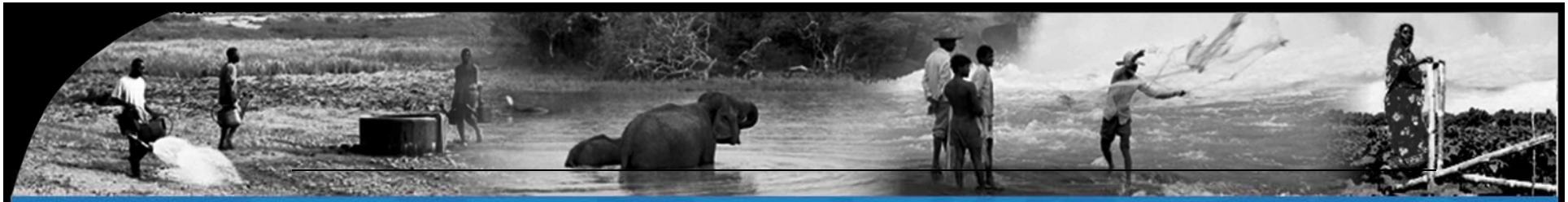


Soil carbon management in developing countries

Andrew Noble

IWMI-SEA, Vientiane Lao PDR

Overview of Presentation

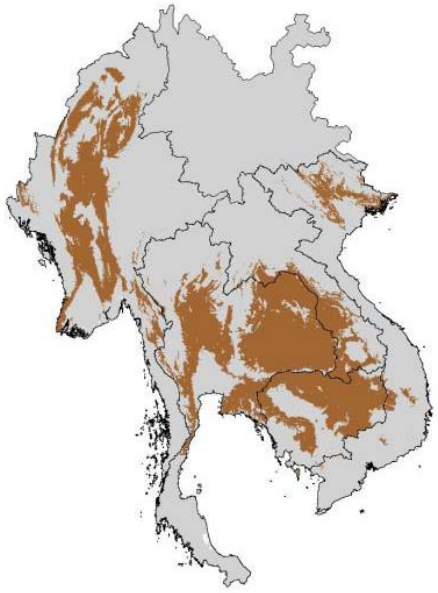
Setting the scene - focus on Southeast Asia (GMS).

Soil carbon management – possible strategies to sequester soil C in these dynamic systems.

