World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES
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Contributions of Tree Crops in Compensating Emitted Carbon in Upland and Peatland

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- Expansion of plantations replacing natural forest has received criticism from the environmental community because of the CO_2 emissions generated.
- Secondary forest, shrubland and Imperata grassland are available for plantation expansion and using these lands poses less environmental damage.
- Time-averaged C stocks of such plantations in comparison to the primary or secondary forests and shrub that they replaced were analyzed under upland and peatland conditions.
- Method and information on carbon budget associated to land use transitions to agriculture is important in designing the sector's contribution in green house gas (GHG) emission reduction strategies.

Calculation of Carbon Budget

$E = E_a + E_{bd} + E_{bo} - S_a$ [1]

E_a = emission from the above ground biomass burning
E_{bd} = emissions from below ground (peat/soil) burning during deforestation,
E_{bo} = emission from below ground oxidation
S_a = sequestration of CO_2 from the atmosphere into plantation crop biomass

$E_a = C_b * 3.67$ [2]

C_b = carbon stock in the biomass of the initial land use [t ha^{-1}]
The coefficient 3.67 is the conversion factor from C to CO_2

$E_{bd} = V_p * C_d * 3.67$ [3]

V_p = volume of peat burned (m^3) and
C_d = peat C density or the mass of C per unit volume of soil or peat (t m^{-3}).

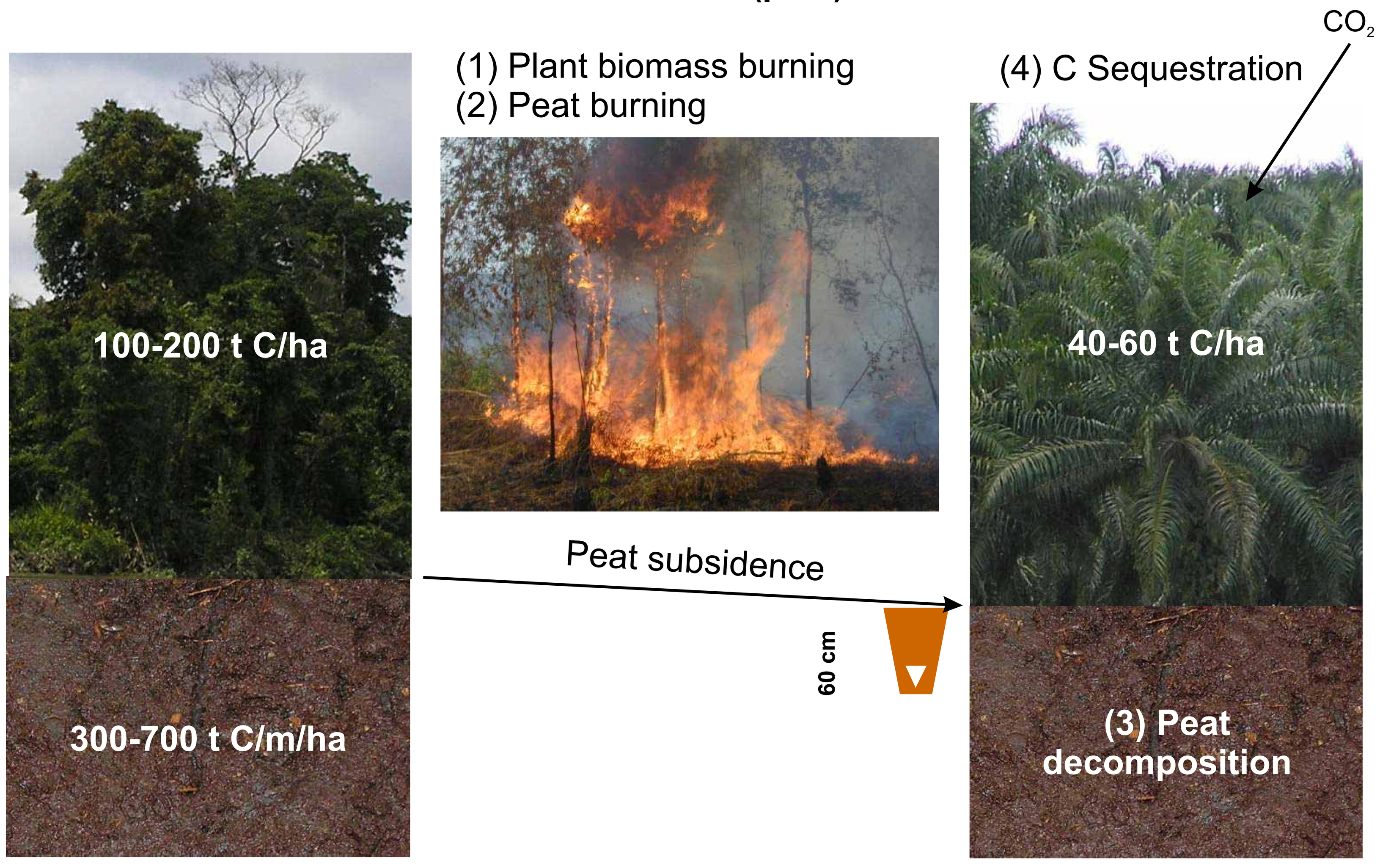
$C_d = B_D * C_c$ [4]

