Mitigation Role of Forestry Plantations & CDM Forestry Experience

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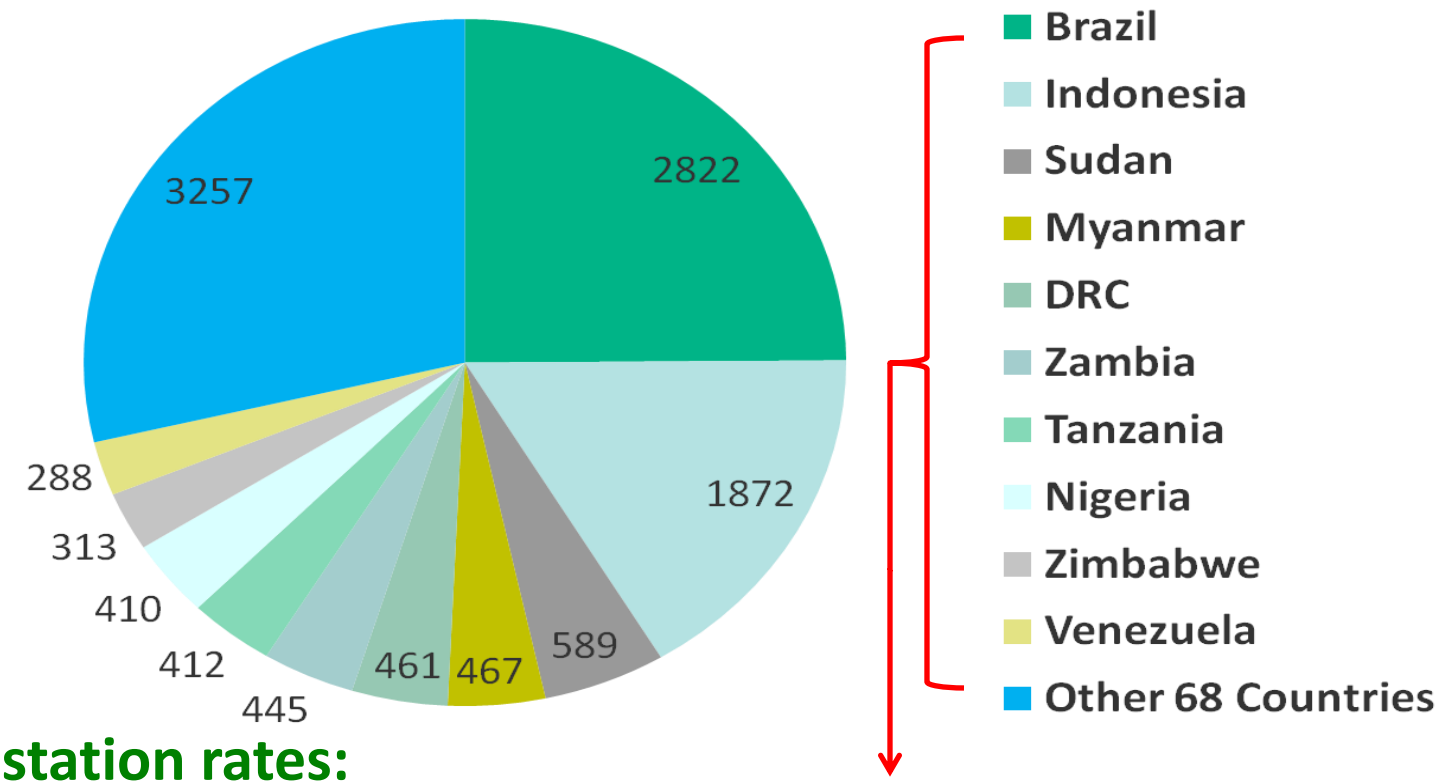
Forest Sector – A source of GHGs

Annual average deforestation rate (1000 hectares/year) in 2000-2005



Deforestation rates:

1990s – 8.3 mha/year

2000s – 6.2 mha/year

10 countries: 71% of total

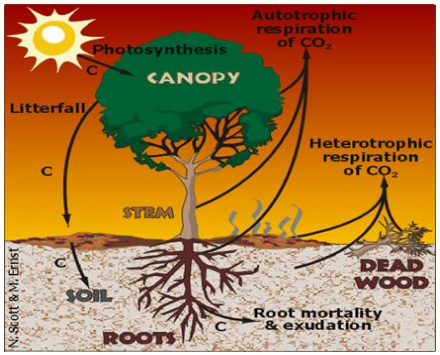
Data: FAO

Mitigation role of Forest Sector

1. As a Carbon Storage

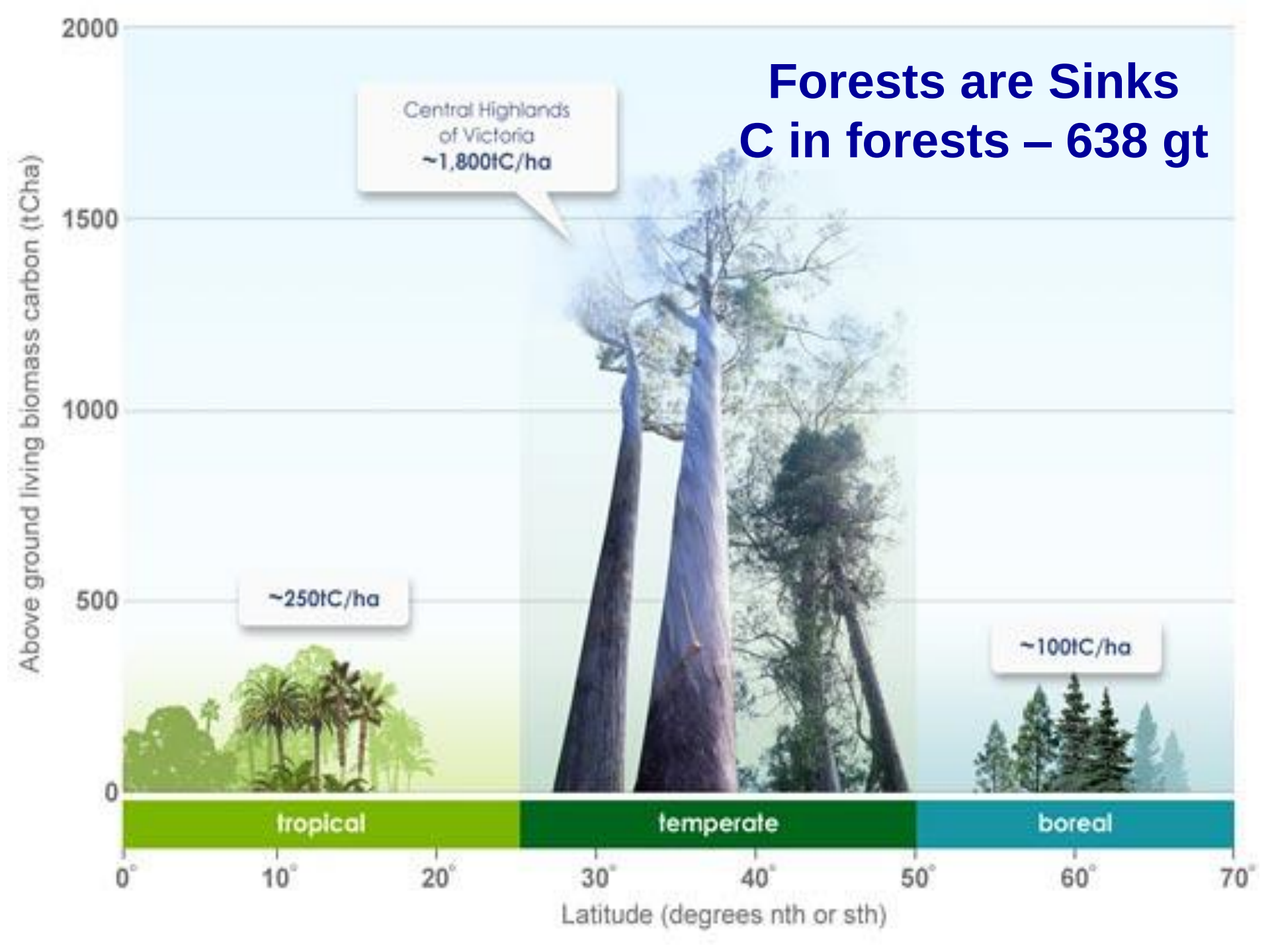
'C-stocks either increase or remain unchanged'

