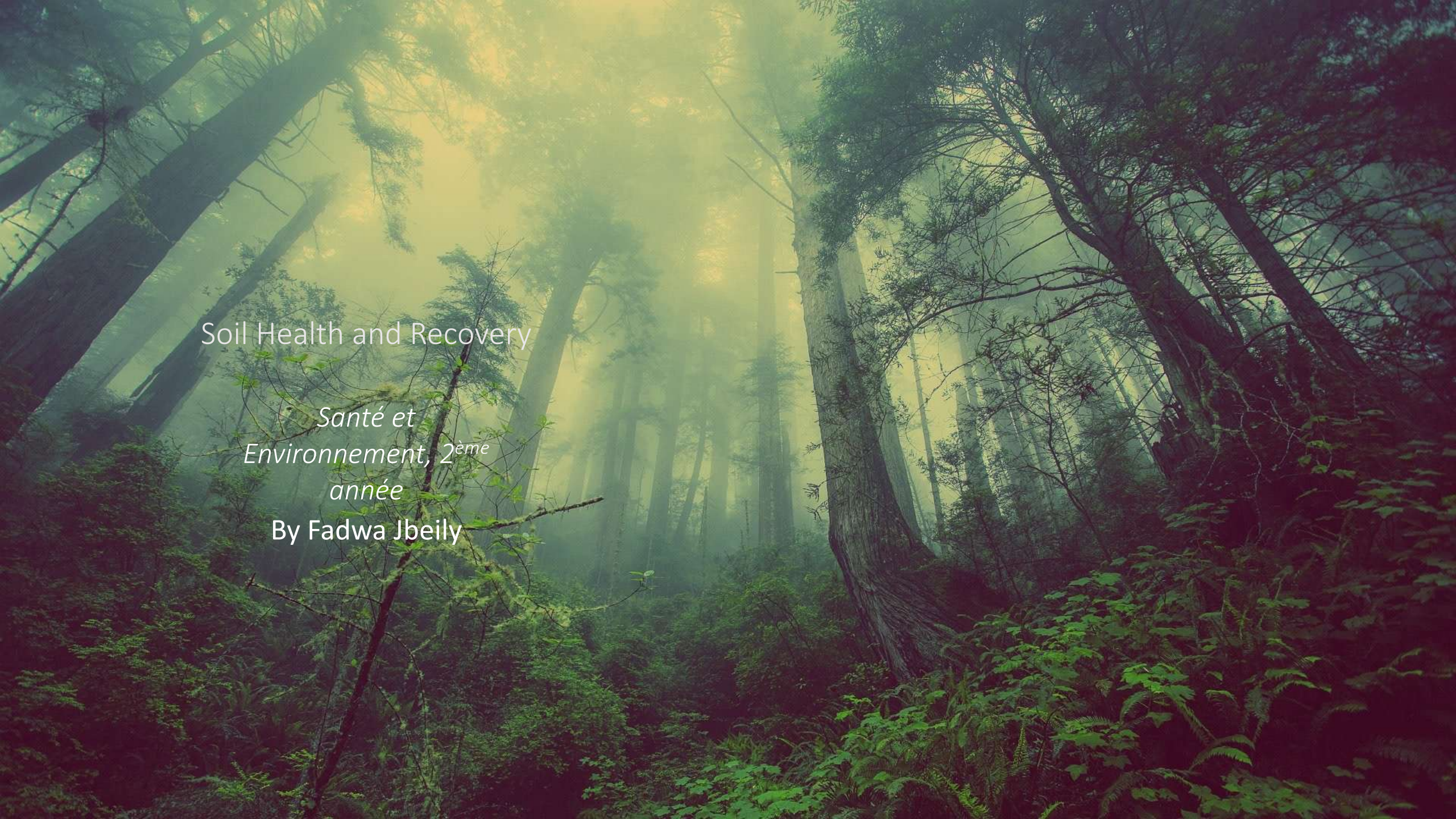


Soil Health and Recovery

Santé et Environnement, 2ème année

By Fadwa Jbeily

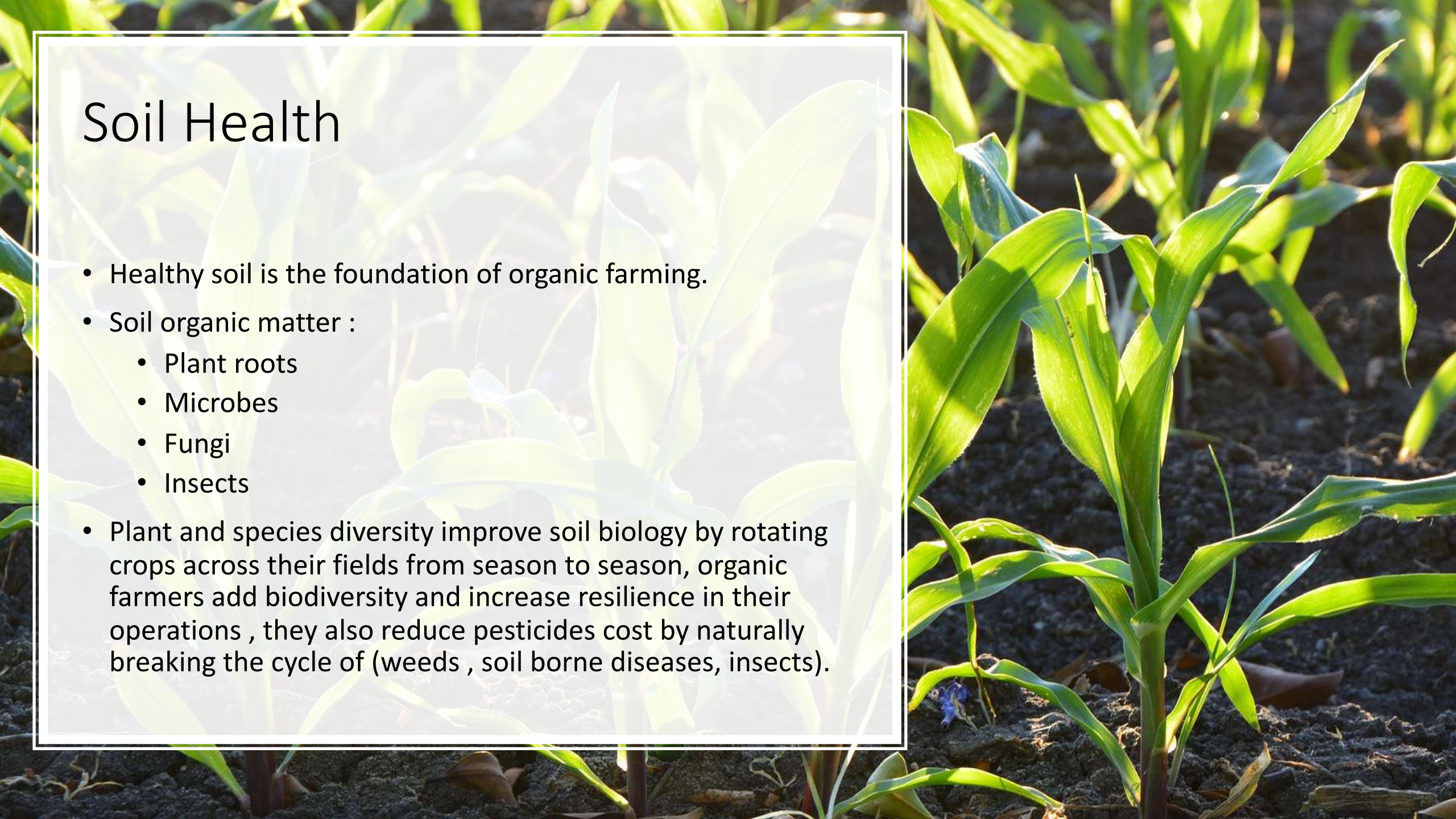
Introduction

- Soil is the earth's fragile skin that anchors all life on Earth. It is comprised of countless species that create a dynamic and complex ecosystem and is among the most precious resources to humans. Increased demand for agriculture commodities generates incentives to convert forests and grasslands to farm fields and pastures. The transition to agriculture from natural vegetation often cannot hold onto the soil and many of these plants, such as coffee, cotton, palm oil, soybean and wheat, can increase soil erosion beyond the soil's ability to maintain itself.
- Half of the topsoil on the planet has been lost in the last 150 years. In addition to erosion, soil quality is affected by other aspects of agriculture. These impacts include compaction, loss of soil structure, nutrient degradation, and soil salinity. These are very real and at times severe issues.

