

An aerial photograph of a regenerative food system on Bowen Island. The image shows a large, fenced-in area with numerous raised garden beds of various sizes, some containing green plants. A blue and white tent is set up on the right side, and a small wooden building is visible in the background. The surrounding area is lush with green trees and vegetation.

Regenerative Bowen Island: Helping to Build a Resilient Food System

by

Phil Gregory

**Professor Emeritus of Physics & Astronomy
University of British Columbia**

April 22, 2023

Earth Day

Bowen Island Library



REUTERS

By Chris Arsenault , Dec. 5, 2014

SUSTAINABILITY

Only 60 Years of Farming Left If Soil Degradation Continues

Some estimates are as low as 30 years

<https://www.scientificamerican.com/article/only-60-years-of-farming-left-if-soil-degradation-continues/>

The primary causes of soil degradation include:

Plowing or tilling,

Chemical-intensive farming,

Current livestock management,

Deforestation,

Industrial & urban land use

Soil degradation

For every ton of food produced
we lose 7 tons of soil

<http://www.cornandsoybeandigest.com/soil-health/economics-soil-loss>

<http://www.farmlandp.com/2012/01/one-acre-feeds-a-person/>

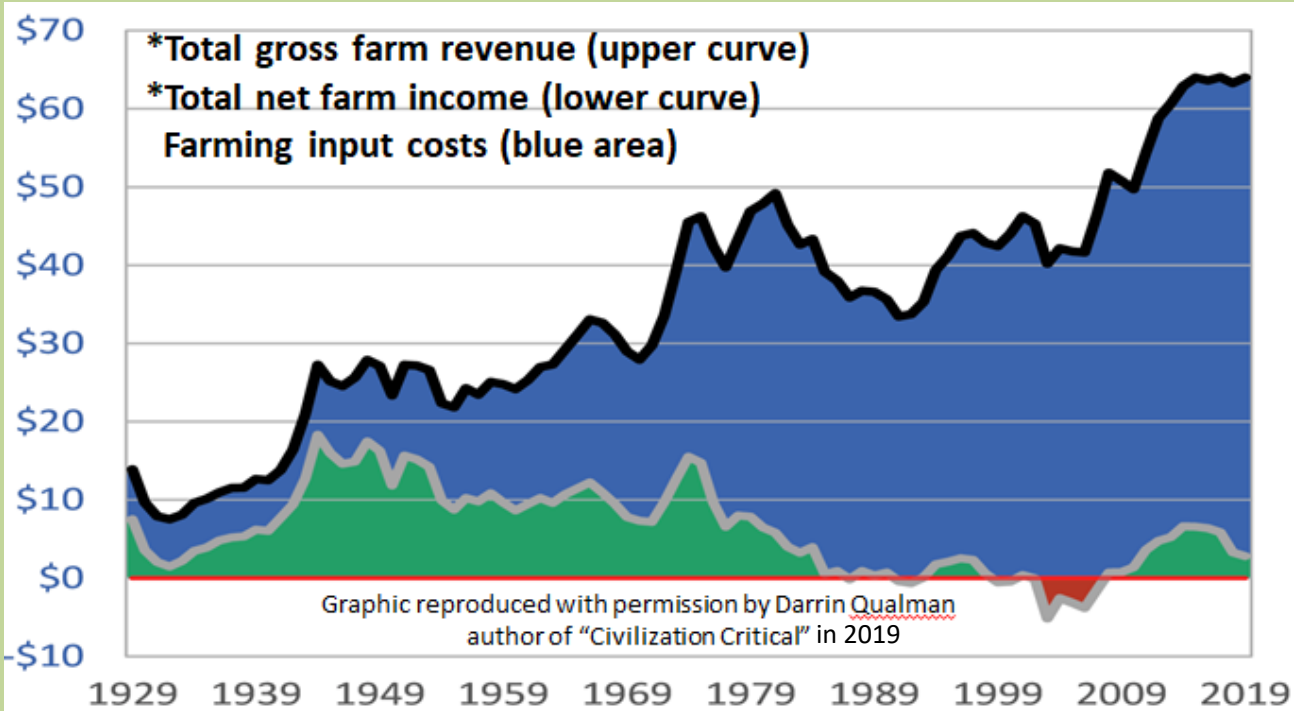
[David Montgomery, Professor of Geomorphology, Washington University https://www.youtube.com/watch?v=c4p-kQ6D8aA](https://www.youtube.com/watch?v=c4p-kQ6D8aA)

Proceedings of the National Academy of Sciences, 08/2007, Volume 104, Issue 33, pp. 13268-13272

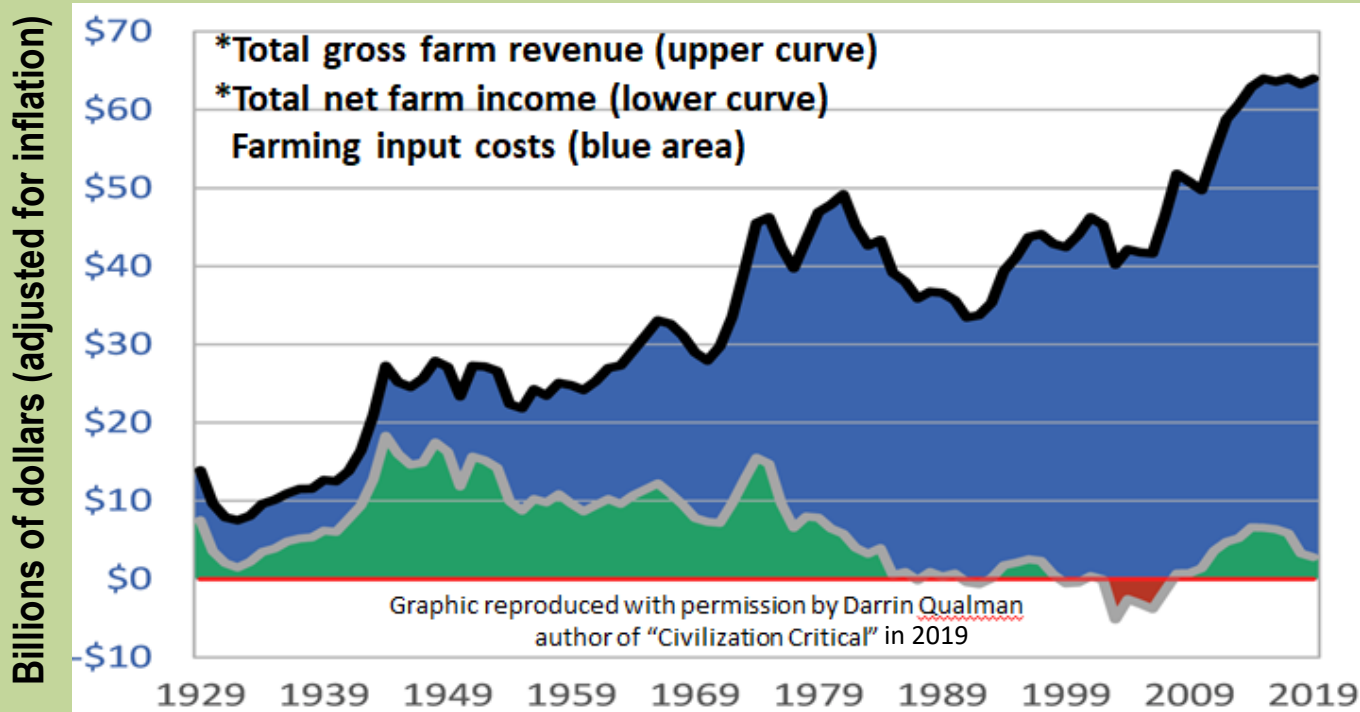
[https://www.amazingcarbon.com/PDF/JONES-OurSoilsOurFuture\(8July08\).pdf](https://www.amazingcarbon.com/PDF/JONES-OurSoilsOurFuture(8July08).pdf)

Canadian Farm Data

Billions of dollars (adjusted for inflation)

