

# **SOC sequestration boosts both food security & mitigates climate change in Sub-Saharan Africa**

**Soil carbon sequestration and food security in  
Sub-Saharan Africa: Synergies and Tradeoffs  
24 March 2022**



**Lydie-Stella Koutika, PhD**

- CRDPI's Director, Pointe-Noire, Congo
- STC's member '4p1000 Initiative Soils for Food Security & Climate'
- FAO Glinka World Soil Prize 2021's Laureate

# Outline

---

**1. Background**

**2. Link among SOC sequestration, food security, and climate change mitigation**

**3. Weaknesses and strengths**

**4. Conclusions & Perspectives**

# 1. Background

**Africa:** The 2<sup>nd</sup> largest and most populous continent after **Asia**

Continents	Size (km <sup>2</sup> )	Population	World's population	Growth rate	Density (km <sup>2</sup> )
<b>Africa</b>	<b>30,065,000</b>	<b>1,406,722,629</b>	<b>17.69%</b>	<b>2.42%</b>	<b>46.40</b>
<b>Asia</b>	<b>44,579,000</b>	<b>4,715,932,231</b>	<b>59.29%</b>	<b>0.80%</b>	<b>146.74</b>

Source: <https://worldpopulationreview.com/continents>

# 1. Background

The current '**Hunger Map**' estimates that **957 million people** worldwide do not have enough to eat on a regular basis (*UN World Food Programme*)

**Twenty-two out of 30** most affected countries by hunger and malnutrition are in **Africa** (*Global Hunger Index 2021*)

<https://www.statista.com/statistics/269924/countries-most-affected-by-hunger-in-the-world-according-to-world-hunger-index/>

