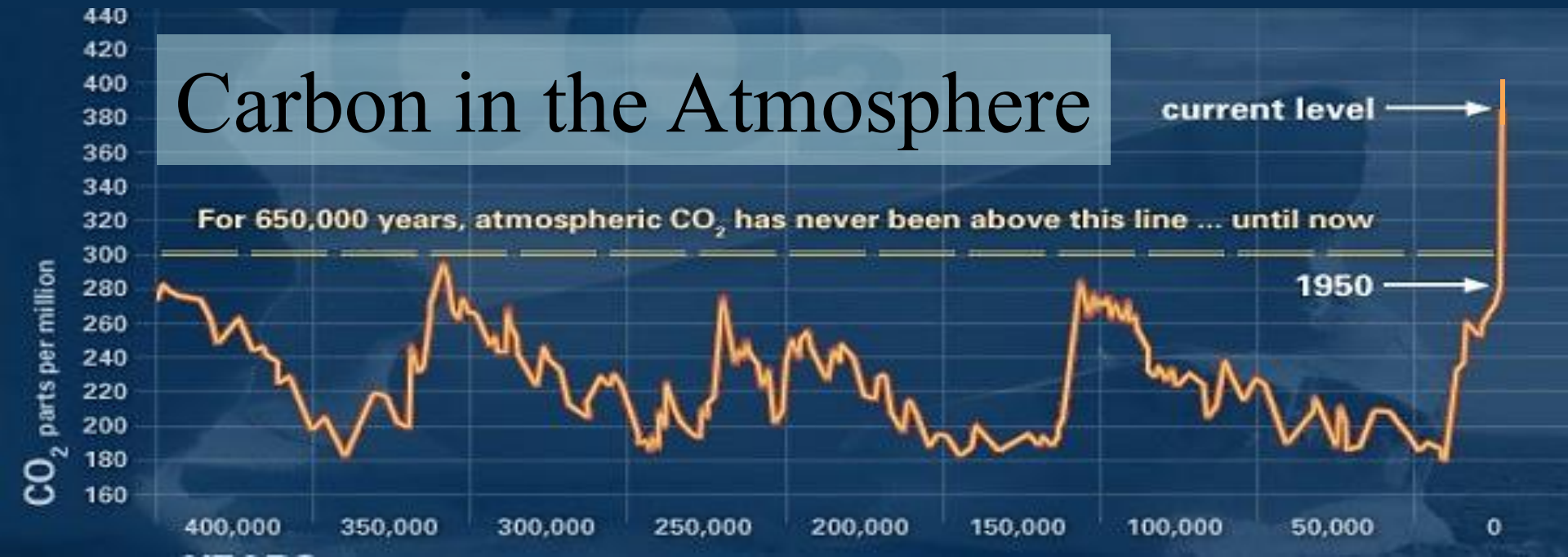
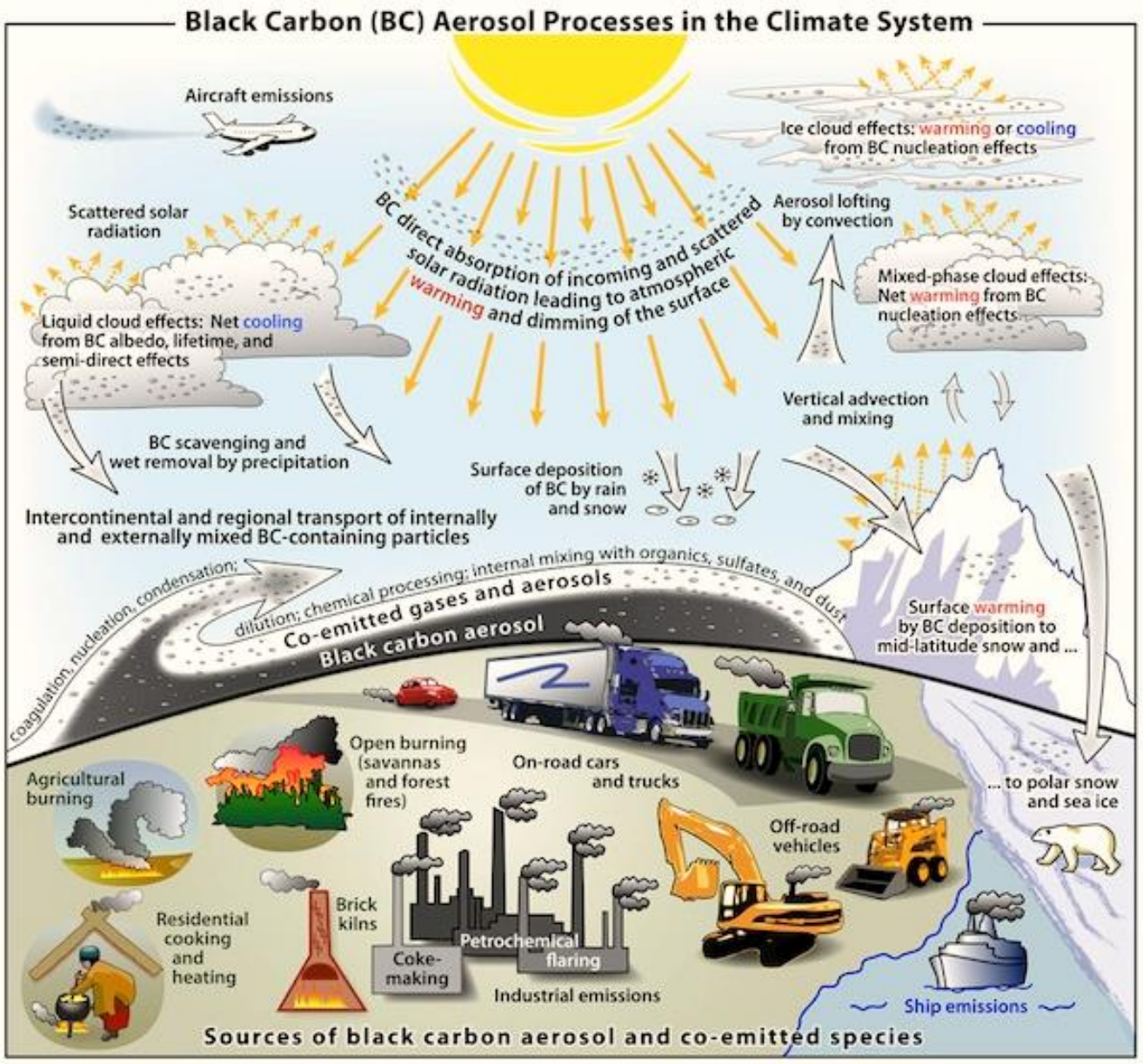
Climate Change and the Contributions of Agriculture