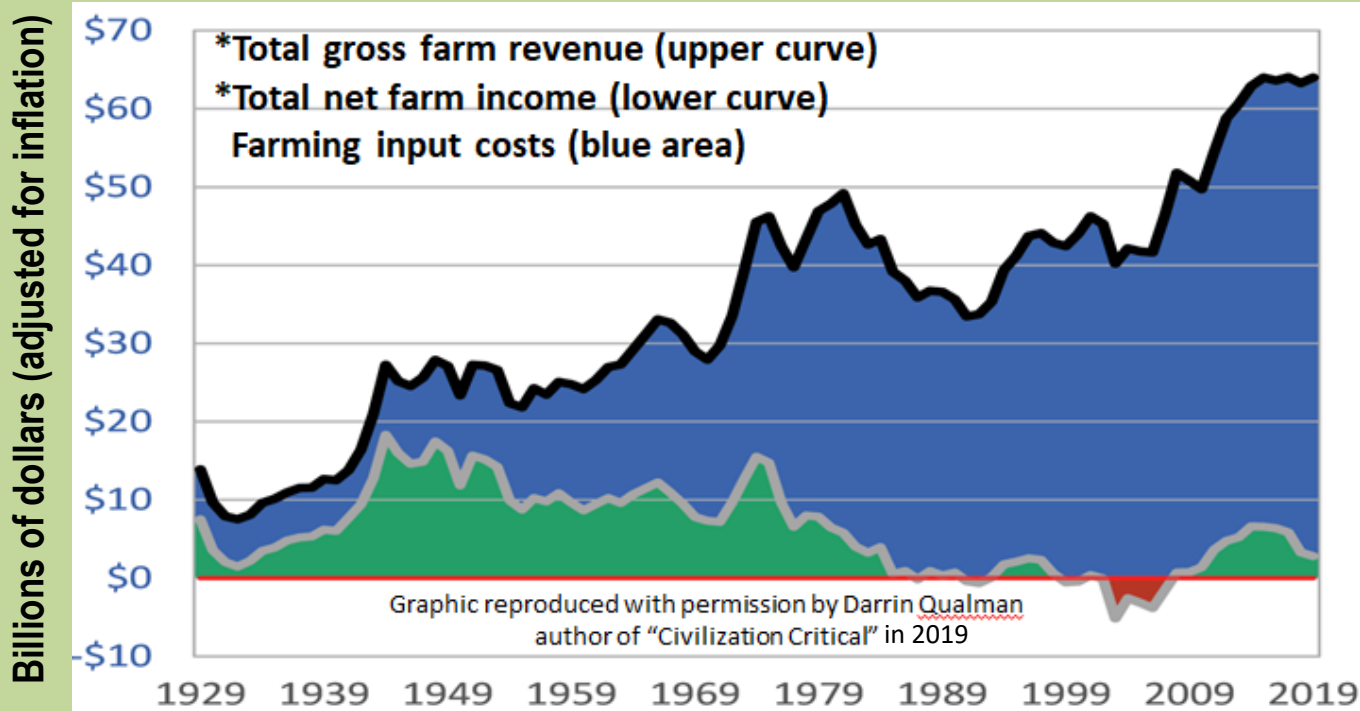


Canadian Farm Data



Since 1985, the corporations that provide the inputs to the farmers have captured 97% of the gross farm revenue, some \$1.59 trillion out of \$1.63 trillion, using a narrative that you can't grow anything unless you use our fossil-fuel based fertilizers, buy our GMO seeds, and spray everything with our fossil-fuel based pesticides.

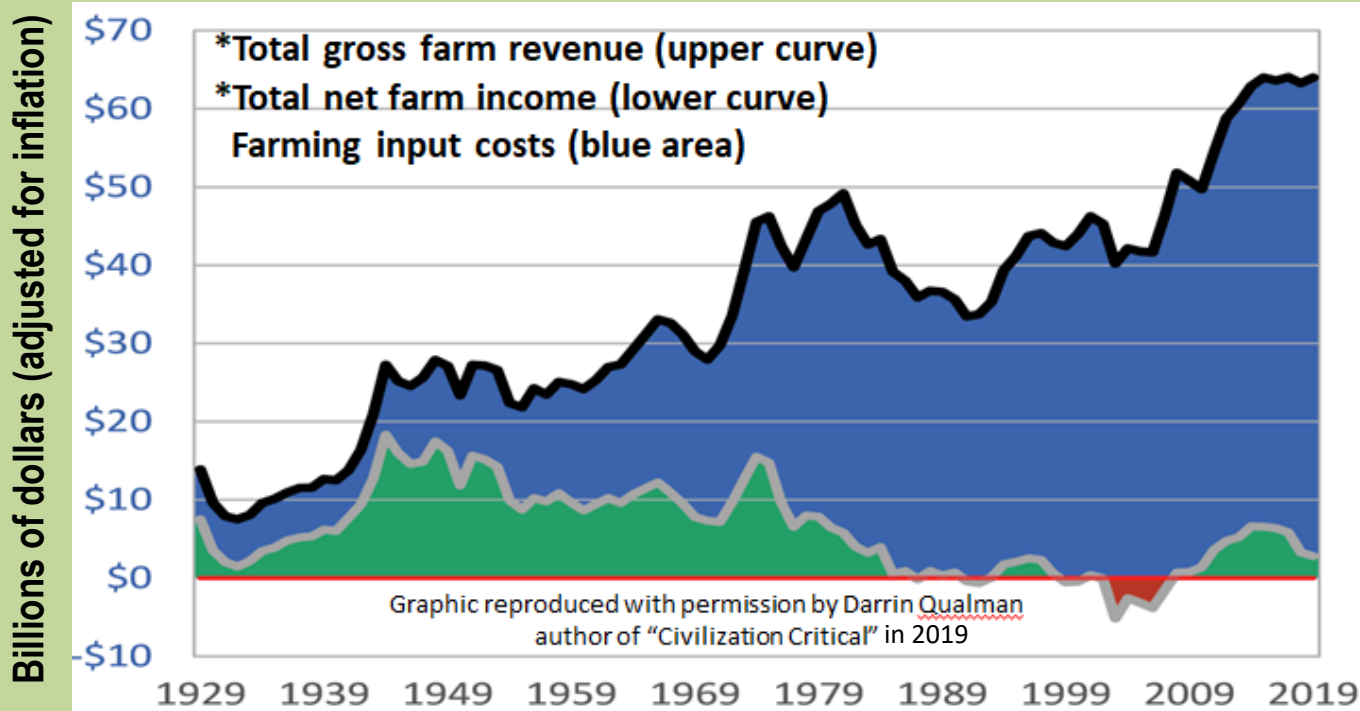
Canadian Farm Data



The farmer doesn't get to buy and own the GMO seeds. Instead they generally have to sign an agreement turning over some of the control of their farm to the corporation.

Other farming inputs include fuel and equipment expenses and banking charges.

Canadian Farm Data



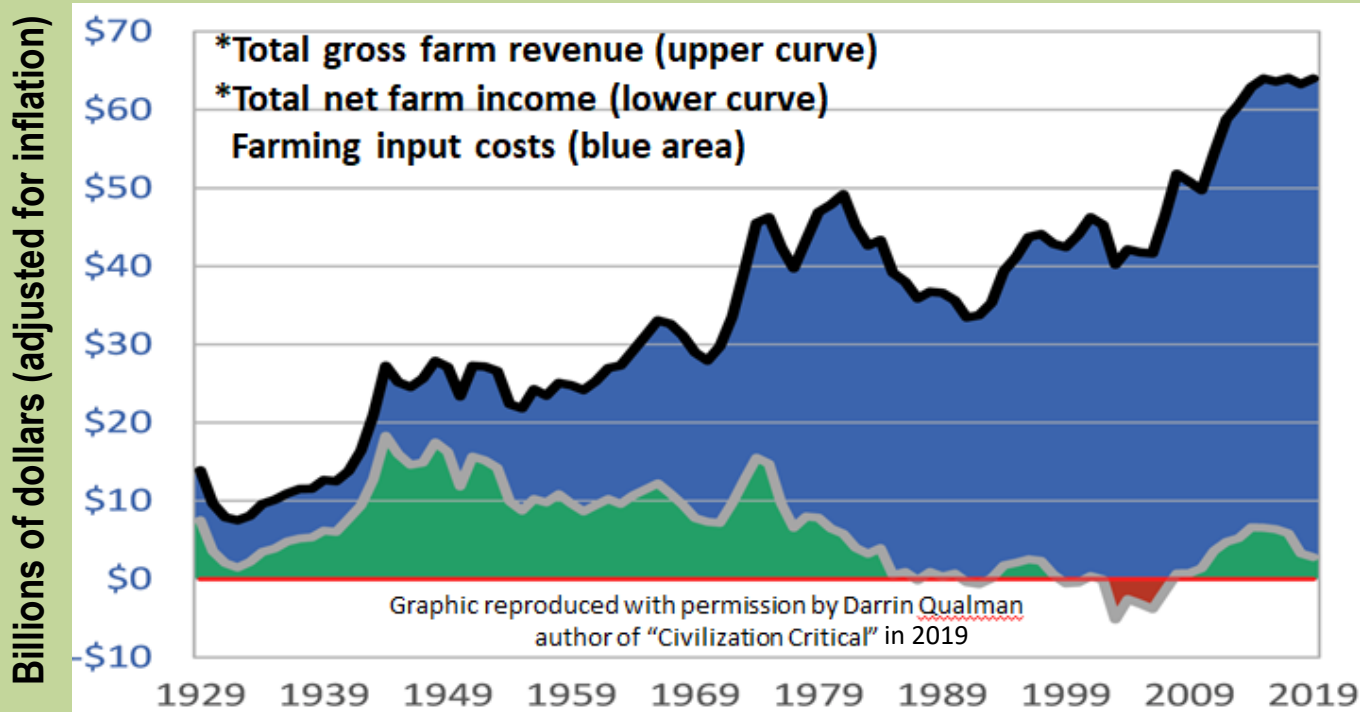
*In both net farm income and revenue, Qualman subtracted off taxpayer-funded farm support payments to remove the masking effects these subsidies can otherwise create.

These subsidies amounted to an average of \$3.4 B per year.

Most farmers have off farm incomes and are deeply in debt. Industrial Ag. is very expensive.

In 2019, farm debt was \$115B, close to the \$119B total taxpayer-funded subsidy since 1985.