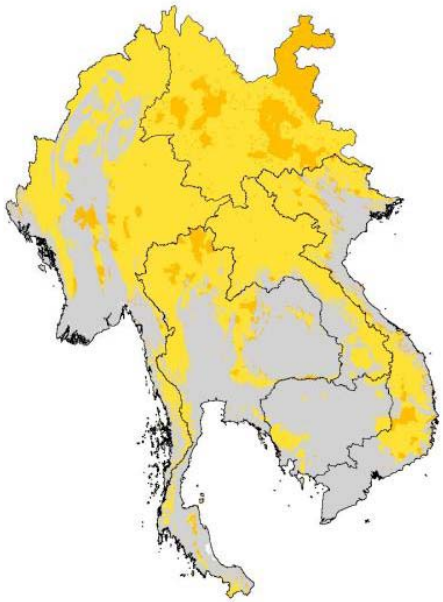
Mega-deltas

Coasts

Plains and plateaus



Uplands – forested vs intensively used

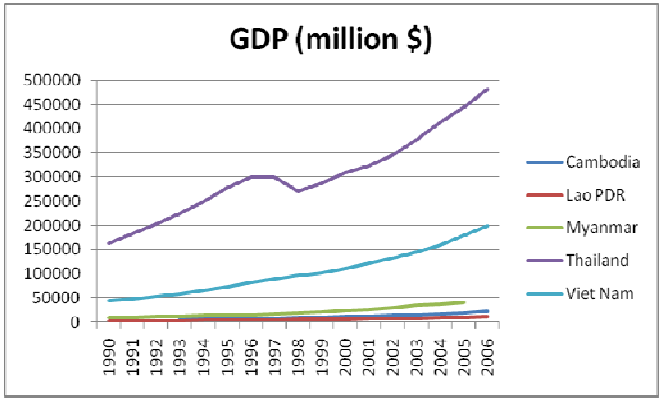


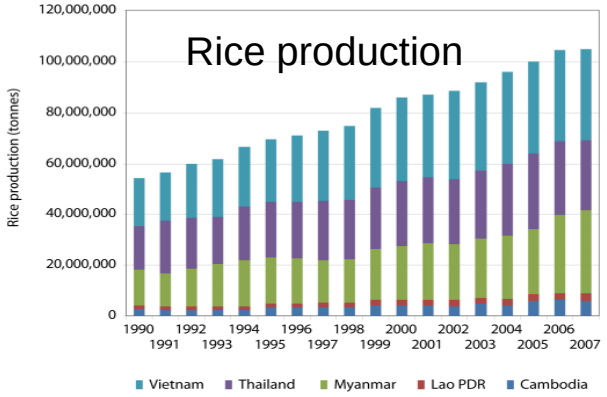
Setting the scene

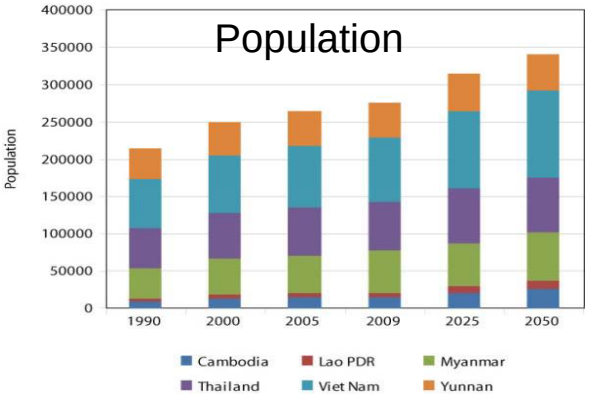
Drivers of change in agriculture and environment

- Population growth
- Food consumption patterns and preferences
- Urbanization and “new rurality”
- Economic growth (financial crisis)
- Global and regional trade – China
- Foreign investment
- Hydropower development
- Climate change
- Political/Social changes

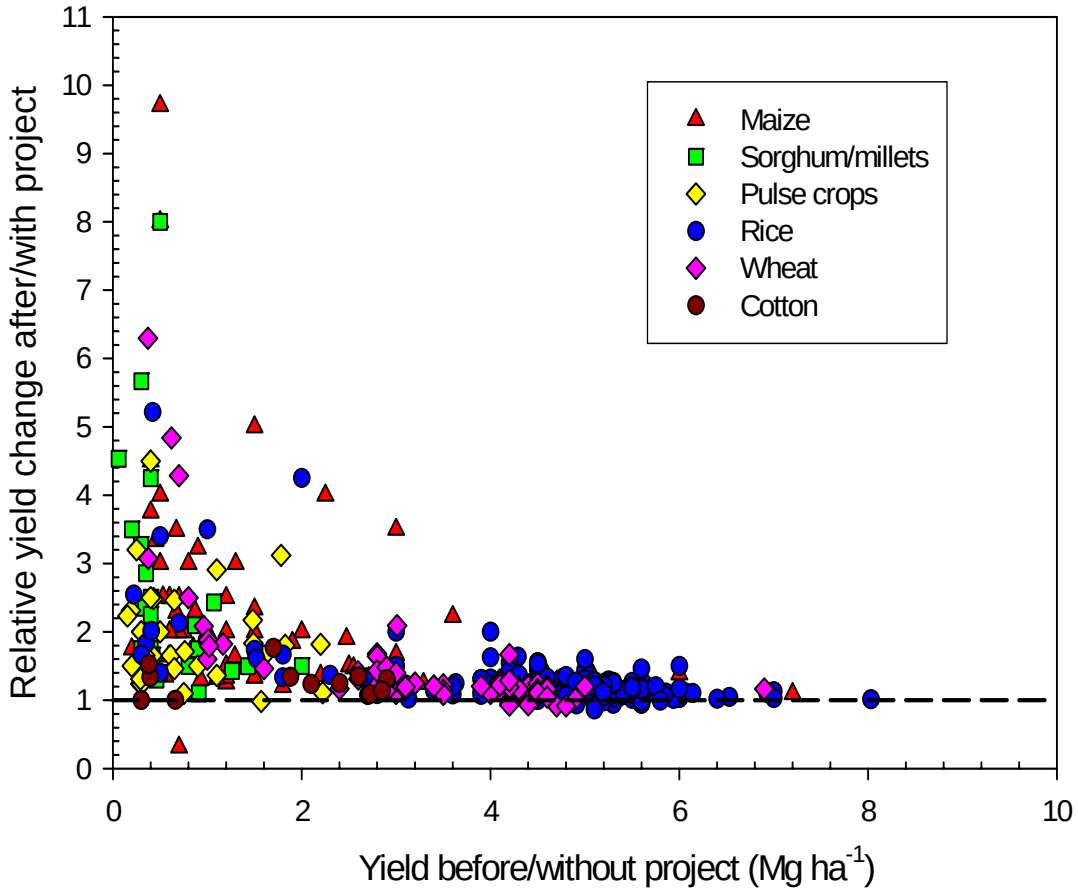
Challenge to increase food production by >25% over next 40 years







