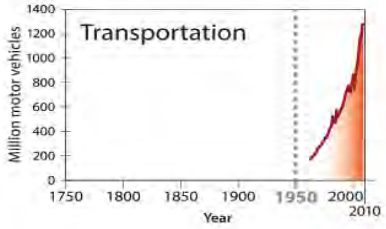


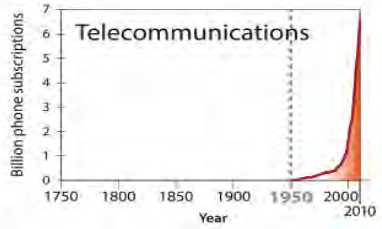


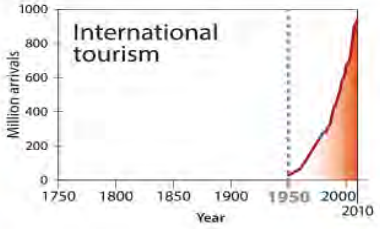




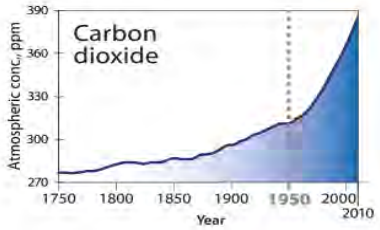


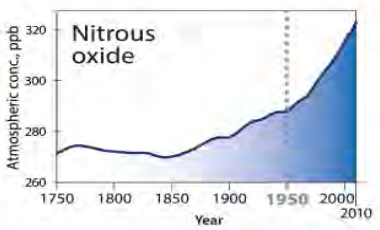


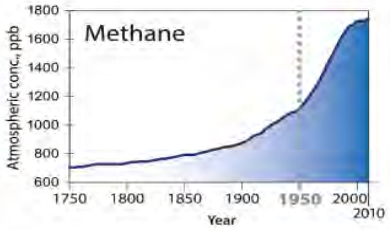


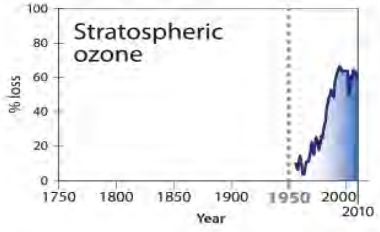