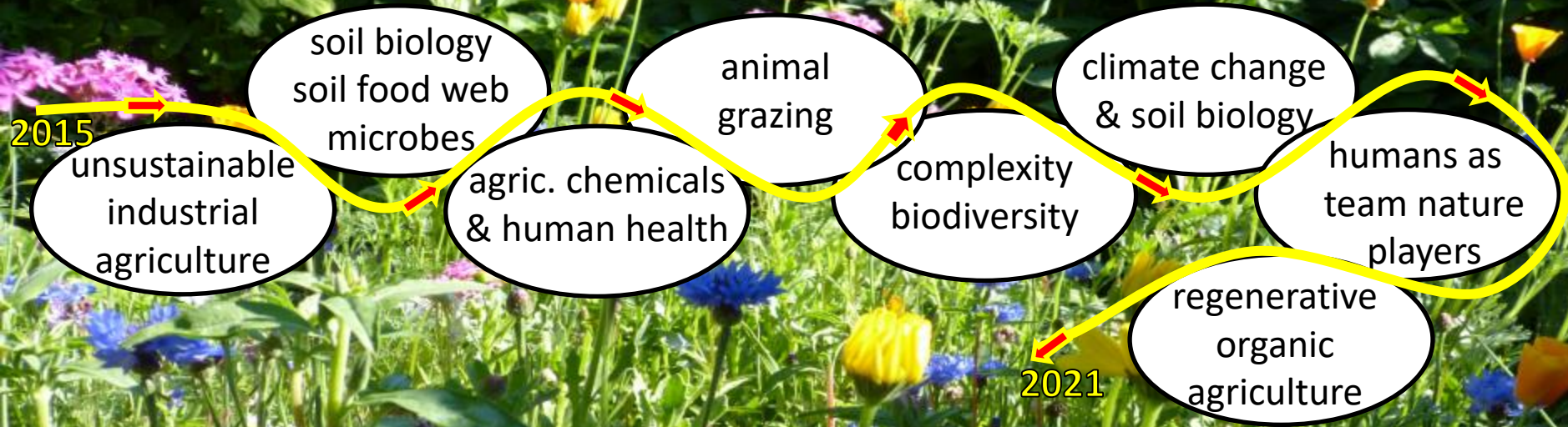
Canadian Farm Data



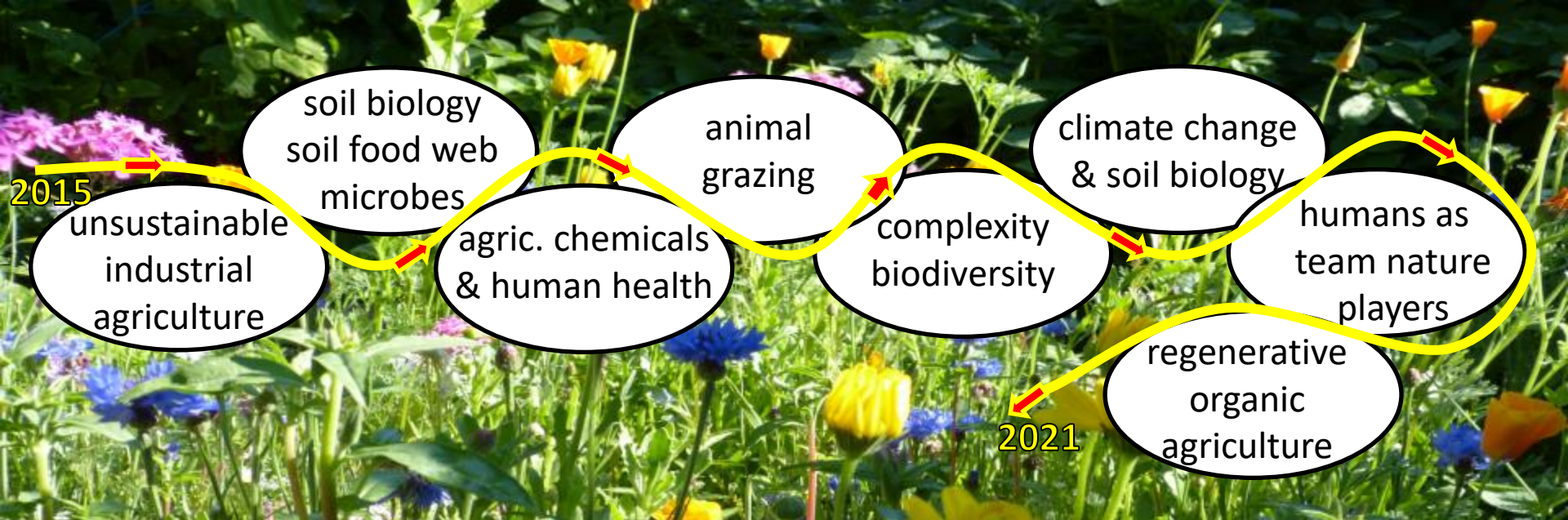
According to Qualman, industrial agriculture replaces nature's diverse circular systems with simplified linear systems where we push huge quantities of fossil-fuel based inputs in at one end and food out the other along with greenhouse gases, eroded soils, chemical runoff, toxicity, depletion, loss, & extinction.

Is there another way, a truly sustainable way? That's what I set out to investigate.

My investigation

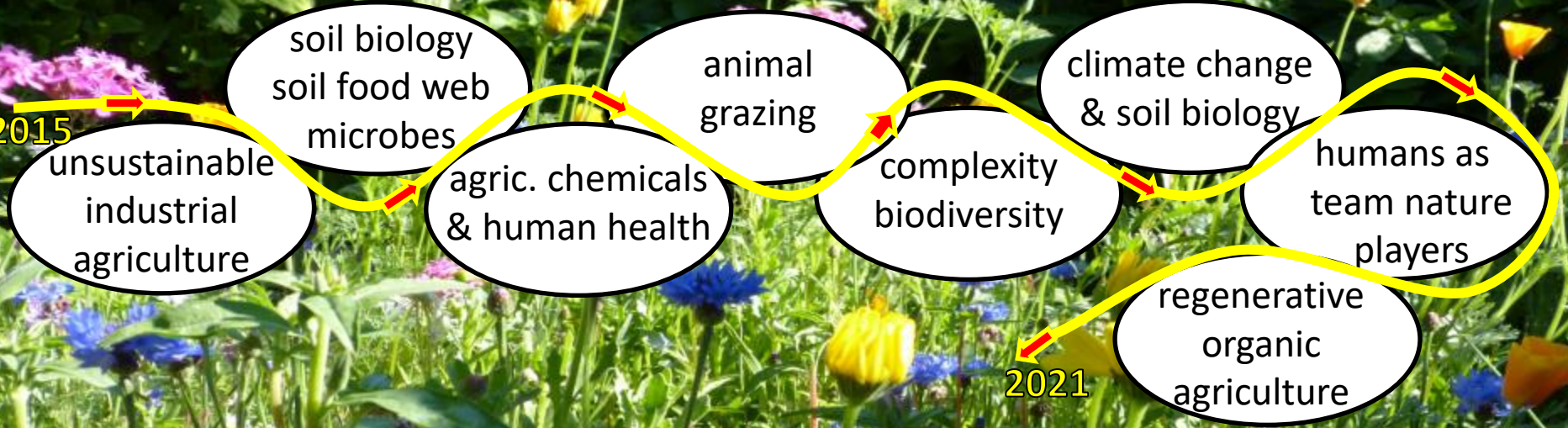
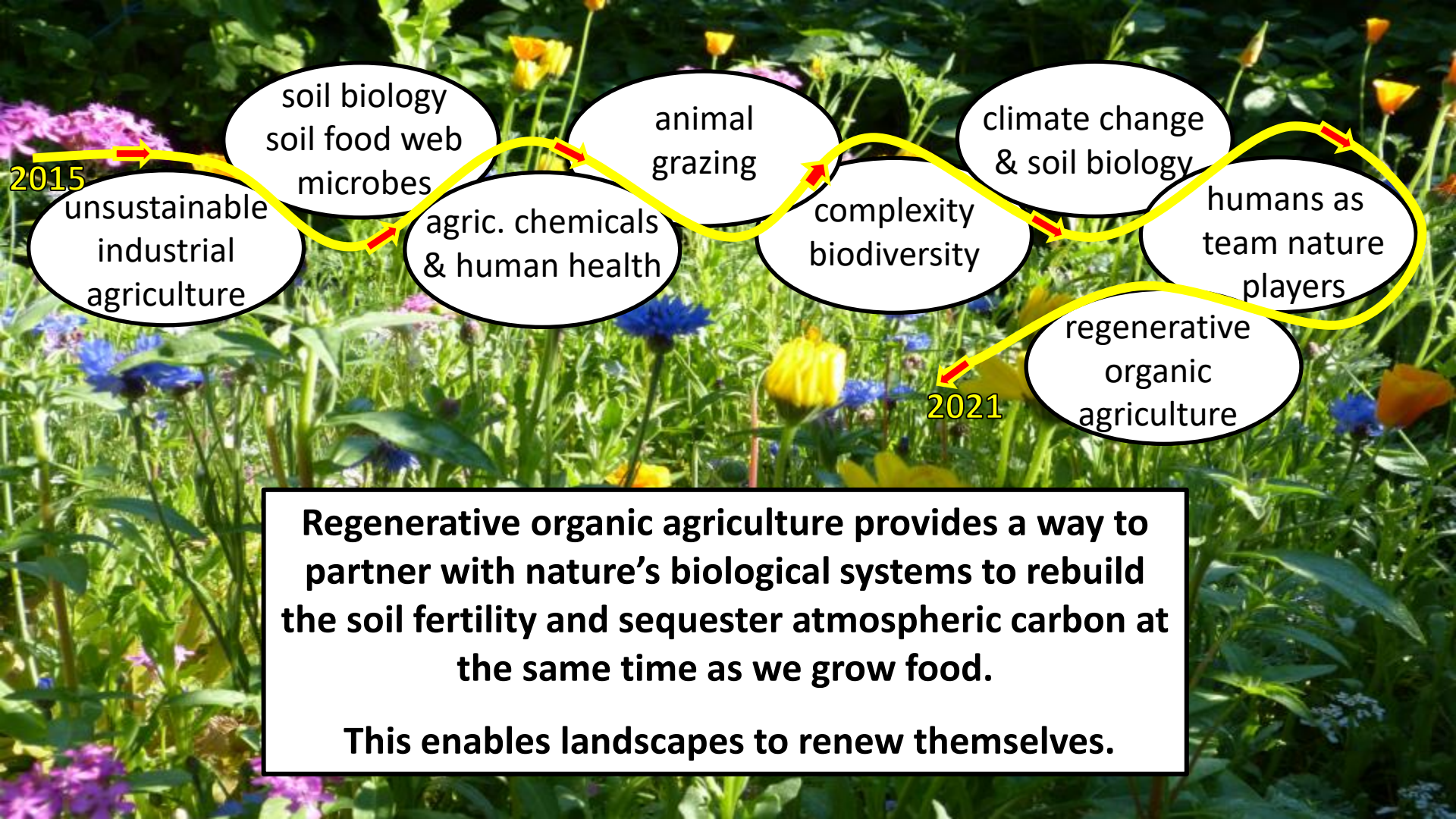


Here are the topics I studied on my 6 year investigation, all to do with how we grow our food and its impact on biodiversity, human health, and climate change.