Global assessment of 'Bright' spots – cause for optimism in adaptation



Comprehensive study of 286 cases in 57 countries where individuals and communities that have adopted simple, non-exploitive, innovations to their production systems that have increased incomes and enhanced food security at the household level.

Bright spots influenced:
10.9 million households
covering **31.6 million hectares**.

Pretty et al., 2006; Noble et al, 2006; 2008; ul Hassam et al., 2005.

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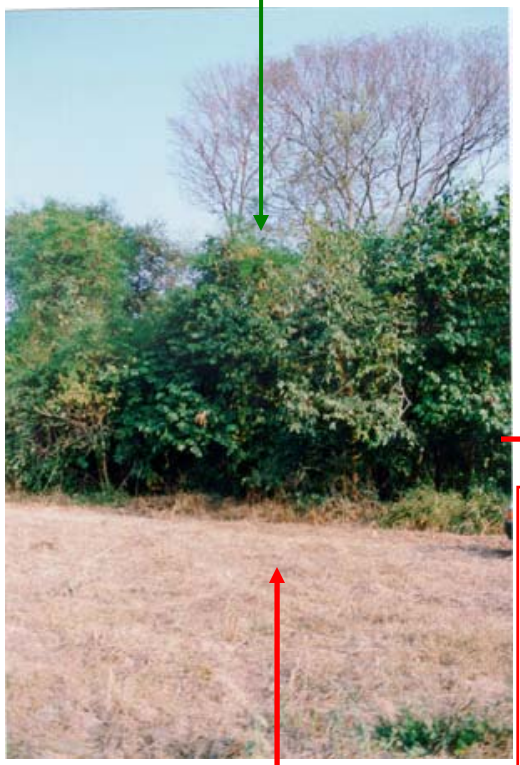
Carbon sequestration

Pretty et al., 2006

FAO farm system category	Carbon sequestered per hectare (t C ha^{-1} y^{-1})	Total Carbon sequestered (Mt C y^{-1})	Carbon sequestered per household (t C y^{-1})
1. Smallholder irrigated	0.15 (±0.012)	0.011	0.06
2. Wetland rice	0.34 (±0.035)	2.53	0.29
3. Smallholder rainfed humid	0.46 (±0.034)	0.34	0.20
4. Smallholder rainfed highland	0.36 (±0.022)	0.23	0.56
5. Smallholder rainfed dry/cold	0.26 (±0.035)	0.20	0.32
6. Dualistic mixed	0.32 (±0.023)	8.03	14.95
7. Coastal artisanal	0.20 (±0.001)	0.032	0.15
8. Urban-based and kitchen garden	0.24 (±0.061)	0.015	0.07
Total	**0.35 (±0.016)**	**11.38**	**0.91**

Soil degradation issues associated with land change.