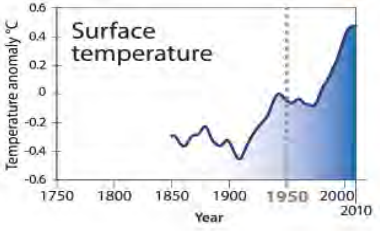
Earth system trends

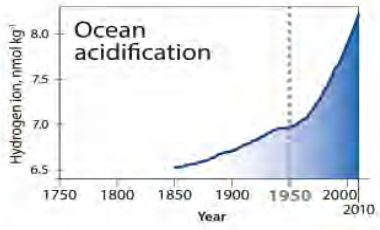


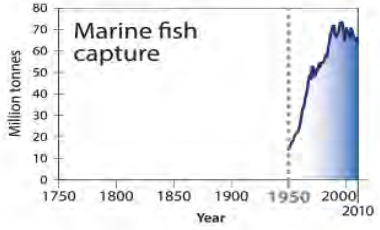


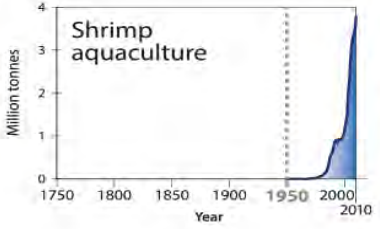


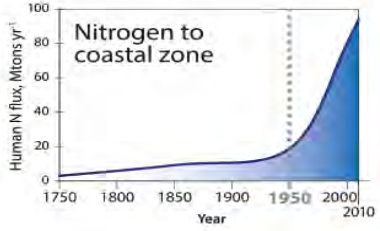


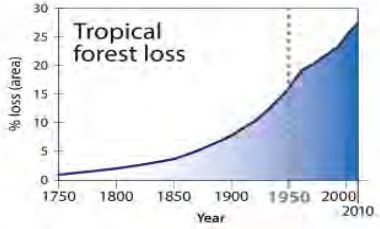


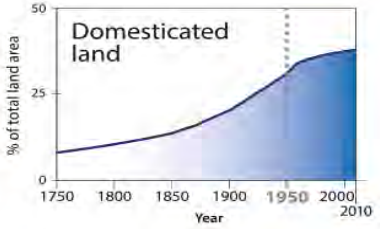


