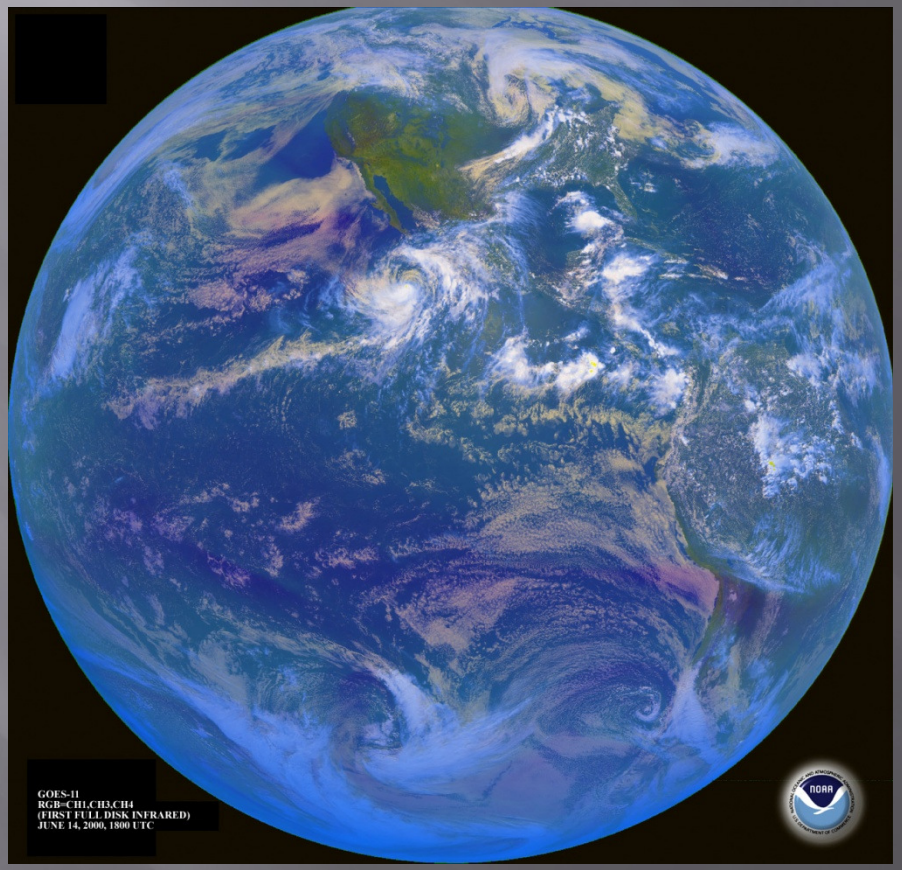
Carbon Farming in a Changing Climate

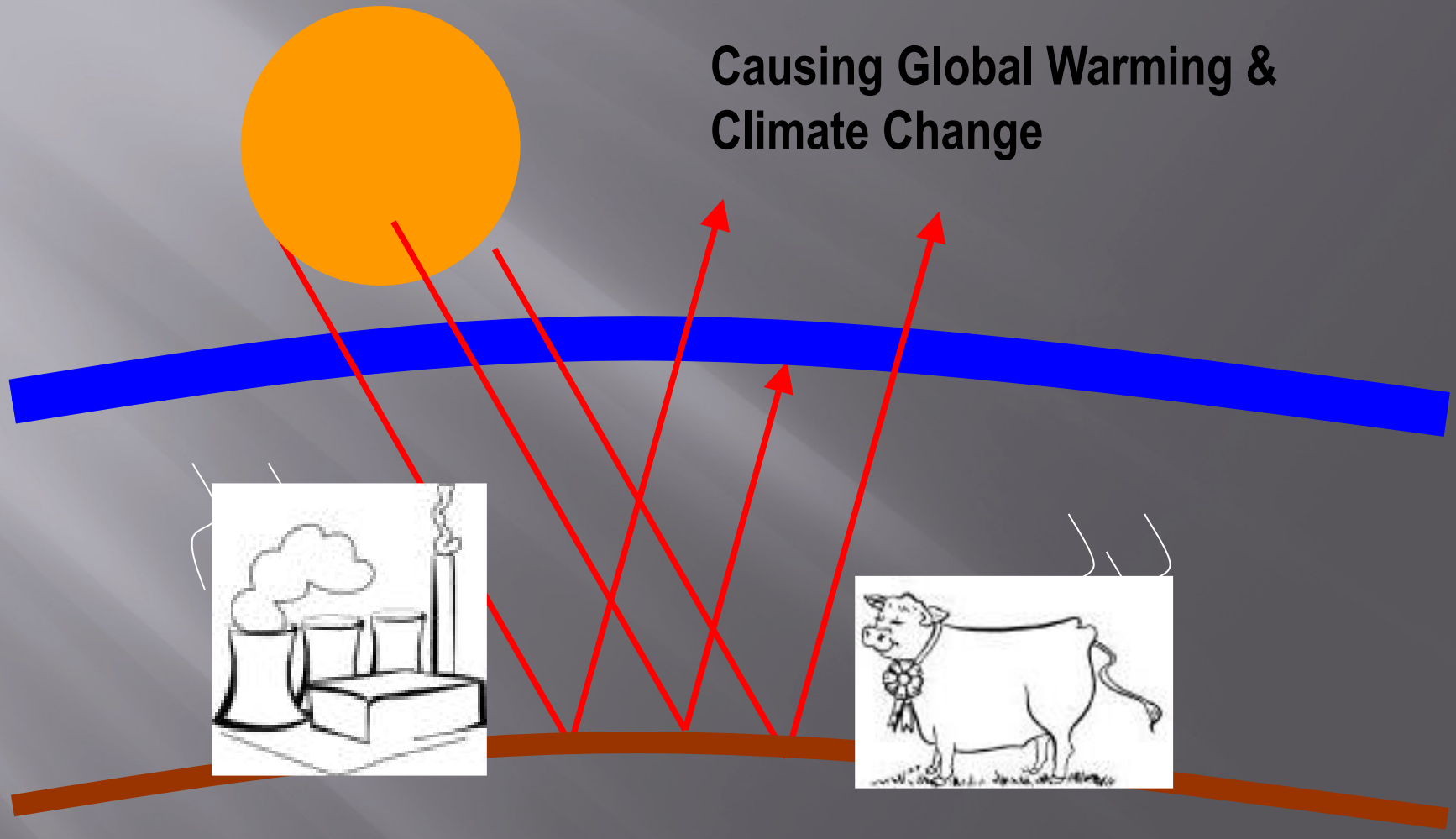
November 2019

The Big Picture
Why has storing carbon become so important?



The Enhanced Greenhouse Effect…

Causing Global Warming &
Climate Change



The Enhanced Greenhouse Effect

Greenhouse gases are a natural part of the atmosphere. They trap the sun's warmth, and maintain the