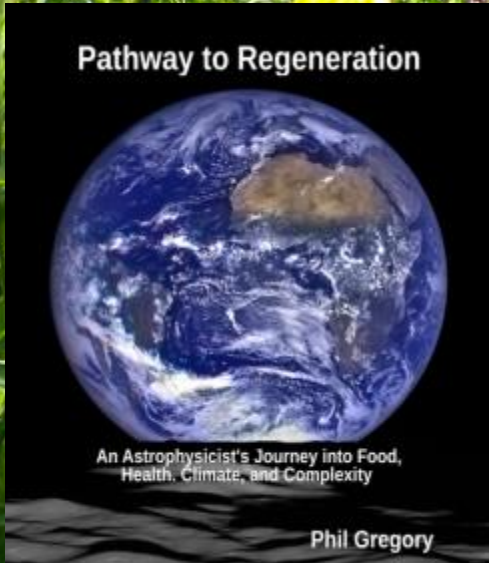
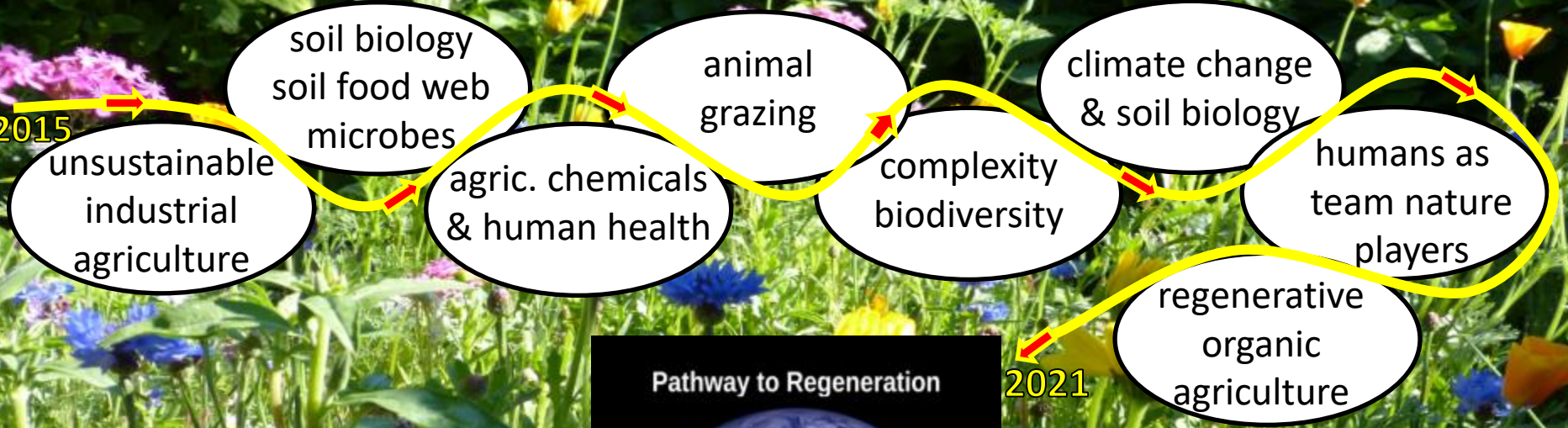
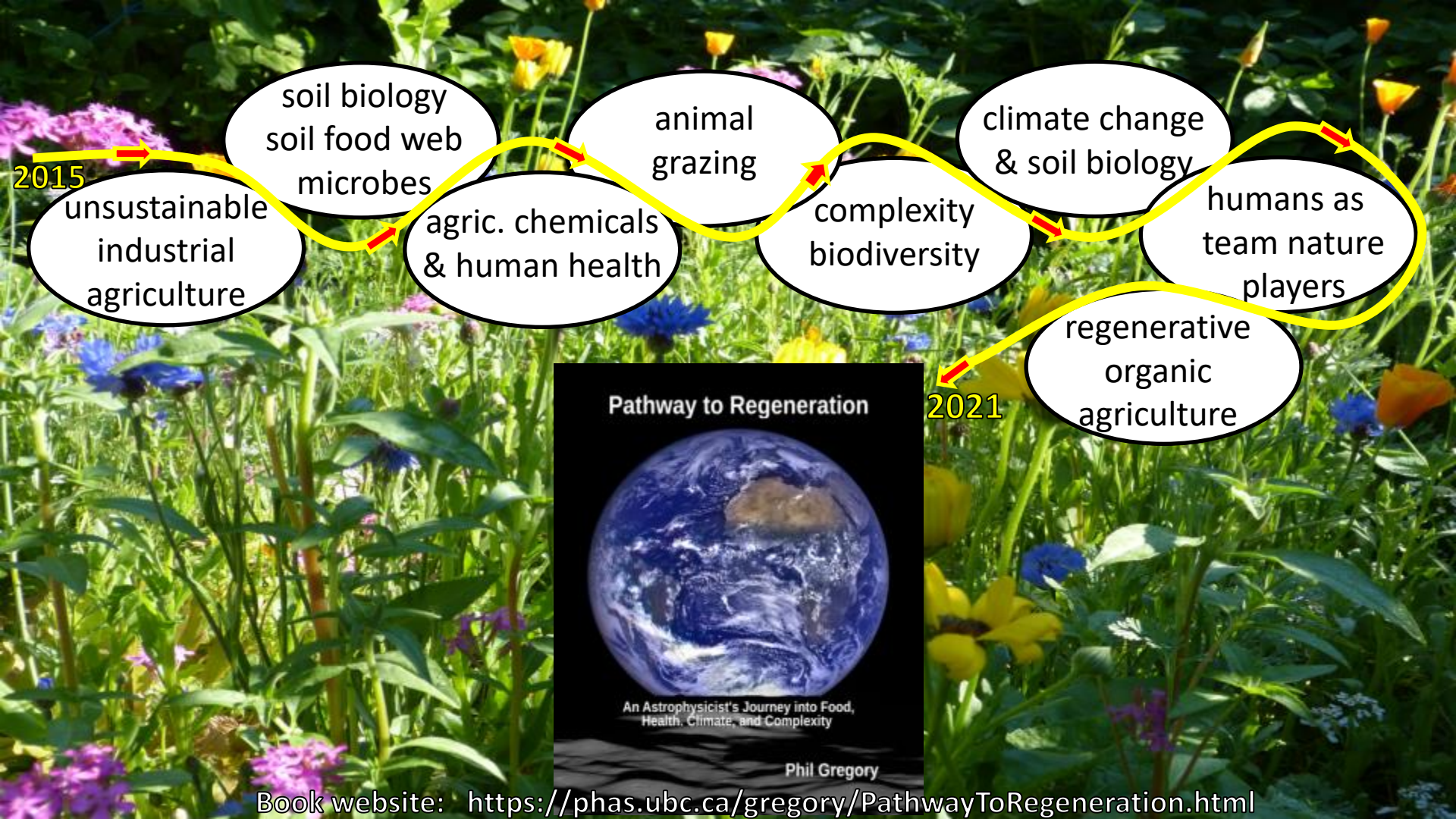
I learned that healthy soil is much more than a mixture of sand, silt, and clay. It is a living system teaming with an invisible world of soil microbes.

They include a huge diversity of bacteria, fungi, and their microscopic predators, that are key to understanding the biological systems nature evolved to make living soil and to support healthy plants and animals.



Regenerative organic agriculture provides a way to partner with nature's biological systems to rebuild the soil fertility and sequester atmospheric carbon at the same time as we grow food.

This enables landscapes to renew themselves.



Book website: <https://phas.ubc.ca/gregory/PathwayToRegeneration.html>

Bowen Library Books by BIFS' Board Members Related to Agriculture



Growing Food During the Pandemic
Bowen Island 2020 ~ Resilient Together

Pathway to Regeneration



An Astrophysicist's Journey into Food,
Health, Climate, and Complexity

Phil Gregory

The lower 2 books
are also available
for free online,
one as a video.