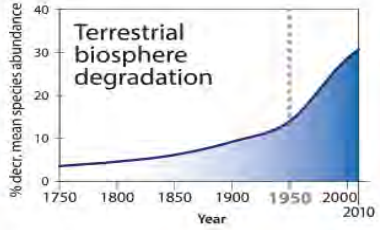


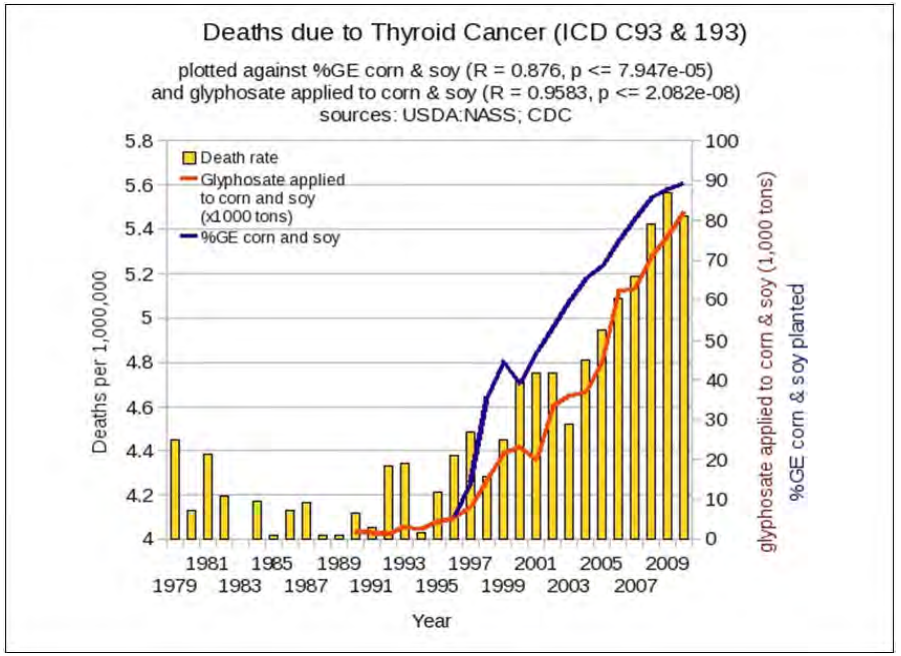


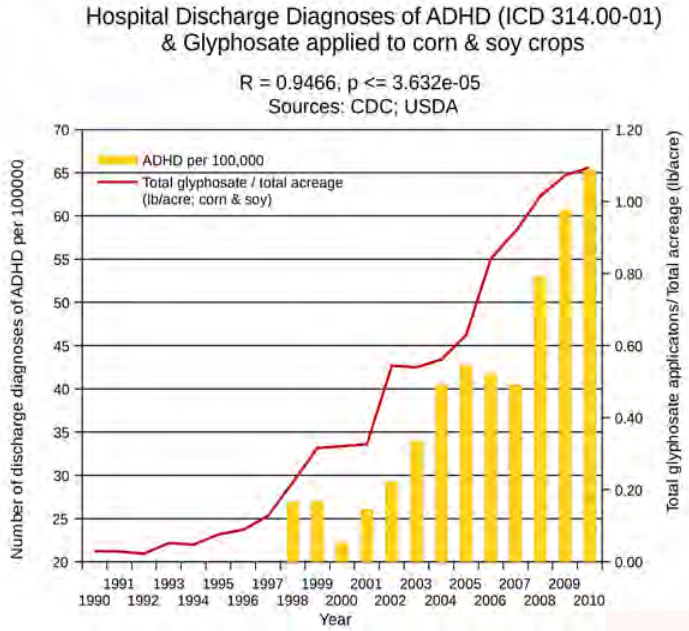


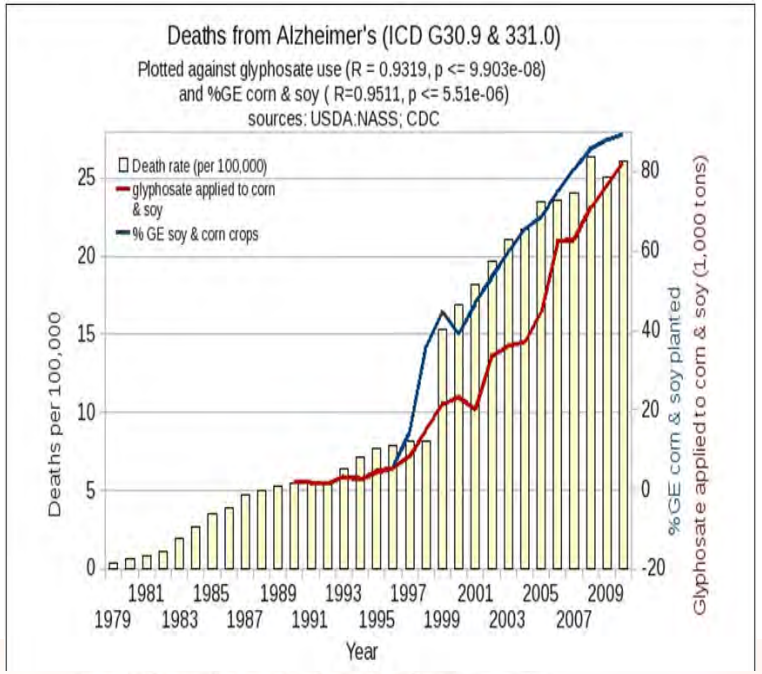












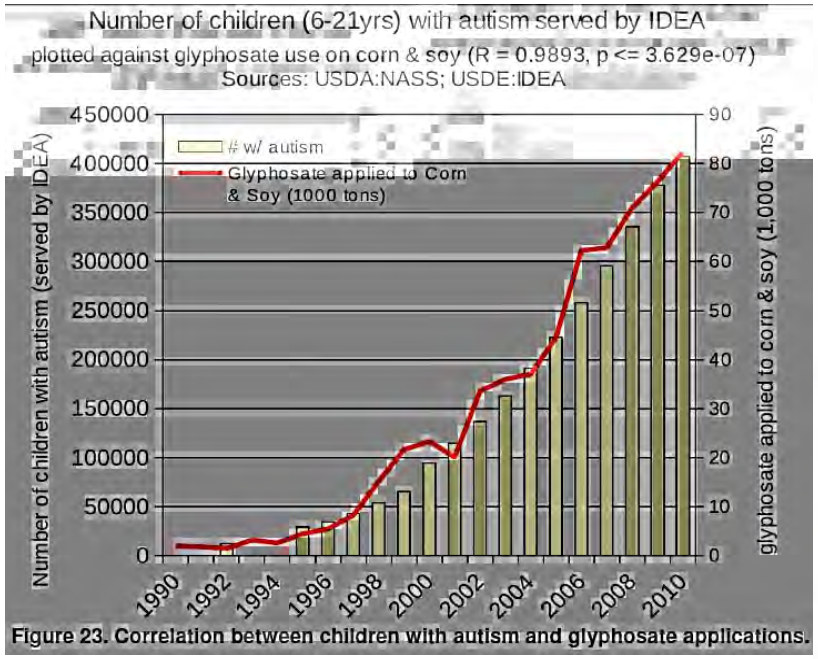


Figure 23. Correlation between children with autism and glyphosate applications.