- **52 GT / year CO2 emissions = 14.5 GT C**
- **9% directly from Agriculture**
- **30% or more from the Food System**
- **Sources: fuels, fertilizers, NO2, methane**
- **A legacy of 10,000 years: forest clearance & tillage destroying soil carbon**
- **Fossil fuel and industrial emissions**



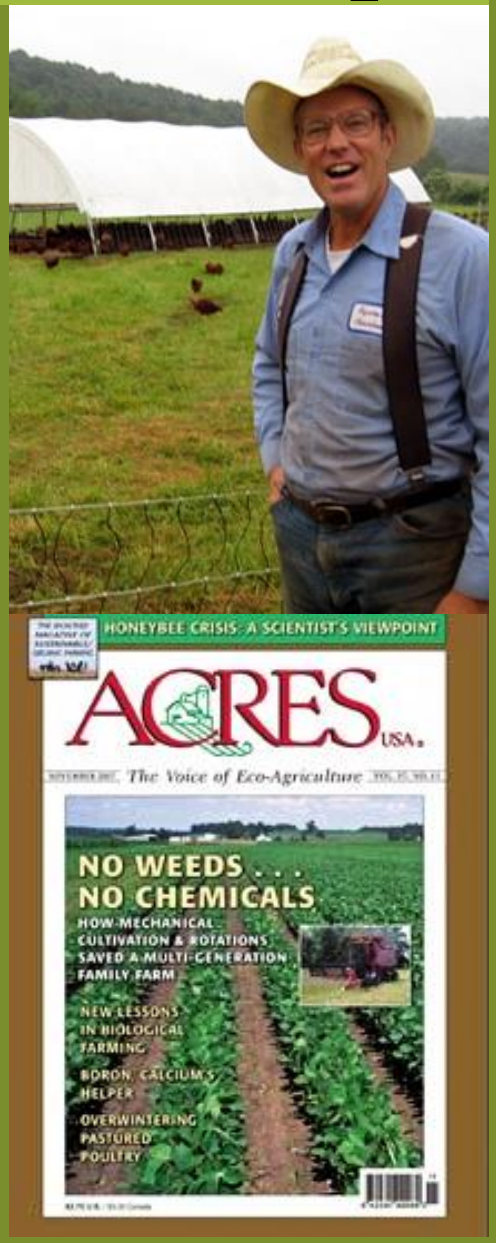


See Dark Snow Project / Jason Box
http://darksnowproject.org/

Black Carbon Aerosols from fires and industry speed melting of ice, glaciers and permafrost adding more heat to polar oceans releasing increasing amounts of methane (100+ times more potent greenhouse gas than CO2)

Farming Can Reverse CO_2 Buildup