2. As a Carbon Sequestration **(Unique property)**



'How fast a tree can sequester and how long it can retain'

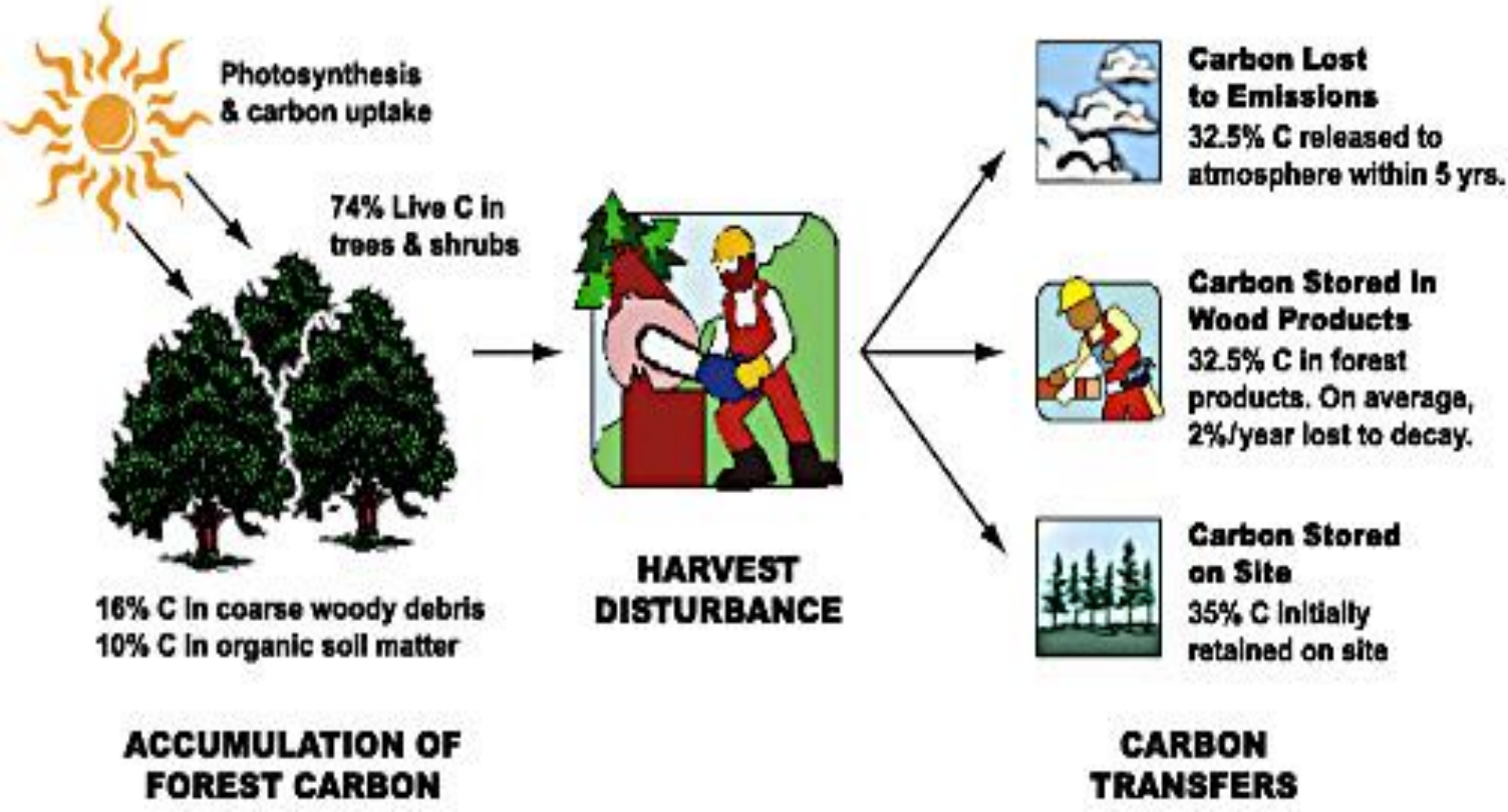
Forests are Sinks
C in forests – 638 gt



Carbon as Ecosystem Service: Reward Mechanisms

- CDM Forestry Projects (KP)
- Non-Mandatory Markets
- REDD-plus (Fund/Market Based)

Reward mechanism cover only a minuscule part of the growing forests/tree plantations



Carbon in Forests: Growth, Harvest & Use

RELEVANT UNITS

1 ton = 1000 kg = 1 Mega gram = 10^6 g

10^6 tons = 1 Mega ton = 1 Tera gram = 10^{12} g

10^9 tons = 1 Giga ton = 1 Peta gram = 10^{15} g

CARBON AND CO_2 RELATIONSHIP

C – 12 (At. wt.)

CO_2 – 44 (Mol. wt.)

C : CO_2 :: 1 : 3.67 (44/12 = 3.67)

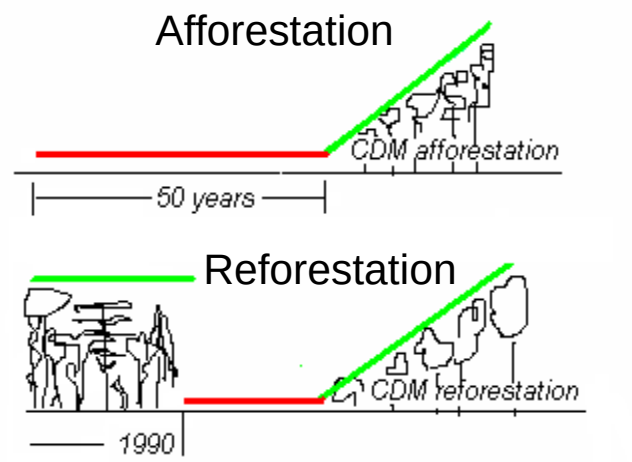
{1tC = 3.67 t CO_2}

1 ton of dry biomass = 0.45 t C = 0.45 x 3.67 = 1.65 t CO_2

Carbon price is given in t CO_2

Forest sector and the CDM

- CDM forestry projects are limited to afforestation and reforestation (A&R).
- C-pools accepted – AGB, BGB, woody litter, dead wood and soil carbon.
- GHG emission offsets are measured in tons of CO_2 equivalent and are called *Certified Emission Reductions* (1CER = 1tCO_2).
- ***Afforestation***
  - Planting with trees, the areas that have not been a forest for the last 50 years.
- ***Reforestation***
  - Planting with trees the areas, that have not been a forest since 31st Dec 1989.



