

Changing the Climate: The Role of Some Widely Used Agrochemicals

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Presentation Overview

- ▣ Synthetic nitrogen fertilizers – widely and excessively used.
- ▣ Neonicotinoids (Neonics) – Most used insecticides in the U.S.
- ▣ Glyphosate – Most used herbicide in the world.
- ▣ There's much to be said about these agrochemicals in Ag but I want to restrict our discussion and questions to their impacts on the soil biota and how those impacts relate to climate change.
- ▣ **What you can do.**
- ▣ **The co-opting of regenerative agriculture.**

Synthetic Nitrogen Fertilizer: Backbone of Industrial Conventional Farming

- ▣ In 2015, 14 million tons of synthetic nitrogen fertilizer was applied to U.S. farmland (USDA).
- ▣ USDA Est. Acreage Planted 2020
 - Corn - GMO - 92 million
 - Soybeans - GMO - 83.8 million
 - Wheat - non-GMO - 44.3 million
 - Cotton - GMO - 12.2 million
- ▣ Total acreage - major U.S. crops - 232.3 million

What is Conventional Industrial Agriculture?

- ▣ High Input
- ▣ Synthetic chemical-dependent
- ▣ Fossil-fueled
- ▣ Major contributor of climate change.
- ▣ In addition to producing food and fiber, industrial agriculture produces a harvest of three major greenhouse gases (GHGs) – carbon dioxide (CO₂), nitrous oxide (N₂O) and methane (CH₄).

Synthetic Nitrogen Fertilizer & The Haber-Bosch Process

- ▣ Consumes enormous amounts of fossil fuel, and produces a matching amount of CO₂.
- ▣ Extremely energy-intensive process that accounts for about 1-2% of total global energy consumption.
- ▣ The Haber-Bosch process also requires hydrogen (H₂) which is mostly sourced from methane (CH₄).
- ▣ Some of the methane (CH₄) and CO₂ are released into the atmosphere during production.

About half of the fertilizer-N applied to fields is used by the target crop. The rest is lost to the environment and can be converted to the potent greenhouse gas, nitrous oxide (N₂O).



Synthetic Nitrogen Fertilizer and Soil Biota

- ▣ Synthetic nitrogen fertilizer stimulates soil microbes, which feast on organic matter.
- ▣ As organic matter dissipates, soil's ability to store organic nitrogen declines. A large amount of nitrogen then leaches away, fouling ground water in the form of nitrates, and entering the atmosphere as nitrous oxide (N₂O).
- ▣ Synthetic nitrogen fertilizer application begins the destruction of soil biodiversity by diminishing the role of nitrogen-fixing bacteria and amplifying the role of everything that feeds on nitrogen. Thus changing the population dynamics of the soil microbes.
- ▣ *“The Myth of Nitrogen Fertilization for Soil Carbon Sequestration”* (Journal of Environmental Quality, 2007) found that synthetic nitrogen fertilizer use was rapidly depleting soil's carbon sequestration abilities.

What are pesticides?

- ▣ A confusing term.
- ▣ A pesticide is any chemical which is used to control pests. The pests may be insects, plant diseases, fungi, weeds, nematodes, snails, slugs, etc.
- ▣ Therefore, insecticides, fungicides, herbicides, etc., are all types of pesticides.

Neonicotinoids (Neonics)



What are Neonics?

- ▣ Neonicotinoid are a family of chemicals that includes acetamiprid, clothianidin, imidacloprid, nitenpyram, nithiazine, thiacloprid and thiamethoxam
- ▣ Introduced in the 1990s, imidacloprid is the most widely used insecticide in the world.
- ▣ neurotoxic, broad-spectrum insecticides
- ▣ Water-soluble
- ▣ Mostly applied as a seed treatment or soil drench
- ▣ Persistent in soil (can exceed 1,000 days)
- ▣ Great quantities used with GMO crops.
- ▣ Systemic

