SELECTION OF LAND CLEARING TECHNIQUE AND CROP TYPE AS PRELIMINARY STEPS IN RESTORING CARBON RESERVE IN TROPICAL PEATLAND UNDER AGRICULTURE

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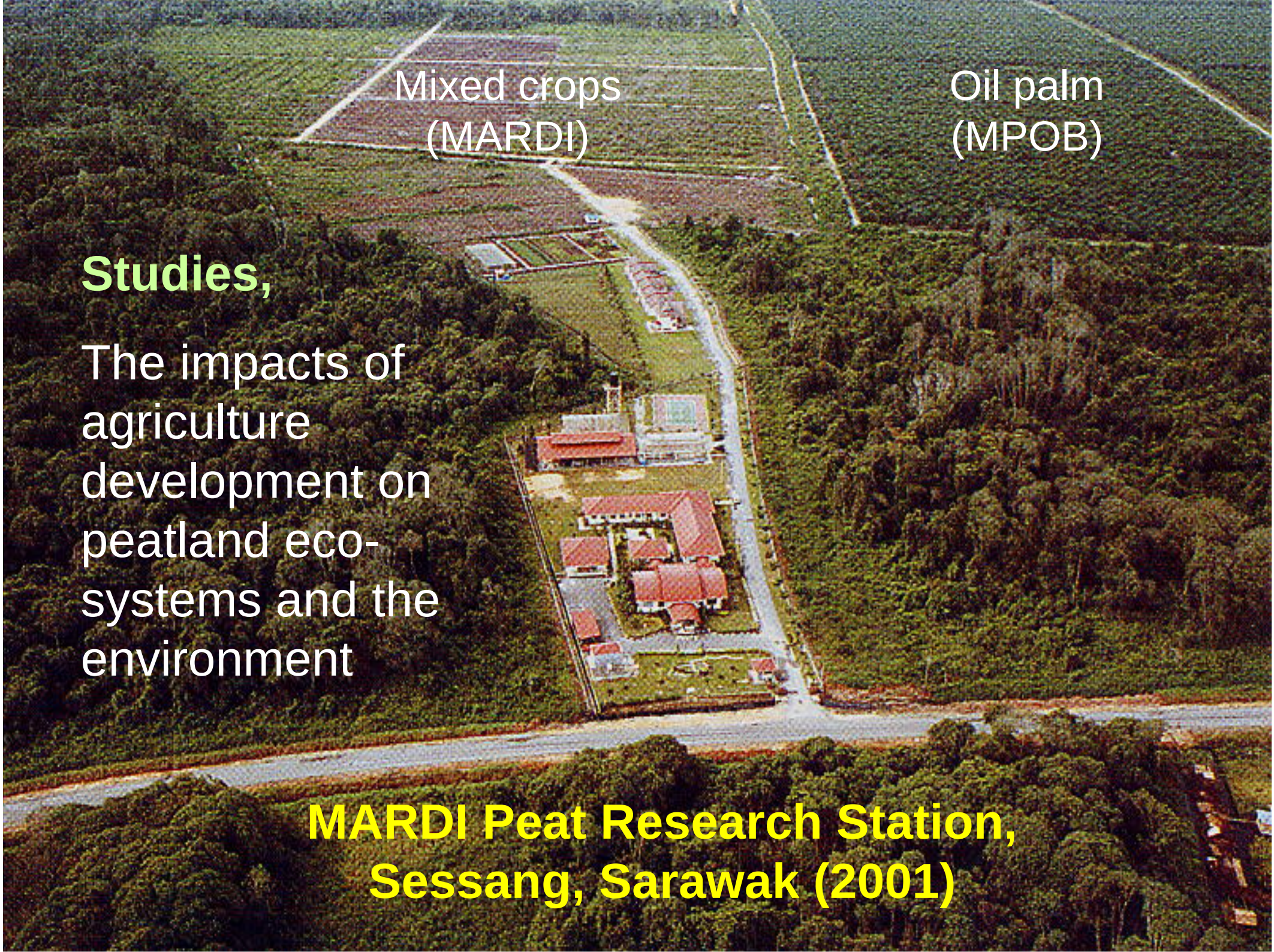
Land area in Malaysia