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Forest sector and the CDM

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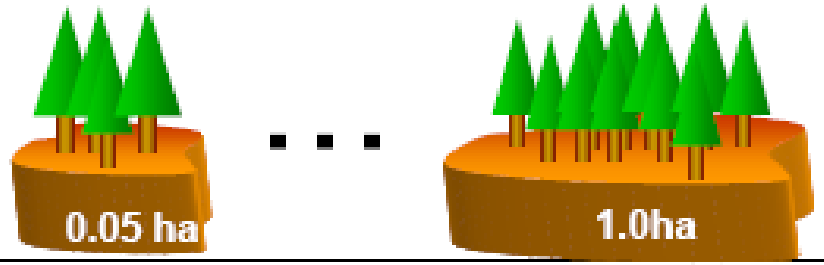
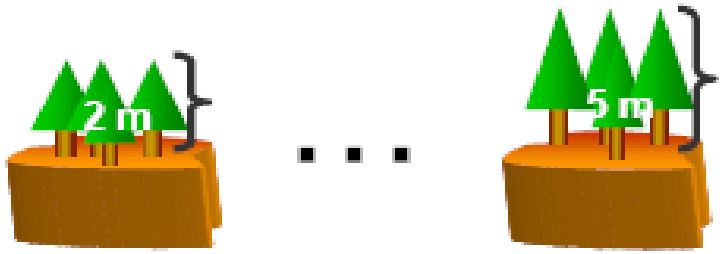
- A/R CDM project activities may include:
  - Afforestation of wastelands
  - Reforestation of degraded forests
  - Agroforestry/Farm forestry
- CERs eligible under forest sector can be two types:
  - lCER (Market price – 60% of normal CER)
  - tCER (Market price – 15-20% of normal CER)
- Crediting period – 20x1, 20x2, 20x3, 30 years (fixed)
- Approved methodologies - 11 large scale & 7 small scale
- Registered projects in forest sector- 55 (9 from India)

Definition of ‘Forest’

(a) Tree crown cover: 10～30%	
(b) Land area value: 0.05～1ha	
(c) Tree height: 2～5m	

The definition applicable to India is:

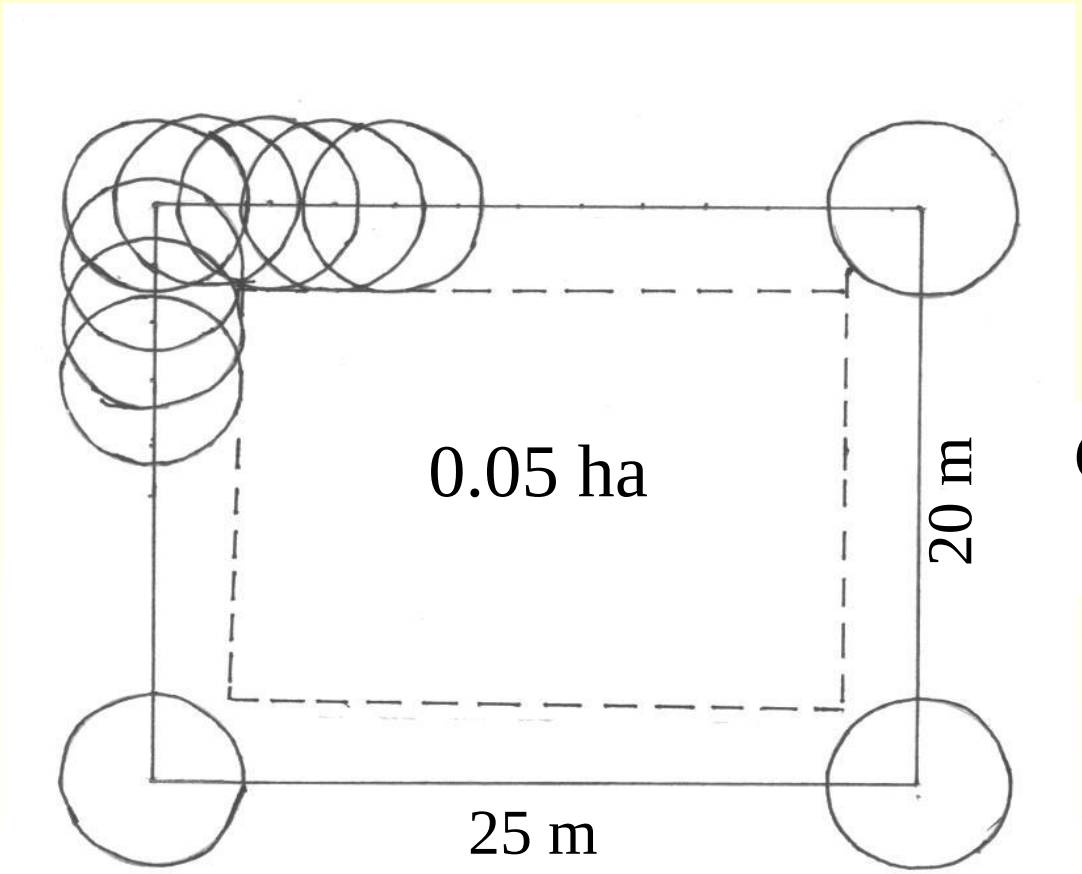
Minimum area – 0.05 ha

Minimum tree ht. at maturity – 2 m

Crown cover – 15%

Indian definition of ‘Forest’ & agro/farm forestry

(Ex. Poplar bund plantation - small farm (Spacing – 2 m, crown dia. – 5.8 m*)