Dipterocarp Forest



Long-term Agriculture

- ❖Species diversity
- ❖High biological activity
- ❖High productivity
- ❖High soil fertility and physical attributes

Aggrading system

Degrading system

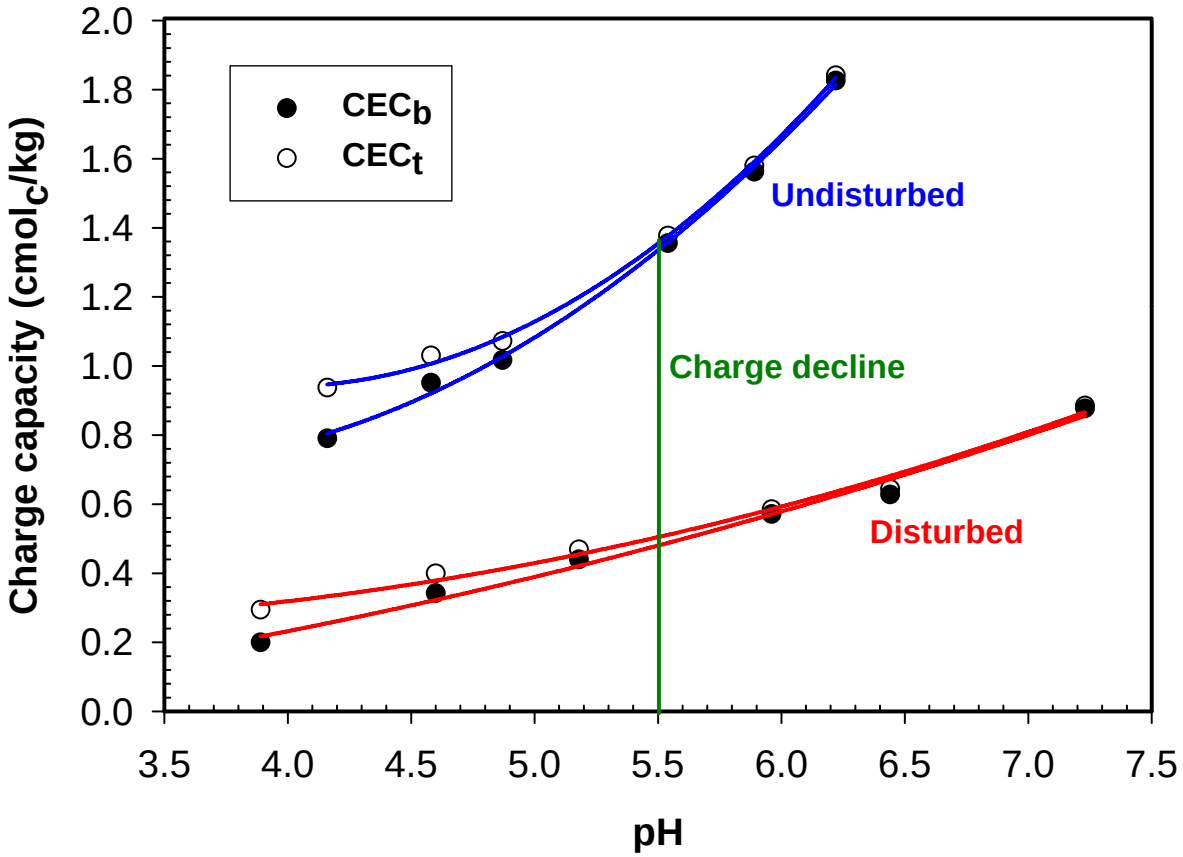
- ❖Loss of nutrients
- ❖Loss of soil organic matter
- ❖Reduction in water holding capacity
- ❖Physical degradation (compaction)
- ❖Leaching losses and acidification

Fertility decline due to changed land use.

Depth	Vegetation	$pH_{0.002}$	OC
(cm)			(%)
0-10	Forest	5.18	0.66
0-10	Cassava	5.00	0.32
20-30	Forest	4.95	0.39
20-30	Cassava	4.86	0.36
50-70	Forest	5.18	0.11
50-70	Cassava	5.04	0.10

Soils of the region are light textured with a clay content of 5.8% - dominated by 1:1 kaolinite with a surface charge of > 5cmol$_c$/kg clay.

Surface charge fingerprints – an integrator of changes in soil C.



Surface charge fingerprints quantifies the **current** and **potential** capacity of a soil to retain nutrients.