- The effects of soil erosion go beyond the loss of fertile land. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species. And degraded lands are also often less able to hold onto water, which can worsen flooding. Sustainable land use can help to reduce the impacts of agriculture and livestock, preventing soil degradation and erosion and the loss of valuable land to desertification.
- The health of soil is a primary concern to farmers and the global community whose livelihoods depend on well managed agriculture that starts with the dirt beneath our feet. While there are many challenges to maintaining healthy soil, there are also solutions and a dedicated group of people, including WWF, who work to innovate and maintain the fragile skin from which biodiversity springs.

Soil Health

- Healthy soil is the foundation of organic farming.
- Soil organic matter :
  - Plant roots
  - Microbes
  - Fungi
  - Insects
- Plant and species diversity improve soil biology by rotating crops across their fields from season to season, organic farmers add biodiversity and increase resilience in their operations , they also reduce pesticides cost by naturally breaking the cycle of (weeds , soil borne diseases, insects).



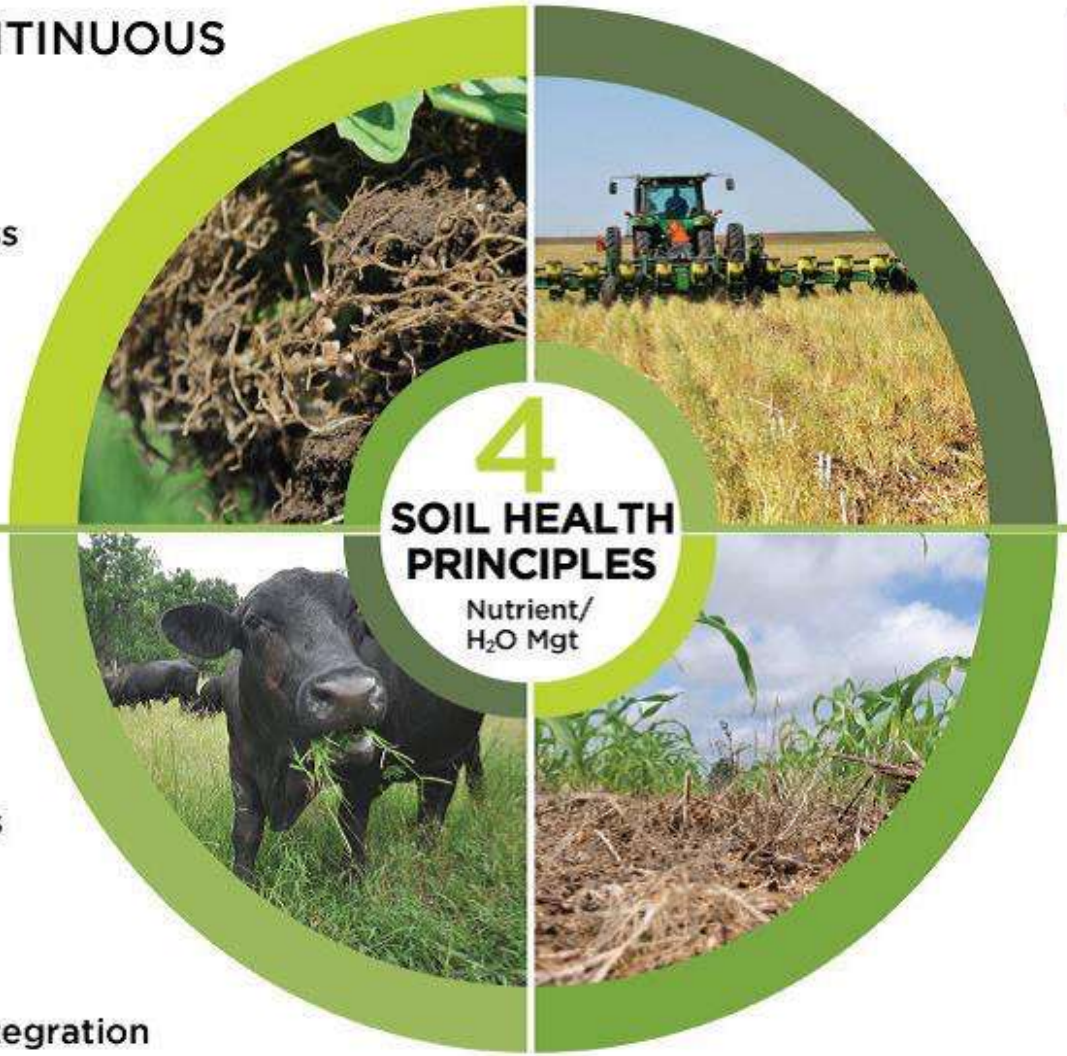
- Healthy soil is the foundation of productive, sustainable agriculture.
- Managing for soil health allows producers to work with the land – not against – to reduce erosion, maximize water infiltration, improve nutrient cycling, save money on inputs, and ultimately improve the resiliency of their working land.