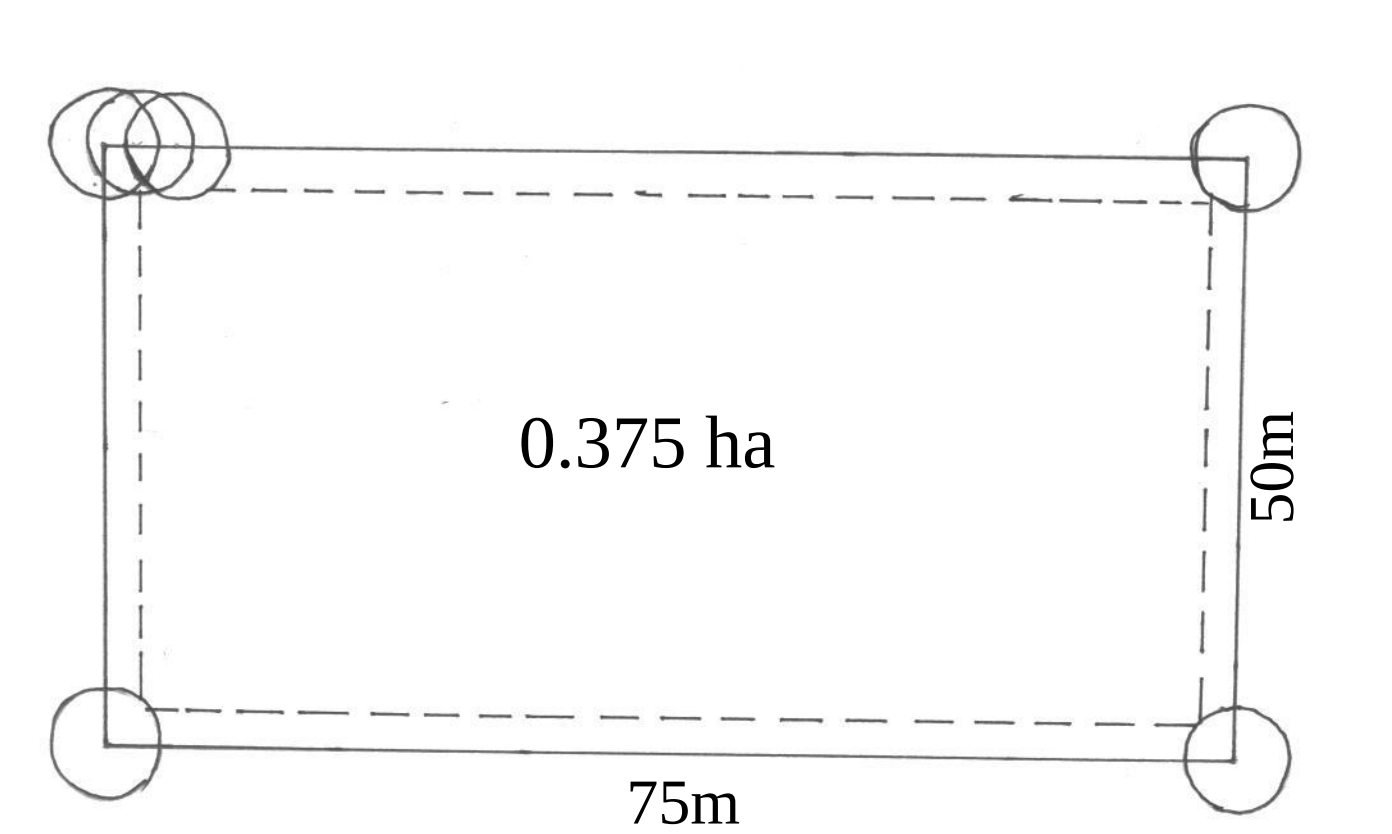


Crown cover – 45.47 %

Gera Mohit, 2007

Poplar bund plantation - large farm

(Spacing – 2 m, crown dia. – 5.8 m)



Crown cover - 18.44 %

Gera Mohit, 2007

Poplar bund plantation: Farm size Vs Crown cover

(Crown dia. at 6 year – 5.8 m)*

Farm size (ha)	Spacing (m)	Crown cover (%)
0.05	2	45.47
0.10	2	34.34
0.13	2	30.14
0.30	2	20.15
0.375	2	18.43
0.45	2	16.65
0.50	2	15.77

30% - 1/3rd acre or smaller area may be eligible

15% - Up to 1.25 acre may be eligible

**(Source: Dr. R.C. Dhiman)*

Bund plantation of other species:
Farm size Vs Crown cover (Crown dia. – 8 m)

Farm size (ha)	**Spacing** (m)	**Crown cover** (%)
0.05	3 – 5	59.2
0.20	3 – 5	32.8
0.25	3 – 5	29.44
0.60	3 – 5	19.50
0.80	3 - 5	17.20
1.00	3 - 5	15.36

30% - 2/3rd acre or smaller area may be eligible

20% - 1 1/2 acre or smaller area may be eligible

15% - Around 2.5 acre may be eligible

CDM Forestry Projects

Requirements for A&R CDM project activity

Land eligibility

Eligibility of land for CDM projects along with approval of the local stakeholders needs to be demonstrated.

Baseline

The baseline is the scenario that reasonably represents the anthropogenic emissions by sources of GHGs that would occur in absence of proposed project activity

A clear and verifiable baseline scenario giving C-stock changes in 'without project' situation needs to be presented using approved methodologies.

Requirements for A&R CDM Project activity

contd…

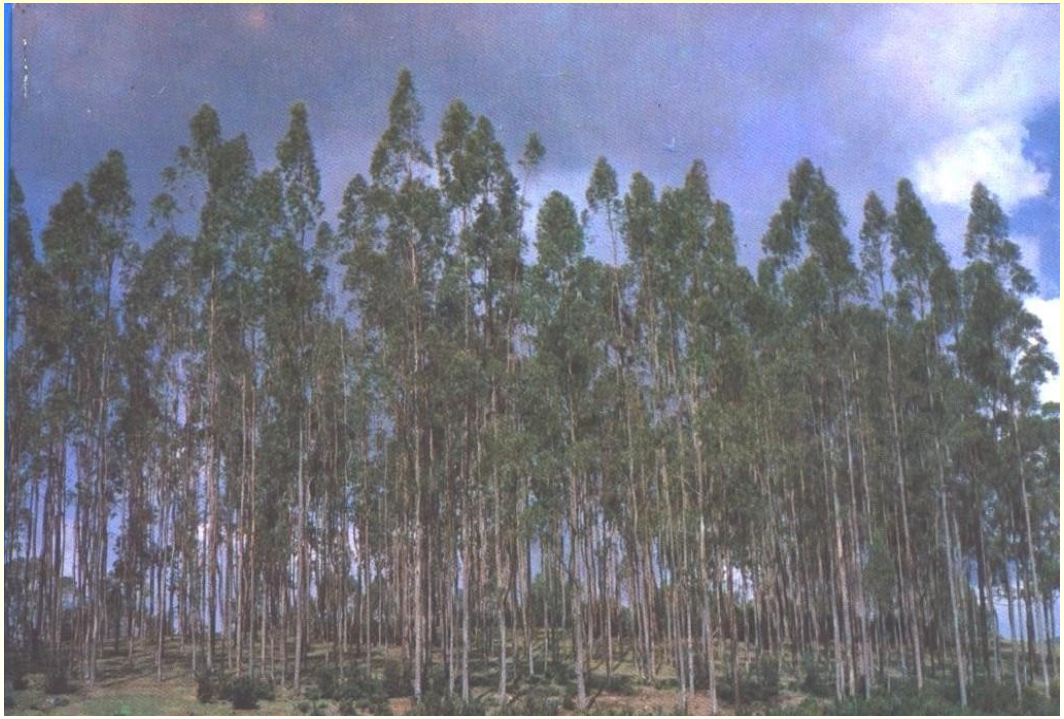
Project boundary

The "project boundary" geographically delineates the project activity under the control of project participants. It may contain more than one discrete area of land. Must be clearly defined in order to estimate C benefits due to project activities and address leakage, if any.

Project activities (Afforestation/Reforestation)

Proposed A&R activities along with area to be dedicated should be described

Potential plantation models under A&R



Species

Eucalyptus spp.
Populus deltoides
Dalbergia sissoo
Tectona grandis
Acacia auriculiformis
Pinus roxburghii
Quercus spp.
Other conifer spp.

Block plantations

Potential plantation models

contd…

Species

Eucalyptus spp.

