THE OHIO STATE UNIVERSITY

Soil Management for Healthy Food and Environment

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THE WHEEL OF LIFE

"Life on the earth depends directly on the balance between producers (crops which have the ability to fix solar energy), consumers (people and animals), and decomposers (the unknown or little-investigated world of soil life)."

"The health of soil , plants, animals and people is one and indivisible.

–Sir Albert Howard (1947)

THE SOIL-LIFE NEXUS

Essentially all life depends upon the soil---There can be no life without soil and no soil without life;they have evolved together (Charles E.Kellogg,USDA)

Rhizosphere may be the only site in the universe where the death is transformed into life

SOIL HEALTH

Soil's capacity, as a dynamic and biologically active entity, within natural and managed landscapes, to sustain multiple ecosystems services including net primary productivity, food and nutritional security, biodiversity, water purification and renewability, carbon sequestration, air quality and atmospheric chemistry and elemental cycling for human wellbeing and nature conservancy.

Lal (2016)

MEETING FOOD DEMAND BY 2050

The world produces enough food to feed 10 billion people . Th and nutritional security must be achieved by:

- **Reducing** waste (30-50%),
- **Increasing** access to food by addressi political instability,
- **Improving** distribution,
- **Increasing** use o et, and alternate source of protein,
- **Ac** ity of not taking things for granted, and

productivity from existing land, restoring degraded BNF by legumes and converting some agricultural land onservancy without any conversion of natural land to agro-stems, through **sustainable eco-intensification and restoration of soil health.**

We must reconcile the need of advancing food and nutritional security with the necessity of improving the environment.

