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Plant Trees to Sequester Carbon in Soils

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Session 7, Workshop 7.1: „Adaptation Strategies I: Sustainable Use of Natural Resources“

Our Common Future, Essen, November 6th, 2010

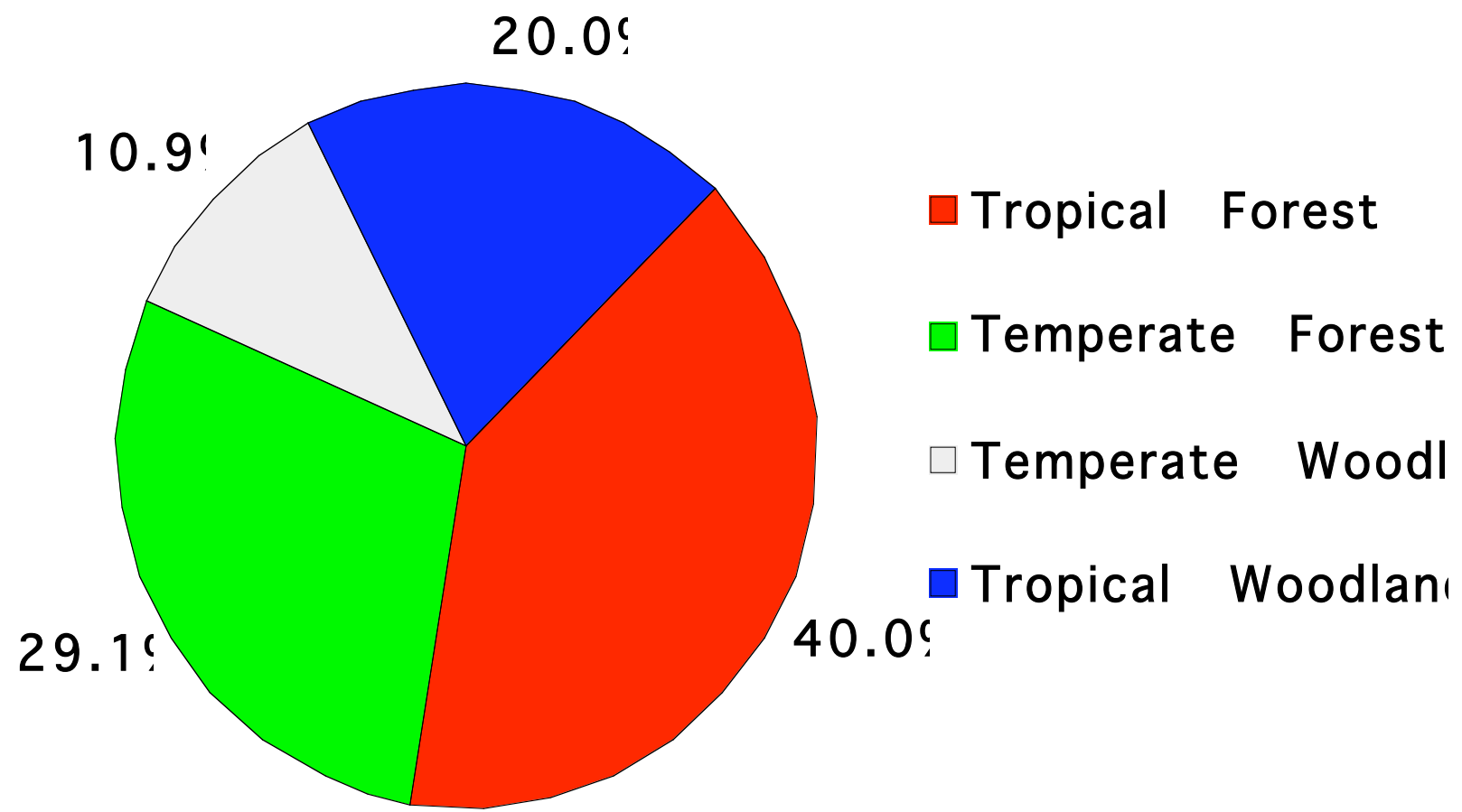
Our Common Future, Hannover/Essen, 2-6 November 2010 (www.ourcommonfuture.de)