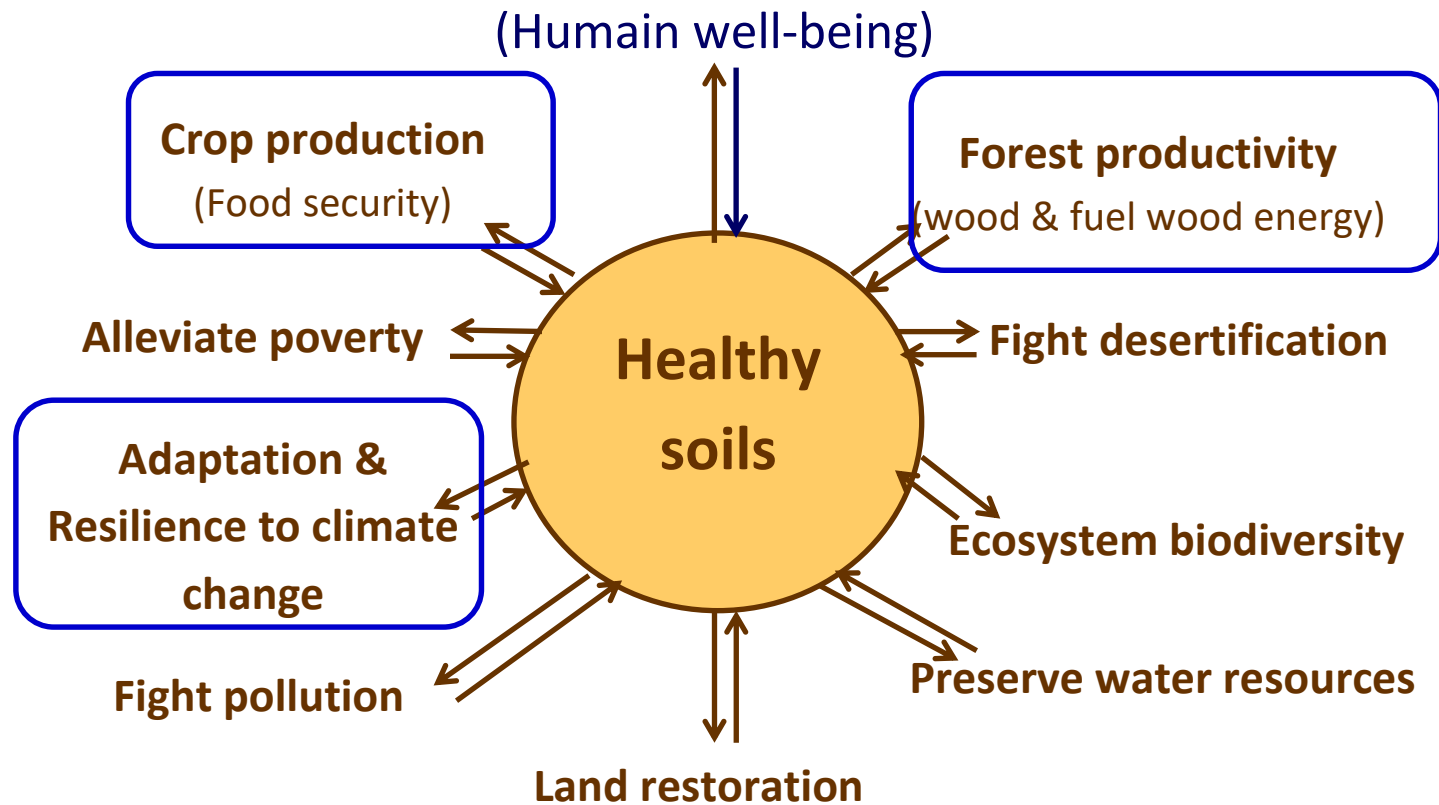


**Food security** cannot be dissociated from **climate change** and its effects on **soil, environment** & overall **human well-being**

**C sequestration** (healthy soils): one of the solutions to simultaneously **mitigate** both **climate change** and **secure food availability** 4

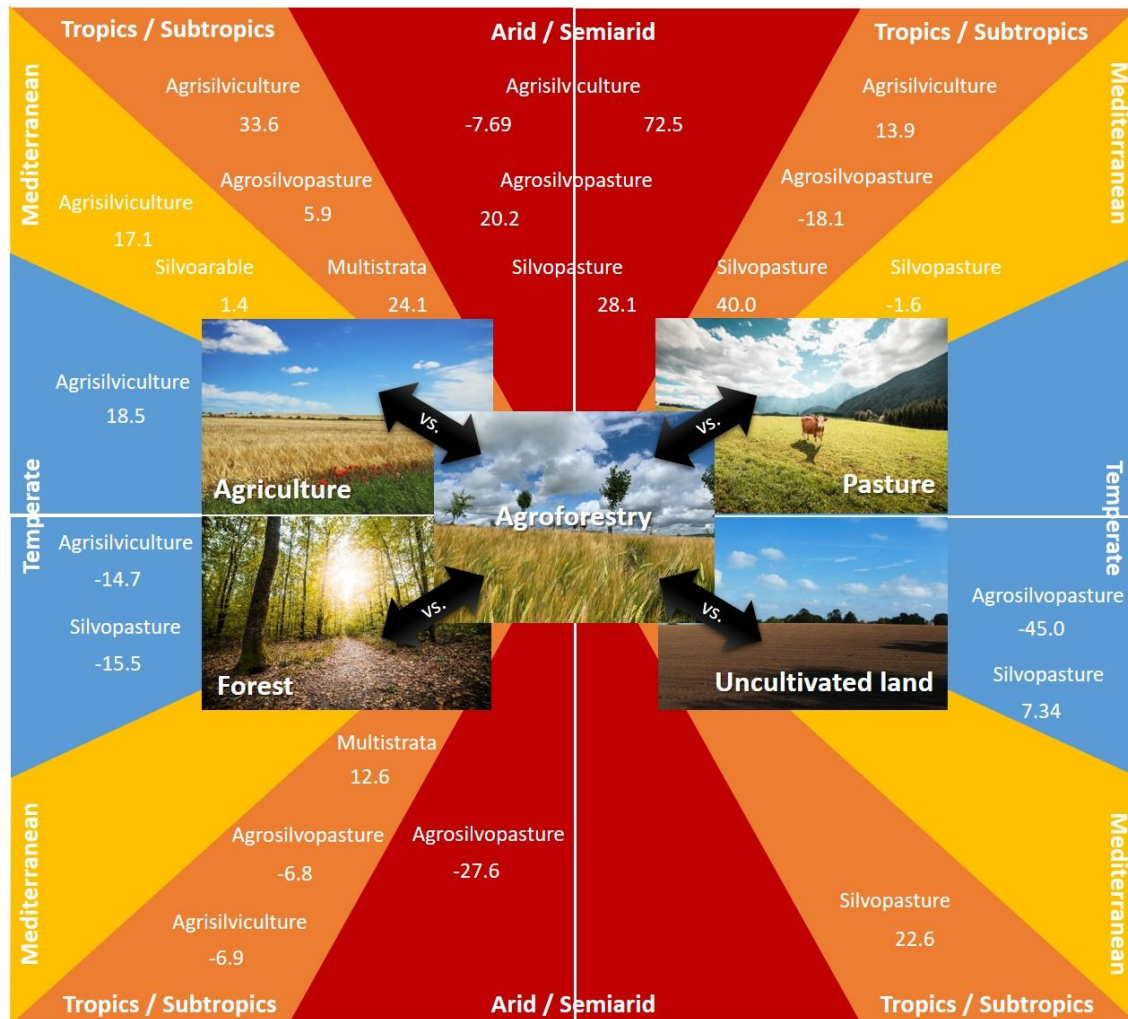
## 2. Link among SOC sequestration, food security, and climate change mitigation