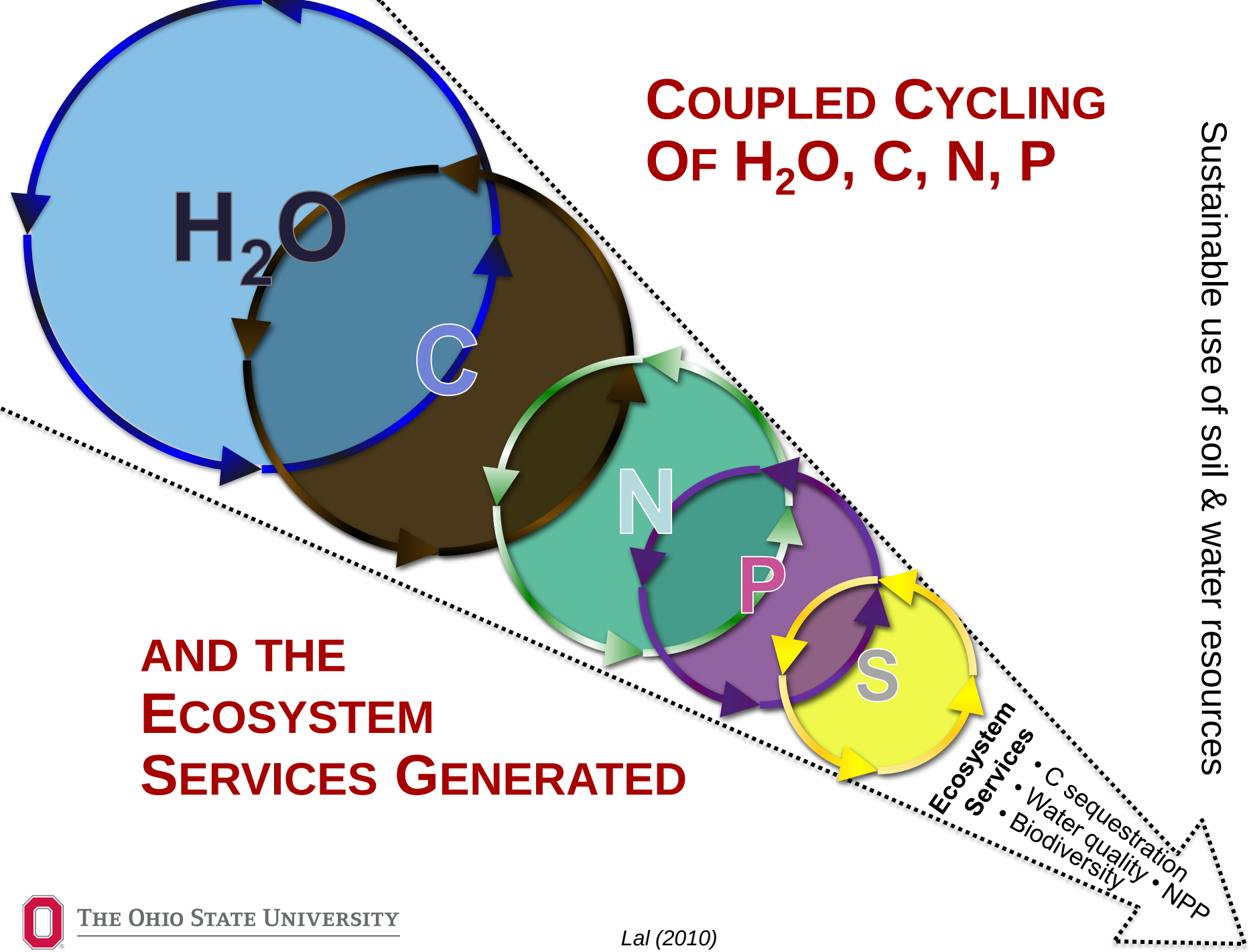
SUSTAINABLE INTENSIFICATION

The strategy is to produce more food:

Produce more from less

- from less land,
- per drop of water,
- per unit input of fertilizers and pesticides,
- per unit of energy, and
- per unit of C emission.