	Peninsular	Sarawak	Sabah
Land area (mil ha)	13.2	12.4	7.4
Mountainous (%)	60-65	70-75	65-70
Peatland (%)	**8**	**12**	**3**
Hilly-Flat (%)	25-30	15-20	30-35

Peatland in Malaysia (mil ha)

	Peninsular	Sarawak	Sabah
Peatland	0.8	1.6	0.2
Developed	**0.3**	**0.3**	**-**
Forested	0.5	1.3	0.2



Studies,

The impacts of agriculture development on peatland eco-systems and the environment

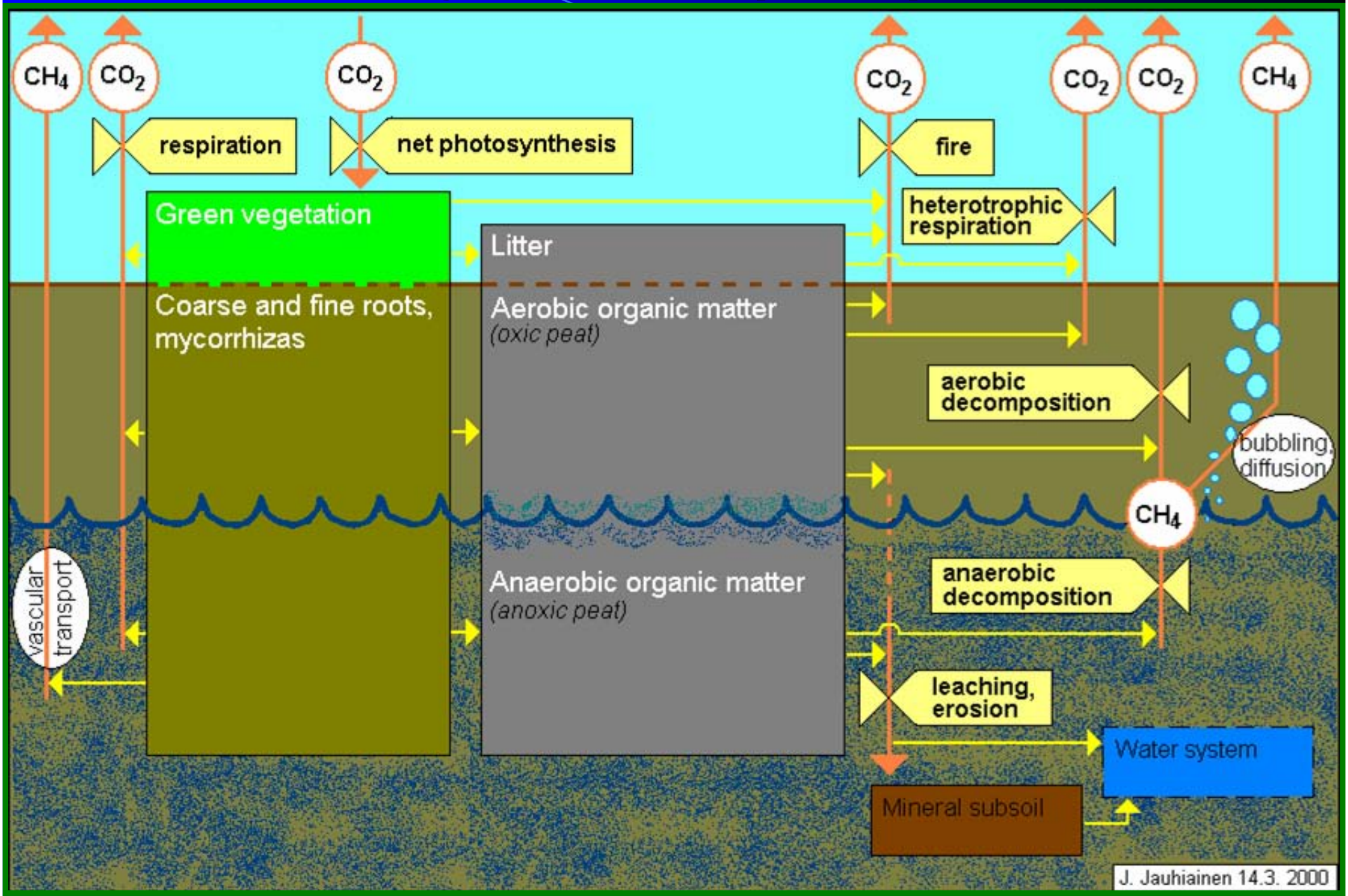
MARDI Peat Research Station, Sessang, Sarawak (2001)

Today's discussion

Carbon balance ….