### SOC sequestration, healthy soils & co-benefits Societies



# 2.1. Agroforestry systems and their potential to sequester C sequestration

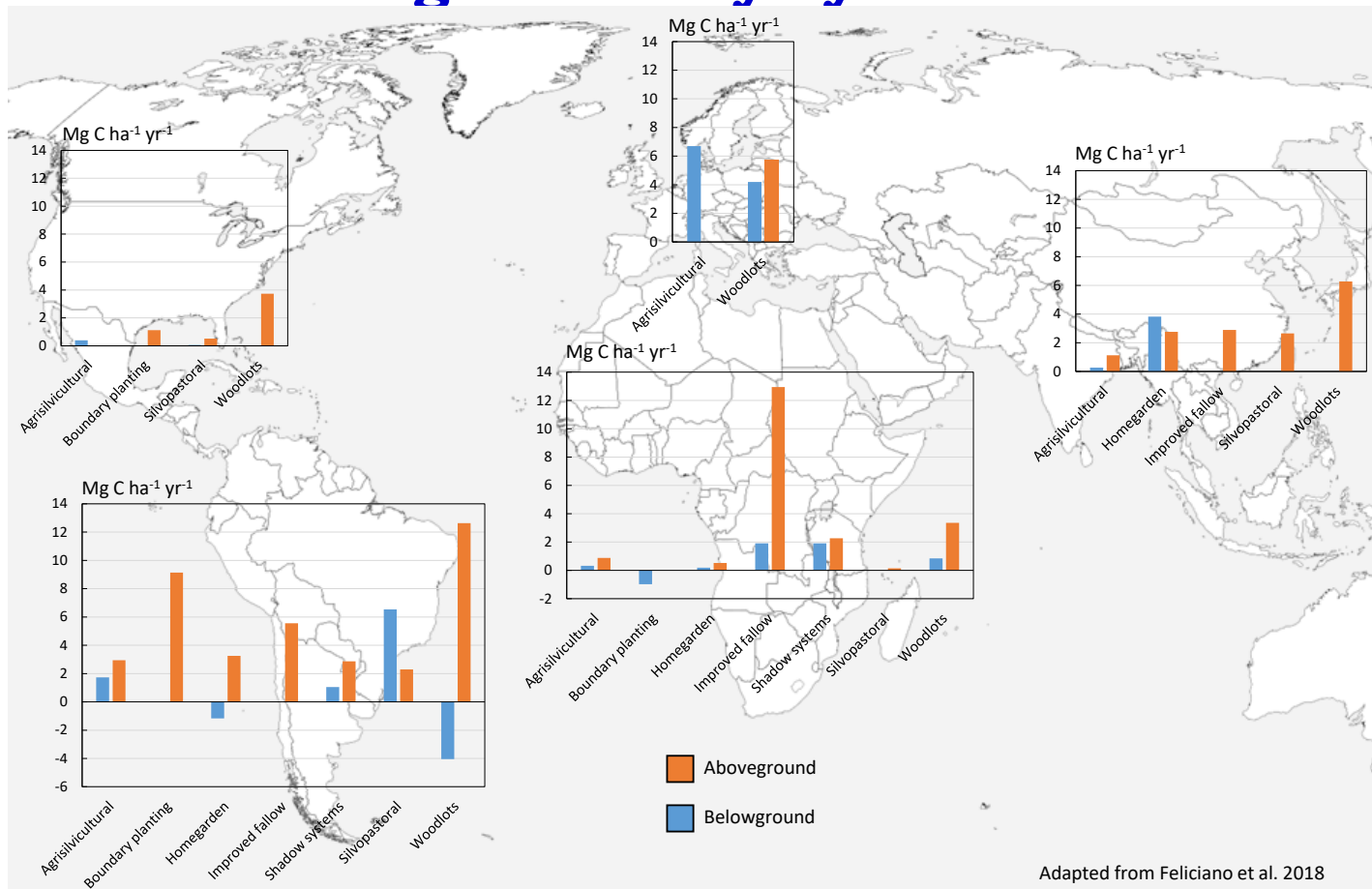
## SOC sequestration in agroforestry systems