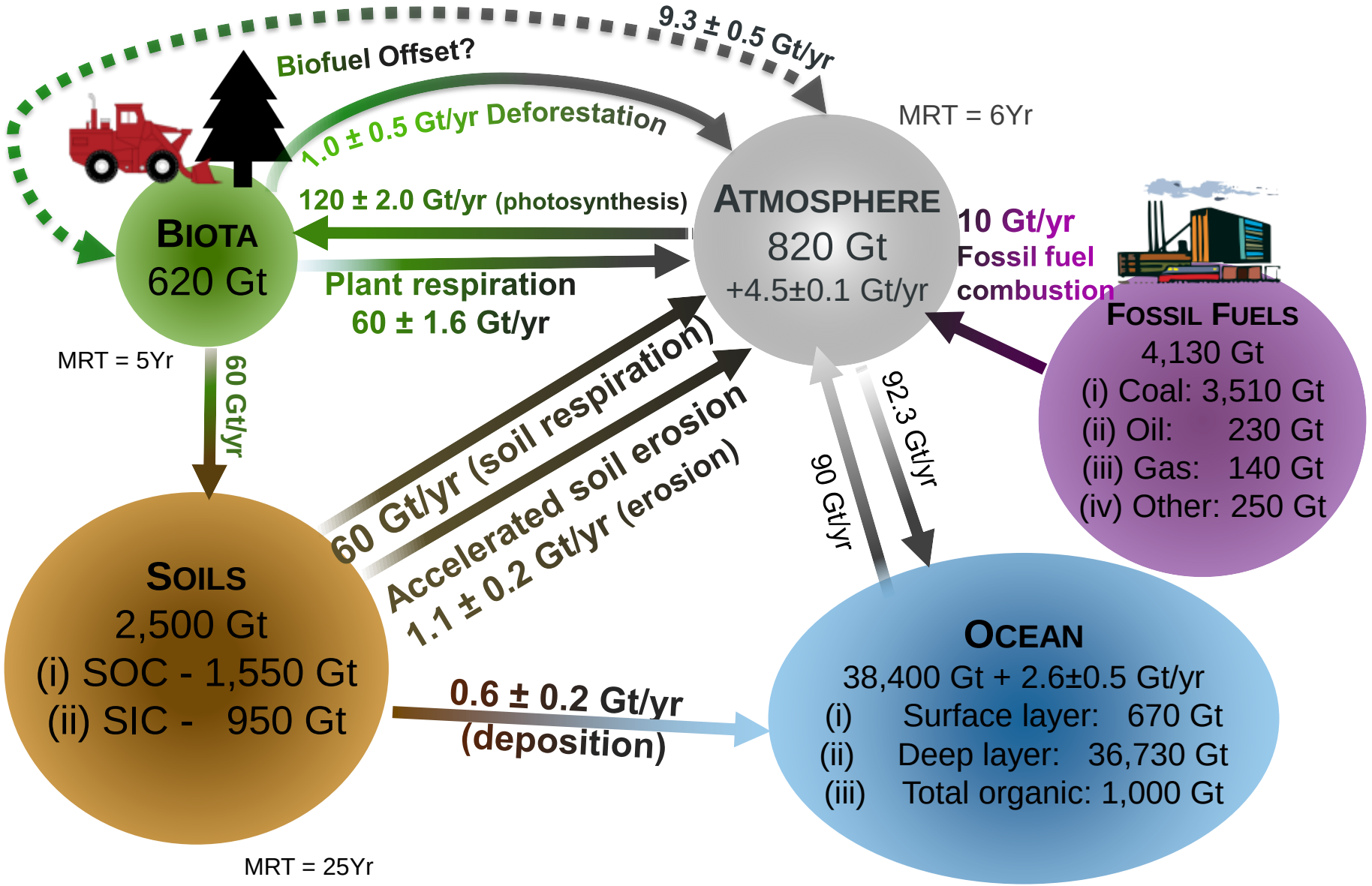
Coupled Cycling Of H_2O, C, N, P



And the Ecosystem Services Generated

Lal (2010)