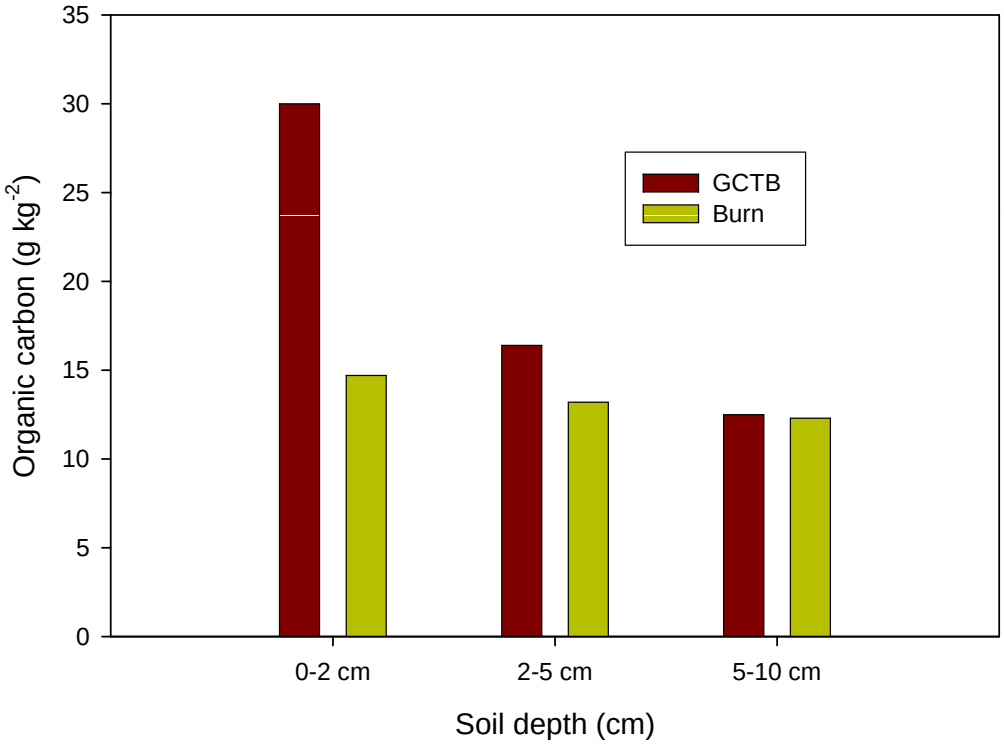
CEC changes a possible measure of increases in soil C.

(Noble *et al.*, 2004)

Conserving organic matter – a challenge in tropical agricultural systems.

Converting from burning to green cane trash blanketing returns 12t DM/ha.year

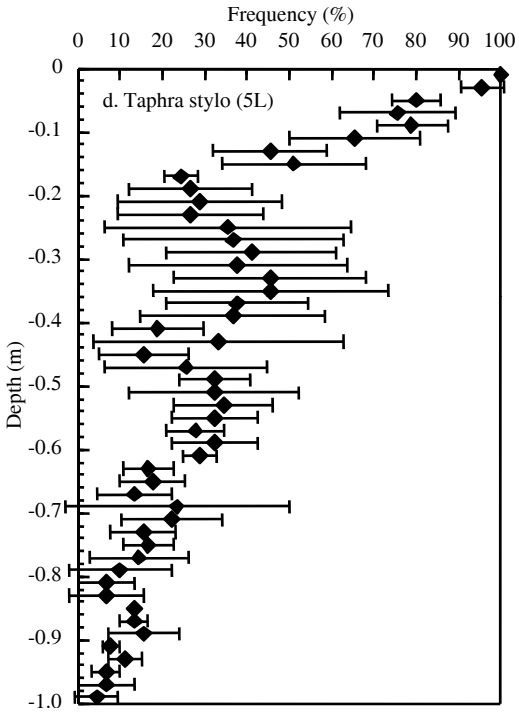
Changing harvesting systems – increases in OC not permanent



- Changing harvesting system in cane results in increased OC.
- As soon as system disturbed OC is lost.
- OC conservation in tropical environments is **often transient**.
- May not be a viable option in many tropical systems.