Plant Trees to Sequester Carbon in Soils

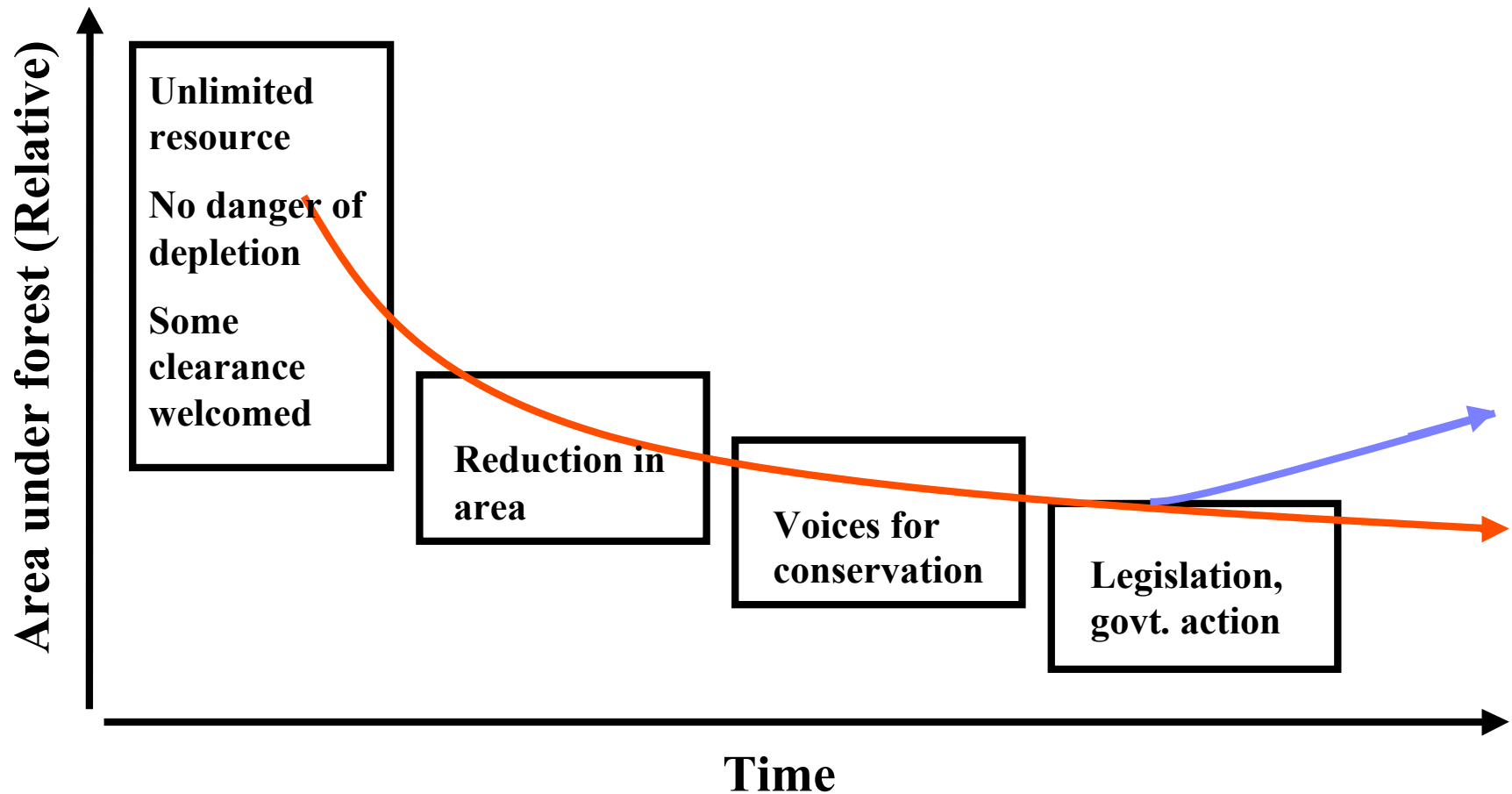
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Essen, Germany
November 2010