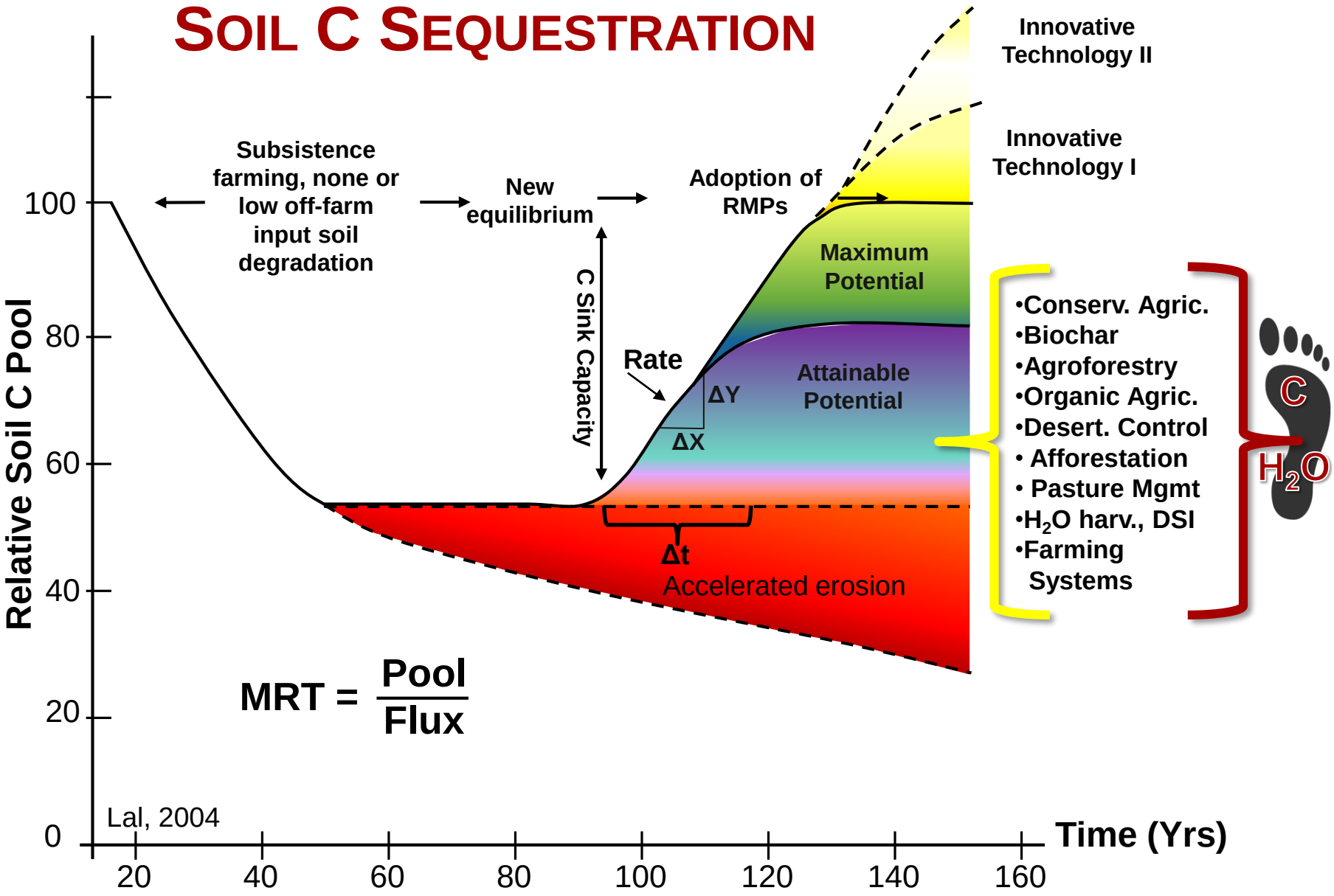
The Short-Term Global Carbon Cycle



SOIL ORGANIC CARBON SEQUESTRATION

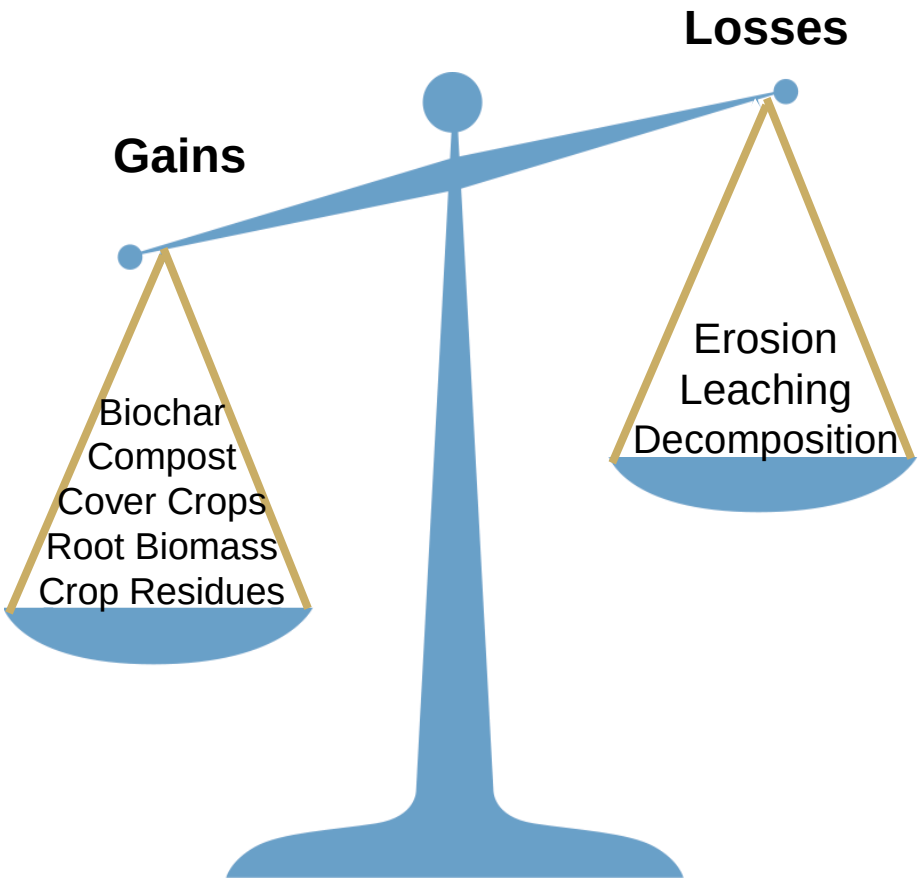
It is the process of transferring CO_2 from the atmosphere **into the soil of a land unit** plants, plant residues and other organic solids which are ***stored or retained in the unit as a part of the soil organic matter*** **with a long mean residence time.**