earth's surface temperature at a level sufficient to support life. The problem we now face is that human actions **– particularly the burning of fossil fuels (coal, oil and natural gas) and land clearing** – are increasing the concentrations of these gases, creating the prospect of global climate change.

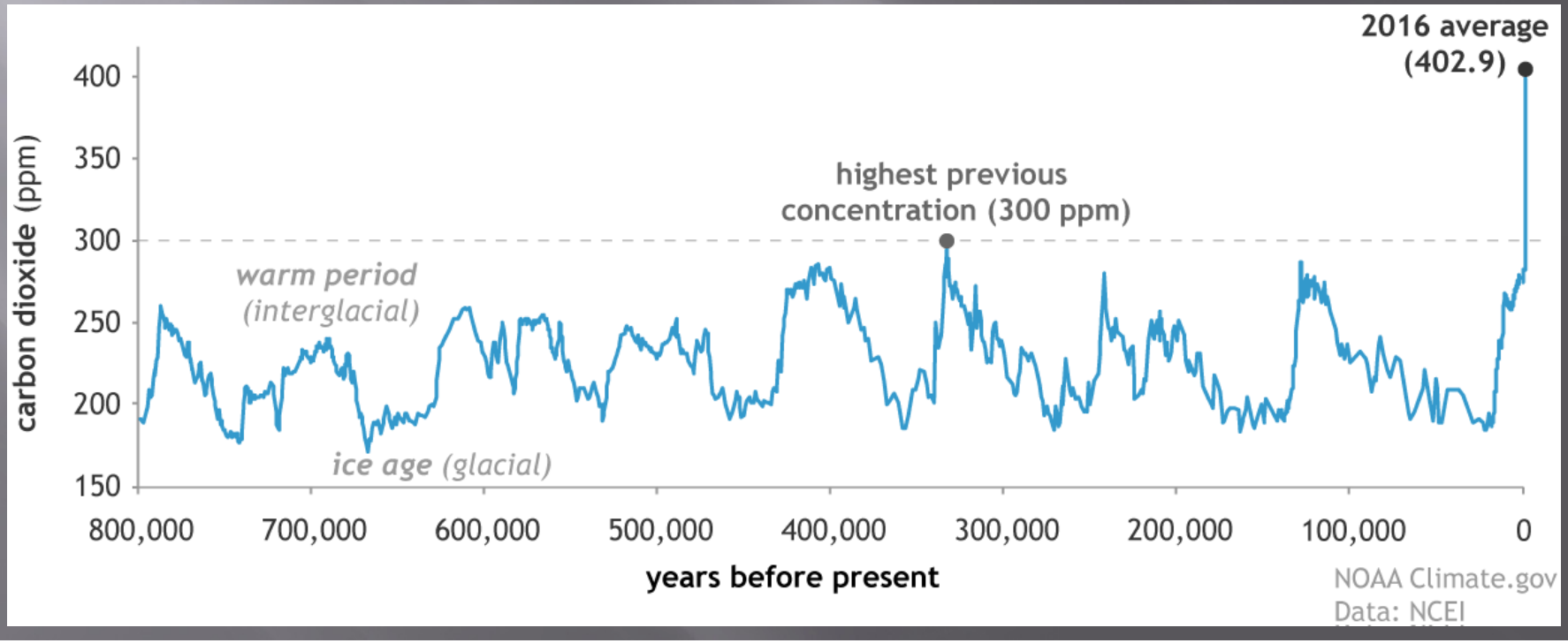
CO_2 during ice ages and warm periods for the past 800,000 years