- during land clearing
- immediately after land clearing
- under agriculture

Carbon cycles in tropical peatland



Carbon in tropical peatland

- 70 bil tons or 20% of soil C is stored in tropical peatland (34 mil t C sink annually)
- 1 cm thick of tropical peatland stored 5 tC/ha
- Loss of 5-42 t C/ha/yr from peatland under agriculture (Immirzi and Maltby, 1992)
- Loss of 7.2 tC/ha/yr from 2 cm/yr subsidence (Wosten et al., 1997)

Land clearing techniques

(MARDI Sessang - 70 ha in 2001)

	Land clearing technique	Cost (USD/ha)
FB	Felling-Burning	527
FSI	Felling-Stacking (Inside)	515
FSO	Felling-Stacking (Outside)	na
FCS	Felling-Chipping-Stacking (O)	1,145
CC	Clean Clearing	1,569
SC	Selective Clearing	1,335
FBy	Felling-Burying (Inside)	1,374

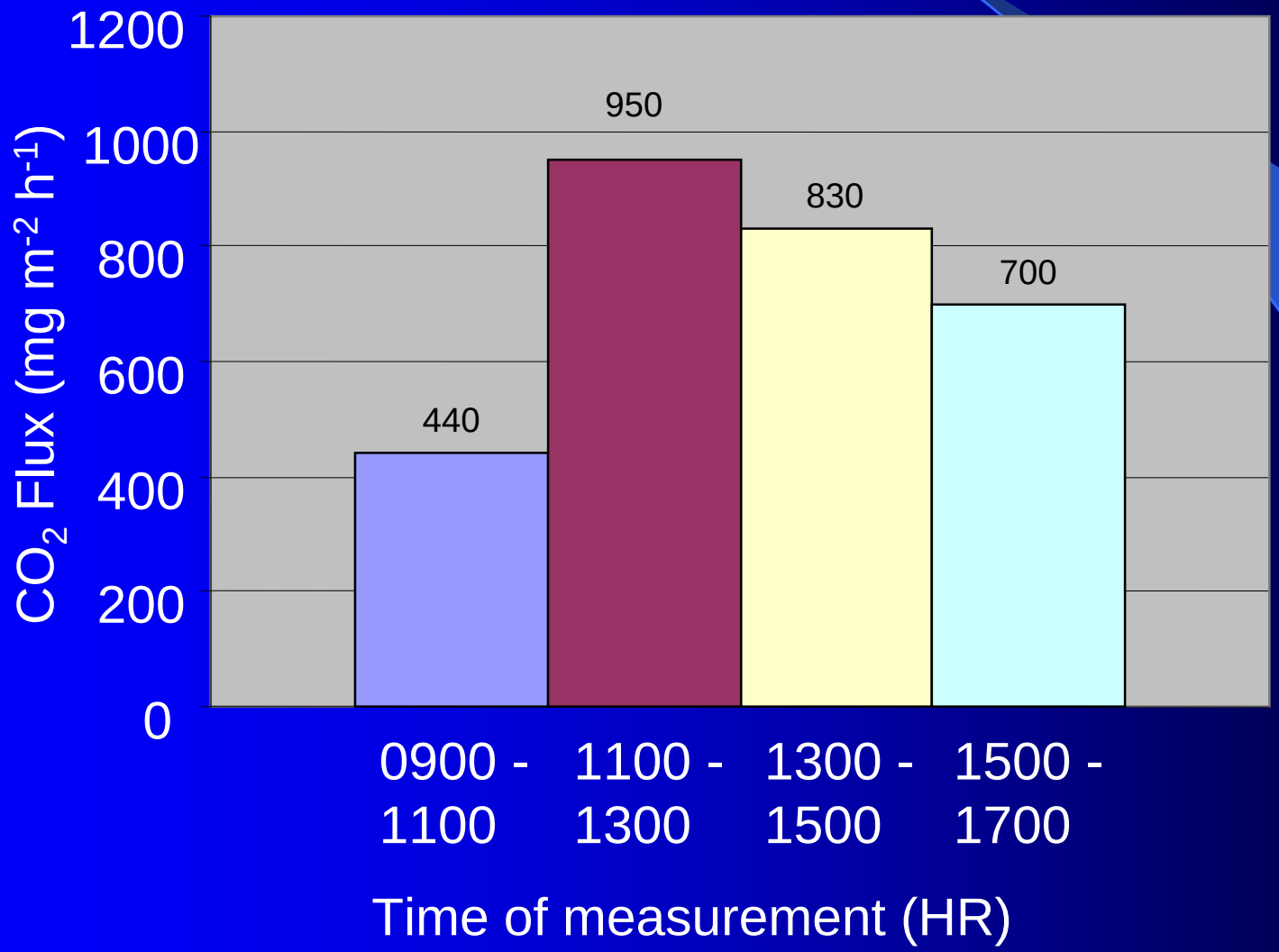
Forest debris after land clearing

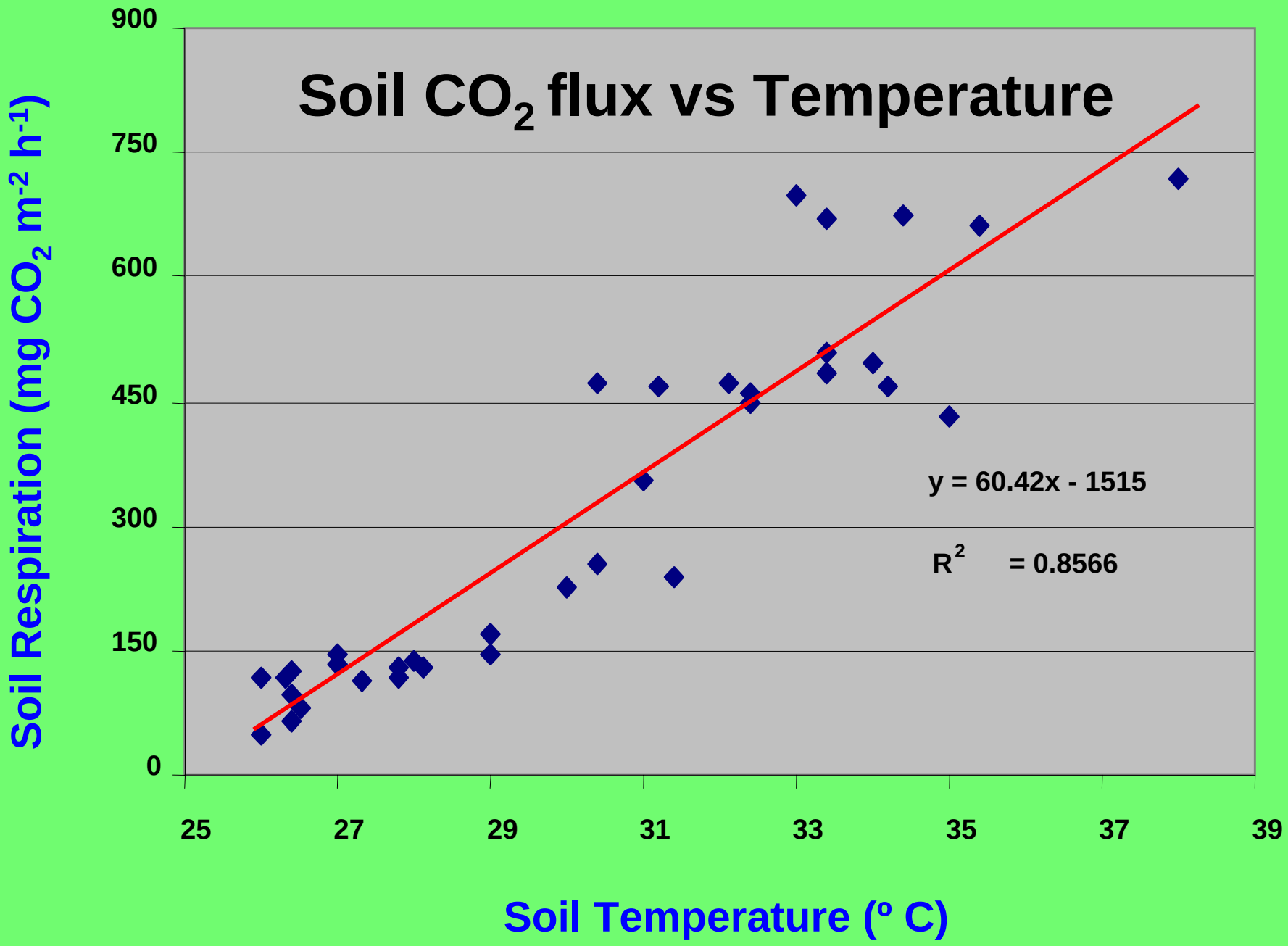
	Weight (t/ha)
Debris > 1.5 cm (3 months after clearing)	123
Estimated C content in debris > 1.5 cm	50-60
Estimated C content in debris < 1.5 cm	40-50