Hugelkultur Garden

By Jackie Bradley and Phil Gregory

<https://phas.ubc.ca/~gregory/papers/HugelkulturGardenBookJackiePhil2014.pdf>



Hannah's Africa Dreamtime

by Phil Gregory

0:01

<https://www.youtube.com/watch?v=fQ4hm1N1mVw>

The Good News

If we transform to Regenerative Organic Agriculture, where we work with nature, we can:

- 1) rapidly reverse soil degradation,
- 2) avoid the looming collapse of agriculture,
- 3) reduce chronic disease epidemics,
- 4) and go a long way to solving global warming.



also need to rapidly reduce fossil fuel emissions

Dr. Elaine Ingham's Soil Food Web School recently produced a set of animations on Nature's biological systems that underpin regenerative organic agriculture.

Dr. Ingham is a pioneer in a recent soil biology revolution.

Animations



What is the Soil Food Web?
Dr. Elaine Ingham

<https://www.youtube.com/watch?v=uAMniWJm2vo&t=2s>



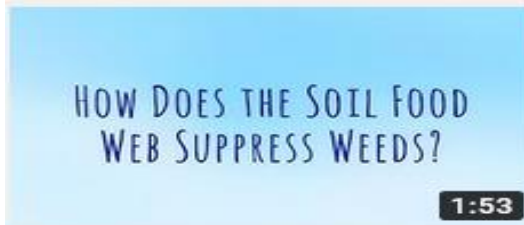
Nutrient Cycling | Soil Foodweb School
Dr. Elaine Ingham

<https://www.youtube.com/watch?v=NVhY4ssMtbI&t=1s>



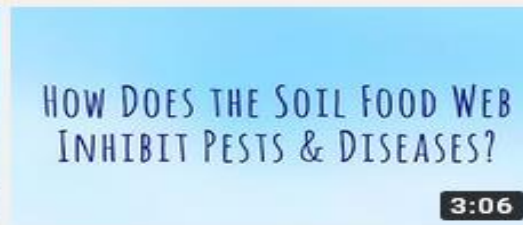
Building Structure | Soil Foodweb School
Dr. Elaine Ingham

<https://www.youtube.com/watch?v=BmZg9ybe62g>



Weed Suppression Using the Soil Food Web
Dr. Elaine Ingham

<https://www.youtube.com/watch?v=pRIXUdhGptU>



Suppressing Pests and Diseases Using the Soil Food
Dr. Elaine Ingham

<https://www.youtube.com/watch?v=hWl8JD7le6g>



Soil Carbon Sequestration and the Soil Food Web
Dr. Elaine Ingham

<https://www.youtube.com/watch?v=ECHYChDUfhQ>

A key paper that sparked the recent soil biology revolution that underpins regenerative organic agriculture

**“Interactions of Bacteria, Fungi, and their Nematode Grazers:
Effects on Nutrient Cycling and Plant Growth”**

**By Russell E. Ingham, J. A. Trofymow, [Elaine R. Ingham](#), and David C. Coleman,
Ecological Monographs, Vol. 55, No. 1 (Mar., 1985), pp. 119-140.
(672 citations to 2016)**

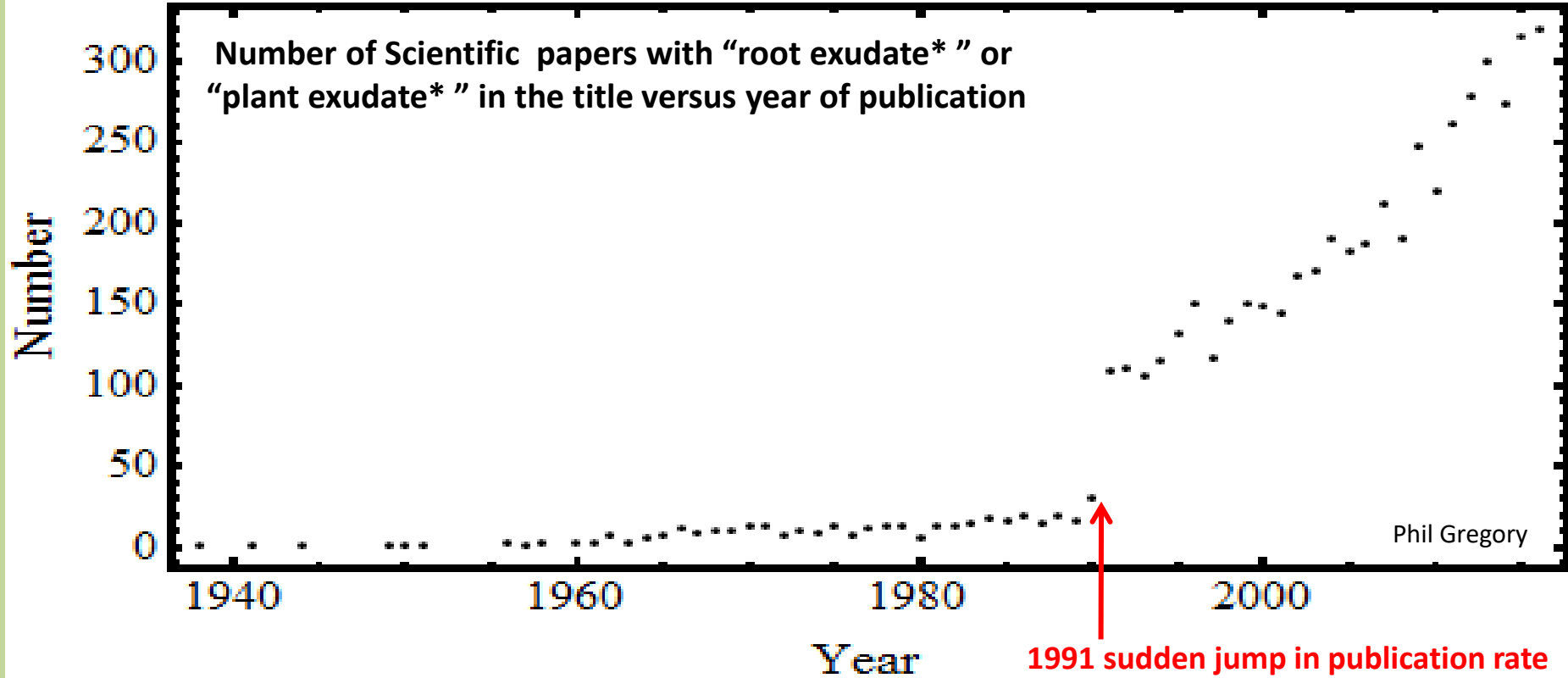
**A key paper that sparked the recent soil biology revolution
that underpins regenerative organic agriculture**

**“Interactions of Bacteria, Fungi, and their Nematode Grazers:
Effects on Nutrient Cycling and Plant Growth”**

**By Russell E. Ingham, J. A. Trofymow, Elaine R. Ingham, and David C. Coleman,
Ecological Monographs, Vol. 55, No. 1 (Mar., 1985), pp. 119-140.
(672 citations to 2016)**

**In 2016, I completed Dr. Elaine Ingham’s four foundational courses
on soil biology through her Soil Food Web School**

One indicator of the recent revolution in soil biology



WHAT IS THE SOIL FOOD WEB?



0:02 / 5:56



<https://www.youtube.com/watch?v=uAMniWJm2vo&t=2s>

5m 56s

Dr. Elaine Ingham's Soil Food Web School



About the Soil Food Web Foundation Courses

Dr. Elaine Ingham

<https://www.youtube.com/watch?v=XGvgkC-x95Y>

Animations



What is the Soil Food Web?

Dr. Elaine Ingham

<https://www.youtube.com/watch?v=uAMniWJm2vo&t=2s>



Nutrient Cycling | Soil Foodweb School

Dr. Elaine Ingham

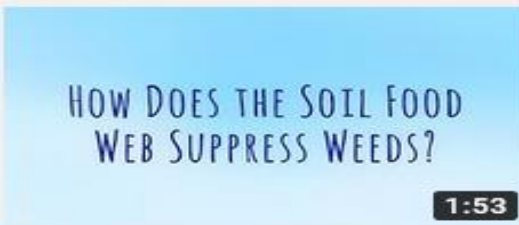
<https://www.youtube.com/watch?v=NvHY4ssMtbI&t=1s>