- Croplands: 21 GT CO_2 / yr potential
  = 1.7 tons C /ac/yr on 3.5 billion acres
- Pastures: 37 GT CO_2 / yr potential
  = 1.1 tons C /ac/yr on 9 billion acres
- 58 GT $CO_2 \geq$ 52 GT emissions
  = 16 GT C on 13 billion acres = 1.25 T / acre
- Polyface Farms: 2 tons/acre/year for 50 yrs



How Can We Do This?

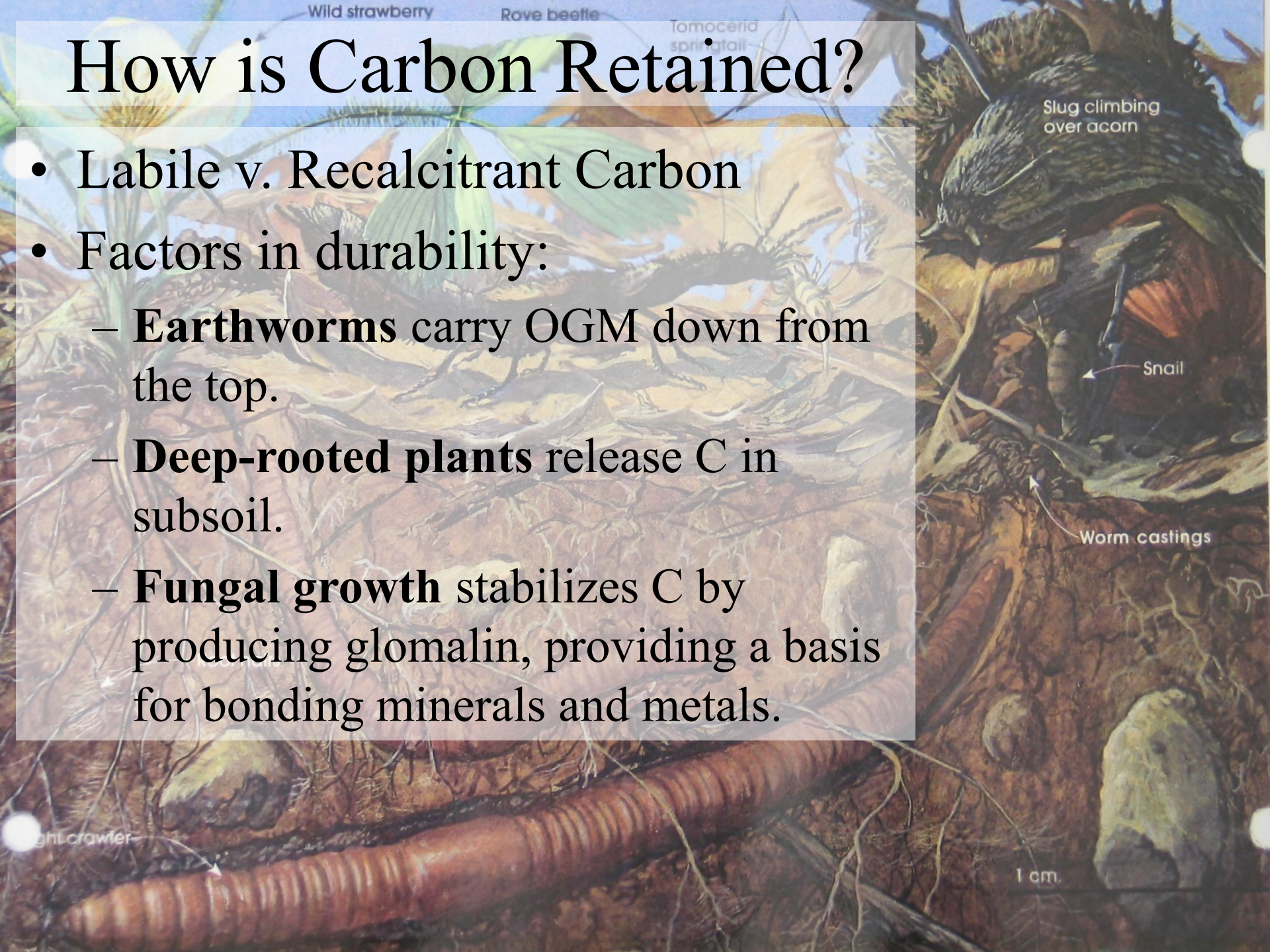
- Regenerative Organic Agriculture
  - 5 techniques: cover crops, residue mulching, composting, crop rotations, conservation tillage
- Agroecology:
  All of the above + IPM
- Permaculture: All of the above+
  - Agroforestry
  - Aquaculture
  - Earthworking, especially Keyline Soil Development