B_D = peat or soil bulk density (t m^{-3}).
Note: If soil carbon is determined by loss in ignition method, then the ash free BD should be used
C_c = the fraction of carbon in the soil mass (t t^{-1} or frequently expressed as percentage).
*Ebo = 0.91 * cm depth of drainage t CO_2 ha^{-1} yr^{-1}* (Hooijer et al., 2006)

$S_a = C_p * 3.37$ [5]

C_p = time average carbon stock in the plant biomass of the plantation system

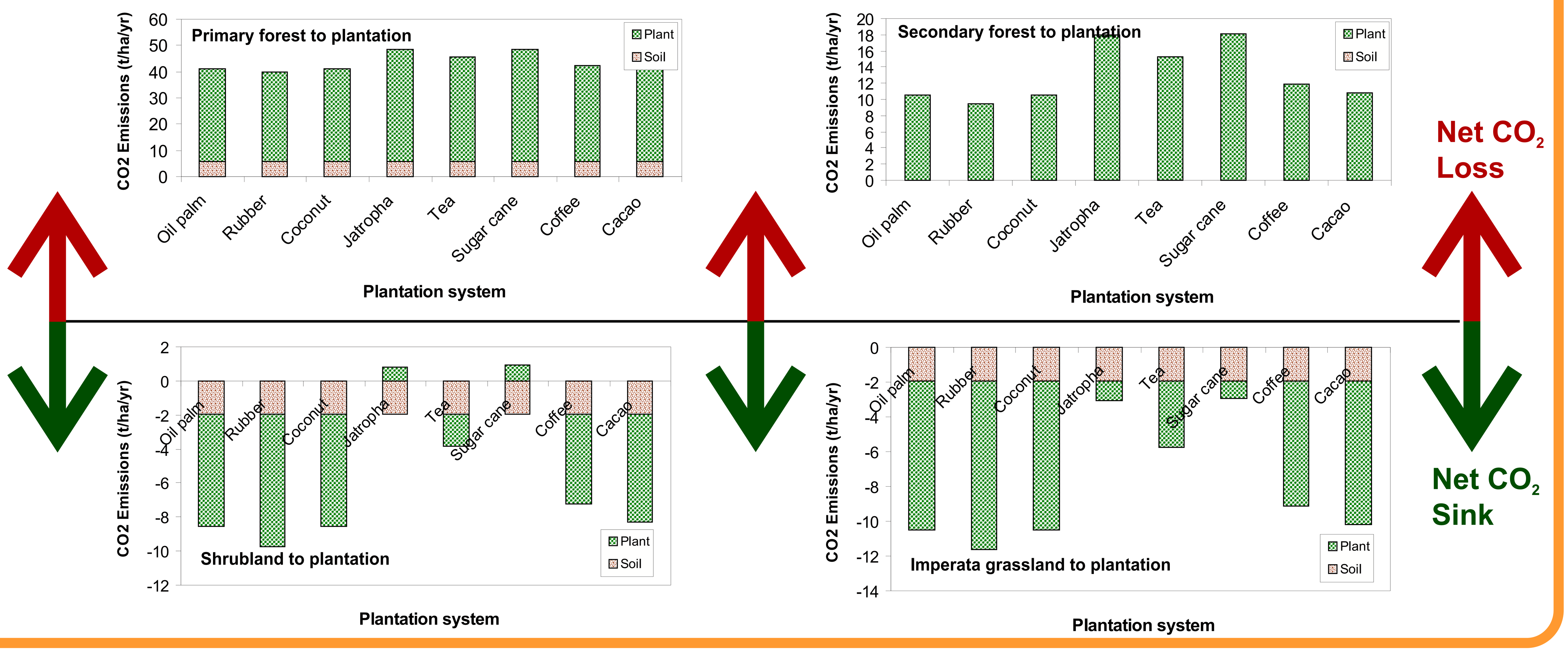
Processes entailed in (peat) forest conversion



For mineral upland soil the carbon balance is determined by the difference in plant C-stock between the initial and the subsequent land uses. In most cases conversion of primary and secondary forests with time average C stocks of about 300 and 132 t ha^{-1}, respectively, results in a net negative carbon balance (C debt).