Building Structure | Soil Foodweb School

Dr. Elaine Ingham

<https://www.youtube.com/watch?v=BmZg9ybe62g>



Weed Suppression Using the Soil Food Web

Dr. Elaine Ingham

<https://www.youtube.com/watch?v=pRIXUdhGptU>



Suppressing Pests and Diseases Using the Soil Food

Dr. Elaine Ingham

<https://www.youtube.com/watch?v=hWl8JD7le6g>



Soil Carbon Sequestration and the Soil Food Web

Dr. Elaine Ingham

<https://www.youtube.com/watch?v=ECHYChDUfhQ>

Nature's barter system

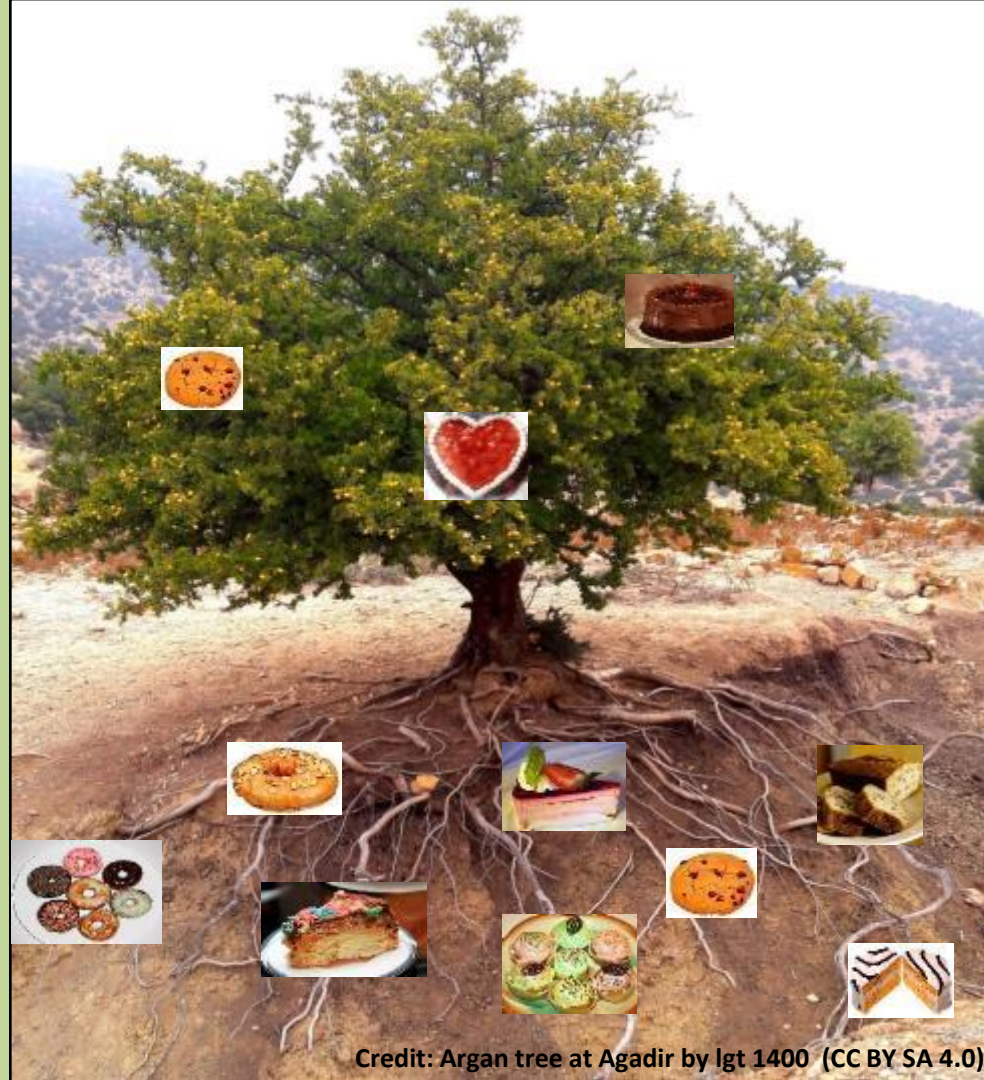
Plants use photosynthesis to capture sunlight energy and store it in the carbon bonds of the sugars they make.

(carbon = currency of barter system)

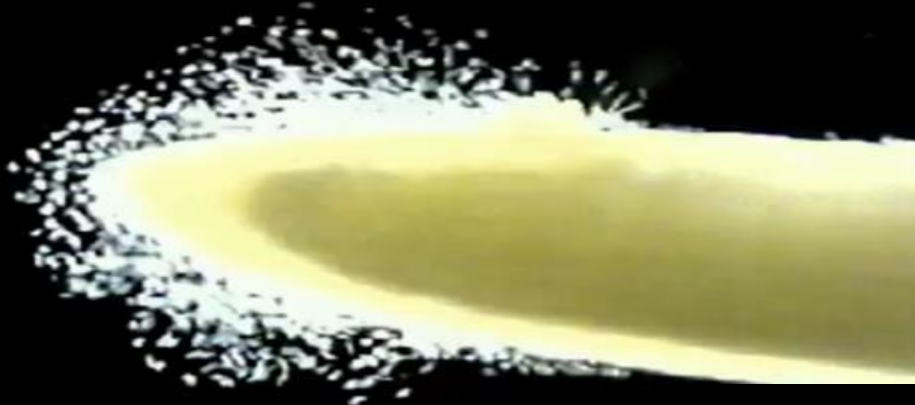
Plants release up to 40% of these carbon compounds as **root exudates** to attract, feed, & power soil microbes.

In turn the microbes carry out nitrogen fixation, mining, and recycling operations to provide all the micronutrients plants require.

For the microbes, exudates are like cakes and cookies.



Roots releasing sugars (liquid sunlight energy)



Here are two frames of a movie showing a plant root releasing sugars from the root tips that attract and feed soil microbes.

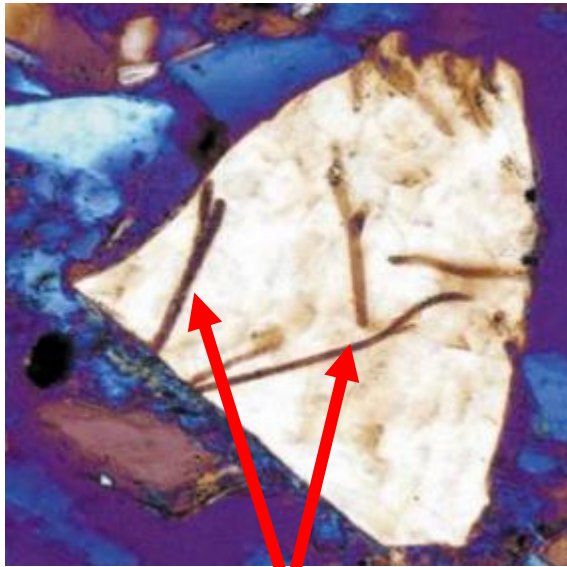
The compounds given off by the root tips are called exudates.



<https://blogs.scientificamerican.com/artful-amoeba/the-world-s-largest-mining-operation-is-run-by-fungi/>

By Jenifer Fraser on November 5, 2015

The World's Largest Mining Operation Is Run by Fungi



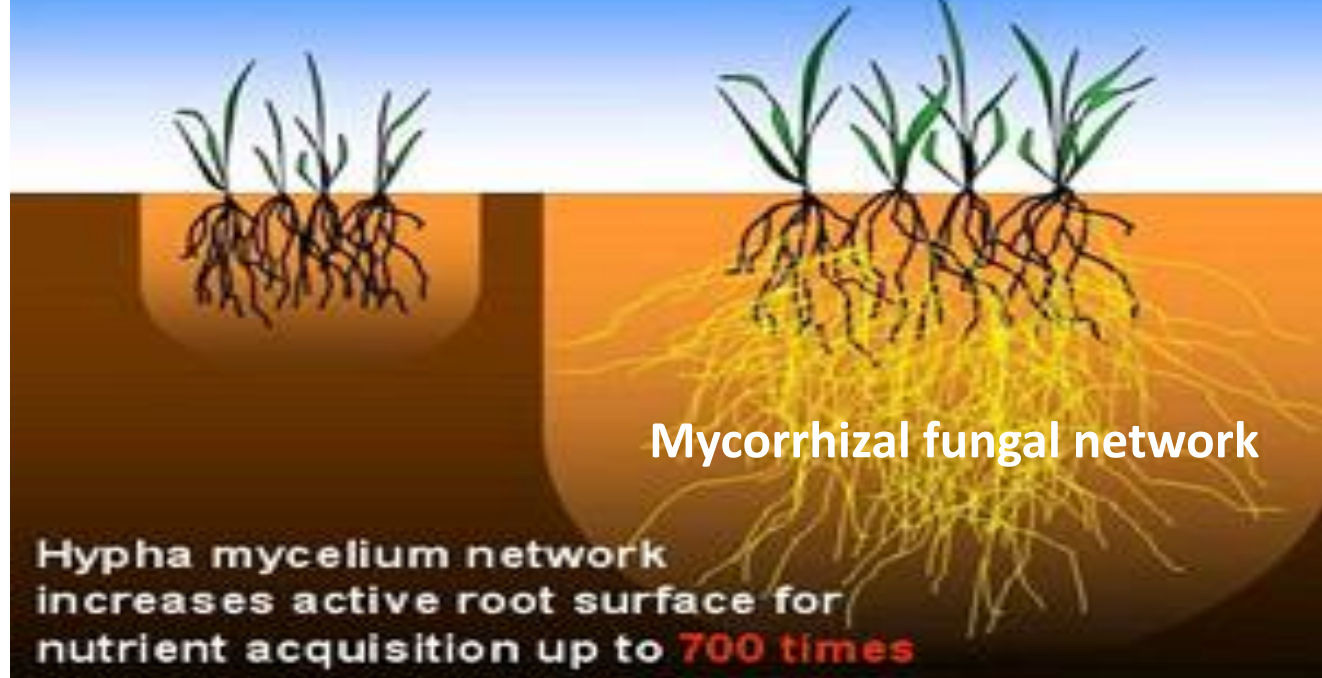
Fungal mining tunnels

**A microscope view of a
thin section of feldspar**

**"Linking plants to rocks: ectomycorrhizal fungi
mobilize nutrients from minerals."**

Box 4 I(c) from Renske Landeweert et al. *Trends in Ecology & Evolution* 16, no. 5 (2001): 248-254.