Percentages of variation in SOC stocks (to 40 cm in depth) when AFSs are compared to agriculture, pasture, forest or uncultivated land in different agro-ecological regions, according to the meta-analysis by Chatterjee et al. (2018). Positive values indicate higher SOC stocks under AFS. Adapted from *Koutika et al. 2021a*.

# 2.1. Agroforestry systems and their potential to sequester C

## C sequestration in above and below ground in agroforestry systems



Adapted from Feliciano et al. 2018

Mean above- and below-ground biomass C sequestration (Mg C ha<sup>-1</sup> yr<sup>-1</sup>) by AFS type and world region according to the meta-analysis by Feliciano et al. (2018). Adapted from Koutika et al. 2021a.

## 2.2. Benefits of afforestation & introducing N<sub>2</sub> fixing trees in forest plantations

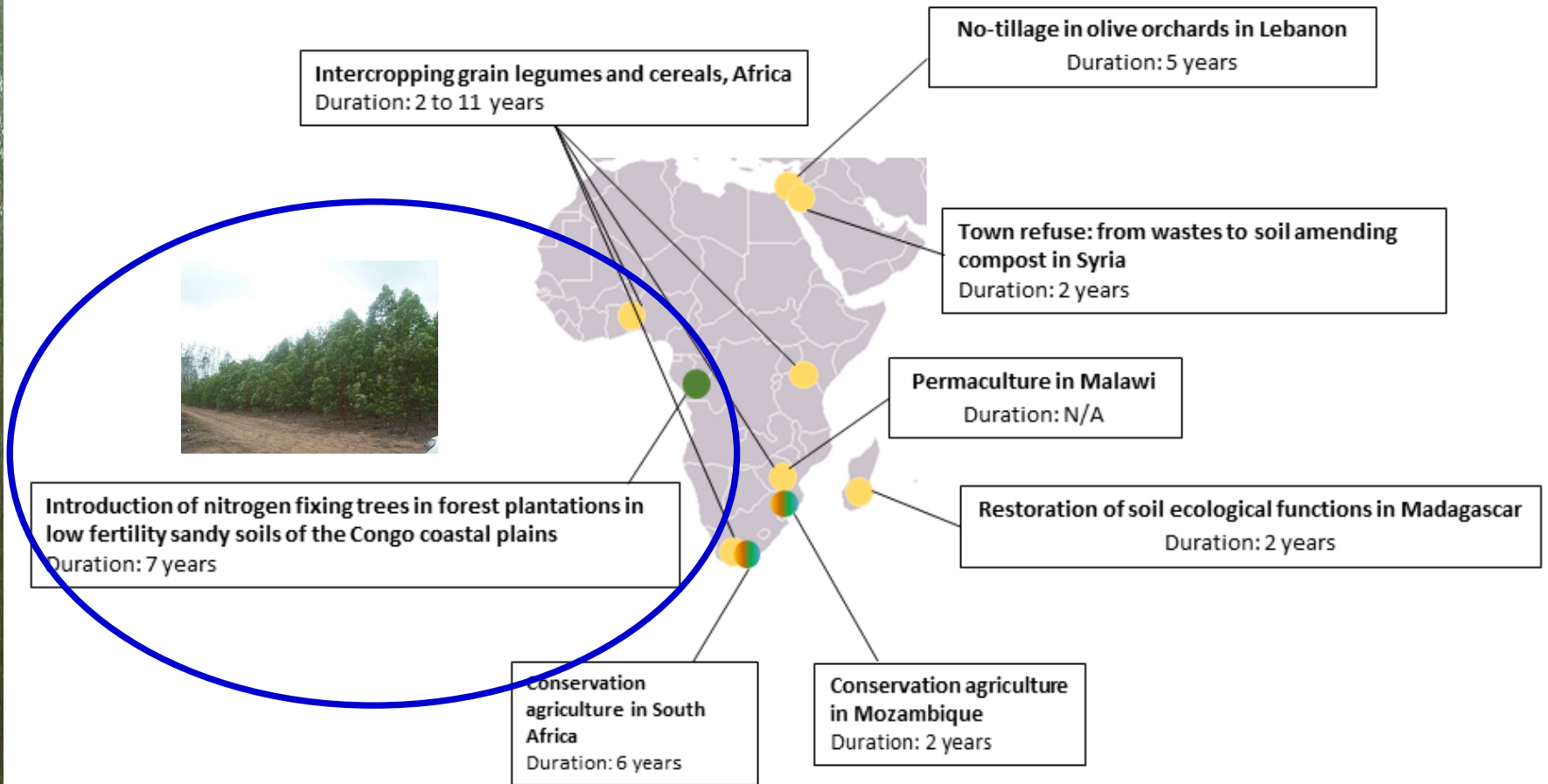
### High C storage in stands containing N<sub>2</sub>-fixing trees