World Forest Distribution



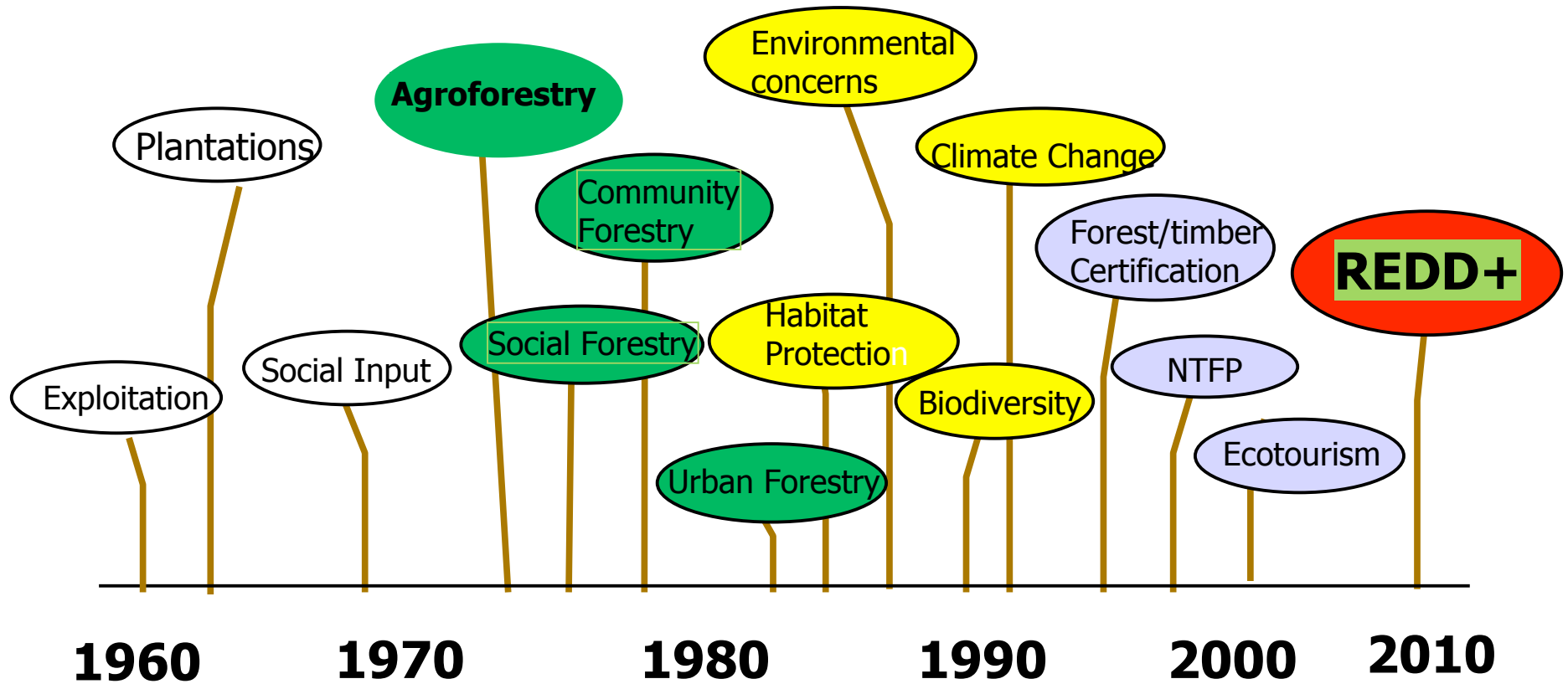
Pattern of Forest Utilization in Time



Deforestation

- Disturbance, conversion, or destruction
- Rates
 - 1850-1980: 15%, globally
 - Currently, tropical deforestation (15 million ha/yr; 1%) is a matter of great concern
- Direct causes
 - agricultural expansion, overgrazing, logging, fuelwood gathering, infrastructure development

Tropical Forestry: Issues, Concerns, Paradigms



AGROFORESTRY

*An interface between
agriculture and forestry*

... the purposeful growing of trees and crops and/or animals in interacting combinations for a variety of objectives (Nair, 1993).