Mycorrhizal Fungal Network

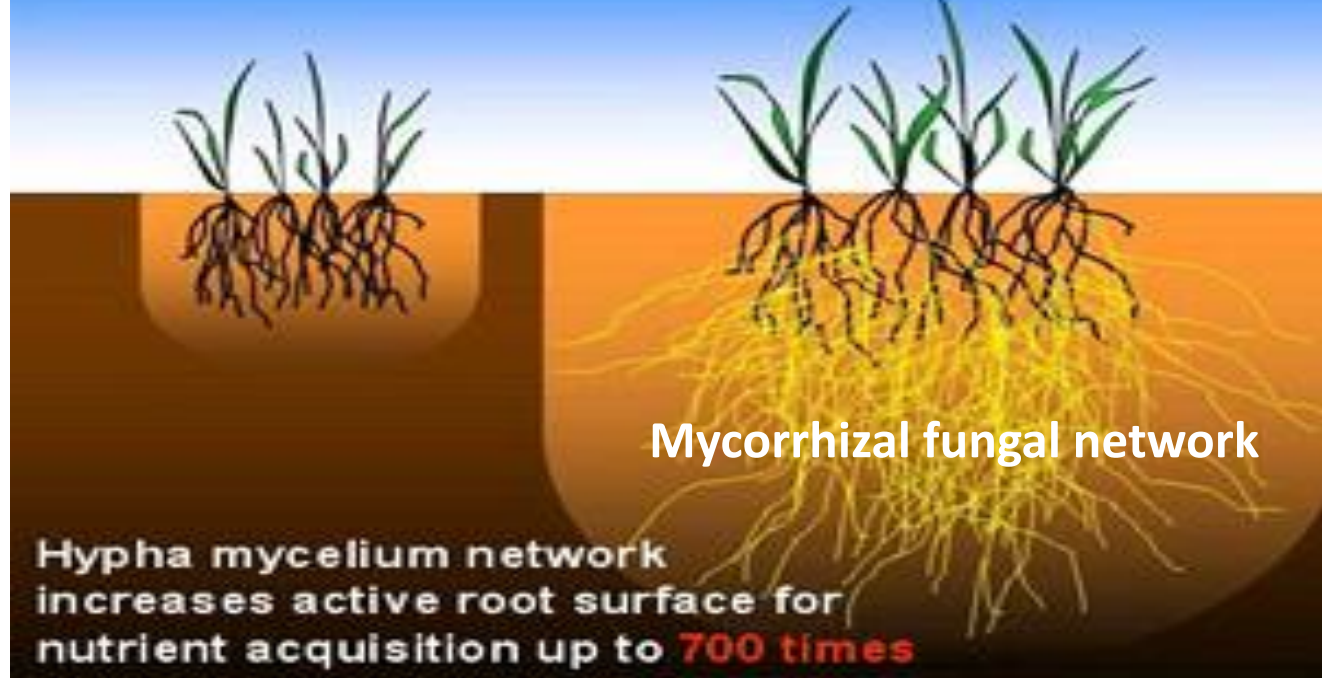


The panel above depicts the root systems of two identical plants.

- The one on the left is planted in dirt.
- The one on the right is planted in soil with a healthy food web giving rise to a mycorrhizal fungal network.

This network extends the root area for extracting nutrients & water.

Mycorrhizal Fungal Network



Through the work of researchers like Professor Suzanne Simard of the University of British Columbia, we now know that fungal networks can link plants together in a [Wood Wide Web](#) allowing them to exchange signals as well as nutrients.

Six Principles of Regenerative Agriculture

1. Limit soil disturbance

Plowing and tilling causes a big loss of soil carbon and destroys soil structure built by the microbes. This leads to greater rain water runoff and soil erosion. Chronic chemical disturbance is just as devastating.

2. Protect the soil surface

One role of plants, whether dead or alive, is to cover the soil surface protecting against rainfall compaction, temperature extremes, drying out, and erosion. Litter also feeds micro-organisms and worms.

3. Build diversity

Nature abhors a monoculture. There is strong evidence that increasing plant diversity increases crop and forage yield, yield stability, pollinators, weed suppression and pest suppression.

4. Keep living roots in the ground

Maintain living roots in the ground as long as possible. This maximizes photosynthesis and feeds soil life which renews soil structure, reduces erosion, and increases rain water infiltration.

5. Integrate animals

Nature does not function without animals. For example, regeneratively grazed livestock are mobile biodigesters and biofertilizers that provide a big improvement in soil health.

6. Context matters

What we do needs to be a good fit with our ecological, financial, and social context. This is important so our behaviours create an environment that will sustain a quality of life for future generations.

Video on the connections between Climate Change, Food Security, and Soil Carbon

“The Soil Story”

3^m 28^s

was produced by Kiss the Ground and is narrated by the Carbon Underground President Larry Kopald.

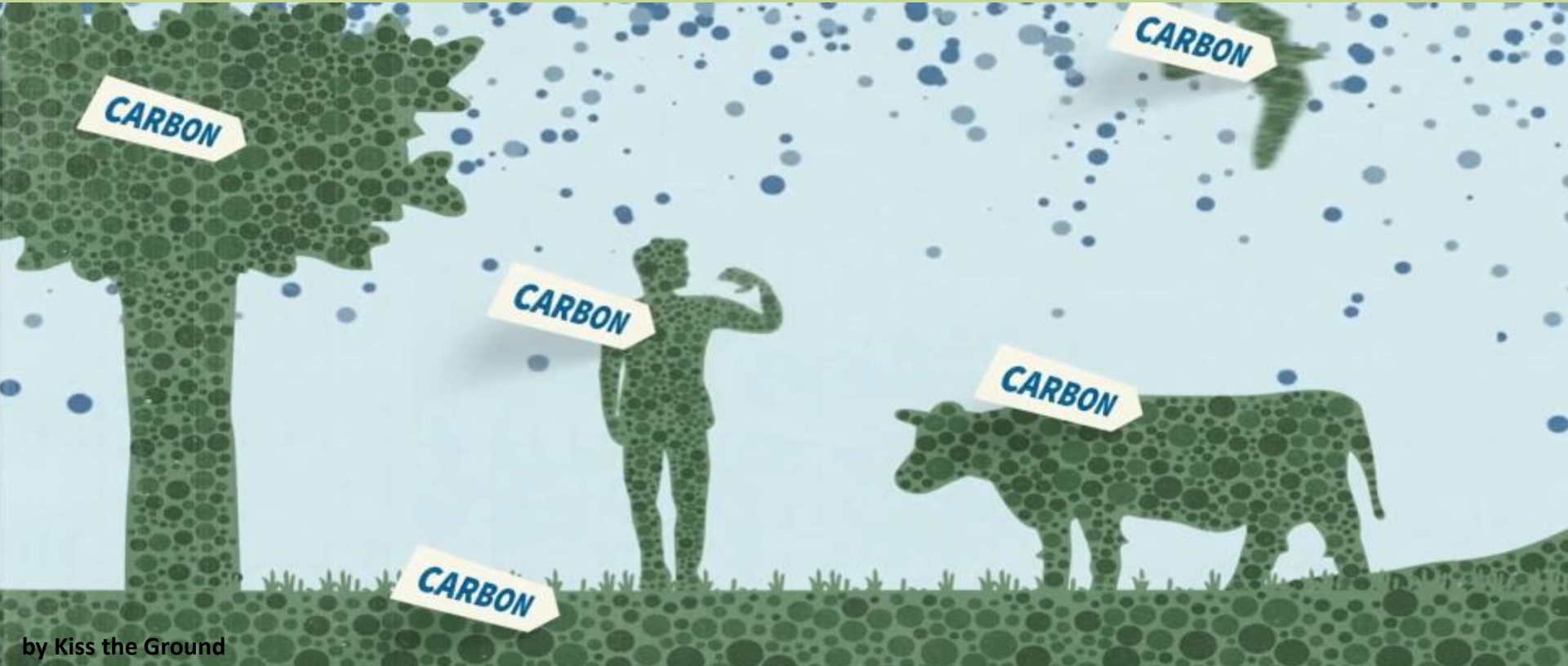
It is open source and free to use for educational purposes.



Carbon is not the enemy

All life on Earth is carbon based

It's a matter of balance



CAN YOU GUESS: how is the 550 Billion tonnes of carbon based life distributed among different life forms?

Life form

% of total Carbon based life



82.5



17.1



0.4

**Life forms: 1 = insects, fish, molluscs, livestock, humans, birds & other animals
(animals you can see with your eyes)**

2 = plants

3 = microbes (can only see with a microscope)

CAN YOU GUESS: how is the 550 Billion tonnes of carbon based life distributed among different life forms?

Life form

% of total Carbon based life

2

82.5

17.1

0.4

Life forms: 1 = insects, fish, molluscs, livestock, humans, birds & other animals
(animals you can see with your eyes)

2 = plants

3 = microbes (can only see with a microscope)

CAN YOU GUESS: how is the 550 Billion tonnes of carbon based life distributed among different life forms?

Life form

% of total Carbon based life

2

Further investigation of microbes
will likely unlock new surprises
we can't imagine.

82.5

3

17.1

1

0.4

Life forms: 1 = insects, fish, molluscs, livestock, humans, birds & other animals
(animals you can see with your eyes)

2 = plants

3 = microbes (can only see with a microscope)

An aerial photograph of a community garden. The garden is divided into numerous raised beds of varying sizes, some containing young plants and others with bare soil. A central area features a large, circular, terraced garden bed with distinct rows of soil. To the right, there is a grassy area with several white plastic chairs and a black tarp covering some equipment. In the upper center, a wooden building with a blue roof and a yellow structure are visible. A paved road with a yellow center line runs along the top left edge of the garden. The surrounding area is lush with green trees and vegetation.