MAXIMIZE CONTINUOUS LIVING ROOTS

- Crop Rotation
- Relay Crops
- Forage and Biomass Planting
- Perennial Crops
- Cover Crops

MINIMIZE DISTURBANCE

- No-till
- Reduced Tillage
- Controlled Traffic
- Avoid Tillage When Wet
- IPM



MAXIMIZE BIODIVERSITY

- Crop Rotation
- Rotational Grazing
- IPM
- Pollinator Plantings
- Organic Fertilizers
- Legumes in Mix
- Agroforestry
- Cover Crops
- Crop/ Livestock Integration

MAXIMIZE SOIL COVER

- Mulching
- Reduced Tillage
- Forage and Biomass Planting
- Residue Retention
- Cover Crops
- Green Manures

Principles to Improve Soil Health

- **Minimize Disturbance:**
- From hooves to plows, soil is disturbed in many ways. While some disturbance is unavoidable, minimizing disturbance events across your operation builds healthier soils.
- To minimize disturbance of your soil, you can:
  - Limit tillage
  - Optimize chemical input
  - Rotate livestock

- **Maximize Soil Cover:**
- As a rule, soil should be covered whenever possible. You can plant cover crops as part of both grazing and cropland operations.
- To maximize soil, cover year-round, you can:
  - Plant cover crops
  - Use organic mulch
  - Leave plant residue

- **Maximize Biodiversity:**
- Increasing diversity across your operation can break disease cycles, stimulate plant growth, and provide habitat for pollinators and organisms living in your soil.
    - Plant diverse cover crops
    - Use diverse crop rotations
    - Integrate livestock

- **Maximize Presence of Living Roots:**
- Living roots reduce soil erosion and provide food for organisms like earthworms and microbes that cycle the nutrients your plants need.
    - Reduce fallow
    - Plant cover crops
    - Use diverse crop rotations

Soil Health Practices for Working Lands

- **No Till or Reduced Till**
  - We've learned that most operations do not need heavy tillage(or often any tillage at all)to produce healthy crops. Minimizing tillage can reduce soil erosion across your operation while saving time and money.
- Benefits:
  - Decreases erosion
  - Reduces Input cost
  - Improves soil health
  - Decreases soil compaction
  - Reduces evaporation
  - Build your soil health
  - More Biological activity
  - More soil structure
  - More Sustainable

Benefits of Cover Crops

- Decreases erosion
- Improves soil health
- Decreases soil compaction
- Reduces evaporation
- Reduces input cost
- Increase water filtration rates

+ Cover Crops may vary by region

+ Aerial planting is one of the methods of planting cover crops

Rotational Grazing

- Grazing animals recycle nutrients across the landscape. By managing your livestock to graze where and when you want, you can return valuable nutrients and organic matter back to your land and ultimately your soil.
- Benefits:
  - Increase forage
  - Improves herd health
  - Decreases feeding cost
  - Limits runoff
  - Protects water quality

Crop Rotation

- Diversity can be improved with cash crops as well as cover crops. Diverse crop rotations can reduce pests and diseases that are specific to certain plant species, build the health of soil microbes that provide nutrients to your plants and ultimately lead to improved yields.
- Benefits:
  - Decreases erosion
  - Improves water quality
  - Improves soil health
  - Decreases weeds
  - Reduces pests and diseases

Soil Pollution: Causes

- There has been a rapid rise in the soil pollution over the last two decades which has posed threat to living beings and the ecosystem as well. Soil pollution is caused by both natural and anthropogenic activities. Former includes volcanic eruptions, earthquakes, tsunamis etc. while the later includes metals (trace and heavy metals), chemicals and radioactive wastes. The chemicals can be grouped into pesticides and allied chemicals, crude petroleum and its derivatives and polymers, plasticizers and other wastes. Radioactive wastes include nuclear power generation wastes and other by products released from nuclear technology (medicines and research). These are harmful substances which stay in the ecosystem for long duration during which they get accumulated and biomagnified to concentration potentially toxic to organisms at higher trophic levels in the food chain.