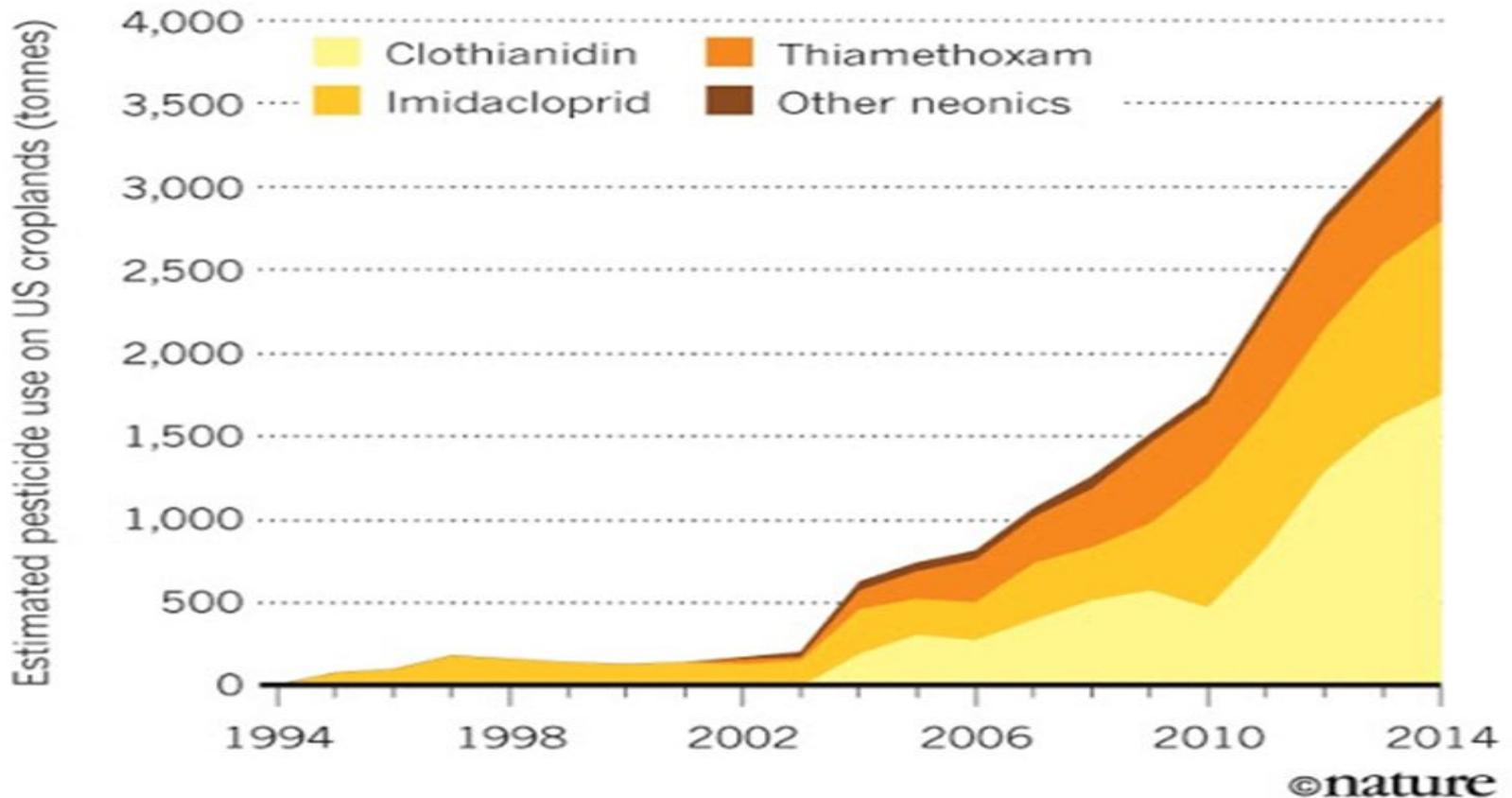
The Neonics family

- ❑ **Difficult scientific names to pronounce and remember.**
- ❑ **Confusing to consumers who want to know what they are spraying or what's added to seeds.**
- ❑ **Confusing to farmers who resort to taking the word of the chemical salesmen.**

Use of Neonics in the U.S.