How Carbon Gets in the Soil

- Mechanical action: mulch & crop residues fall on the surface, feeding soil life.
- Root penetration & dieback carries carbon to deep soil levels.
- Woody material & untilled soil promote **fungal** growth & development.

How is Carbon Retained?

- Labile v. Recalcitrant Carbon
- Factors in durability:
  - **Earthworms** carry OGM down from the top.
  - **Deep-rooted plants** release C in subsoil.
  - **Fungal growth** stabilizes C by producing glomalin, providing a basis for bonding minerals and metals.

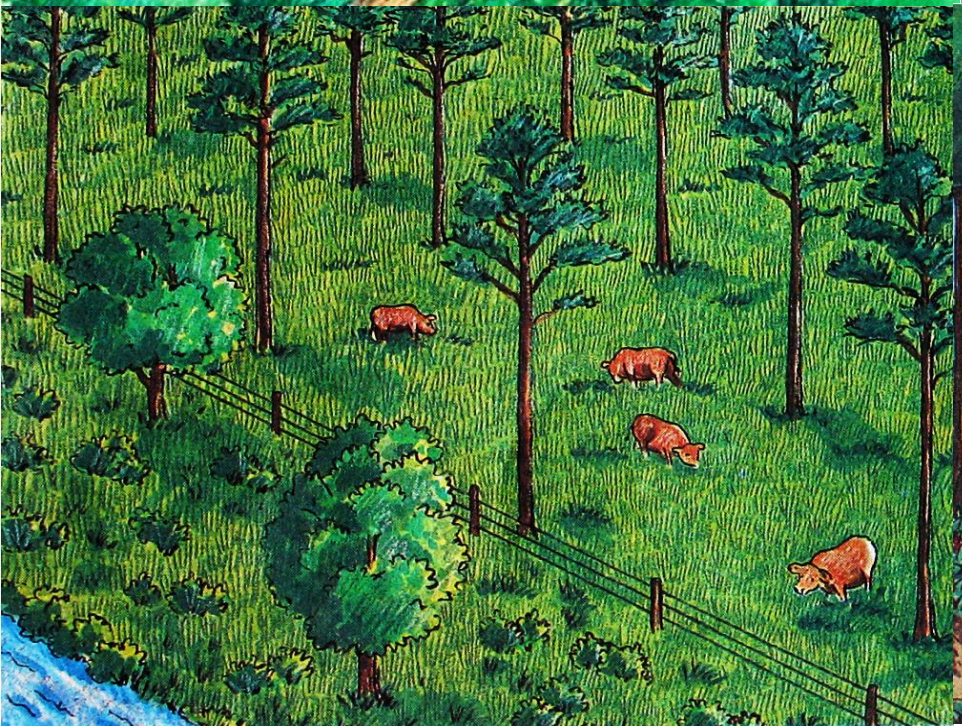


Good News

- Poor soils can stockpile C fast (1.6 t/ac/yr. in early years vs. 0.35 t/ac/yr over 30 yrs)
- Rapid uptake means quick climate payoffs
- Carbon in soil is directly related to water-holding capacity & nutrient retention, providing SYNERGIES for farmers.