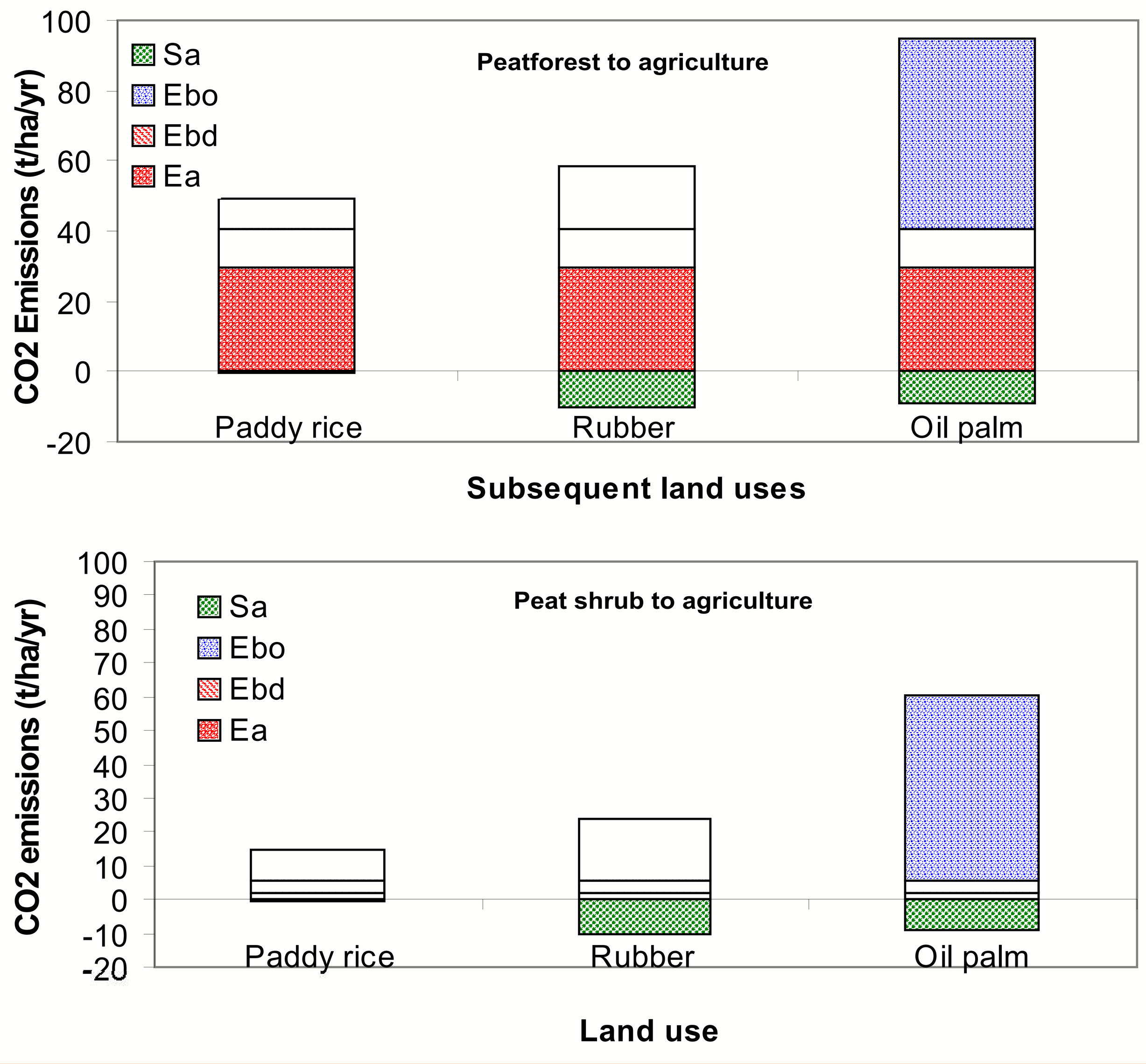
If shrub or *Imperata* grassland, with respective C stocks of 15 and 2 t ha^{-1} is converted to plantation, it generally results in an increase in the land C stock. Infrastructural, socio economic and tenure constraints for such carbon efficient conversion should be overcome by the responsible institutions.

Estimated annual average Co_2 emission in plant and in **mineral soil** associated with land use changes into plantation.



Emission from peat decomposition is a major source of CO_2 for systems requiring deep drainage such as oil palm plantation. If peat forest is converted, plant biomass burning and peat burning during peat forest clearing also contribute substantially to CO_2 emission. If peat shrub, instead of peat forest is used for plantation, emissions from plant biomass and peat biomass burning decreased significantly, but emissions from peat decomposition is likely unchanged.

Maintaining shallow water table, e.g. through canal blocking reduces CO_2 emissions



On mineral soils, greenhouse gas emissions could be reduced either through avoided deforestation and/or establishment of high carbon stock plantation systems on low carbon stock ecosystems such as idle Imperata grassland or shrub land.
For peatland, avoided deforestation is the most effective approach of terrestrial C conservation. Once the peat forest is converted, the CO_2 emission escalates and the management systems required by the subsequent land uses determines the emission rates. The utilization of peat shrub rather than peat forest for plantation systems reduces emissions from plant biomass and peat burning, but can not always turn the land from carbon emitter to carbon sequester.

Imperata and shrubland with low carbon stock

Some natural proof of peat subsidence

Using of Peat auger

The 2nd World Congress of Agroforestry 2009; "Agroforestry - The Future of Global Land Use"