RISING TIDE

Use of neonicotinoid insecticides has rapidly increased in the United States.



Neonics and Soil Biota

- ▣ The current scientific literature is mainly focused on the impact of these insecticides on pollinators and some aquatic insects.
- ▣ Leaving a knowledge gap concerning soil invertebrates. More research is needed.
- ▣ Broad-spectrum pesticides, like neonicotinoids, indiscriminately kill pests and nontarget organisms alike, as their ubiquitous use contaminates soils.

Neonics – Soil impacts

- ▣ As a seed treatment Approx. 5% absorbed by the plant. 95% remains in the soil.
- ▣ 100% of conventional GMO corn and 50% of GMO soybeans are treated with Neonics.
- ▣ The persistence in soils, waterways, and nontarget plants is variable; for example, the half-lives of some neonicotinoids in soils can exceed 1,000 days.
- ▣ Neonicotinoids exhibit extremely high toxicity to most soil invertebrates like detritivores.

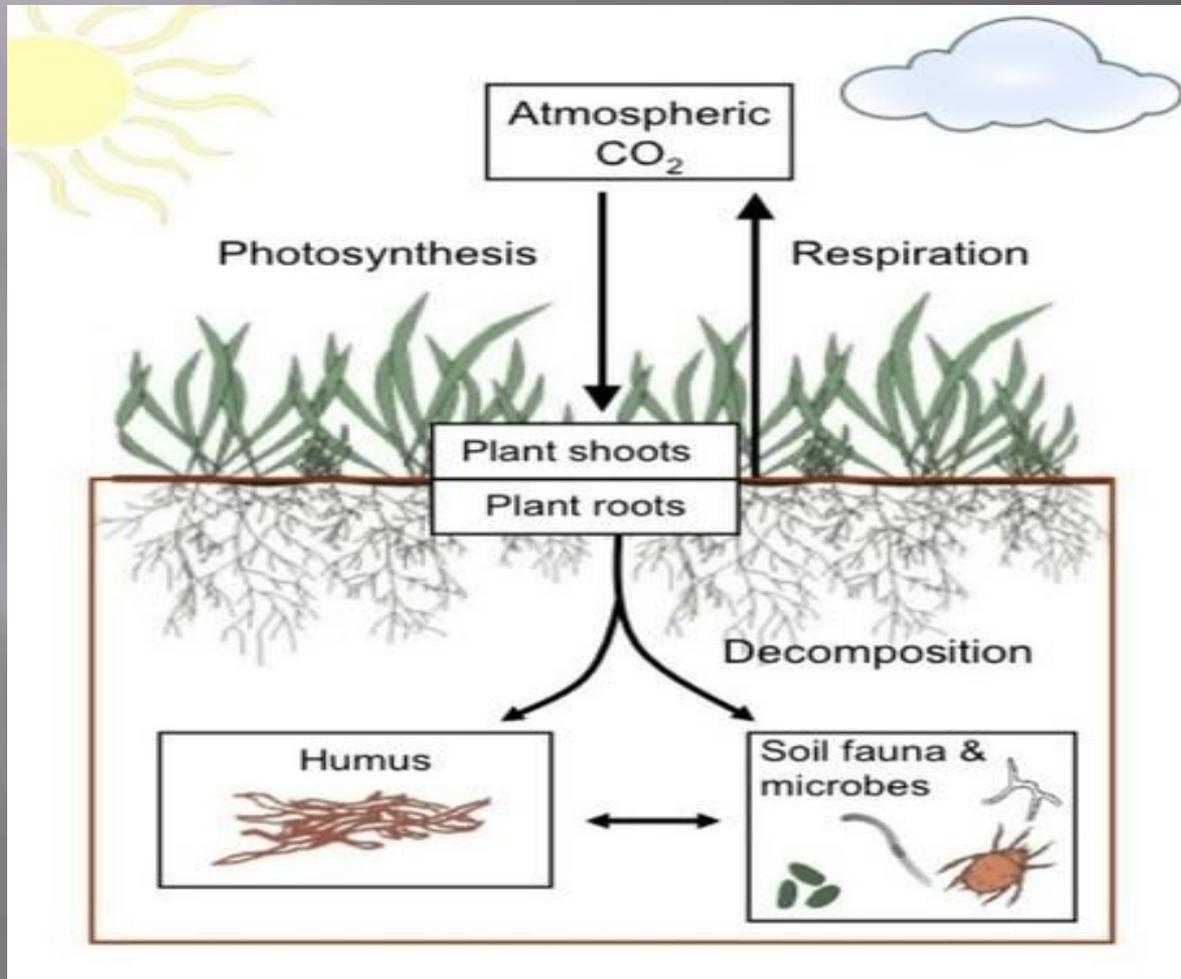
What are Detritivores?