Techniques for Building Carbon

- Non-tillage: permanent covers, rolling cover crops, overseeding, perennials
- Deep-rooted perennial grasses, forbs, shrubs & trees
- Agroforestry practices
- Keyline plowing, w/legumes, animals, trees
- Soil climaxes: Intensive grazing, tree fodder, coppice



Five Organic Techniques

- Cover Crops - roller crimper, aggressive rooting crops to suppress weeds, 12-month cover
- Residue Mulching, no burning
- Composting, especially w/manure
- Crop Rotations - involving a range of plants to diversify nutrient use
- Conservation tillage - using contour, intercropping permanent cover strips, choosing minimal disturbance tools

Agroforestry Practices

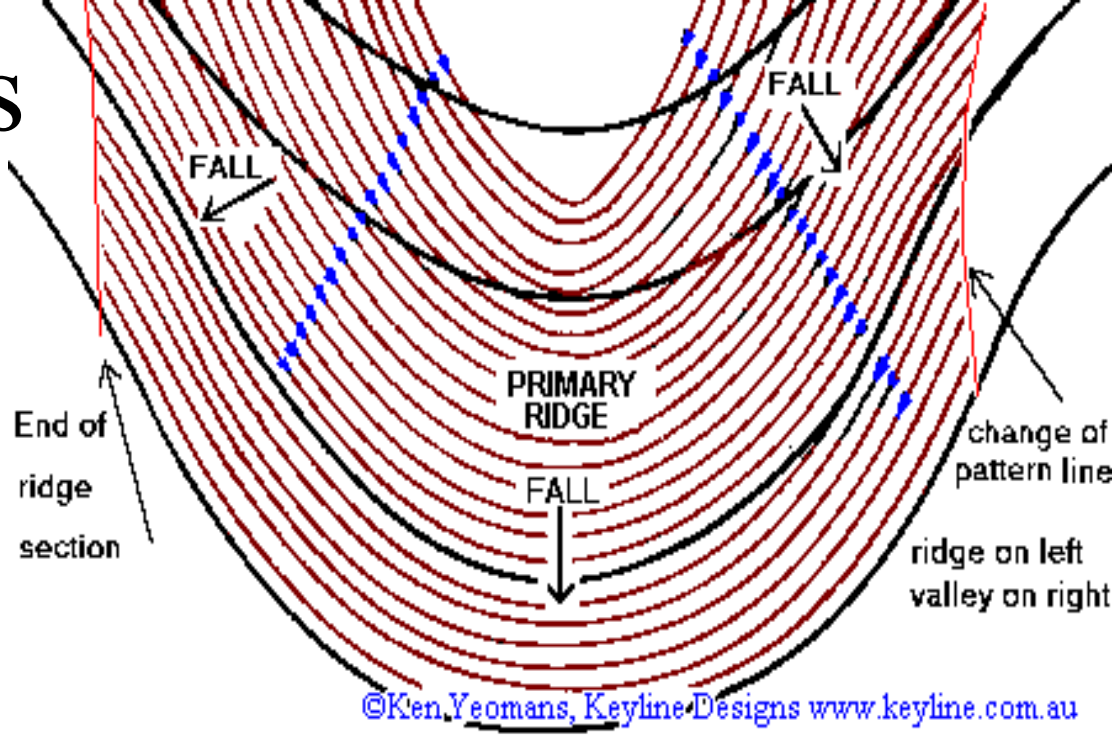
- Hedgerows, Windbreaks, Riparian Buffers
- Alleycropping
- Sylvopasture