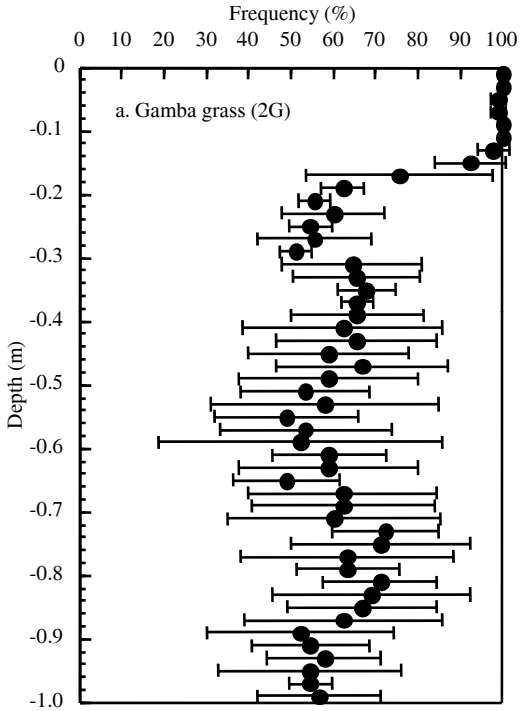
Noble et al., 2003

Increasing carbon to depth through forage introductions.



Stylos

Introducing forage species that are able to grow on acid light textured soils

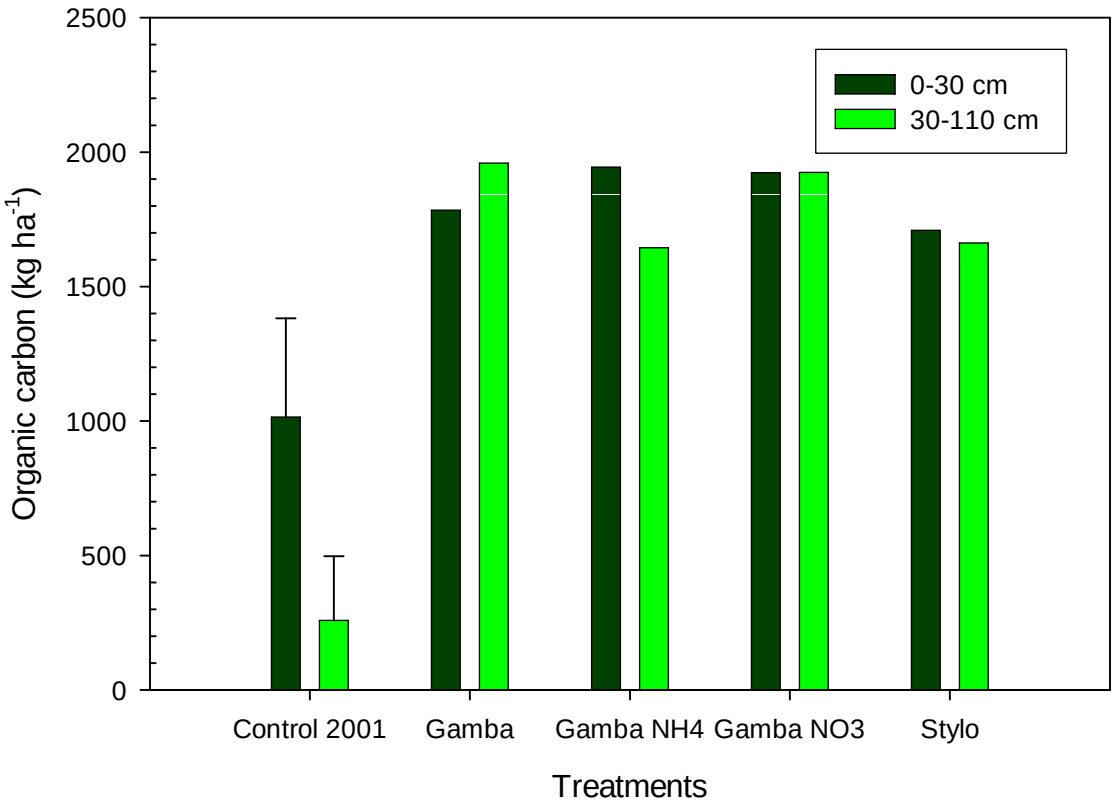


Gamba

Increased root frequency under Gamba (*Andropogen sp*) when compared to Stylos.