- ▣ Commonly called shredders.
- ▣ Common shredders include millipedes, springtails, woodlice (sow bug), dung flies, slugs, and many terrestrial worms.
- ▣ Detritivores feed on the larger particulate organic material in the early stages of decomposition, and in doing so, fragment the material in to smaller sized pieces.

Importance of Detritivores (Shredders) in Soil

- ▣ **Detritivores increase the surface area of organic matter for attack by bacteria, fungi and other microorganisms, and thus assists the decomposition process.**
- ▣ **Then decomposers such as fungi and bacteria perform true decomposition, using chemical compounds and digestive enzymes to convert material excreted by the detritivores into further simpler substances such as inorganic carbon.**
- ▣ **The reduction of detritivores populations by Neonics reduces the efficiency of the decomposition process, thus reducing the efficacy of carbon capture.**

Decomposition in Soil



Neonics and Climate Change

- ▣ Neonics are insecticides that kill insects and other soil invertebrates like shredders (detritivores).
- ▣ Shredders are key organisms in the decomposition of organic matter and the sequestering of carbon.
- ▣ Thus Neonics disrupt the natural soil processes that help mitigate climate change.

Glyphosate (Roundup)



What Is Glyphosate?

- ▣ Killing ingredient in Roundup and other glyphosate-based herbicides (GBH).
- ▣ Broad-spectrum herbicide
- ▣ Water-soluble
- ▣ Systemic pesticide (herbicide)
- ▣ Glyphosate kills plants and bacteria by preventing essential proteins from being produced.
- ▣ Great quantities used with GMO crops.
- ▣ Ubiquitous in food and the environment

Glyphosate Use in the U.S.

- ▣ 280 million pounds of glyphosate are used just in agriculture, sprayed on 298 million acres of cropland annually.
- ▣ 84% of glyphosate used in agriculture is applied to GMO soy, corn and cotton.
- ▣ Glyphosate is also used on lawns, gardens, landscaping, roadsides, schoolyards, national forests, rangelands, power lines and more.
- ▣ Used to desiccate nonGMO crops – (e.g. wheat, oats, dried beans)

More Than Just an Herbicide

Glyphosate patents:

- ❑ 1964 – chelating agent – cleaning and descaling boilers and pipes – Stauffer Chemical
- ❑ 1974 – herbicide – plant killer – Monsanto
- ❑ 2003 – Antimicrobial (antibiotic) – kills bacteria - Monsanto

Glyphosate and the Soil

- ▣ About 280 million pounds of glyphosate are applied to an average of 298 million acres of crop land annually (USDA).
- ▣ Researchers have found that, after years of consistent application to agricultural crops, the chemical accumulates and persists in area soil.
- ▣ In addition, the chemical is likely released in soil from the roots of plants that have absorbed the compound, as well as from decomposing plants that have been exposed to it.
- ▣ USDA - half-life of glyphosate in soil ranges from 3 to 249 days. This range means that it remains possible for Roundup to stay active in the soil for possibly over a year.