Populus deltoides

Dalbergia sissoo

Acacia nilotica

Emblica officinalis

Terminalia belerica

Terminalia chebula

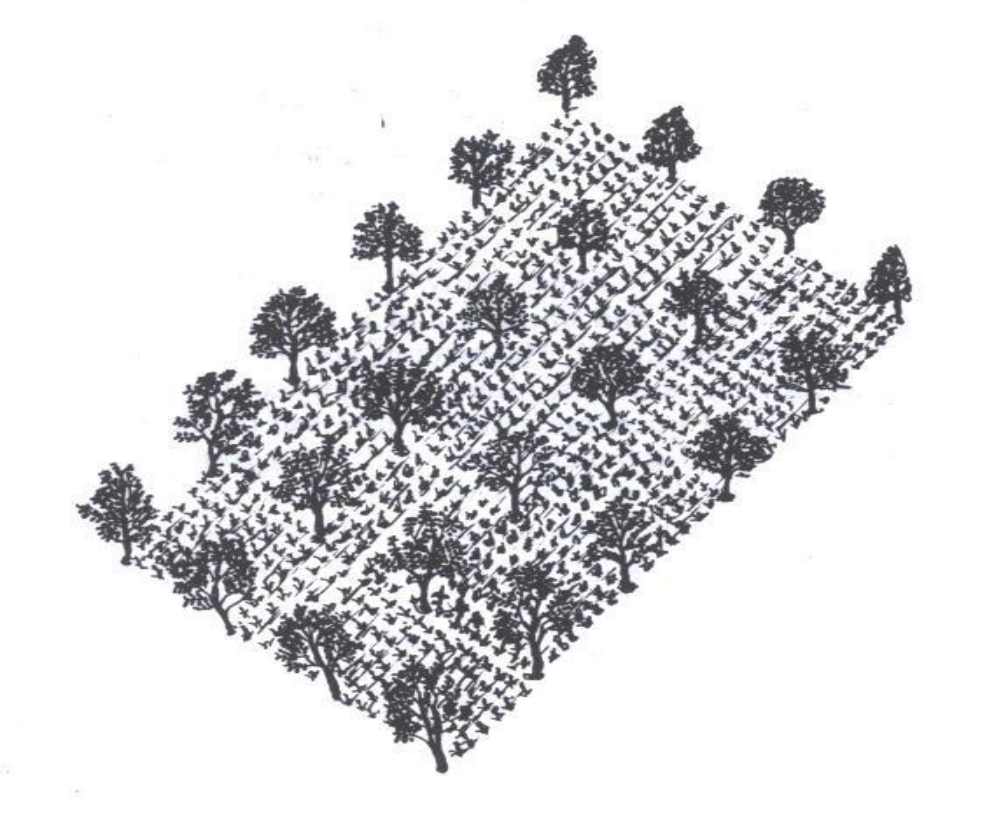
Horticulture species

Bund Plantation

Block plantation of Poplar

Potential plantation models

contd…



Species

Populus deltoides

Eucalyptus spp.

Emblica officinalis

Mangifera indica

Litchi chinensis

Citrus spp.

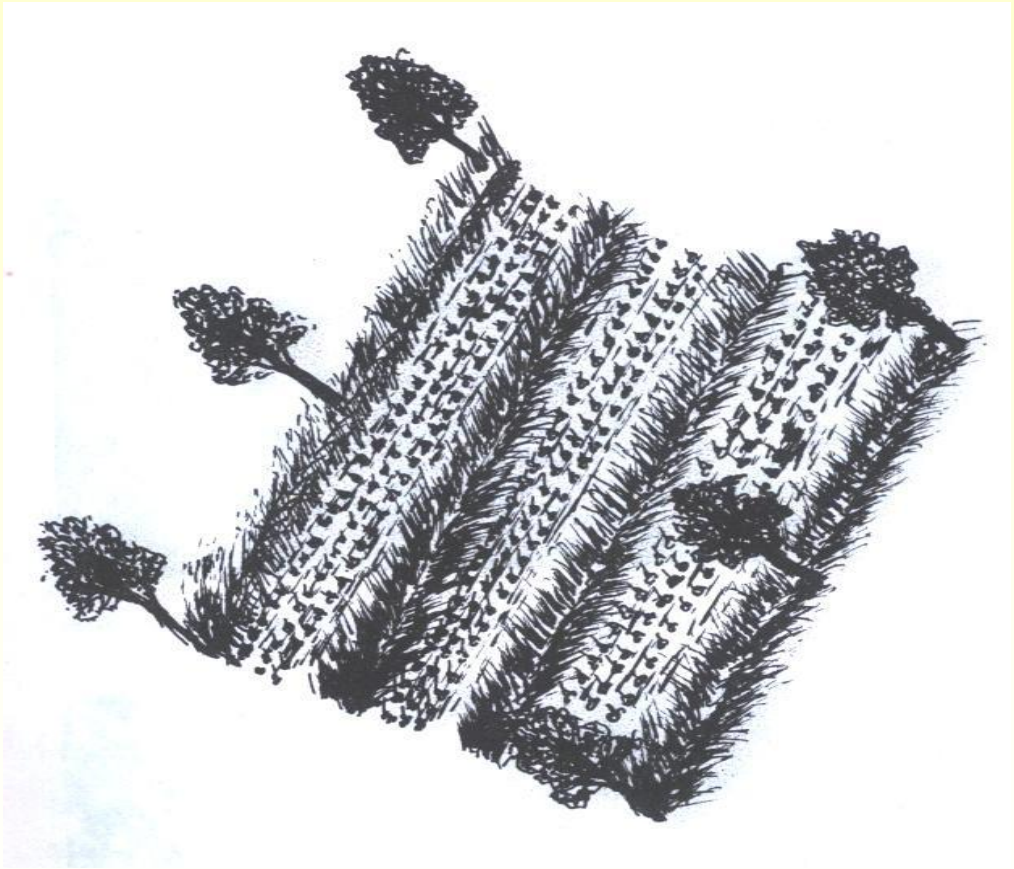
Other horticulture spp.

Block plantation on farm lands

(Agri-silviculture / Agri-horticulture)

Potential plantation models

contd…



Species

Grevia optiva

Melia azedarach

Toona ciliata

Ficus spp.

Bauhinia spp.

Artocarpus heterophyllus

Ailanthus excelsa

Inter-cropping on farm lands (Agrisilvipastoral)

Requirements for CDM Project *contd...*

Leakage

- Leakage is the increase in GHG emissions by sources which occurs outside the boundary of the project activity which is measurable and attributable to the project activity
- The project should also demonstrate how leakage issue will be addressed to ensure sustained carbon benefits.