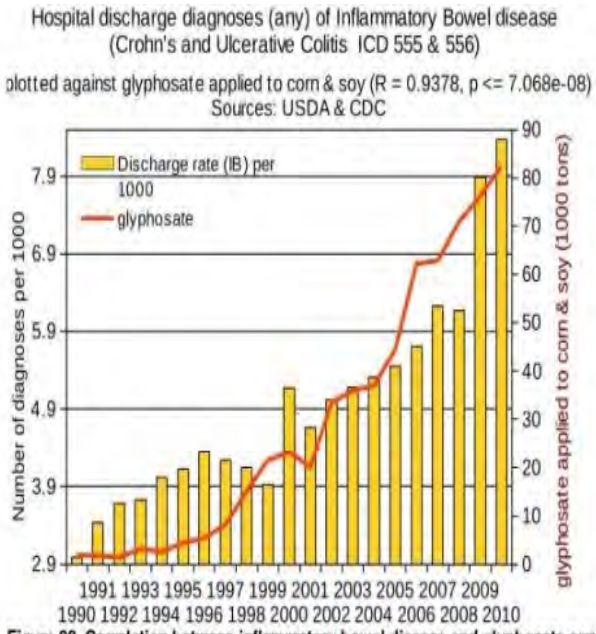
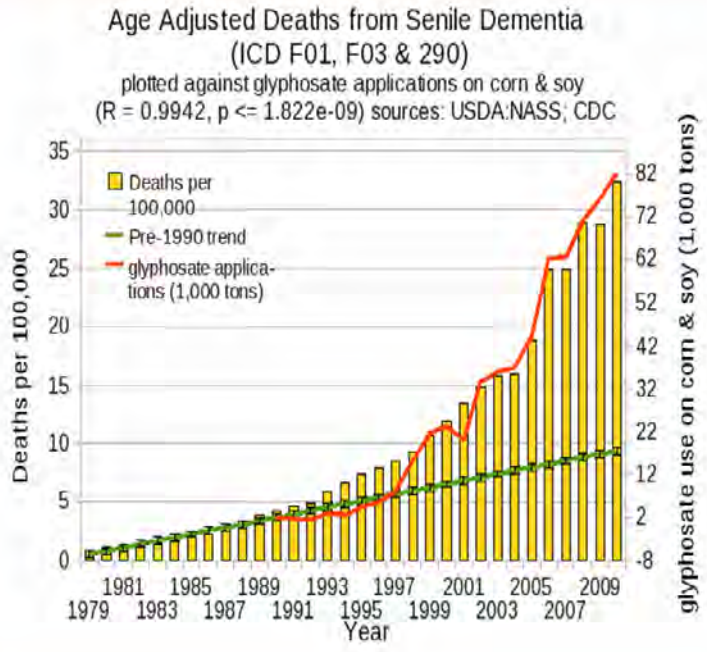


Figure 20. Correlation between inflammatory bowel disease and glyphosate applicatio
corn and soy crops.




Industrial Agriculture destroys food nutrient availability, diversity & quality, & delivers man-made poisons into our industrial foods