Glyphosate as a Chelating Agent – Soil Impacts (Cont.)

- ▣ **A chelating agent binds nutrients, essential for many plant processes and pathogen resistance.**
- ▣ **Glyphosate can strongly bind to Ca, Fe, Zn, Al, and Mn**
- ▣ **Therefore, some nutrients already in the soil are bound in the soil by glyphosate and are not available to soil biota.**

Glyphosate Studies have Found:

- ▣ **Glyphosate damages the ecology of mycorrhizal fungi that enable the flow of carbon to the soil.**
- ▣ **The casting activity of earthworms at the soil surface nearly disappeared after three weeks of glyphosate application.**
- ▣ **Earthworm reproduction was reduced by 1/2.**
- ▣ **An increase in pathogenic microorganisms in the soil**
- ▣ **Mineral immobilization (chelation) for plants, microorganisms and macroorganisms (Shredders)**

Other Soil Biota Concerns:

- ▣ **Reduction of nutrient availability for plants and organisms**
- ▣ **Disruption to organism diversity, especially in the areas around plant roots**
- ▣ **Reductions of beneficial soil bacteria**
- ▣ **Increases in plant root pathogens**
- ▣ **Disturbed earthworm activity**
- ▣ **Reduced nitrogen fixing at plant roots**
- ▣ **Compromised growth and reproduction in some soil organisms.**

**How can we best help
change the climate
changing farming practices
associated with industrial
conventional agriculture?**

What Can Consumers do to Change Industrial Agricultural Practices?

- ▣ Farmers grow what they can sell.
- ▣ GMO crops are grown with excessive amounts of synthetic fertilizers and massive amounts of pesticides.
- ▣ If consumers reject foods with GMO ingredients then they are also rejecting the climate changing practices used to grow those crops.
- ▣ Reject GMOs and buy organic regenerative produced food. Especially reject conventional oats, wheat, dry beans, etc. Why?
- ▣ If enough consumers buy foods that are produced using organic regenerative practices then farmers will grow what they can sell.

How to Avoid foods with GMO Ingredients

- ▣ Educate yourself and others
- ▣ Read labels
- ▣ Avoid processed food
- ▣ Grow your own
- ▣ Buy organic
- ▣ Buy locally grown food from someone you trust (ask questions)
- ▣ Buy non-GMO verified foods without ingredients desiccated with glyphosate (beware of wheat and oat products).
- ▣ Buy foods without corn or soy or derivatives of corn or soy
- ▣ Eat organic or grass-fed animals
- ▣ Phase out GMO products – one or two a week
- ▣ Avoiding GMOs = avoiding the synthetic fertilizers and pesticides used to grow those crops.

Take home messages

- ▣ **Healthy soils contain flourishing and diverse biological communities.**
- ▣ **Using synthetic nitrogen fertilizers and pesticides significantly alters a soil's diverse biology.**
- ▣ **Healthy soils are best at sequestering carbon.**
- ▣ **To mitigate climate change it's essential that legacy atmospheric carbon as well as carbon being released today into the atmosphere are sequestered in healthy soil.**
- ▣ **Soils treated with synthetic agrochemicals will never be truly healthy.**

Pesticide Companies: Marketing Themselves as a Solution to Healthy Soil and Climate Change

- ▣ From the Bayer/Monsanto web site -
- ▣ “Saving the earth: How to sustainably boost soil health”
- ▣ Syngenta describes “investing in soil health” as one of its corporate commitments.
- ▣ “Cargill to advance regenerative agriculture practices” – from Cargill web site

- ▣ Let’s make sure organic regenerative is not lost in this sudden greenwashing race to hijack the word regenerative.