Non-permanence

Non-permanence is to be addressed by project participants by selecting one of the following approach:

tCERS

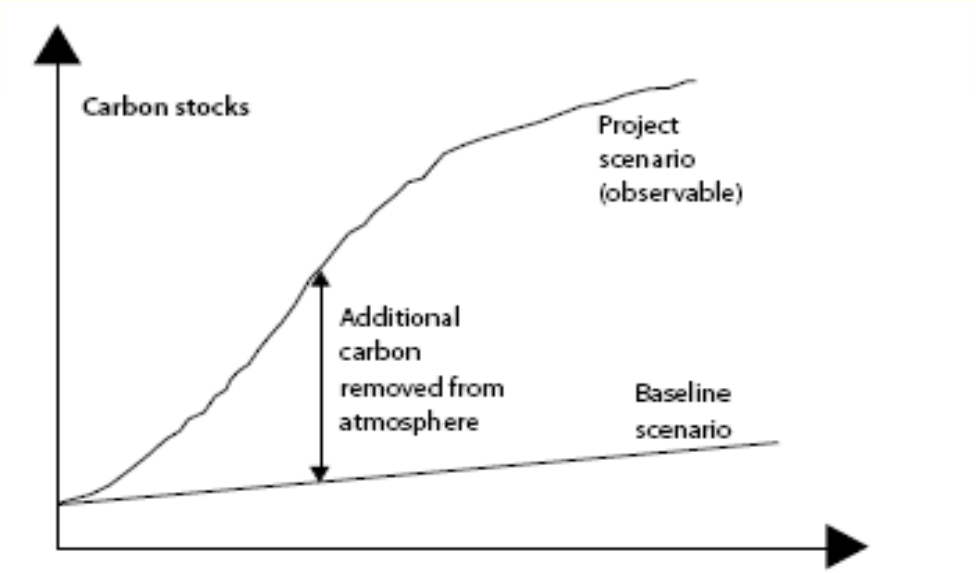
lCERs

Requirements for CDM Project *contd...*

Additionality

- **Sequestration additionality**

A/R CDM activity is additional, if it leads to increase in net C-sequestration to what would have happened in B-A-U scenario. To demonstrate additionality, prove that the project would not have occurred in the absence of CDM benefits.



Requirements for CDM Project *contd…*

Monitoring

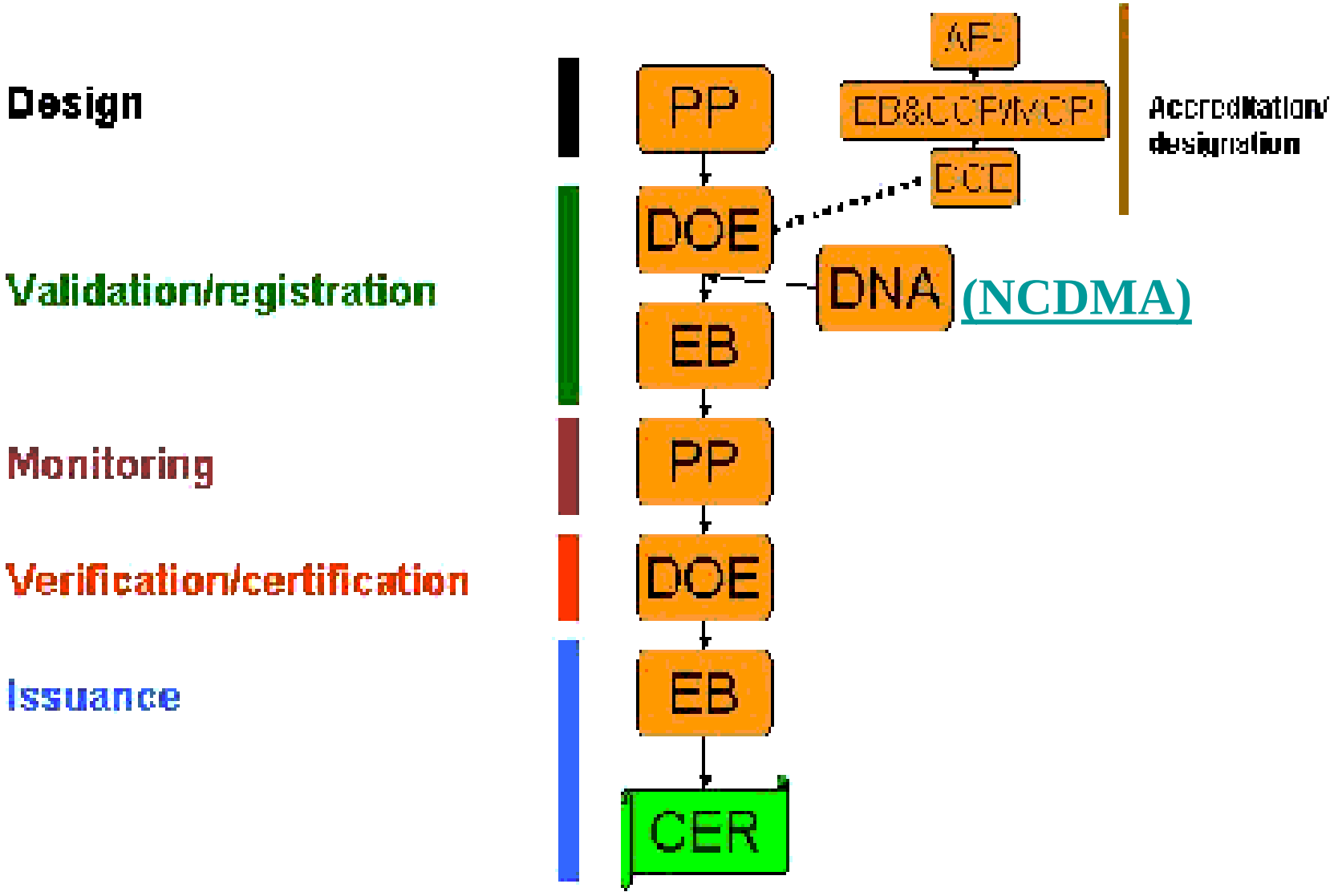
The proposal should include a detailed measurement & monitoring plan for collection and archiving data (as per approved methodology)

- **Project boundary area**
- **C - stock changes**
- **Parameters & frequency of measurements**
- **Leakage estimation**
- **Assessment of Environmental Impacts**

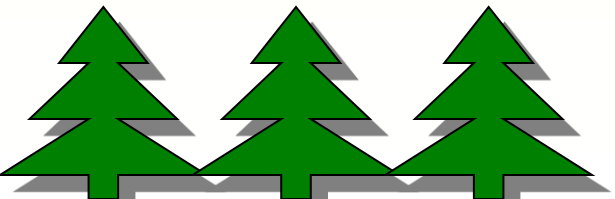
Project Design Document (PDD) must contain the following information:

- Description of the project
- Methodology for baseline and additionality assessment
- Accounting period
- Actual GHG removals by sinks
- Monitoring plan as per approved methodology
- Estimation of GHG emission by sources (Leakage)
- Social and environmental impacts
- Stakeholder comments