Consequences: Polluting our soils is polluting our future

- Healthy soils are the key to food security and our sustainable future. They help sustain food production, mitigate and adapt to climate change, filter water, improve resilience to floods and droughts and so much more. Yet, an invisible threat is putting soils and all that they offer at risk.
- Soil pollution causes a chain reaction. It alters soils' biodiversity, reduces soil organic matter and soils' capacity to act as a filter. It also contaminates the water stored in the soil and groundwater and causes an imbalance of soil nutrients.

- Soil pollution is devastating to the environment and has consequences for all forms of life that encounter it. Unsustainable agricultural practices that reduce soil organic matter can facilitate the transfer of pollutants into the food chain. For example: polluted soil can release contaminants into the groundwater, which goes on to accumulate in plant tissue, and is then passed to grazing animals, birds, and finally to the humans that eat the plants and animals. Pollutants in soil, groundwater and in the food, chain can cause a variety of diseases and excess mortality in humans, from short-term acute effects, such as intoxications or diarrhoea to long-term chronic effects, like cancer.

Why Soil Pollution can’t be underestimated!?

- Soils need to be recognized and valued for their productive capacities as well as their contribution to food security and the maintenance of key ecosystem services. Here are just a few reasons why soil pollution can’t be underestimated:
- **Soil pollution affects everything.** The food we eat, the water we drink, the air we breathe – our health and the health of all the organisms on the planet is dependent on healthy soil. The nutrient content of a plant’s tissues is directly related to the nutrient content of the soil and its ability to exchange nutrients and water with the plant’s roots.

- **Soil pollution is invisible.** Today, one third of our soils are moderately or highly degraded due to erosion, loss of soil organic carbon, salinization, compaction, acidification and chemical pollution. It takes about 1 000 years to form 1 cm of topsoil, meaning that we won’t be able to produce more soil within our lifetime. What we see is all there is. Yet, soils are facing even more pressure from soil pollution. The current rate of soil degradation threatens the capacity of future generations to meet their most basic needs.

- **Soil pollution can be a result of poor agricultural practices**. Unsustainable agricultural practices reduce soil organic matter, compromising soils' capacity to degrade organic pollutants. This increases the risk of the pollutants being released into the environment. In many countries, intensive crop production has depleted the soil, jeopardizing our ability to maintain production in these areas in the future. Sustainable agricultural production practices have therefore become imperative for reversing the trend of soil degradation and ensuring current and future global food security

Harmful effects of soil contamination

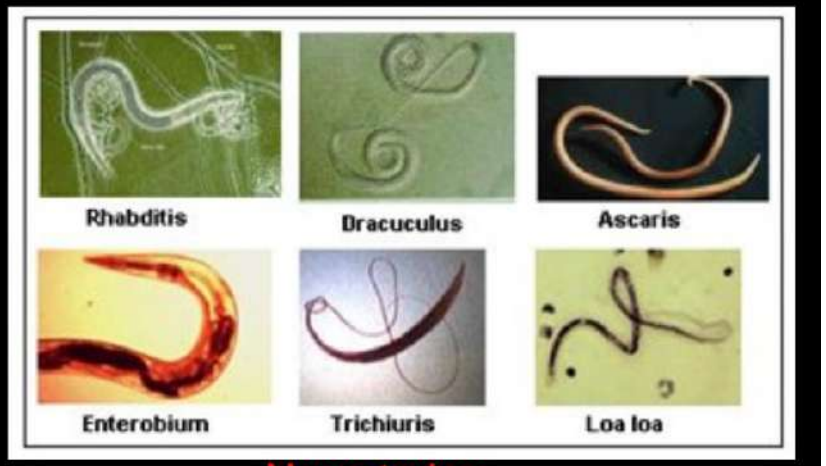
People and animals can be exposed to soil contaminants in several ways: by ingesting soil; by breathing violates and dust; by absorbing contaminants through the skin; or by eating food grown in contaminated soil.

Depending on the type of contaminant and the level of exposure, soil contamination can have serious health implications. This can significantly limit potential land use, precluding building work

The environment will continue to present a risk unless, or until, soil remediation has occurred.