Industrial Agriculture's Legacy

- ▣ **Conventional/industrial agriculture is the largest polluter in the U.S.**
- ▣ **Agbiotech (GMO) technologies are not only producing poor quality food with allergens, reduced nutrition and pesticide residues but are polluting the air, water, soil, our food, our bodies and the Earth.**

REGENERATION MASSACHUSETTS



- ▣ Regeneration Massachusetts (RM) is a statewide organization dedicated to educating consumers about the healthy, carbon-capturing soils associated with regenerative organic agriculture and the critical role they play in human nutrition and in mitigating climate change.
- ▣ RM is affiliated with Regeneration International
- ▣ Follow us on Facebook at <https://www.facebook.com/marighttoknowgmos/>

- • Glyphosate is likely to injure or kill 93% of the plants and animals protected under the Endangered Species Act.
- • 1,676 endangered species are likely to be harmed by glyphosate.
- • Glyphosate adversely modifies critical habitat for 759 endangered species.
- • 280 million pounds of glyphosate are used just in agriculture, sprayed on 298 million acres of cropland annually.
- • 84% of glyphosate used in agriculture is applied to GMO soy, corn and cotton.
- • Glyphosate is widely used in non-GMO fruit and vegetable production.
- • Glyphosate is also used on lawns, gardens, landscaping, roadsides, schoolyards, national forests, rangelands, power lines and more.

What is Glyphosate?

- ▣ Background
- ▣ Define and explain how and why used in conventional Ag
- ▣ More than just an herbicide - patents, desiccant
- ▣ Energy used in production and GHGs produced if any during the process
- ▣ Any conversions in the soil to a GHG?
- ▣ Impacts on the soil microbiome. How does gly hamper carbon sequestration and the essential soil community?

- The best way to support and care about agricultural workers is to buy organic food products. In organic fields workers are not exposed to toxic chemical residues.
- Eating organic is one of the best things you can do for farm workers.
- Chart listing types of plant exudates

Healthy Soils

- ❑ A biologically diverse soil is a healthy, carbon-capturing soil.
- ❑ Healthy soils grow healthy crops and are best for capturing carbon.
- ❑ Soils doused in agrochemicals like synthetic fertilizers, Neonics and glyphosate can never be considered healthy and regenerative because the agrochemicals degrade and disrupt the soil biological communities that are essential for a healthy soil.

Residues of currently used pesticides in soils and earthworms: A silent threat?

- ▣ Thirty-one pesticide residues were analyzed in 180 agricultural topsoils and 155 earthworms.
- ▣ The soils (100 %) and earthworms (92 %) contained at least one pesticide.
- ▣ Both treated fields and nontreated seminatural habitats were contaminated.
- ▣ A greater number and higher concentrations of pesticides were found in treated areas.
- ▣ The initial predicted environmental concentrations in soils were exceeded in 22 % of the soils.
- ▣ A high risk of pesticide mixtures to earthworms was predicted in 46 % of cases.