Baseline C stock (tC per ha)	Additional C storage potential (tC per ha)	Treatment
15.9 (eucalyptus plantation)	0.8	Acacia plantation
	1.9	Acacia and Eucalyptus plantations

(Koutika, 2021)



## 2.2. Benefits of afforestation & introducing N<sub>2</sub> fixing trees in forest plantations



## 2.2. Benefits of afforestation & introducing N<sub>2</sub> fixing trees in forest plantations

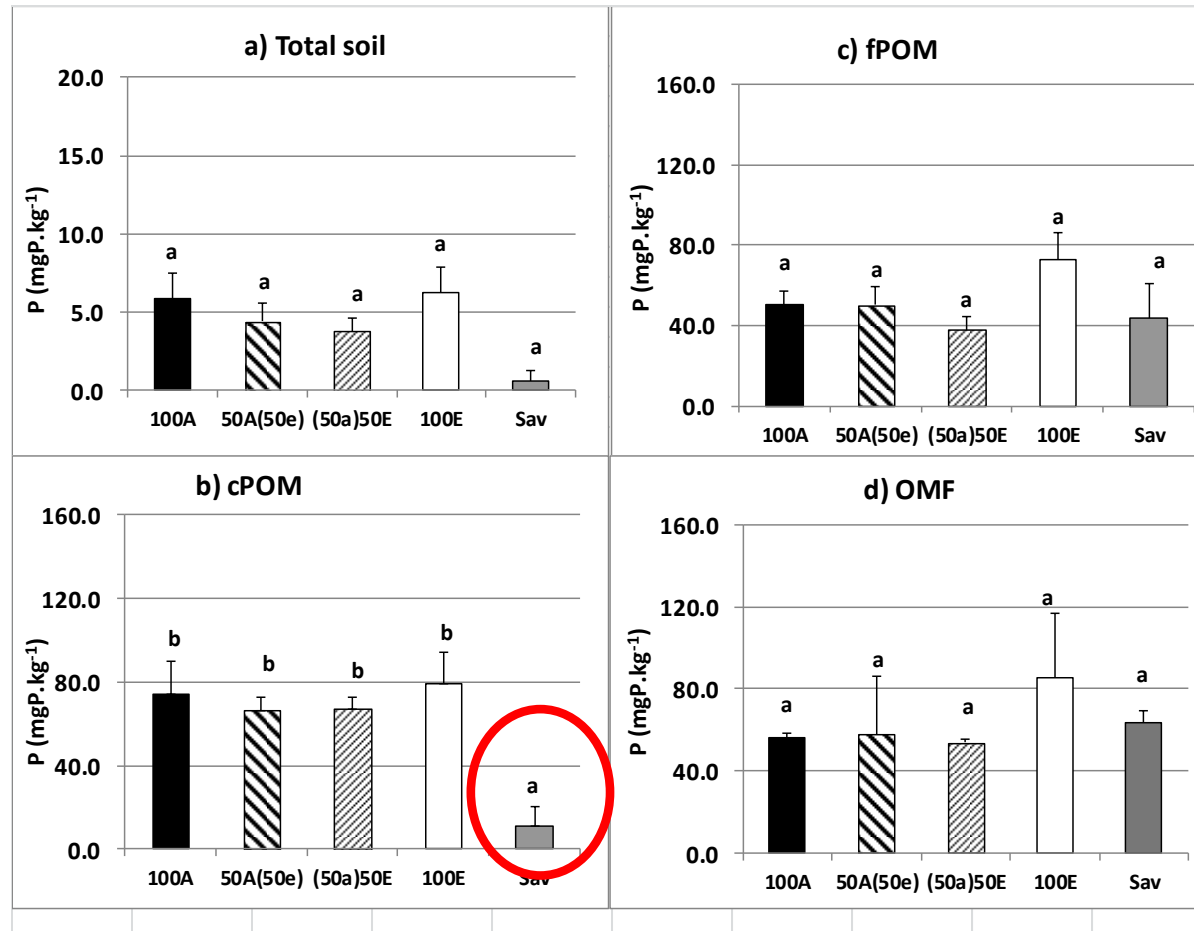
### Improvement in N status in stands containing N<sub>2</sub>-fixing trees