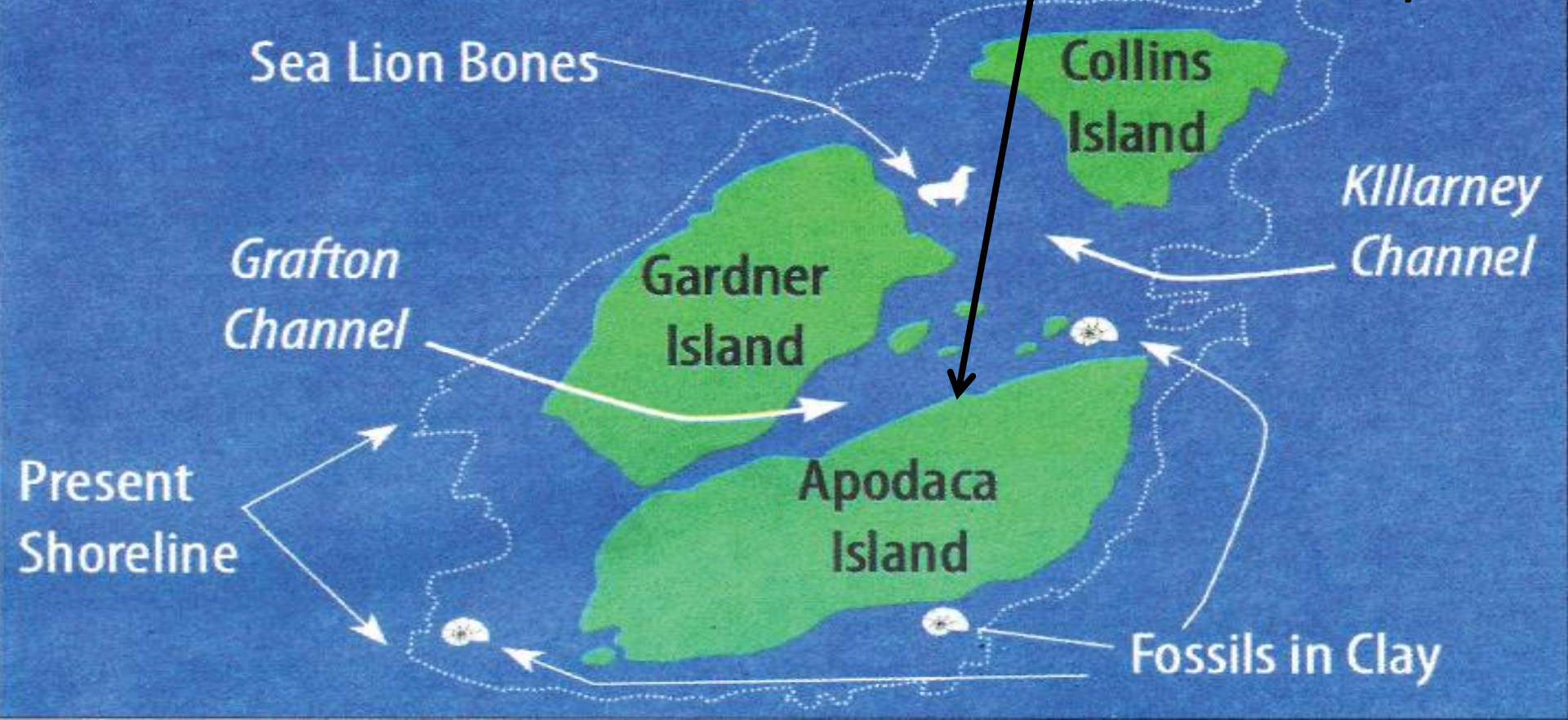
The Grafton Commons

Managed by BIFS since May 2020

Bowen Island 12,500 Years Ago

First published in the Undercurrent Dec. 18, 1992

Grafton Commons was a sandy beach



Bob Turner and Will Husby Map (for an explanation see *Exploring Bowen's Marine World*, by Len Gilday, Will Husby, and Bob Turner)

Building a Lasagna Bed with IDLC students Oct. 2021



Techniques to achieve continuous no-till organic farming & gardening

1. Lasagna garden (sheet composting) avoids need for initial tilling in garden

Plant & Cover with Mulch

1"- 2" of mulch, wood shavings, straw, fine bark

Compost or Soil

1"- 2" layer of aged compost or soil

Bulk Mulch

8"- 12" layer of mulch, straw, wood chips
Moisten as you construct

High Nitrogen Layer

Thin layer of lawn clippings, veggie scraps, coffee grounds, kelp, compost or manure (aged)

Sheet Mulch Layer

cardboard or newspaper ½" thick
overlap by 6", water well

High Nitrogen Layer

coffee grounds, high N mulch,
manure (aged), compost or compost extract or tea

Existing Vegetation

Cut down, leave in place, remove woody stems

Existing Soil

Water well night before

Photo on right

Start of a Lasagna garden showing a layer of kelp on cardboard



Lasagna garden
← layers

You'll need cardboard, mulch and/or organic matter, and manure (but that's optional). At a minimum, you just need enough cardboard to cover the earth and enough mulch to cover the cardboard. From there the sky is the limit: You can pile up as many layers of manure and organic matter as you want. Woodchips, straw, leaves, crop wastes, and animal bedding are all examples of organic matter – basically anything you would put in a [compost pile](#), other than kitchen scraps, which you probably don't want strewn about your yard.

<https://modernfarmer.com/2016/05/sheet-mulching/>

**Shed construction thanks to
Jaymie Arnold & Brent O'Malley**



**The roof shingling, door, & window
thanks to Rob and Shelley Tompkins**



**Shed construction thanks to
Jaymie Arnold & Brent O'Malley**



**The roof shingling, door, & window
thanks to Rob and Shelley Tompkins**



Recently, the Bowen Rotary Club has offered to finish off the shed



Compost bins made by volunteer Jim Clarke in 2022

Bin lids & plywood siding (not shown) added by Phil Gregory and Hasan Hutchison

Future Greenhouse Project

Part of BIFS' big vision is to increase our ability to grow more food at Grafton. In a recent study (sponsored by THRIVE) , KPU recommended we acquire a polytunnel/greenhouse to accomplish some of our goals.

The project estimate of \$25,000, is based on a recent quote for a made in BC 40 ft x 12 ft polytunnel which includes assembly at Grafton.

As a registered Society, BIFS succeeded in raising about half of the estimated cost.

Recently, Bowen Rotary Club successfully partnered with us to raise the balance of the funding for this project. So stay tuned!



Grafton Agricultural Commons 2021 Season

[Video](#)

Managed by BIFS

Bowen Island FoodResilience Society

BIFS is looking for volunteers

Are you looking for a community of like minded individuals wanting to create a healthier planet and contribute to food resilience on our island?

BIFS' long term vision for the Grafton Commons:

a regenerative agriculture farm and education centre

Volunteer activities:

- to help with site preparation for the polytunnel
- to improve the irrigation system, help connect the polytunnel to our well
- to repair fencing, tools, or do small construction projects like an owl box
- to organize or participate in leaf collection and storage at the garden (important for composting and soil building)
- to organize or participate in acquiring large pieces of cardboard for garden
- to work with garden mentors in preparing beds while learning regenerative agriculture skills to apply in your own garden
- to grow seedlings in your home for spring planting at Grafton
- to help with weeding, watering, composting and general garden upkeep
- to help with harvesting and marketing
- to help the Grafton Commons fruit and nut tree care & pruning
- to join BIFS Low Hanging Fruit project and become a picker and/or donor
- to help write/edit BIFS articles for the Undercurrent

Keen to support our mission, regular time to commit, candidate for BIFS board

Grafton Commons

Six Principles of Regenerative Agriculture

1. Limit soil disturbance

Working and tilling soil causes the soil to lose carbon and fertility. The less the farmer disturbs the soil, the more carbon and fertility are preserved.

2. Protect the soil surface

Protecting the soil surface with cover crops, mulch, and other organic matter helps to reduce erosion and improve soil health.

3. Build diversity

Increasing the diversity of plants, animals, and microorganisms in the soil and on the farm improves soil health and resilience.

4. Keep living roots in the ground

Living roots in the soil help to build soil structure and fertility. Farmers should use cover crops and other plants that keep roots in the ground year-round.

5. Integrate animals

Integrating animals into the farm cycle helps to improve soil health and fertility. Farmers should use manure and other animal products to fertilize the soil.

6. Context matters

Regenerative agriculture is not a one-size-fits-all approach. Farmers should adapt these principles to their own farms and local conditions.

The Soil is an Ecosystem



The Farm Project at Grafton

When we think of plants we picture vegetation. But the soil is a living system. Plants are neither the cause nor the result of soil health.



Monoculture Versus Multi-Crop



Microbes are big players in the diversity of Earth's carbon based life

Life form	As a percentage of total biomass	As a percentage of total genetic diversity
Fungi	8-11%	~10%
Invertebrates	~1%	~15%
All life forms	~1%	~15%

All plants and animals are compressed in a microbial world and have a microbial world embedded in them.

The natural world is a compound of interdependent communities. All organisms.

How Nature Grows Plants and Creates Soil

Nature's barrier system

- Plants, plants and soil are connected with water, nutrients, the nitrogen cycle, and carbon. In exchange, the soil provides plants with water and nutrients.
- Soil is full of life. Microbes, fungi, and other organisms are always there, even when you can't see them.
- For example, the bacteria working these microbes on the soil are called.



Fun facts



Bacteria & Fungi Build Soil Structure



**Other videos, presentations, and books
by Phil**

<https://phas.ubc.ca/gregory/>

Pathway to Regeneration



**An Astrophysicist's Journey into Food,
Health, Climate, and Complexity**

Phil Gregory