Synthetic Nitrogen Fertilizers



USDA Est. Acreage Planted 2020

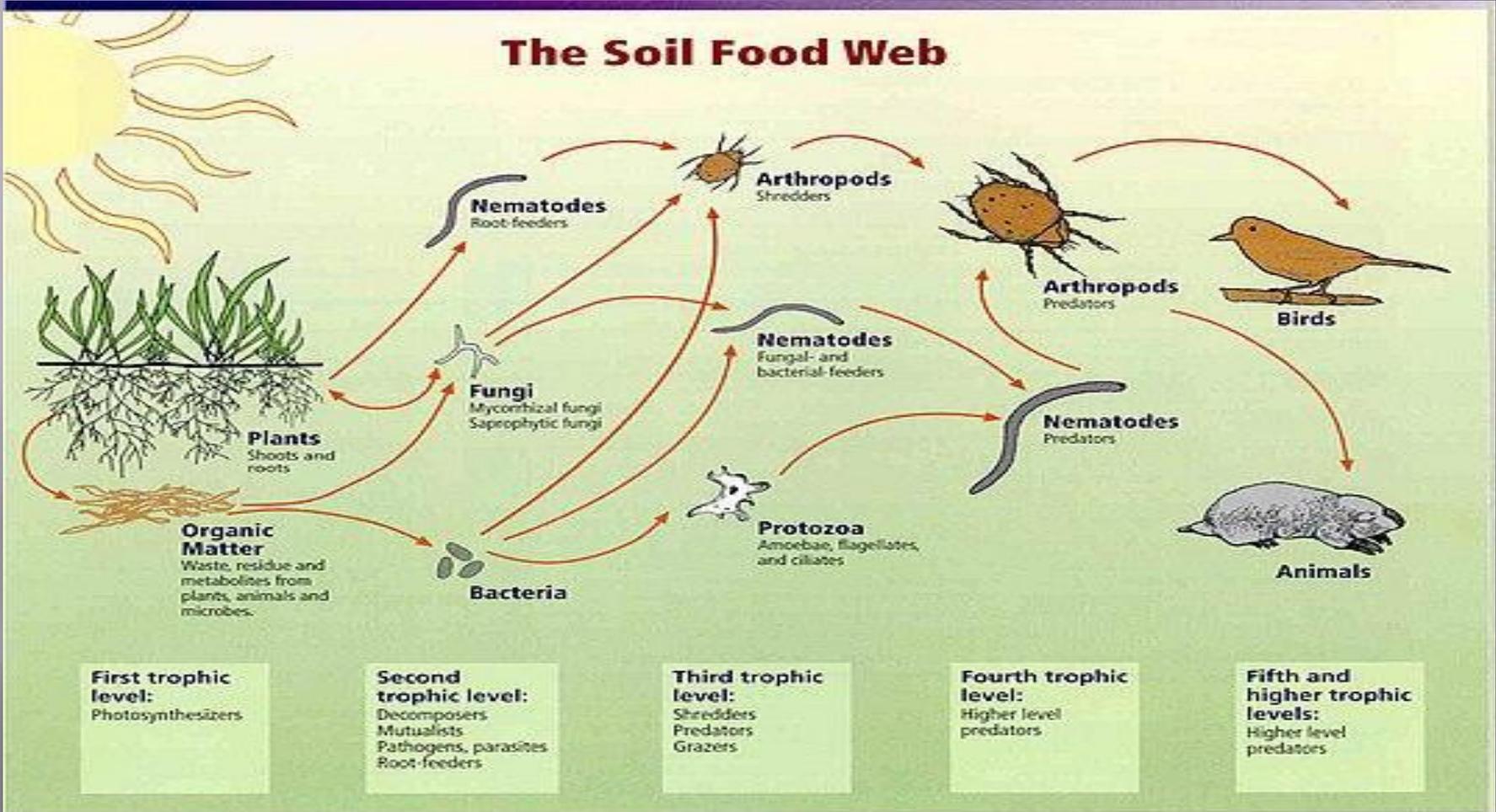
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Neonicotinoids