Gamba makes use of stored subsoil moisture and grows throughout the year – forage for livestock.

Soil C storage after 3 years fallow.

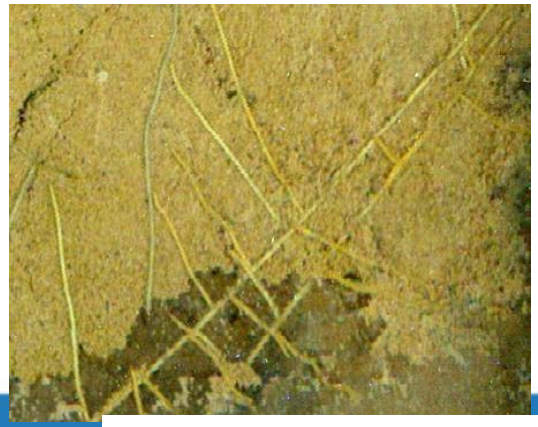


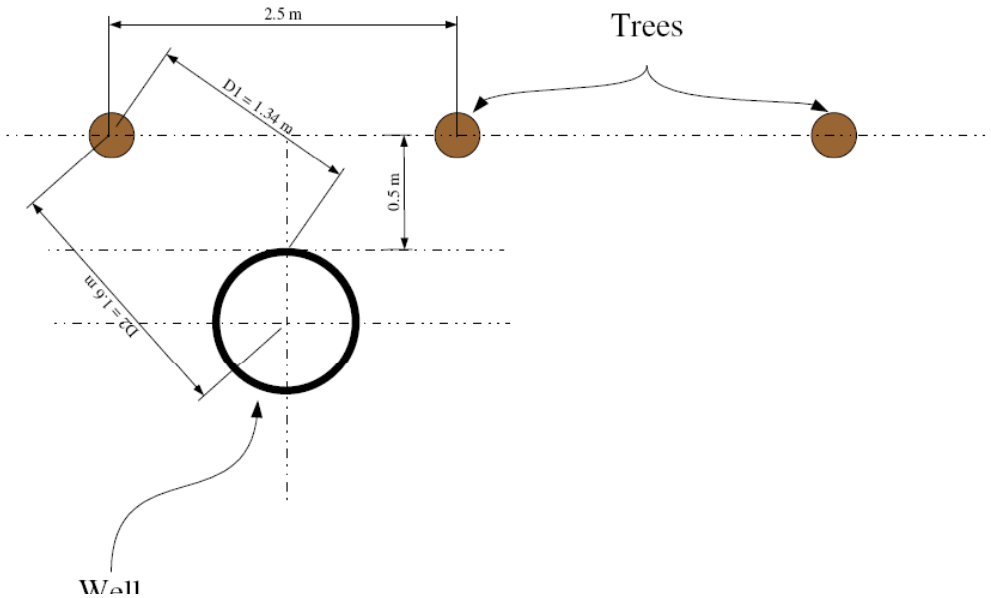
- Increased C below 30cm due to rooting attributes of forage.
- Residence time of C below 30cm significantly longer.

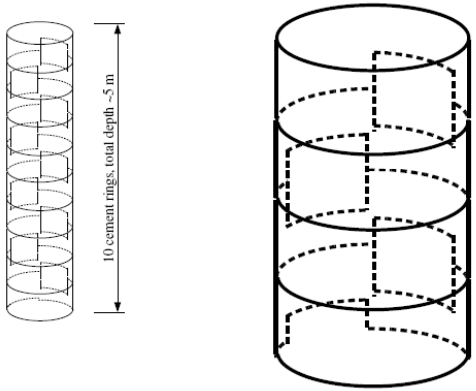
Noble et al., 2008

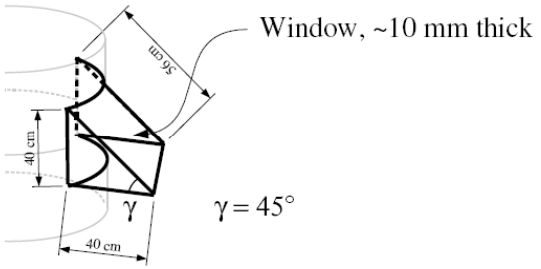
Fine root dynamics in a rubber tree plantation (NE Thailand)