Estimated to be practiced on over 1 billion ha of land by 1.5 billion farmers in the tropics (ICRAF, 2009).



Modern Agroforestry emerged in the tropics in the 1970s and 1980s as an approach to addressing the pressing land-management problems such as deforestation, land degradation, and food-, fodder-, and fuelwood shortages.



Agroforestry Practices in North America

Alley cropping



Trees planted in single or grouped rows with crops in the wide alleys between the tree rows



Forest farming

Producing specialty crops for medicinal, ornamental, or culinary uses in forested areas

Riparian buffer strips



Strips of perennial vegetation planted between croplands/pastures and streams, lakes, wetlands, etc.



Silvopasture

Combining trees with forage (pasture or hay) and livestock production

Windbreaks



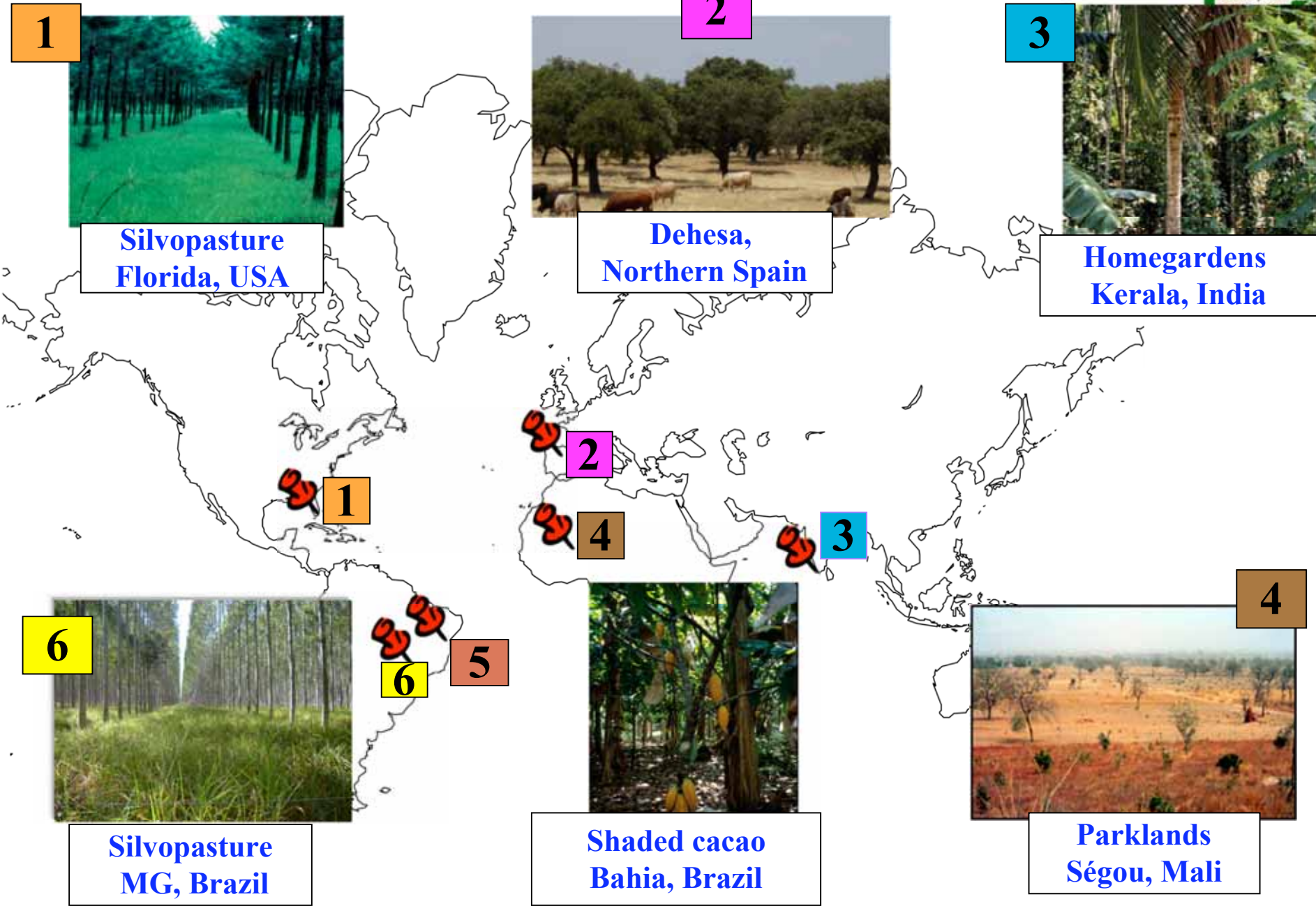
Row trees around farms and fields, managed as part of crop or livestock operation to protect crops, animals, and soil from wind hazards