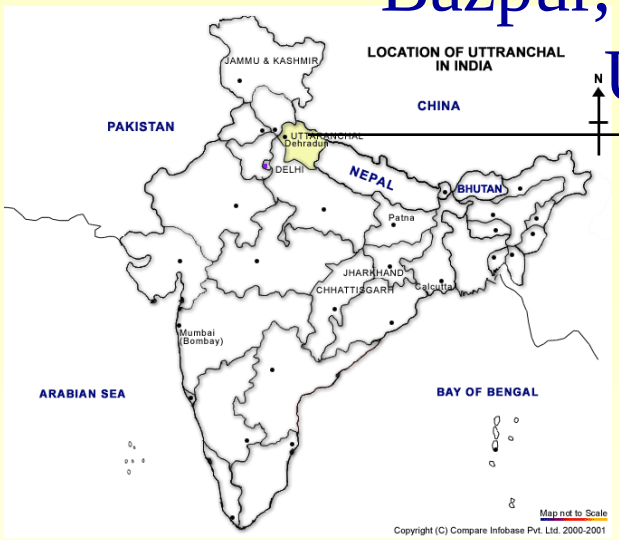
CDM project activity cycle

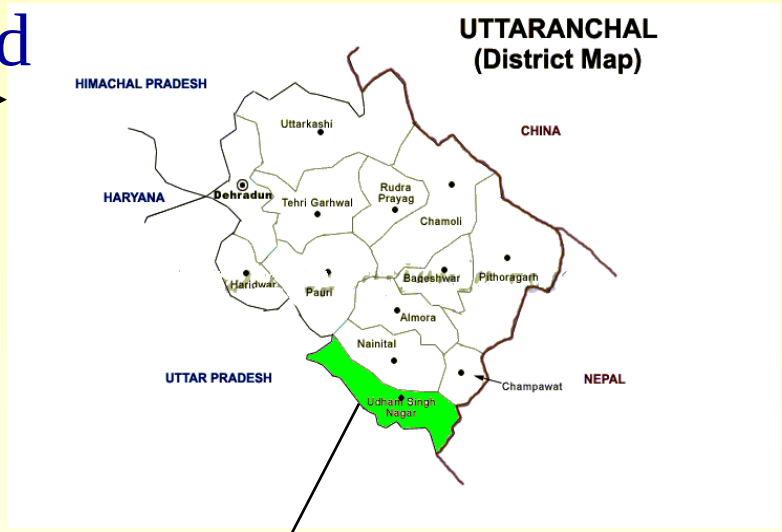


CASE STUDY ON CARBON SEQUESTRATION POTENTIAL ASSESSMENT



Bazpur, Udhamsingh nagar Uttarakhand





BAZPUR

Location of the site

PROJECT ACTIVITIES

- Poplar block plantation
- Eucalyptus bund plantation
- Teak block plantation
- Mango block plantation
- Litchi block plantation

PRO-COMAP - Key input data

Parameter	Poplar	Eucalyptus	Teak	Mango	Litchi
Land area dedicated (ha)	1190	590	177	355	355
Rotation (yrs)	6	10	20	60	60
M.A.I (tB/ha/yr)	25.15	11.25	10.8	2.84	2.84
Rate of carbon uptake in soil (tC/ha/yr)	1.21	1.14	2.18	0.20	0.20
Woody litter (tB/ha/yr)	0.35	0.27	0.38	0.45	0.45
Decomposition period (yrs)	2.94	3.64	3.08	4	4
Opportunity cost of land (Rs/ha)	20,000/-	8,000/-	10,000/-	8,000/-	8,000/-

PROCOMAP - Key input data *contd…*

Product Life

• Saw logs	70 yrs
•Chip logs	30 yrs
• Pulp logs	3 yrs
• Poles	12 yrs
• Veneer	30 yrs
Analysis Period	**2005-2030**

PRO - COMAP MODEL

"Comprehensive Mitigation Assessment Process" (COMAP) for project activities.

The model is used to analyze mitigation potential and cost effectiveness of C- sequestration projects.

It takes into account 5 C-pools

- Above Ground Biomass
- Below Ground Biomass
- Woody litter
- Soil carbon
- Harvested Wood Products

Carbon stock changes under baseline and mitigation scenarios

Carbon increments per ha for various interventions for the period 2005-2030 (tC/ha)

Interventions		2005	2010	2015	2020	2025	2030
Poplar	Baseline	26.1	26.1	26.1	26.1	26.1	26.1
	Mitigation	26.88	53.48	85.79	98.67	110.21	119.24
	Increment	0.78	27.38	59.69	72.57	84.11	93.14
Eucalyptus	Baseline	26.1	26.1	26.1	26.1	26.1	26.1
	Mitigation	26.48	39.39	63.69	71.62	75.20	77.27
	Increment	0.38	13.29	37.79	45.52	49.10	51.17
Teak	Baseline	26.1	26.1	26.1	26.1	26.1	26.1
	Mitigation	26.53	40.44	69.61	100.67	122.20	105.10
	Increment	0.43	14.34	43.51	74.57	96.10	79.00
Mango	Baseline	26.1	26.1	26.1	26.1	26.1	26.1
	Mitigation	26.19	29.40	37.03	46.10	55.13	64.16
	Increment	0.09	3.30	10.93	20.00	29.03	38.06
Litchi	Baseline	26.1	26.1	26.1	26.1	26.1	26.1
	Mitigation	26.19	29.40	37.03	46.10	55.13	64.16
	Increment	0.09	3.30	10.93	20.00	29.03	38.06

Poplar graphs

ESTABLISHMENT COST AND CARBON STORED UNDER TREE PLANTATIONS

Inter-vention	Land area (ha)	Initial cost (Rs. ha^{-1})	Mitigation potential (ha^{-1})	Carbon flow (tC)
Poplar	1190	12,950/-	93 (55)**	110,841 (65,769)
Eucalyptus	590	4,500/-	51 (43)	30,191 (25,209)
Teak	177	17,249/-	79 (74)	13,982 (13,127)
Mango	355	10,150/-	38	13,513
Litchi	355	10,150/-	38	13,513
Total	**2,667**	**10,621/-**	**68.14***	**182,040 (131,131)**

* Weighted average value

**Without wood products

CARBON SEQUESTERED & LIKELY BENEFITS UNDER SELECTED PLANTATIONS (2005-30)

Plantation model	Mitigation potential (tC ha $^{-1}$)	Annual incremental C (tC ha^{-1})	Likely C-benefits (Rs. ha^{-1}yr^{-1})
Poplar block	93 (55)*	3.58 (2.13)	3154/- (1876/-)
Eucalyptus bund	51 (43)	1.96 (1.64)	1723/- (1445/-)
Teak block	79 (74)	3.04 (2.85)	2678/- (2511/-)
Mango block	38	1.46	1286/-
Litchi block	38	1.46	1286/-

Carbon price - \$5/ tCO_2 and 1\$ = Rs. 48/- ; * Without wood products

Carbon Sequestration potential under other A & R options

Carbon Sequestration Potential of Commercial Tree Species and likely Carbon benefits

Plantation Inter-vention	Annual incre-mental carbon (t/ha/yr)	Annual incre-mental carbon (tCO_2/ha/yr)	Likely carbon benefits (Rs/ha/yr)
Poplar block	2.54 (4.42)*	9.3 (16.22)	2558 (4461/-)
Poplar bund	1.42 (2.46)	5.21 (9.03)	1433 (2483/-)
Eucalyptus bund	1.62 (2.15)	5.95 (7.89)	1636 (2170/-)

Carbon price \$5/tCO_2 , \$1= Rs.55/-

* With wood products

Source – Study from Rupnagar Punjab, 2004

Carbon Sequestration Potential of Tree species of Medicinal Importance and likely Carbon benefits

Plantation Inter-vention	Annual incre-mental carbon (t/ha/yr)	Annual incre-mental carbon (tCO_2/ha/yr)	Likely carbon benefits (Rs/ha/yr)
Amla block	0.90	3.30	908/-
Bahera bund	2.93	10.75	2956/-
Harad bund	2.30	8.44	2321/-
Reetha bund	2.60	9.54	2624/-

Carbon price \$5/tCO_2 , \$1= Rs.55/-

Source- Study from Terai region of Uttarakhand

Carbon Sequestration Potential of Horticulture Tree Species and likely Carbon benefits