The world reached 400 ppm CO_2 in 2016 – the highest level in 800,000 years

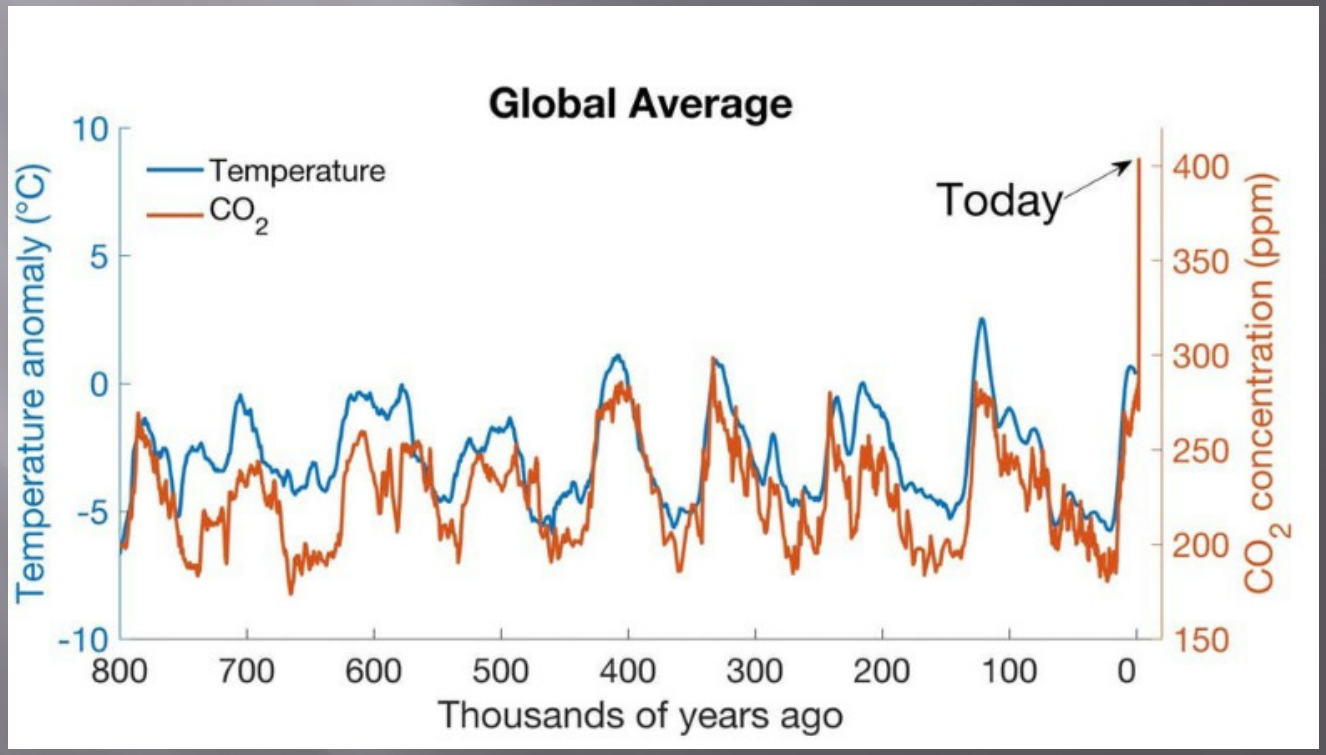
If we capped GHGs, this will mean 3.5 to 5 C degrees warmer

CO_2 has been increasing by 2 ppm per year

Last year it increased by 3.3 ppm – a new record



CO_2 and Temperature



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MAIN GREENHOUSE GASES

Greenhouse Gas	Chemical Formula	Pre-Industrial Concentration	Concentration in 2005	Atmospheric Life (years)	Anthropogenic Sources	Global Warming Potential (GWP)
Carbon-dioxide	$C0_2$	280 ppm	379 ppm	Variable	Fossil Fuel Combustion Land Use Conversion Cement Production	1
Methane	CH_4	700 ppb	1774 ppb	12	Fossil Fuel Rice Paddies Landfill Waste Livestock	21
Nitrous oxide	N_20	275 ppb	319 ppb	114	Fertilisers Combustion Industrial Processes	310