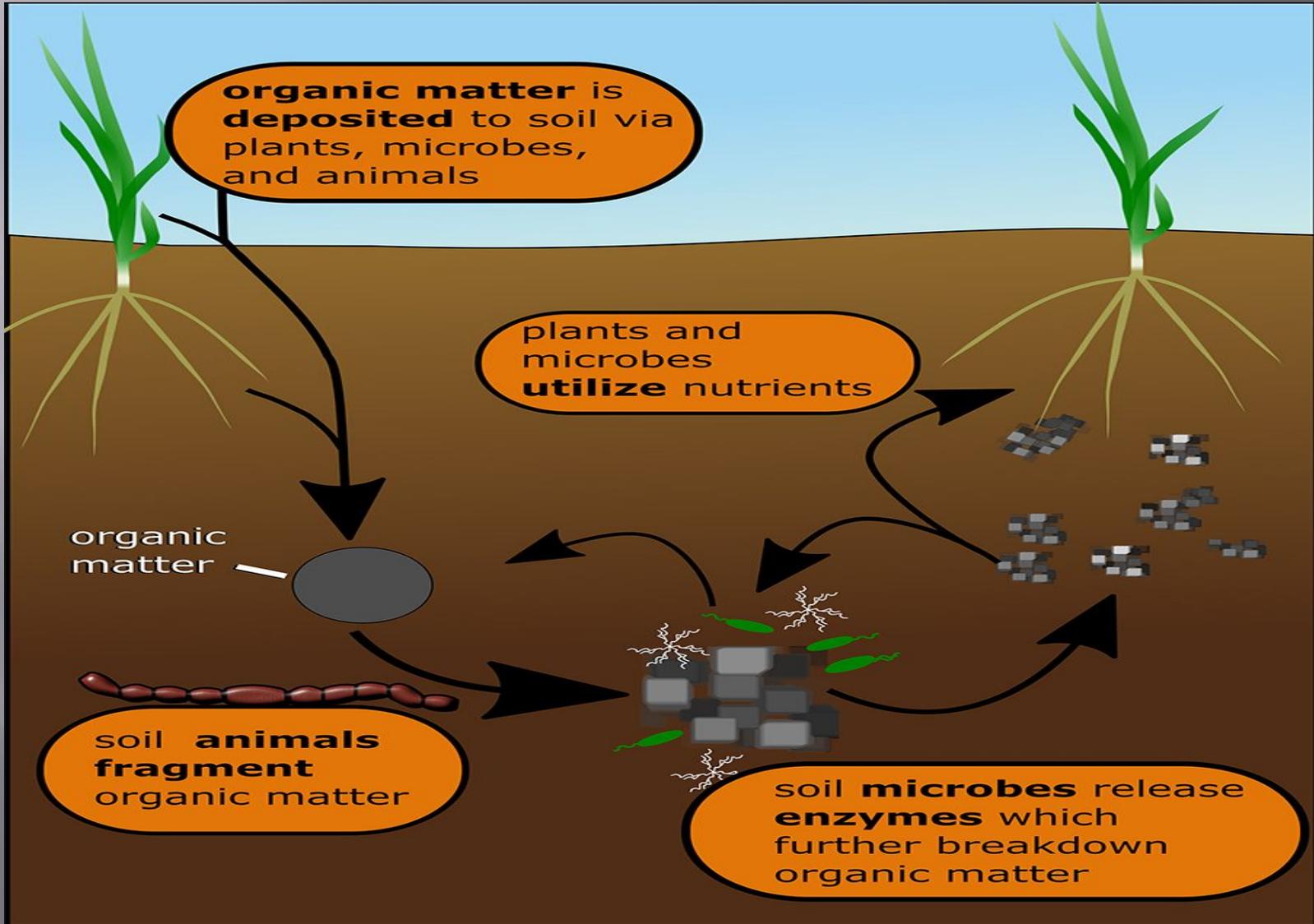
- ▣ Background
- ▣ Define and explain how and why used in conventional Ag
- ▣ Energy use in production and are there any GHGs produced.
- ▣ Conversion to any GHG in the soil after application
- ▣ Impacts to the soil microbiome and the hampering of carbon sequestration by soil microbes.

Soil Food Web

The Soil Food Web



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



How to Best Influence Farming Practices

- ▣ **Farmers grow what they can sell.**
- ▣ **GMO crops are grown with a plethora of agrochemicals.**
- ▣ **If consumers stop purchasing foods with GMO ingredient and food desiccated with glyphosate the market for those foods/crops will dry up.**
- ▣ **If consumers then buy food grown using organic regenerative methods.**
- ▣ **High-input, chemical-dependent, fossil-fueled industrial agricultural practices will change and farmers will grow what they can sell.**

What Can Food Consumers Do To Help Mitigate Climate Change?

- ▣ **GMO crops are grown with excessive amounts of synthetic fertilizers and massive amounts of pesticides.**
- ▣ **These synthetics can directly or indirectly add greatly to climate change.**
- ▣ **By not purchasing food with GMO ingredients consumers can best help mitigate the impacts of climate change.**