Mineral depletion in meat - 1940 - 2002

Iron reduced by 50%

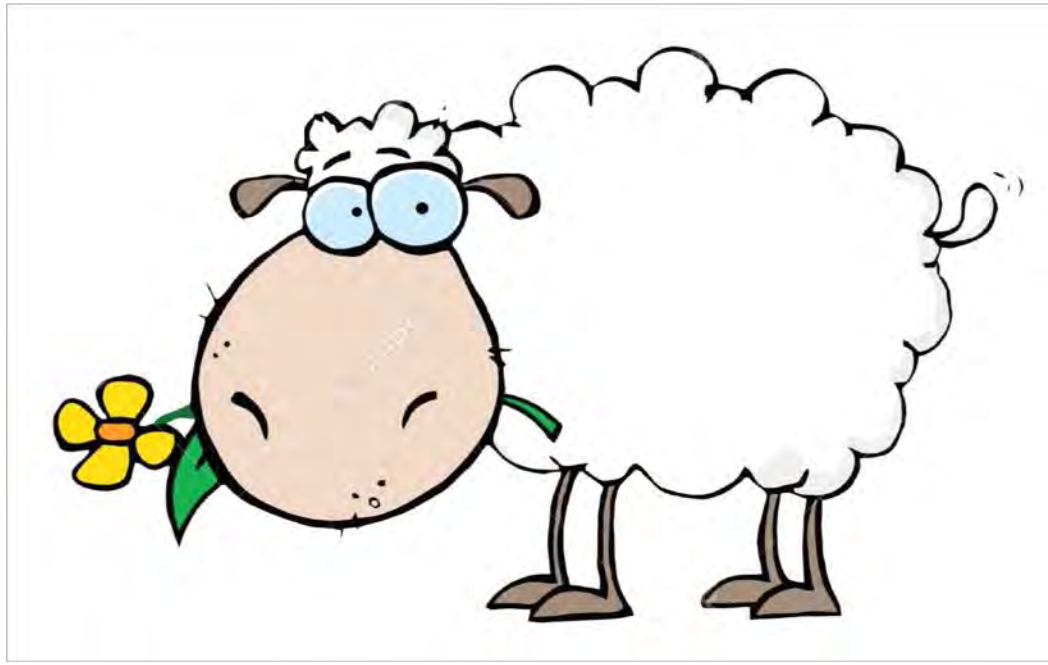
Copper reduced by 55%

Calcium reduced by 29%

Magnesium reduced by 15%

Potassium reduced by 9%

Phosphorus reduced by 21%



(Source: UK Ministry of Agriculture)

(Similar results industrial Grains, Dairy & Horticulture)

CAUSES OF DECLINE IN NUTRIENTS?

1. Over-processing of food

2. Genetic modification of complex genomics & narrow breeding goals

3. Industrial chemicals/fertilizers killing soil biology

4. **But MOST** of this decline in nutrients is related to a serious decline in Soil health and Soil Carbon → **nutrient-poor foods**

But there is a second alarming issue:

SILENT SPRING II

A MASSIVE VULNERABILITY:

GLOBAL RELIANCE ON
GLYPHOSATE (a.k.a. *Roundup*)

The Elephant in the room:

Glyphosate & soil, plant, animal & human health

CONCLUSION

“Today’s problems cannot be solved with today’s mind”

(James Gustave Speth. 2008. *The Bridge at the End of the World*)

That is:

We Need to Change Our Mindscapes Before We Can Change Our Landscapes, Ourselves & our Planet