Ewings, 2007

Source: http://www.global-greenhouse-warming.com/global-warming-potential.html

Slide 7

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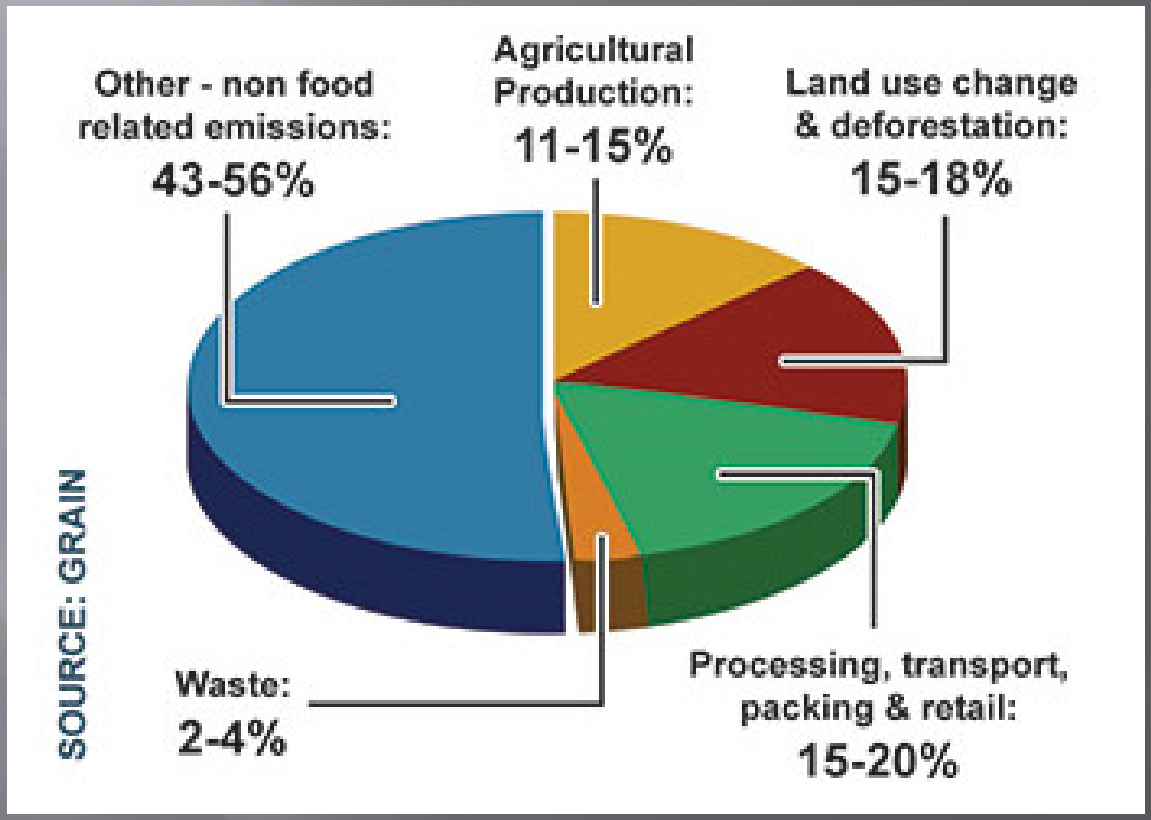
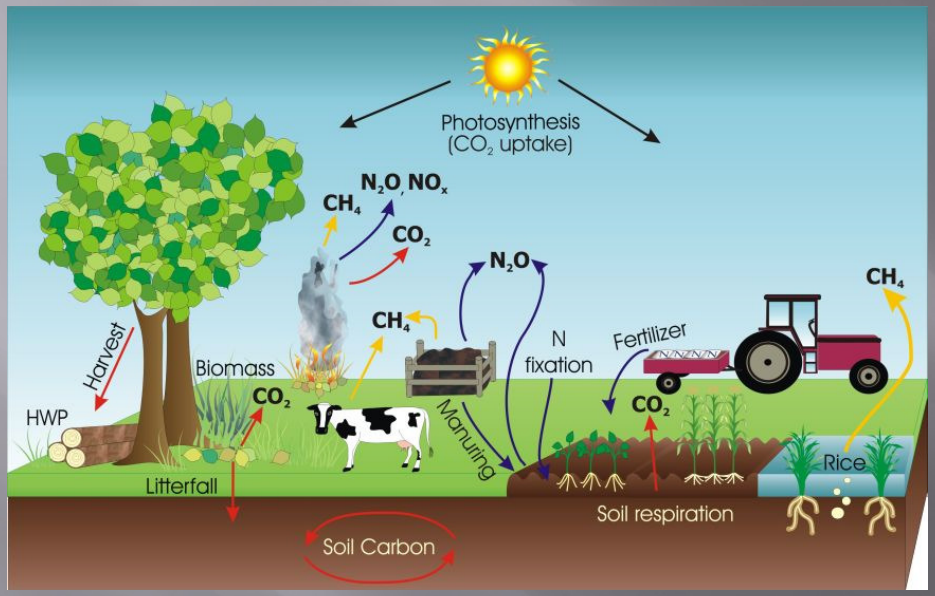
Paleo ice core data 400, 000 yrs
10,000 yrs
300 yrs
CO2-e?? explanation
Lester, 30/03/2010

Food and Climate Change Emissions



Greenhouse Gases in Agriculture

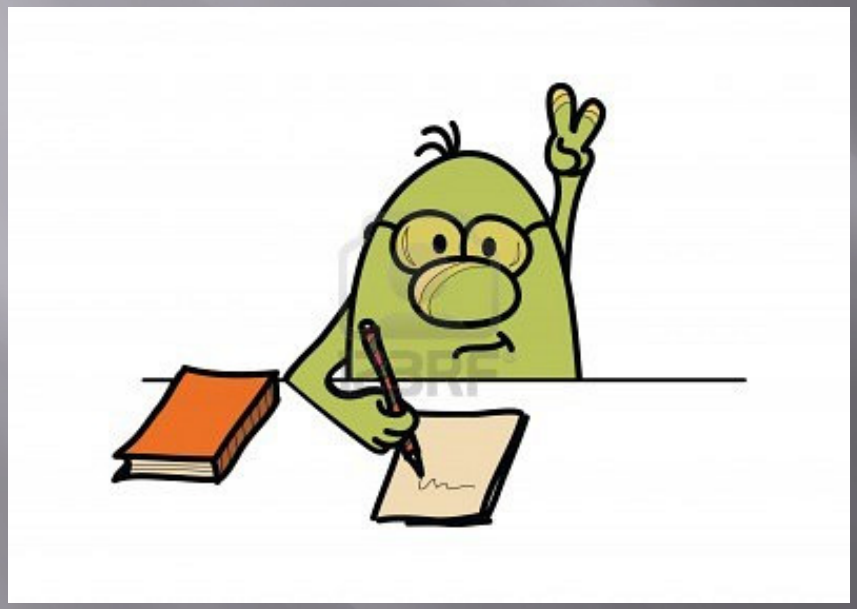


Source

Sink

Agriculture is both a source and a sink for greenhouse gases (GHGs)

How Can Agriculture Reduce CO2 Levels in the atmosphere?