Carbon Sequestration

The process of removing C from the atmosphere and depositing it in a reservoir.

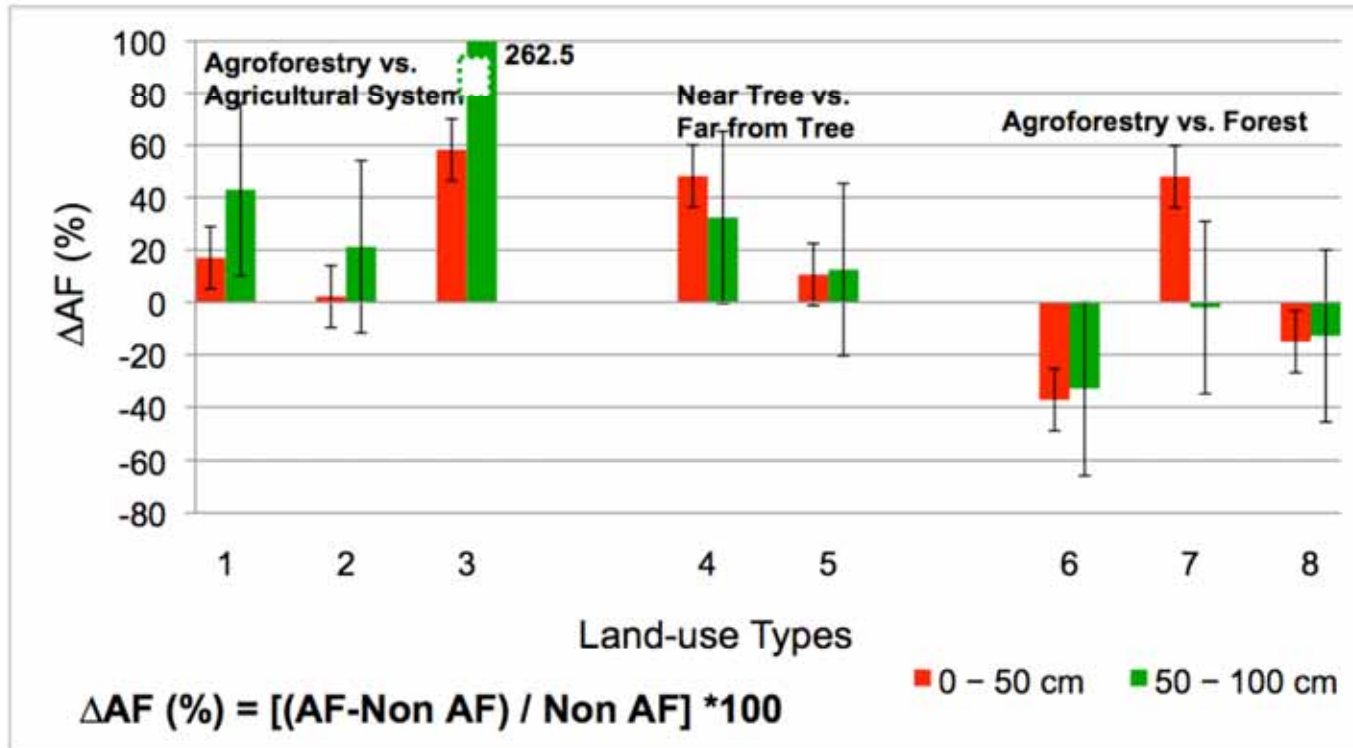
It entails the transfer of atmospheric C, especially CO₂, and its secure storage in long-lived pools.