SOIL C SEQUESTRATION

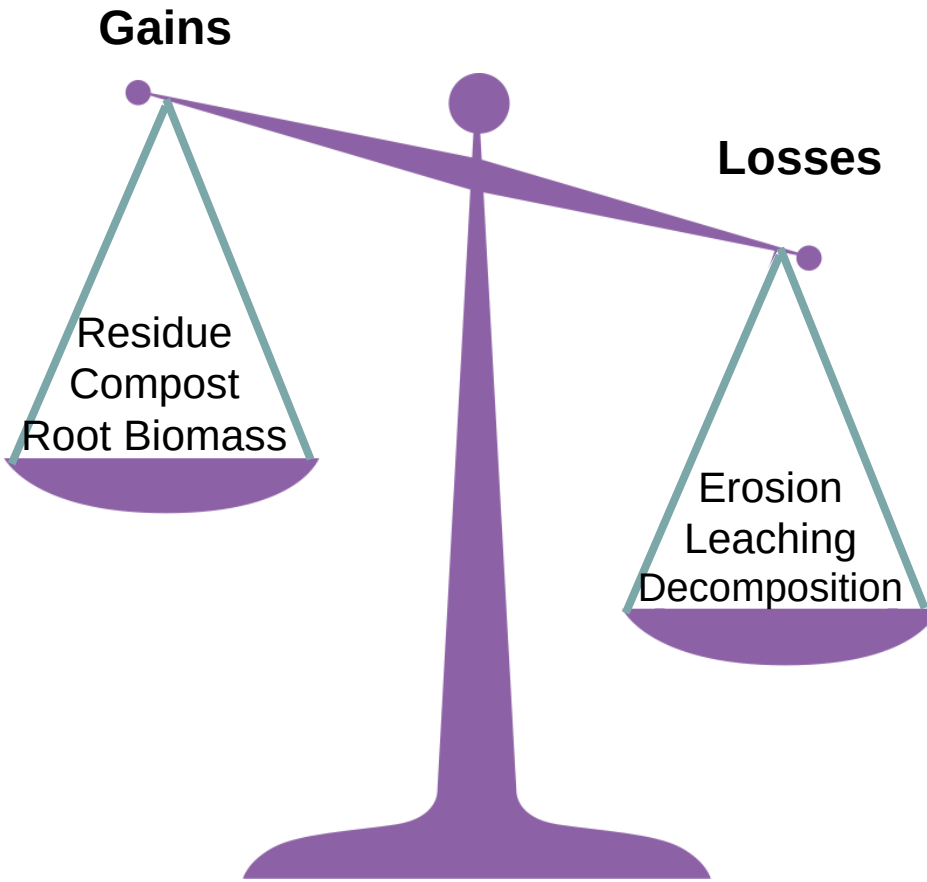


$$\text{MRT} = \frac{\text{Pool}}{\text{Flux}}$$

CREATING POSITIVE C BUDGET

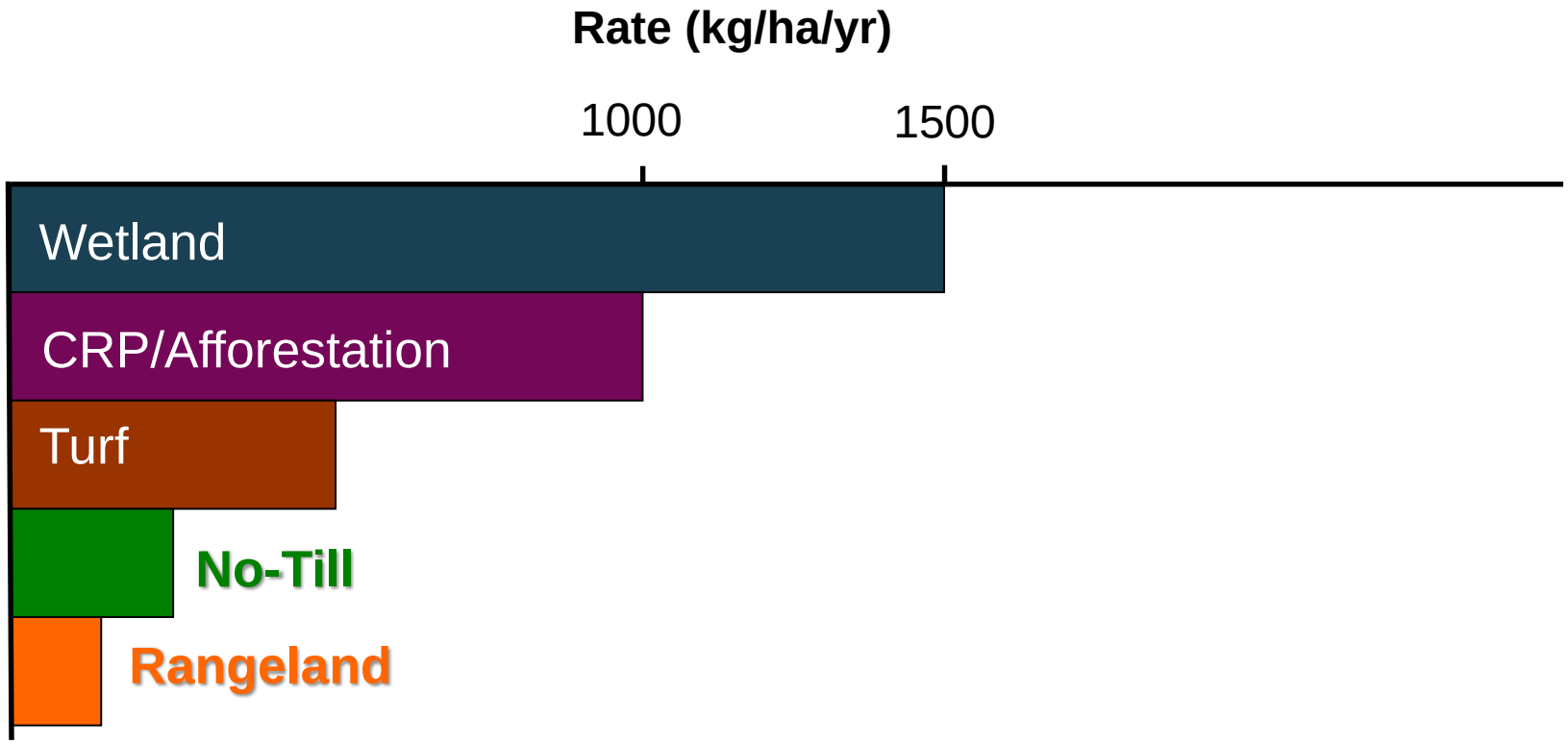


Soil Carbon Sequestration



Soil Carbon Depletion

RATE OF CARBON SEQUESTRATION



DROUGHT OF 2012

Corn with no residue.

Corn with 100% residue

NUTRIENTS REQUIRED TO CONVERT BIOMASS INTO HUMUS

Crop Residues

Biochemical Transformations

+ (N, P, S etc.)