Terrestrial Carbon Storage

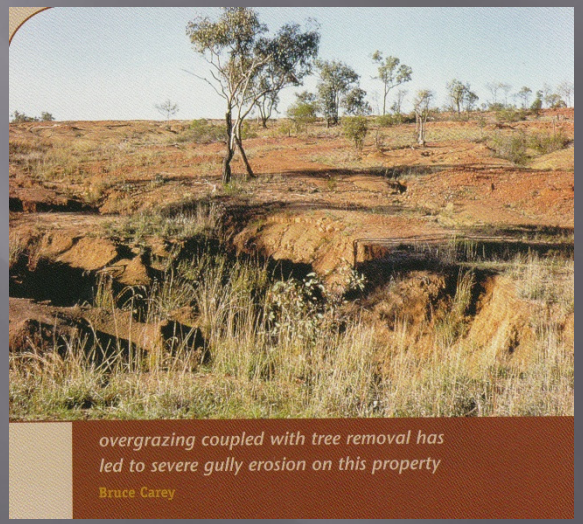
Pasture and Landcare planting
Strzelecki Ranges

The Wentworth group of concerned scientists (2009) suggest that a 15% increase in the world's terrestrial carbon stock (forests, woodlands, swamps, grasslands and farm soils) would "remove the carbon fossil fuel pollution generated since the industrial revolution".

Australian Soil's Organic Carbon

'More than 75 percent of Australian farming soils have organic carbon contents less than 1.75 percent,'

Dr Brian Tunstall of the Environmental Research and Information Consortium, formerly with CSIRO



overgrazing coupled with tree removal has led to severe gully erosion on this property
Bruce Carey

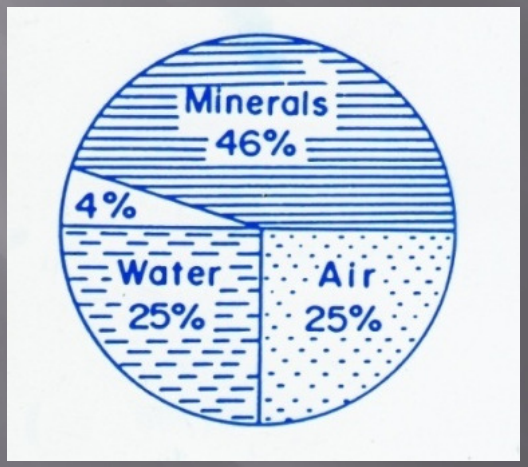
How do we get carbon into the soil?