(UNFCCC = UN Framework Convention on Climate change).



Locations of CSTAF (Univ of FL) Soil Carbon Sequestration Studies

| Sites | | | Agroforestry Systems |
|--|--|---------------------------|---|
| Location Coordinates | Climate (m.a.p; mean temp. range) | Soil | |
| Florida, USA 28° to 29° N; 81° to 83° W | Humid subtropical; 1330 mm; -3 to 28° C | Ultisols | Silvopasture: slash pine (<i>Pinus elliottii</i>) + bahiagrass (<i>Paspalum notatum</i>); 5–20 yr |
| Northern/ Central Spain 40 to 43° N; 6 to 7° W | Humid Atlantic/ subhumid Mediterranean; 1200/ 600 mm; 6-18°C/ 8-26°C | Alfisols | Dehesa oak silvopasture (<i>Quercus suber</i>); >50 yr |
| Kerala, India 10°32' N; 76°14'E | Humid tropical; 2700 mm; 27 to 32°C | Inceptisols | Homegardens: Intensive multispecies mixtures of trees, shrubs, and herbs in small (< 0.5 ha) holdings; > 35 yr |
| Ségou, Mali 13° 20' N; 6° 10' W | Semiarid tropical; 500 to 700 mm; 29 to 36°C | Alfisols | Parklands: Intercropping under scattered trees, > 30 yr old; and live fences and fodder banks, ~ 9 yr. |
| Bahia, Brazil 14° 0' S; 39° 2' W | Humid tropical; 1500 mm; 25 to 32°C | Reddish-yellow Oxisols | Cacao (<i>Theobroma cacao</i>) under thinned natural forest (<i>cabruca</i>) or planted shade trees; 30-yr old. |
| Minas Gerais, Brazil 17° 36' S; 46° 42' W | Cerrado: Subhumid tropical; 1350 mm; 22°C | Oxisols | Silvopasture: <i>Eucalyptus</i> spp. with understory of <i>Brachiaria</i> spp (fodder grass) or rice (<i>Oryza sativa</i>). |



| # | Systems; age (# years since AF system installation) | Location | Soil Order |
|---|---|----------------------|-------------|
| 1 | Pine + pasture vs. treeless pasture; 30 yr | Florida, USA | Ultisols |
| 2 | Pasture under birch trees vs. treeless pasture; | Northern Spain | Inceptisols |
| 3 | Home garden vs. rice paddy; >50 y | Kerala, India | Inceptisols |
| 4 | Under tree vs. away from trees (Dehesa); 80 y | Northern Spain | Alfisols |
| 5 | Under trees vs. away from trees; Parkland system; >50 y | Ségou, Mali | Alfisols |
| 6 | Homegardesn vs. forest: >50 y | Kerala, India | Inceptisols |
| 7 | Cacao under shade vs. forest; > 30 y | Bahia, Brazil | Oxisols |
| 8 | Brachiaria + Eucalyptus vs. Treeless forage stand; 30 y | Minas Gerais, Brazil | Oxisols |