Biological Indicators for Soil Quality

Earthworms



Nematodes

Ants & Termites

Fungi

PLANTS AS BIO-INDICATOR

- Plant organisms play an important role in their natural habitats - they supply oxygen, control organic substance circulation and biological balance of the soil and bottom deposits, provide food and shelter to other organism.
- **Phytoindicators** are more and more frequently used for ecosystem quality assessment due to their sensitivity to chemical changes in environmental composition and the fact they accumulate pollutants.
- The use of plants as bio-indicators has many advantages, including **low costs**, the possibility of **long-term sampling** and **high availability**.
- Lower plant organisms (grasses, mosses, lichens, fungi and algae) are used most often in analyses of atmospheric depositions, soil quality and water purity.

Common treatment methods for contaminated soil

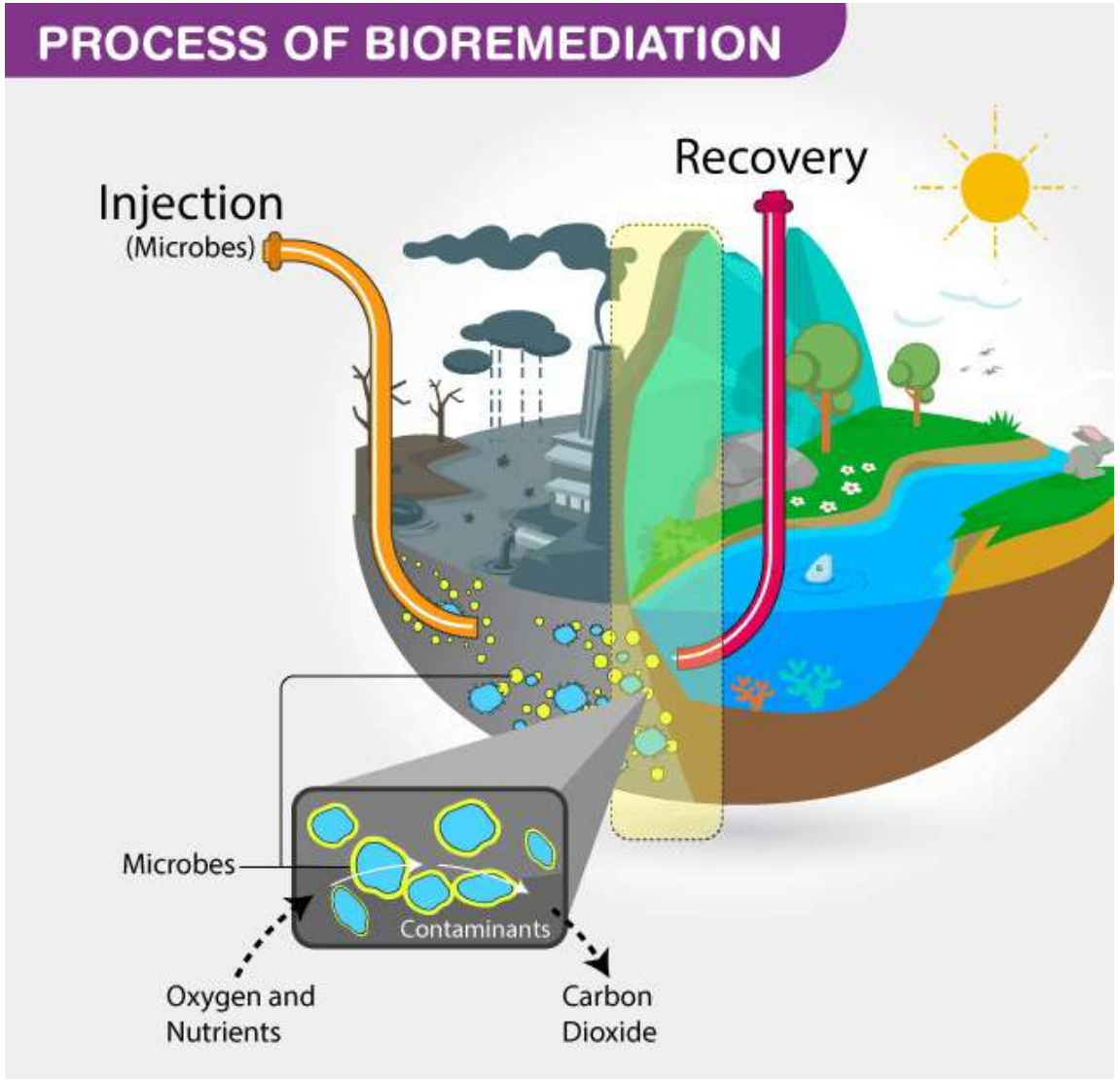
- After testing to determine the type and level of contaminants present, soil can be subjected to remediation techniques for the purposes of site decontamination. This can be carried out in-situ, or soil may excavate and removed for treatment ex-situ.