COMPACTED MACCLESFIELD SILTY LOAM

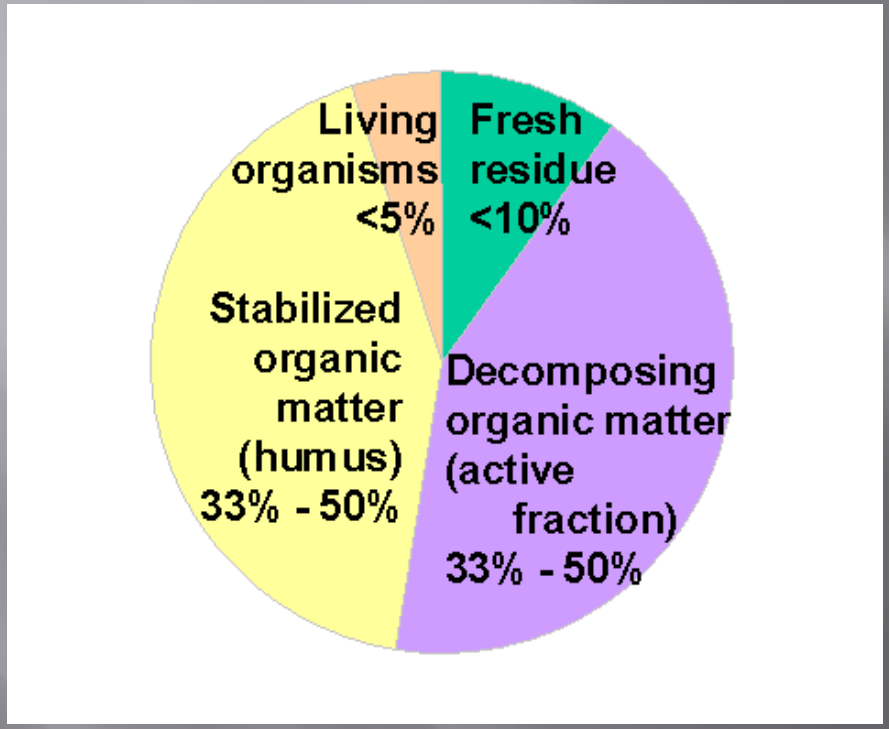
STRUCTURED CLAY LOAM NEERIM JUNCTION

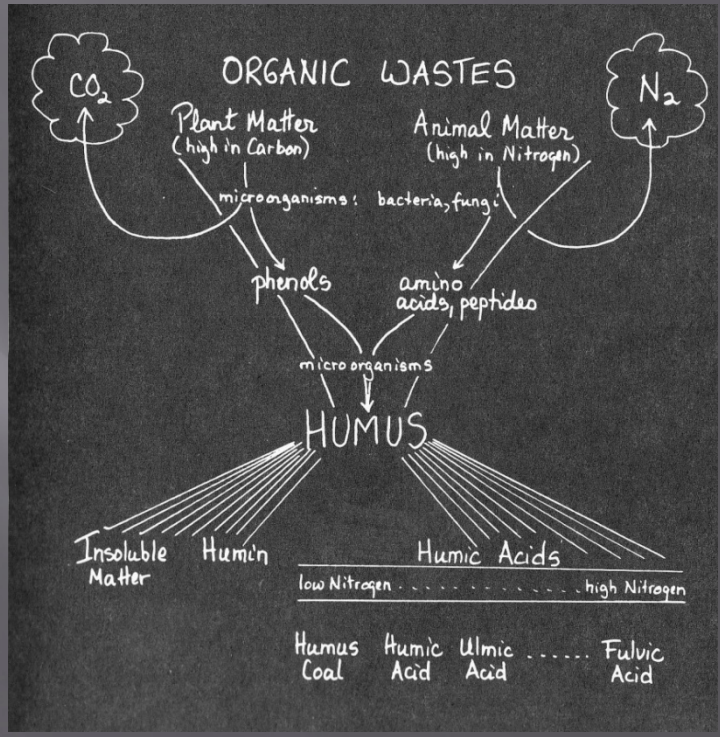
Organic Matter

Soil organic matter comprises all the living, dead and decomposing plants, animals and microbes in the soil along with the organic residues and humic substances they release.



Organic Matter



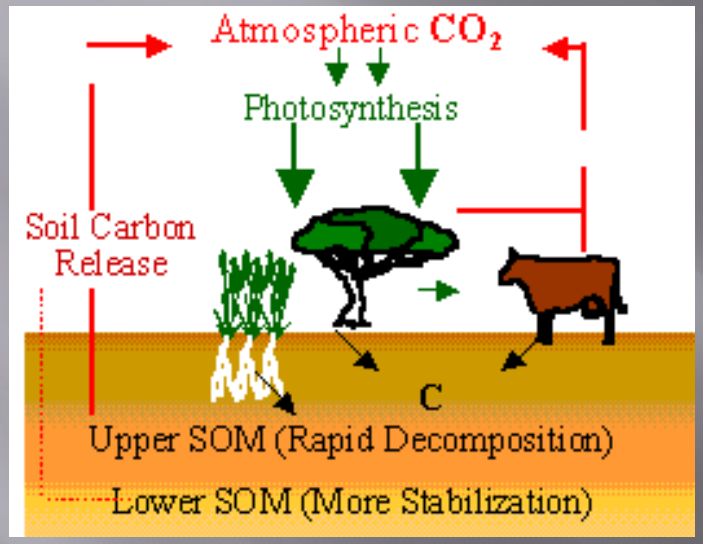


The Greenhouse House Gas Mitigation Potential of Soils

- Terrestrial biosphere sequesters 2 billion tonnes of carbon annually
- Soils contain 82% of terrestrial carbon
- Enhancing natural processes are the most cost effective means of reducing CO_2 levels
- Soil organic carbon largest reservoir in contact with the atmosphere
- A hectare of pasture sequesters more carbon than a hectare of forest
- Soil is the largest carbon sink over which we have control

Coutesy Carbon Coalition- https://soilcarboncoalition.org/

Soil Carbon Sequestration (Storage)



Soil carbon stored in soil resulting from:

- Decomposition of plant/tree roots
- Organic wastes
- Green manure crops, composts
- Soil carbon additions

Carbon Concentrations in Soils

Observations of the world's ecosystems show that organic carbon concentrations in soils (to a depth of one metre) under various land uses were:

- 122.7 tonnes per hectare for tropical forests,
- 117.3 tonnes for tropical savannas,
- 96.2 tonnes for temperate forests,
- just 80 tonnes for croplands,
- 236 tonnes for temperate grasslands.

Watson RT, Noble IR, Bolin B, Ravindranath NH, Verardo DJ and Dokken DJ (2000) *Land Use, Land-use Change, and Forestry: A Special Report of the IPCC,* Cambridge University Press, Cambridge , USA.

Some Benefits of Contributing to Carbon Sequestration Include the Following

- Improved soil health
- Increased soil fertility, boosting productivity
- Better water usage, reduced erosion, silting
- Reduced danger of rising salt levels, lowering water table
- Increased ground cover, reduced loss of topsoil
- Increased farm incomes
- Potentially increased farm values

The Potential of Soil Carbon Storage

Soils contain 82% of terrestrial carbon

Regenerative Agriculture

Regenerative agriculture has been practiced across **Australia** for many years. It is a holistic approach to land management that keeps water in the landscape, improve soil health, stores carbon and increases biodiversity.