Plantation Inter-vention	Annual incre-mental carbon (t/ha/yr)	Annual incre-mental carbon (tCO2/ha/yr)	Likely carbon benefits (Rs/ha/yr)
Apple block	0.75	2.77	762/-
Pear block	0.73	2.67	734/-
Plum block	0.19	0.68	187/-
Mango block	1.15	4.21	1158/-

Carbon price $5/tCO$_2$, $1= Rs.55/-

Source- Study from Terai region & Nainital, Uttarakhand

Carbon Sequestration Potential of Long Rotation Tree Species on Forest Lands

Plantation Inter-vention	Annual incre-mental carbon (t/ha/yr)	Annual incre-mental carbon (tCO_2/ha/yr)	Likely carbon benefits (Rs/ha/yr)
Pine	**4.81**	**17.65**	**4854/-**
Pine-Oak-Mixed	**3.69**	**13.53**	**3721/-**
Mixed species*	**3.99**	**14.65**	**4029/-**

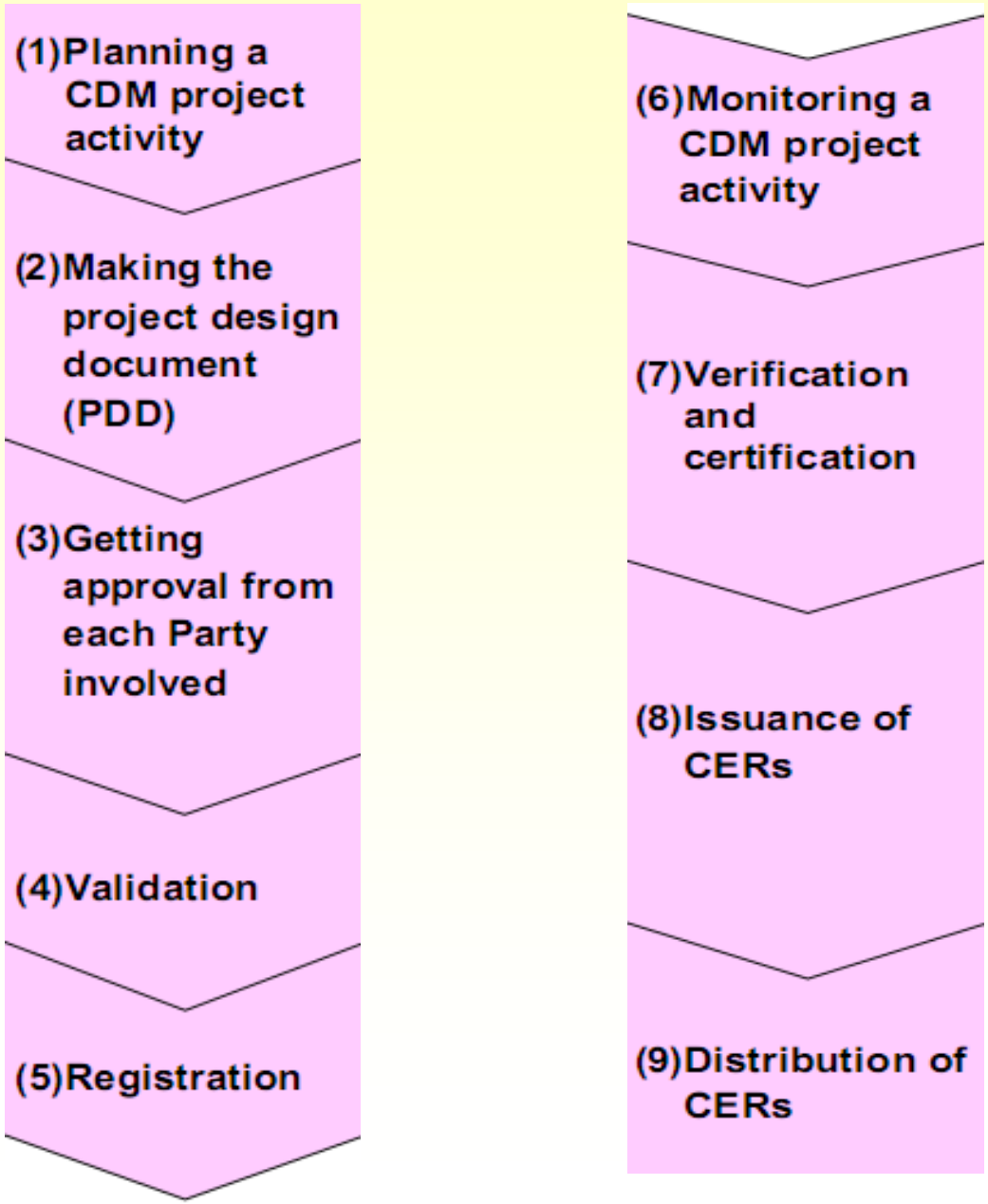
Carbon price \$5/tCO_2 , \$1= Rs.55/-

* Mixed species: *Alnus nepalensis, Pyrus peshia, Aesculus indica, Fraxinus* spp., Oak, Cupressus etc.

Source- Study from Nainital, Uttarakhand

Financial efficacy of CDM forestry projects

The CDM project cycle



Assumptions for analysis

Project size (CERs/yr)	Land required (ha)
Large - 50,000	6,812
Medium - 30,000	4,087
Small - 15,000	2,046
Very small - 7500	1,023

Average sequestration potential – 2 tC/ha/year

Or 2x3.67 = 7.34 tCO_2/ha/year

Analysis period – 30 years

Transaction costs associated with selected project size under two C-price scenarios

(All figures in 000 Rs.)

Project size	Project Develo-pment cost	Valid-ation cost	Regist-ration fee	Moni-toring cost	Veri-fication & Certi-fication cost	Issu-ance Fee (every 5 years)	Tax	Adaptation levy (every 5 years) at C-price	
								$ 4/ tCO_2	$ 8/ tCO_2
Large - 50,000 CERs/yr	3600	1125	382.5	200/500	1125	1800	Nil	900	1800
Medium -30,000 CERs/yr	2700	900	202.5	150/350	900	1080	Nil	540	1080
Small - 15,000 CERs/yr	1125	500	67.5	50/150	300	540	Nil	Nil	Nil
Very small - 7500 CERs/yr	900	350	33.75	35/100	225	236.25	Nil	Nil	Nil

Cost effectiveness indicators at three discount rates under two carbon price scenarios

Project size	Cost effective-ness indicator	C-price at $ 4/ t CO_2				C-price at $ 8/ t CO_2			
		Discount rate			IRR (%)	Discount rate			IRR (%)
		6%	9%	12%		6%	9%	12%	
Large - 50,000 CERs/yr	B/C ratio	6.10	5.54	5.03	74	10.87	9.98	9.14	110
Medium - 30,000 CERs/yr	B/C ratio	5.30	4.78	4.30	65	9.59	8.73	7.93	98
Small - 15,000 CERs/yr	B/C ratio	7.14	6.33	5.60	72	14.28	12.65	11.21	107
Very small - 7500 CERs/yr	B/C ratio	5.13	4.50	3.94	55	10.27	8.99	7.89	85

Learnings…

- Requirements of CDM Forestry Projects
- Sequestration potential of long rotation tree crops could be substantial
- Fast growing tree species sequester better if not harvested in short rotations
- Wood products in case of a short rotation crop constitutes a substantial carbon pool
- Forestry sequestration projects are viable, even at low price of $3 per ton of CO2.

Discussion. . .