Choice of land clearing technique

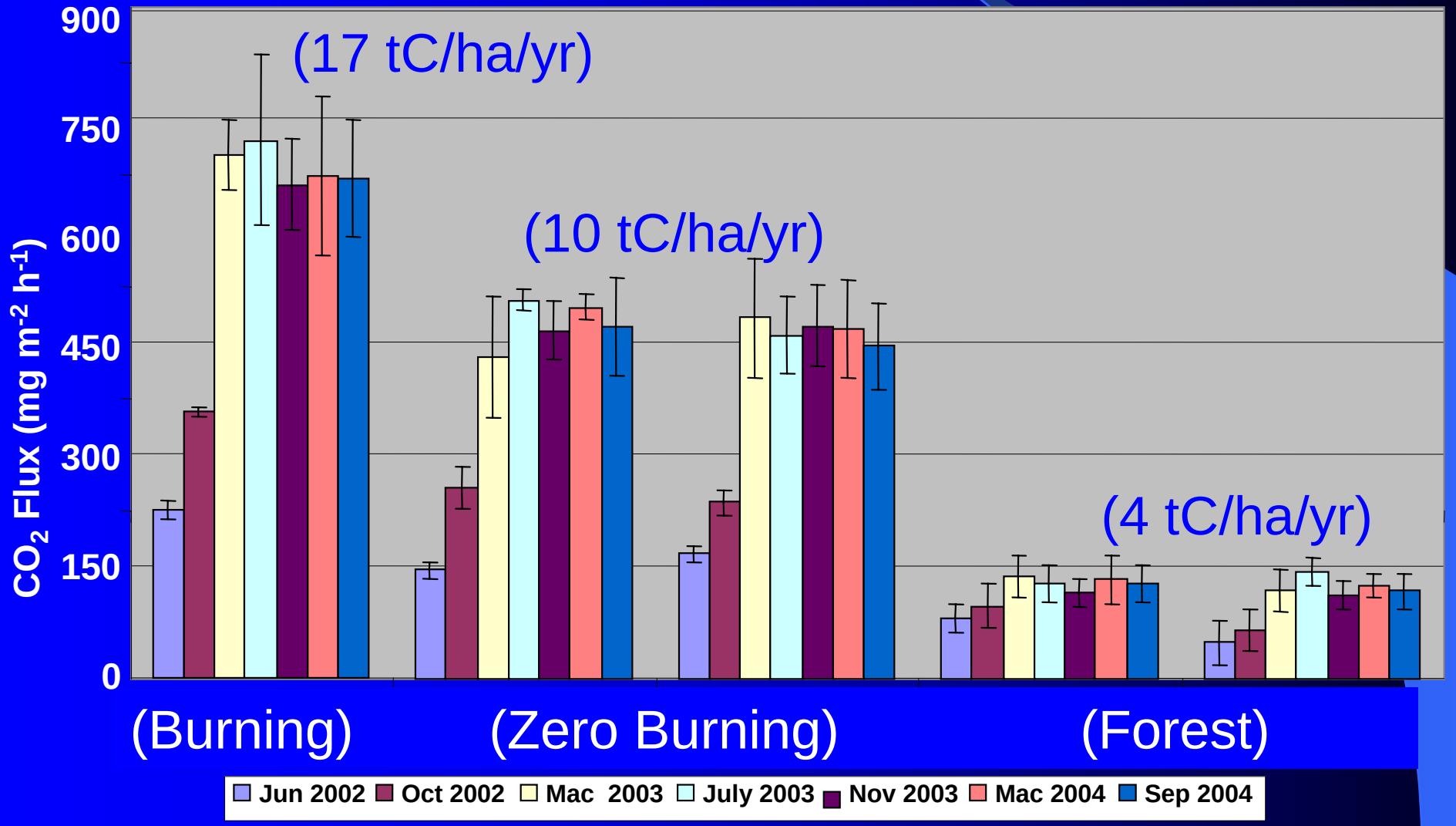
Burning (FB)	Practical, suitable for many crops, emit smoke & toxic gases, release >100 tC/ha (plus 5 tC/ha from every 1 cm peat burning), risk of peat fire
Zero burning (stacking) (FSI)	Suitable for tree crop, release >100 t C/ha in 3-4 years, termites problem
Burying (FBy)	Suitable for many crops, add >100 tC/ha into peatland, very costly