Niels Olsen illustrating plant root growth in Soilkee pastures

Soil Cores before and after Soilkee cultivation

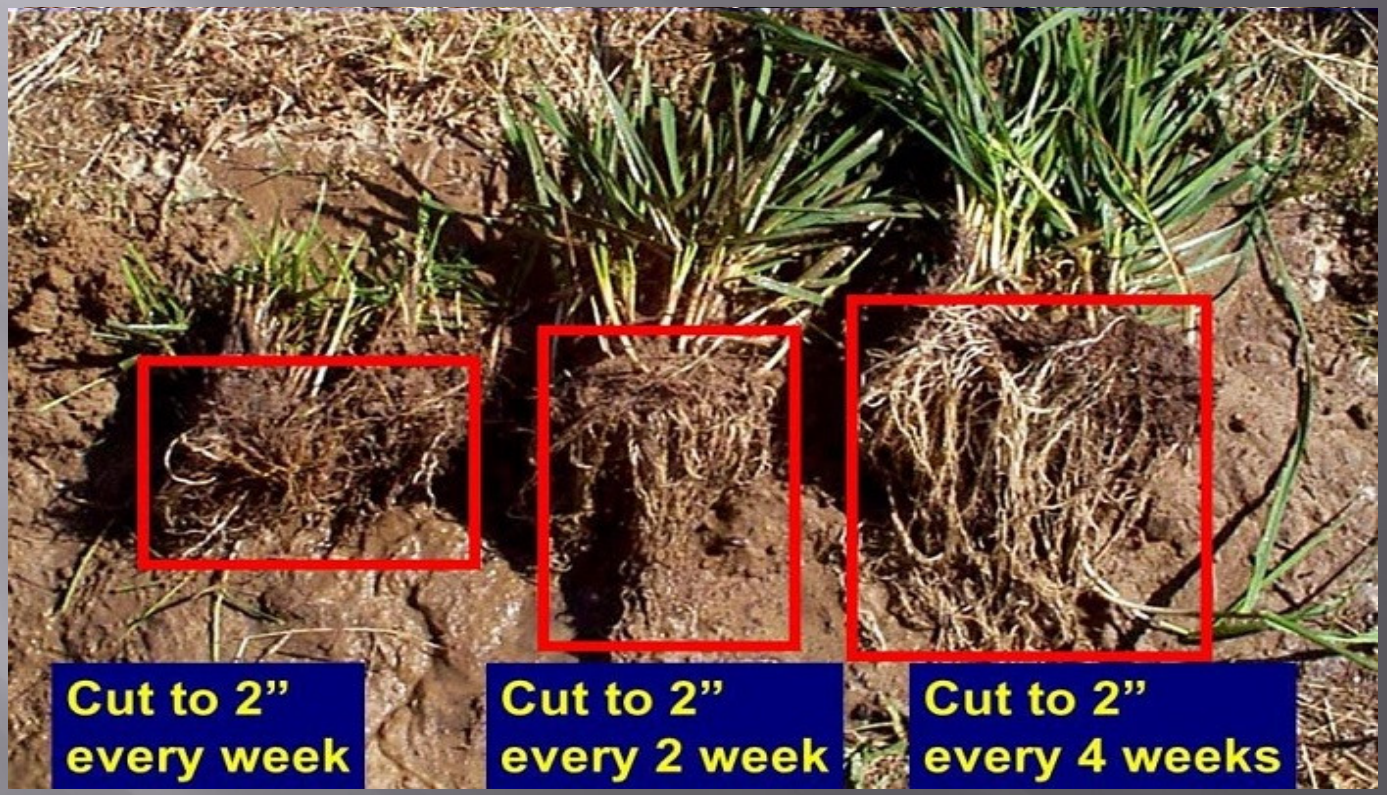
Pastures and carbon Storage

The Sequestering Potential of Perennial Pasture Given Thoughtful Rotations

Organic Matter & Root Mass

The total *length* of root tissues in a single *rye plant* is around 612 kilometres!

Effect of grazing on root growth



“the use of deeper rooted plant systems was shown to be an effective adaptation to mitigate some of the effect of lower rainfall”
(Crop & Pasture Science, 2009, 60 (10). pp. 933-942).

Organic Matter (carbon) Adjustment

Pastures

- Animal manures/plant root mass
- Stock rotations

In Situ

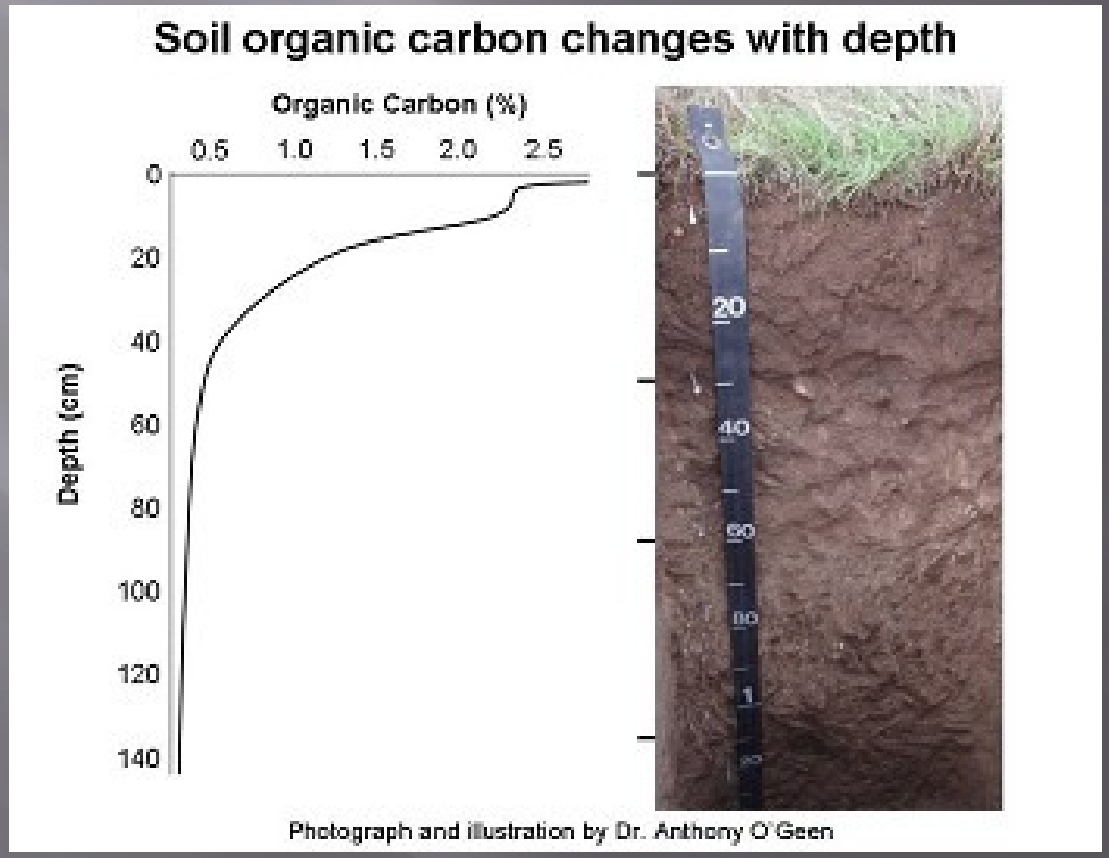
- Green manure/cover crops
- Crop residues/root mass
- No till/conservation cropping

Waste products

- Composted animal/poultry manures
- Industry/garden waste, grape marc, brown coal, humic materials

Carbon in the Soil Profile

Surface organic matter (carbon) is involved in nutrient cycling whereas carbon stored at deeper levels is longer lived.