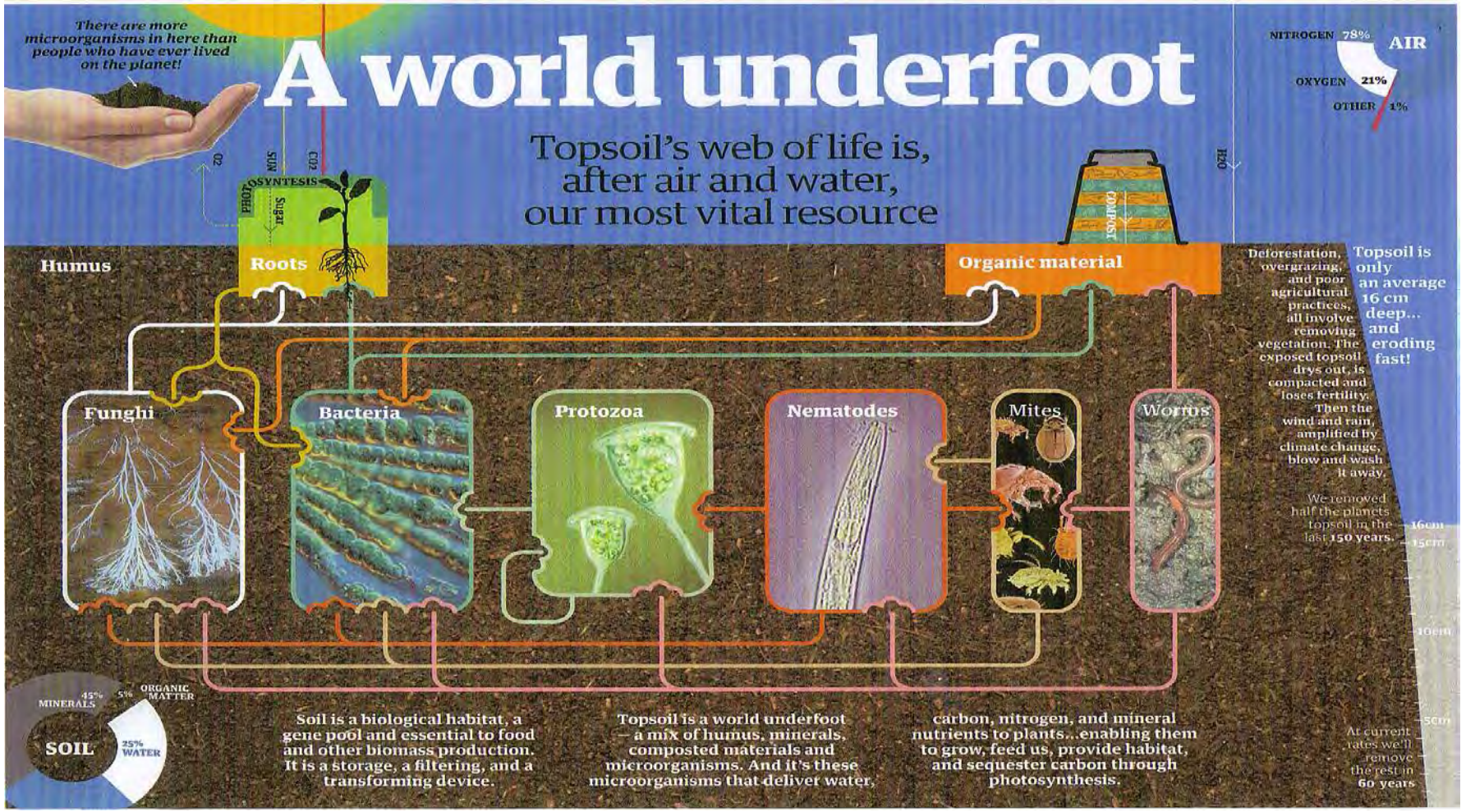
We need to overthrow 10,000 years of agricultural Tradition – based on the plough, poor mechanical & chemical intervention & poor grazing management

- **Our role as landscape managers is to enable all landscape functions to return to health**

KEY: ENABLING SELF-ORGANIZATION TO WORK

= The 'BIG ENGINE' that drives, underpins & structures the functioning of the natural world

WE NEED HEALTHY, BIOLOGICALLY ALIVE SOILS



REGENERATIVE AGRICULTURE

Profound Solutions for Challenging Times

1. Key Solutions to the Anthropocene Crisis
2. An Agriculture that heals Natural Systems
3. Key Solutions to the Human Health Crisis

AGRICULTURE: FRONT & CENTRE TO OUR FUTURES

Donald Worcester's 3 principles for 'good farming'

1. It should make people healthier

2. It should promote a just society

3. It should preserve the earth & its network of life.

(Worcester 1993: 92. *The Wealth of Nature: Environmental History & the Ecological Imagination)*

REGENERATIVE AGRICULTURE DOES THIS