CO_2 daily flux after clearing (FB plot)




Soil CO_2 flux vs Temperature
Soil Respiration (mg CO_2 m^{-2} h^{-1})
900
750
600
450
300
150
0
25
27
29
31
33
35
37
39
Soil Temperature (º C)
y = 60.42x - 1515
R^2 = 0.8566

Soil CO_2 emission after land clearing
(averaged at noon)



Re-growth after land clearing

BURNING

DEBRIS STACKING

Two years

Three years

Flora regeneration after land clearing

> 70 plant species regenerated after clearing – dominated by fast growing *Macaranga spp*.

Macaranga triloba
(3 years old)

6 years old *Macaranga triloba*	
Stand density (No/ha)	2,000
Height (m)	15-20
Girth size (cm)	20-60
Estimated fresh biomass weight (t/tree)	0.3
Estimated C content (tC/ha)	150
Estimated annual C sink (tC/ha/yr)	25
Annual soil C flux (tC/ha/yr)	-4

Agriculture on tropical peatland

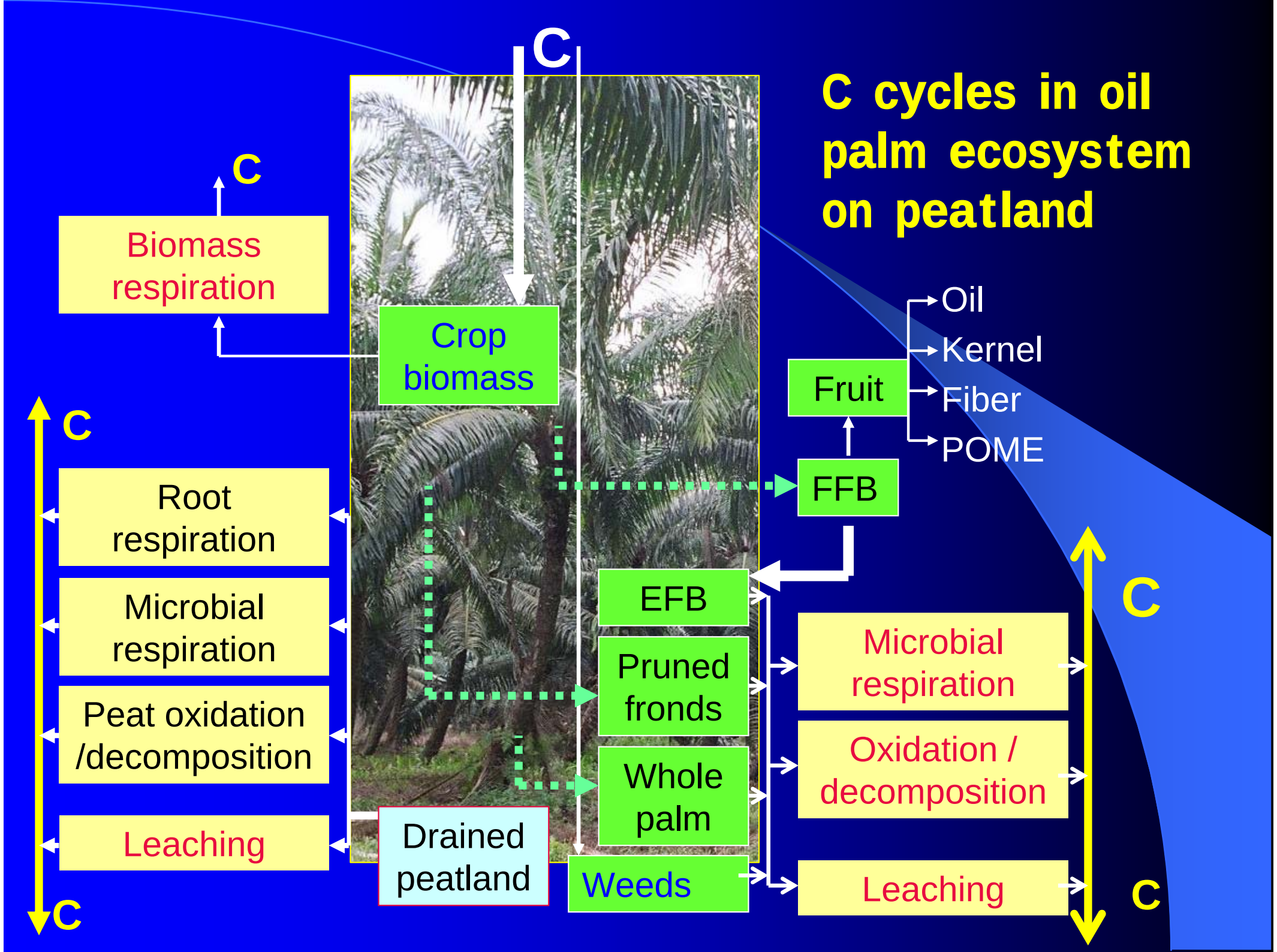
Weeds regeneration under agriculture on peatland

Crop types	Weed diversity		
	Families	Genera	Species
Sweet potato	34	60	74
Papaya	33	59	75
Jackfruit	30	52	64
Oil Palm	47	72	87
Total	**51**	**97**	**118**