Options for treating contaminated soil include:

- *Biological treatment/bioremediation* uses bacteria to break down substances in the soil
- *Chemical oxidation* converts contaminated soils into non-hazardous soils
- *Soil stabilisation* involves the addition of immobilizing agents to reduce a contaminants' leachability
- *Physical methods*, like soil washing, use water to separate or remove contaminants

Bioremediation

- Bioremediation is the use of biological processes to degrade, transform, or essentially remove contaminants from soil and water. This process relies on micro-organisms including bacteria and/or fungi, which use the contaminant as a food source. For this reason, bioremediation is widely used to remediate organic contaminants and can be an effective means of mitigating:
  - hydrocarbons
  - halogenated organic solvents
  - halogenated organic compounds
  - non-chlorinated pesticides and herbicides
  - nitrogen compounds
  - metals (lead, mercury, chromium)
  - radionuclides
- Often, bioremediation presents a more economic option to disposal, however it can take anything from one to several months to carry out.



Chemical oxidation

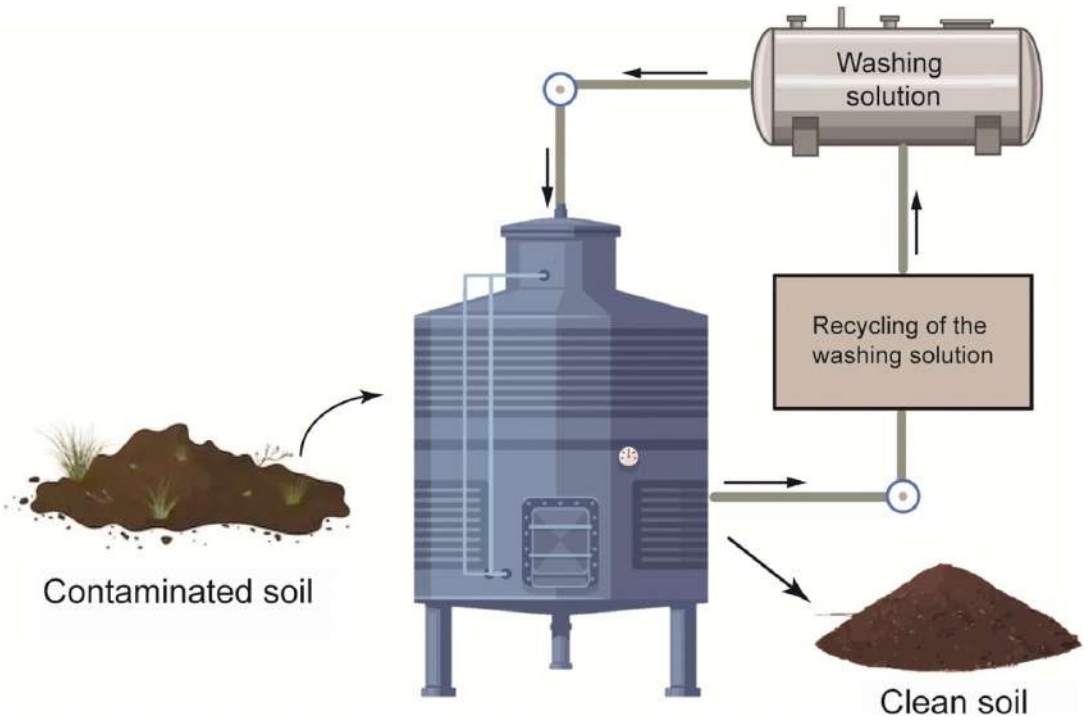
- Chemical decontamination methods generally focus on chemical oxidation, whereby reactive chemical oxidants are injected into the soil and groundwater for the purpose of rapid and complete contaminant destruction. *In* situchemical oxidation (ISCO) is a versatile solution, particularly when remediating contaminants located in difficult to access areas such as soils at depth or soils beneath buildings. Chemical oxidation has wide ranging applications and can be used to treat various organic contaminants including TPH, BTEX and PCBs.