Pure acacia (tC per ha)	Acacia and eucalyptus (50:50) (tC per ha)	Eucalyptus (tC per ha)
1.25 ±0.02ab	1.28 ±0.03a	1.09 ±0.02b

*(Koutika et al. 2014; Tchichelle et al. 2017)*

## 2.2. Benefits of afforestation & introducing N<sub>2</sub> fixing trees in forest plantations

Higher phosphorus availability in afforested stands relative to savannas



*(Koutika and Mareschal 2017)*

## 2.2. Benefits of afforestation & introducing N<sub>2</sub> fixing trees in forest plantations



### 1st rotation (End 7 yrs):

↪ **Increase in stand wood biomass** in mixed-species (50A50E) stands (*Epron et al. 2013*).

↪ **N & C accretion** in mixed-species stands (*Koutika et al. 2014, 2017; Tchichelle et al. 2017*).

↪ **Decrease in available P** in stands containing *acacia* (*Koutika et al. 2014, 2016*).

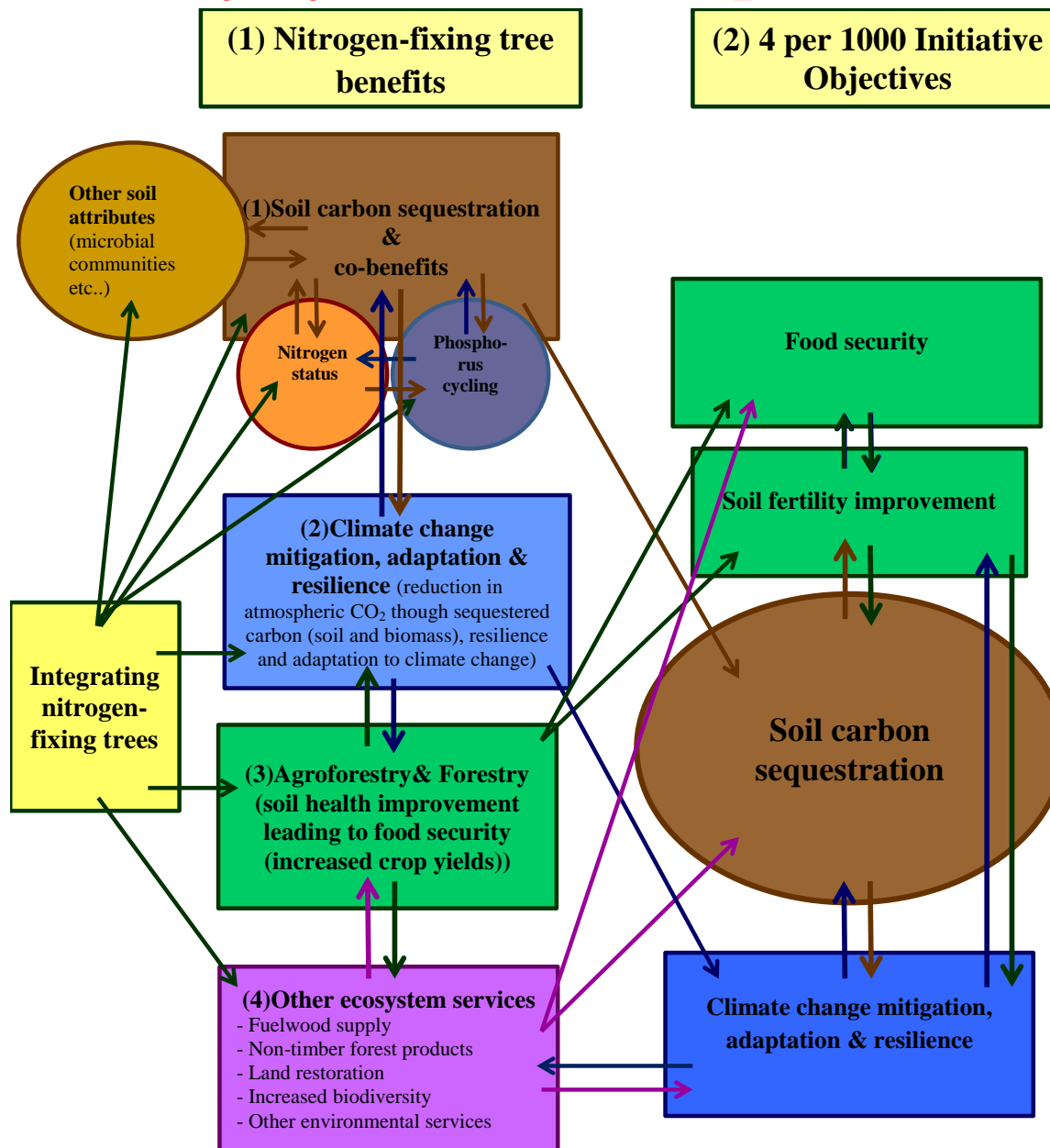
### 5 yrs into 2nd rotation:

↪ **Decline in SOM quality** (decreased N & C concentration in POM fractions) (*Koutika et al. 2019*).

↪ **Prevention of P losses via leaching** i.e., sustaining P demand in medium term (**high immobilized organic P forms**) in mixed-species stands (*Koutika et al. 2020a*).

↪ **Shift in bacterial community** (*Koutika et al. 2020b*).

## 2.3. How research in forestry may benefit to both agroforestry systems and 4 per 1000 Initiative objectives



**Conceptual diagram showing (1) N-fixing tree (NFT) benefits and links to (2) the '4 per 1000' Initiative objectives:** how introducing NFTs in agroforestry and forestry leads to C sequestration and co-benefits in other ecosystem services, and promotes the '4 per 1000' Initiative in the Congo Basin (DR Congo and Rep. Congo).  
*Adapted from Koutika et al. 2021b.*

### 3. Weaknesses and strengths

#### Weaknesses

**Low adoption** of practices leading to **sequester SOC** and secure crop production (**food security**) and **mitigate climate change** in many parts of Africa.

**Low promotion of appropriate practices** in specific ecosystems i.e., **coastal regions, deserts and semideserts, mountains, savanna grasslands, and forests**. The resources aren't used well.

<https://geography.name/ecosystems/>

### 3. Weaknesses and strengths

#### Strengths

**Youngest world population** (70% of Sub-Saharan Africa are under the age of 30) & **highest growth rate (2.42%)**.  
(<https://www.un.org/ohrlls/news/young-people's-potential-key-africa's-sustainable-development>)

**Agroforestry** as a **win-win solution** in many part of the Sub-Saharan Africa, specificity of ecosystems must always be considered (*Mbow et al. 2014; Koutika et al. 2021*).

## 4. Conclusions & Perspectives

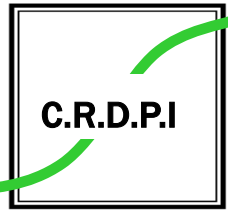
*Sustainable soil management through practices (such as agroforestry, forestry, organic residues management) leading to sequester C in different ecosystems of Africa is **CRUCIAL** to further secure food availability & mitigate climate change*

*It is vital to involve not only the youth (for it's the continent with the largest youth population) but the women as well (their rate is more than 50% in the agriculture).*

*Efforts must be made to promote appropriate practices in different Sub-Saharan African ecosystems to meet the **2030 Sustainable Agenda.***







**Thank you!**