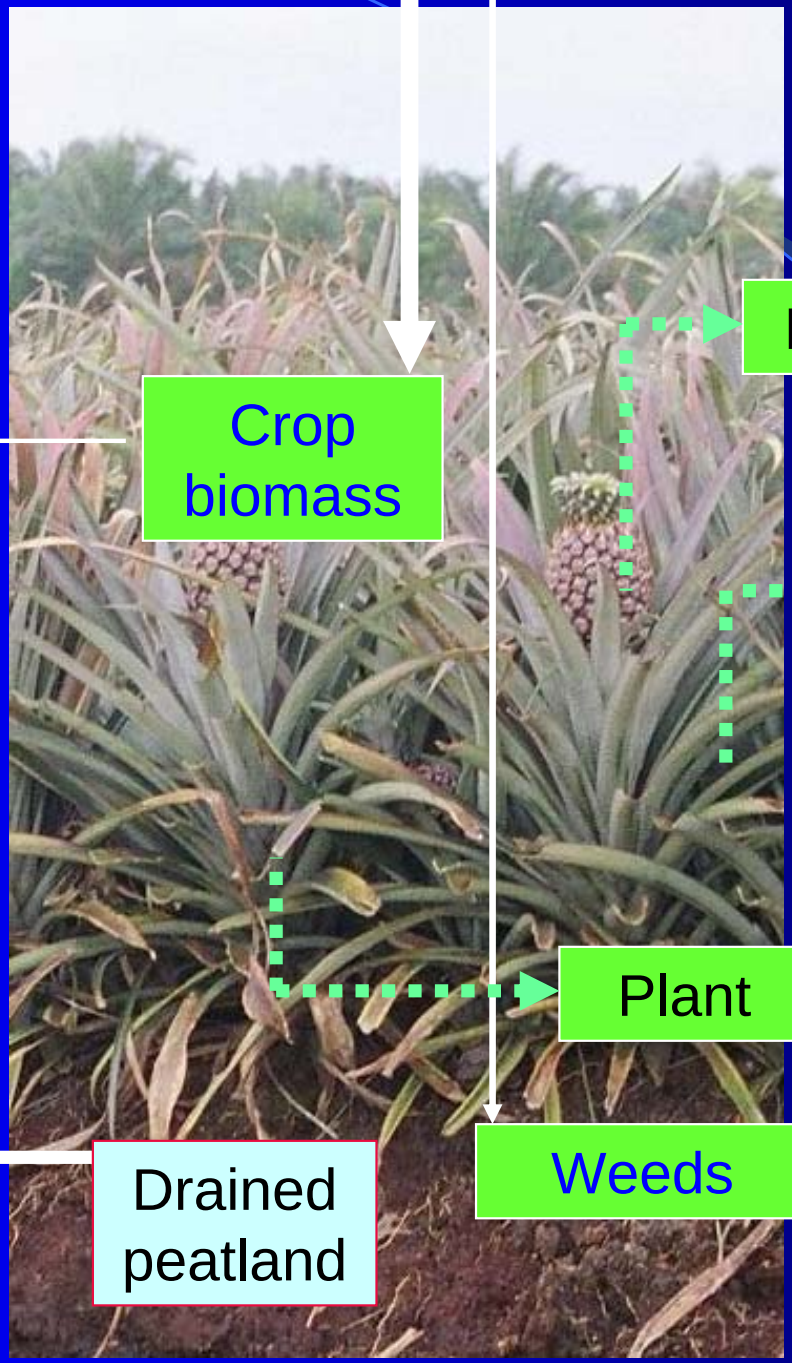
15 trees, 24 shrubs, 34 herbs, 19 climbers, 10 ferns, 8 grasses & 8 sedges.

Soil CO_2 emission under various crops on peatland

	Oil Palm	Jack-fruit	Pine-apple
Age (yr)	10	2	1
Crop cycle	1st	1st	2nd
Water table (cm)	35-80	30-70	10-50
Average soil CO_2 emission ($mg/m^2/hr$)	**150-200**	**100-120**	**120-150**


C cycles in oil palm ecosystem on peatland
C
Biomass respiration
Crop biomass
Oil
Kernel
Fiber
POME
Fruit
FFB
C
Root respiration
Microbial respiration
Peat oxidation /decomposition
Leaching
C
EFB
Pruned fronds
Whole palm
Weeds
Drained peatland
Microbial respiration
Oxidation / decomposition
Leaching
C
C

C cycles in pineapple ecosystem on peatland



C

C

Biomass respiration

Crop biomass

Fruit

Product

Waste

Planting material

C

Root respiration

Microbial respiration

Peat oxidation /decomposition

Leaching

C

Drained peatland

Plant

Weeds

Burning

Microbial respiration

Oxidation / decomposition

Leaching

C

C

Estimated C balance in agro-systems on peatland

Source of C sink (+) / loss (-) (tC/ha/yr)	Oil Palm	Pine-apple
Soil CO_2 flux	-4	-3
Biomass respiration	-?	-?
Leaching	-?	-?
Crop harvest *	6-3	6-1
Crop biomass waste *	8-5	9-7
Weeds *	1-1	1-1
Balance (tC/ha/yr)	**15-(13+?)**	**16-(12+?)**

* Estimated 70% loss from biomass decomposition in the field

CONCLUSION

- There is a possibility to achieve net C-sink from agri-systems on peatland through 1) land clearing involves burying the forest debris, 2) let the newly cleared land, if not immediately used, naturally colonized by *Macaranga spp.,* and 3) increase utilization of crop biomass waste. These tasks, however, require financial and technological support.
- More damaging effect of agriculture development on peatland is the continuous depletion of C reserve from peat decomposition under aerobic conditions.


Thank you
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