Humus

Elemental Ratio	Cereal Residues	Humus
C:N	100	12
C:P	200	50
C:S	500	70

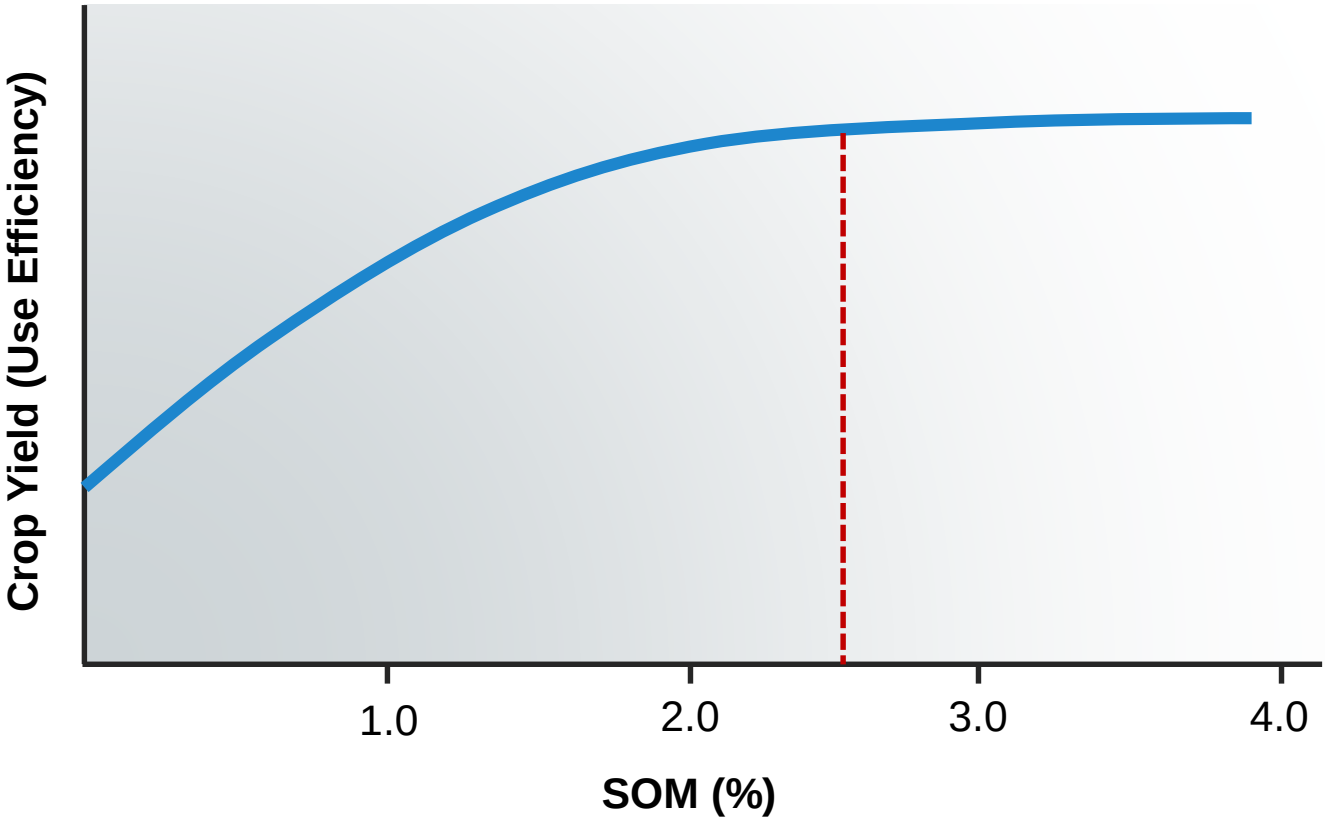
SOCIETAL VALUE OF SOC

- Cost of Residue + Nutrients: **$120/ MgC**
- Cost of Nutrients Only : **$102/ MgC**

Payments for Ecosystem Services at $40 / ha. yr

THRESHOLD LEVEL OF SOIL ORGANIC MATTER IN 0-30CM LAYER

SOM : 2.5 - 3.5%
SOC : 1.5 - 2.0%



CROP YIELD INCREASE WITH INCREASE IN SOC BY 1 MgC/ha

Crop	Yield Increase (Kg/Ha•MgC)
Maize	100 - 300
Soybeans	20 - 50
Wheat	20 - 70
Rice	10 - 50
Sorghum	80 - 140
Millet	30 - 70
Beans	30 - 60

30-50 million tons/yr in developing countries

Lal (2005)

REDUCING LAND AREA UNDER CEREALS IN THE 21ST CENTURY SAVING LAND FOR NATURE CONSERVANCY

Parameter	Year 2005–07	2050	2080	2100
Population	6.4	9.7	10.6	11.2
Per capita food consumption (kcal)	2772	3070	3200	3300
Cereal production (10^6 Mg)	2012	3012	3350	3540
Land area needed for intensive agriculture (Mha)	613	600	560	500
N fertilizer use (10^6 Mg)	200	160	120	100
The desired global average cereal yield (kg ha^{-1})	3280	5000	6000	7000

"Use the best, save the rest"

Lal (2016)

SECURITIZATION OF FOOD AND THE ENVIRONMENT THROUGH SOIL SUSTAINABILITY

Security → Political → Economic → Social → Environmental

- Human (Gender)
- Societal (Ethnic)
- National
- Regional
- International
- Global

SOILS AND ECOSYSTEM SERVICES