Soil Climaxes

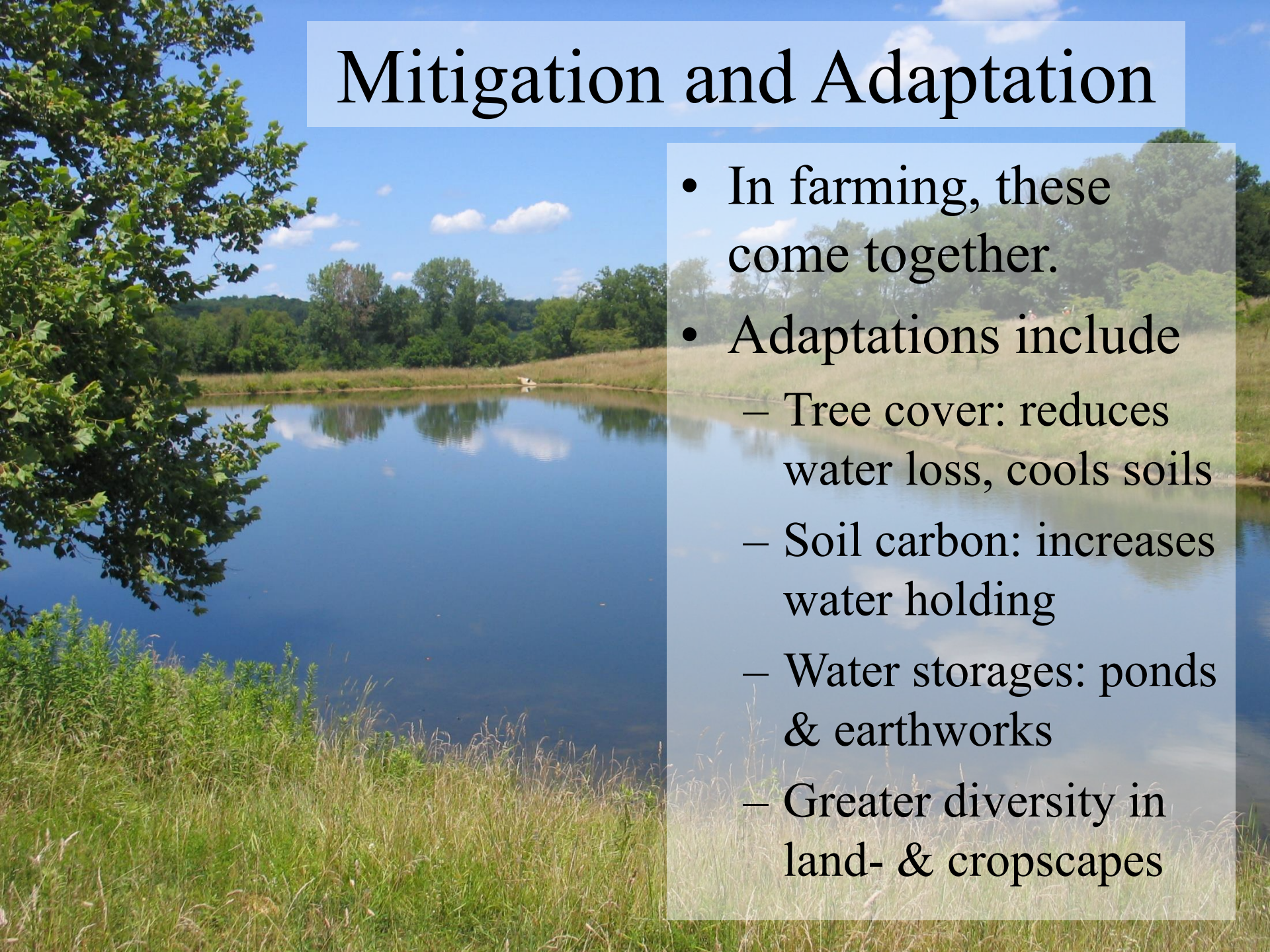
- Root dieback and decay follows mowing, harvest or grazing, providing food for soil organisms at deep layers.
- Intensive livestock rotations ensure rapid & complete cycling of surface growth while keeping regenerative capacity in roots that also decay. New seeds sprout; manures fertilize the sward.
- Coppice of tree and shrub fodder or of brash/tops for mulch does much the same.

Keyline Patterns for Soil Bldg.

- Water storage & distribution
- Subsurface furrows
- Contour patterning
- Deep-rooted forage legumes
- Pulsed growth & grazing
- Working at the subsoil edge
- Strip forests anchor the ecosystem.



Mitigation and Adaptation



- In farming, these come together.
- Adaptations include
  - Tree cover: reduces water loss, cools soils
  - Soil carbon: increases water holding
  - Water storages: ponds & earthworks
  - Greater diversity in land- & cropscapes