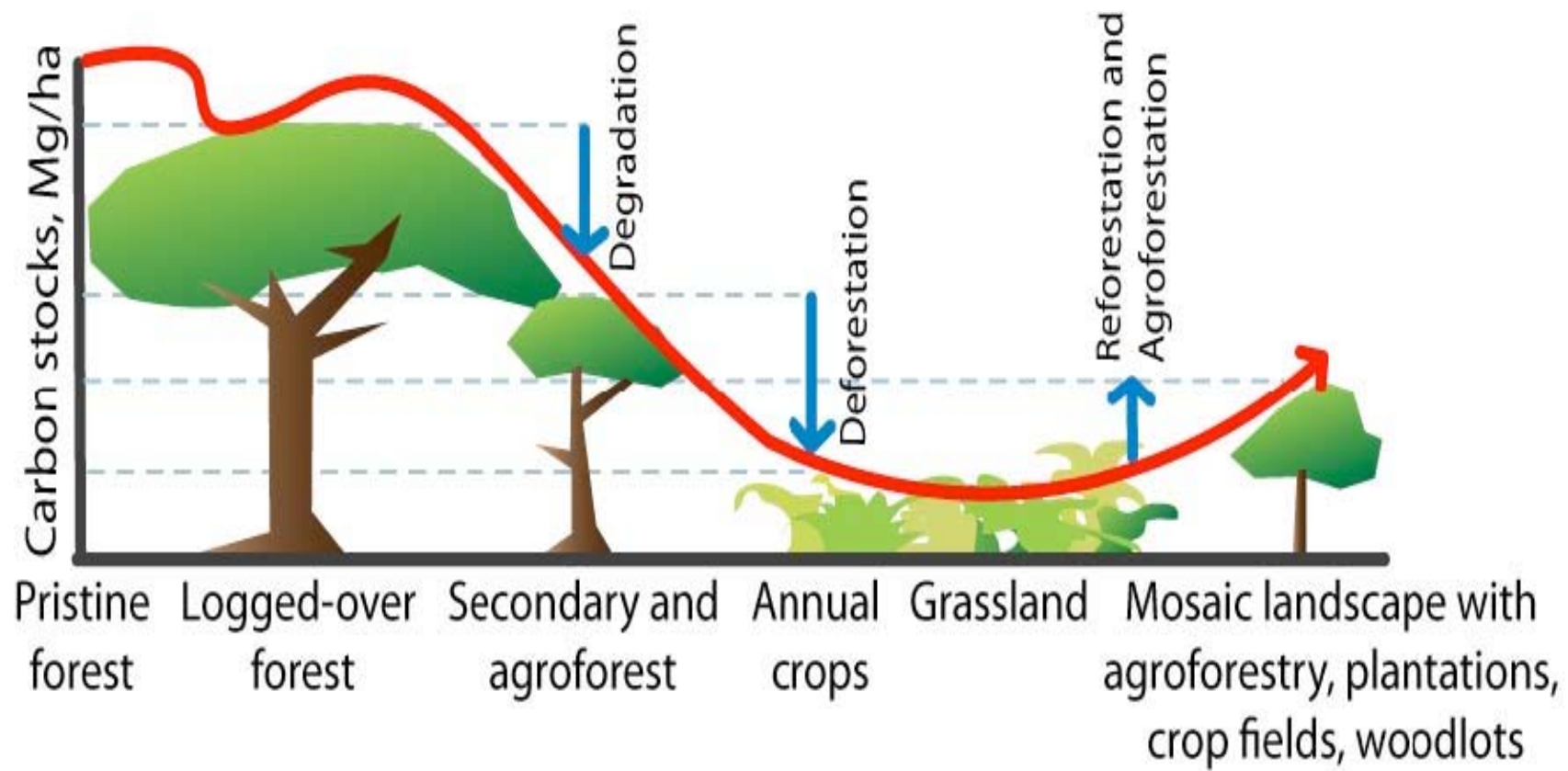
Changes in soil C stock in top soil and sub-soil under different AF vs. non-AF systems

Summary of Results

- Tree-based systems, compared to treeless under similar conditions, store more C in deeper soil.
- High tree density → high SOC content, esp. in the upper 50 cm soil and <math><53\ \mu\text{m}</math> soil fraction.
- SOC stock under AF systems with high tree-density (e.g., homegardens, shaded perennials) comparable to that of natural forests.
- In sparse tree-density AFS, soil stores more C near than away from the tree.
- C3 plants (trees) contribute to more stable C than C4 plants in deeper soil profile.

The Message is Simple...

- Forests are good for the environment; but they are being destroyed in a massive way, and it is difficult to stop deforestation.
- Agroforestry is a desirable way of incorporating trees on agricultural lands and thus an alternative way of getting some of the tree benefits.
- Three decades of efforts in agroforestry have given convincing results.
- Contribution of trees to carbon sequestration is one of the unexploited advantages of agroforestry.



General land-use continuum in forested tropical countries with changes in types and extent of tree cover.

(Source: Consortium Research Program, 2010.)