Soil stabilisation

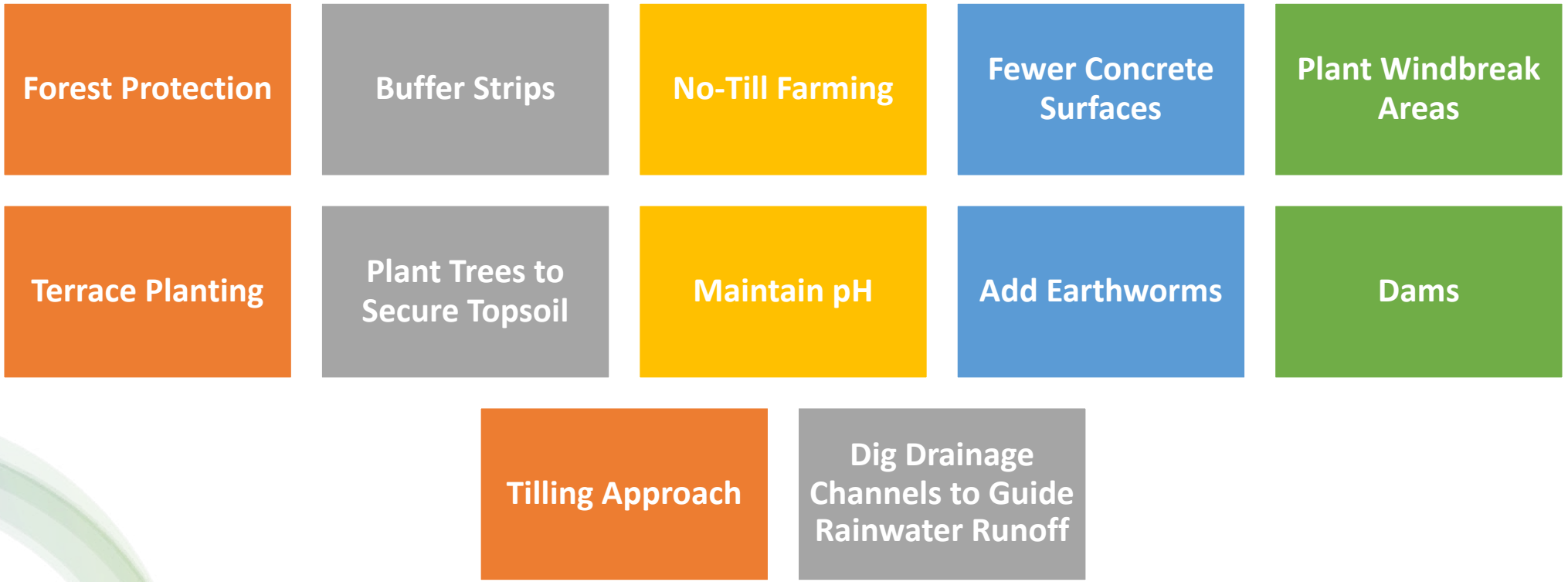
- Stabilisation reduces the risks from contamination by effectively locking contaminants in the soil. It can be achieved in two ways: firstly, by modifying the contaminant in the ground to a less dangerous form; secondly, through solidification, by reducing the mobility of the contaminant and binding it in place so it can’t reach any receptors.
- Soil stabilisation relies on the addition of immobilizing agents which reduce a contaminants’ leachability and bioavailability. This technique can also be used to improve the geotechnical competency of the ground, making it more suitable for construction work due to higher resistance and lower permeability.

Soil washing

- Soil washing eliminates hazardous contaminants by washing the soil with a liquid wash solution. During this process, fine grained soils, such as silts and clays, are washed away along with contaminants, which are more prone to bind to fine soils. Thus, contaminated fines are separated from cleaned coarse grained soils, such as sands and gravels, which can be safely re-used. Soil washing does not destroy or remove the contaminants and therefore the contaminated soil must be disposed of in a licensed facility.



Remarkable Ways to Conserve and Protect Soil



FOR DR.
MOHAMMAD
KABBARA

And Now, the project is done, I hope you were entertained, and found it helpful and interesting.

FADWA JBEILY