Carbon Research- Dr Christine Jones

Two soil profiles 10 metres apart:

Carbon levels 0-10cm similar

Carbon levels below 30cm much greater in left profile

33t of CO_2 per ha

Are Agricultural Soils the Answer?

- **Capacity:** Soil organic matter is the largest reservoir interacting with the atmosphere
- **Cost effective:** Enhancing the natural processes that remove CO_2 from the atmosphere is thought to be the most cost effective means of reducing atmospheric levels of CO_2
- **Available:** Grazing land comprises 2/3 of the total land surface- some 5 billion ha

The Simple Maths Behind Soil Carbon

- One ha = 10,000m^2
- Soil 33cm deep (1 foot) approx.
- Bulk density = 1.4 tonnes per m^3
- Soil mass per ha = approx 4,600 tonnes
- 1% change in soil carbon = 46 tonnes
- A 1%increase in soil carbon will capture 168.8t of atmospheric CO_2 equivalents

Handy carbon calculations

- **One tonne carbon = 3.67 t carbon dioxide (CO_2) equivalent**
- Tonnes carbon per ha = % soil organic carbon × soil bulk density × sampling depth (cm)
- % Soil organic matter = 1.72 × % soil organic carbon
- In terms of global warming potential, 1 unit of nitrous oxide (N_2O) is equivalent to 310 units of CO_2, and 1 unit of methane (CH_4) is equal to 23 units of CO_2

Soil Carbon Sequestration

Agriculture, Ecosystems & Environment Journal study:

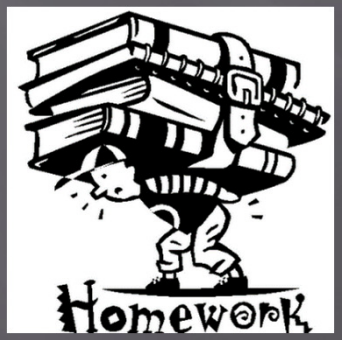
- 24 comparison trials from Mediterranean Climates in Europe, the USA and Australia. Organic systems sequestered 3.56 tonnes of CO_2/ha/yr. (Aguilera et al., 2013)
- The Rodale FST manured organic plots sequestered 3.6 tonnes of CO_2/ha/yr.
- Sekem, Egypt, has sequestered 3.3 tonnes of CO_2 per hectare per year

Soil Carbon Sequestration

- **The Rodale Compost Utilization Trial** sequestered 8.2 tones of CO_2/ha/yr.
- **Soilkee Gippsland** sequestered 11.2 tonnes of CO_2e/ha/yr.

Please Carefully Consider

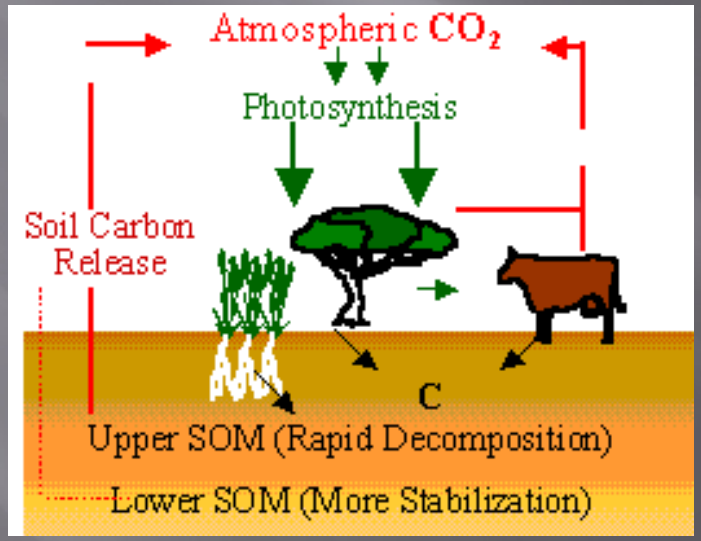
- Benchmarking and monitoring is the key if considering C trading.
- Ensure the science is well established and well founded.
- Don't underestimate the importance of your own observations
- Cultivation, overgrazing, drought and fire can reduce soil carbon levels in the soil
- "We need to make sure that the debate about how to mitigate climate change doesn't undermine efforts to build soil health for productivity, and water quality." Stephen Wood, soil scientist
- Never stop learning




THANK YOU!

Holistic Management – Carbon You Tube

- Holistic Management2_ manufacturing carbon in soil takes plac.flv



Importance of Organic Matter

- “ The role of organic matter can be summarised in this way. It is necessary as food for the bacteria, fungi, and earthworms. The bacteria, fungi and earthworms are essential, for building soil structure. **The chief cause of soil decline** is the loss of organic matter”.
- US Soil Conservation Service, 1938

Biodiversity in the Strzelecki's