Root observation access-well









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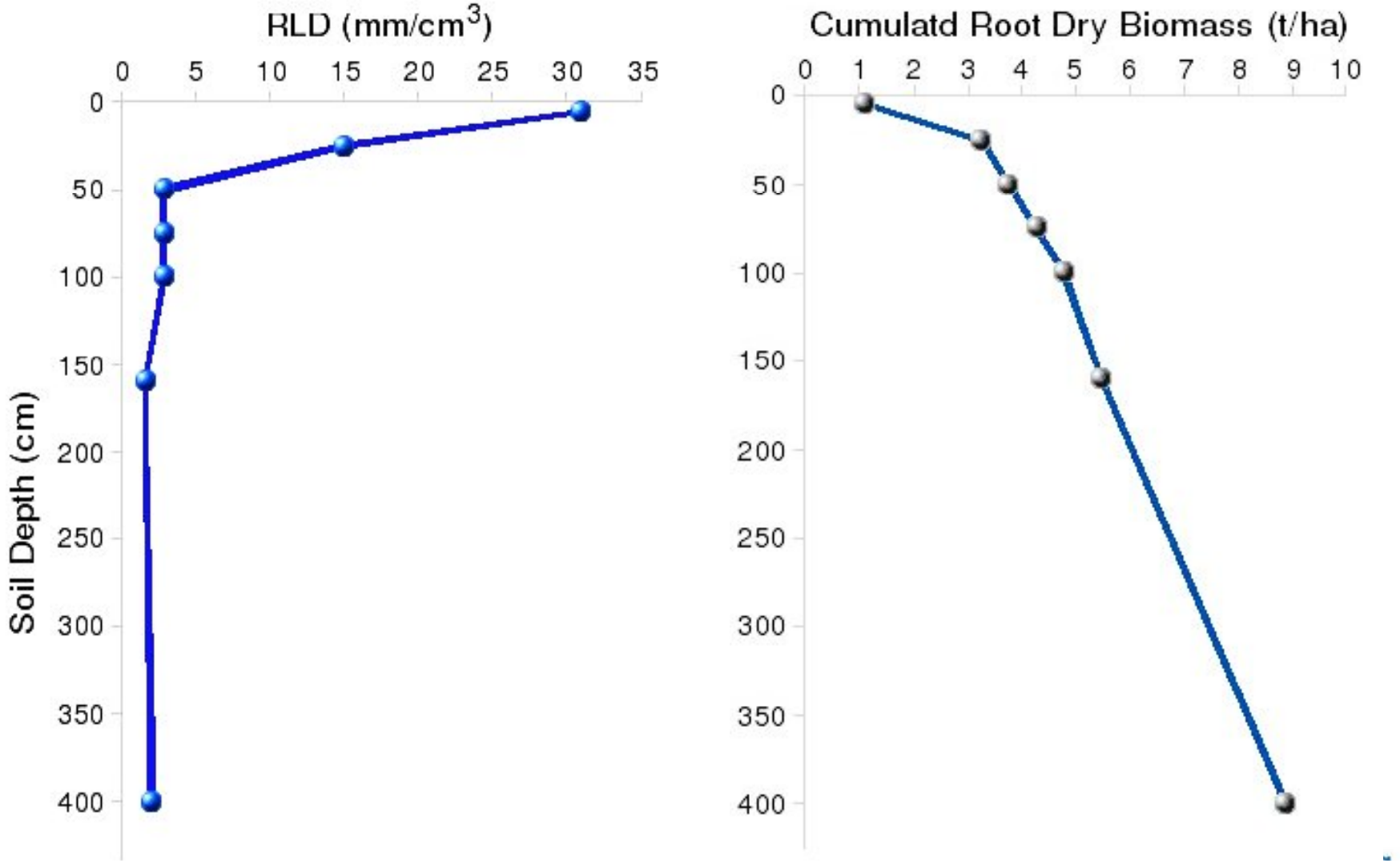
Gonkhamdee S. et al. (2010). Khon Kaen Argiculture Journal, 37: 265-276.

Fine root distribution in a rubber tree plantation (NE Thailand)



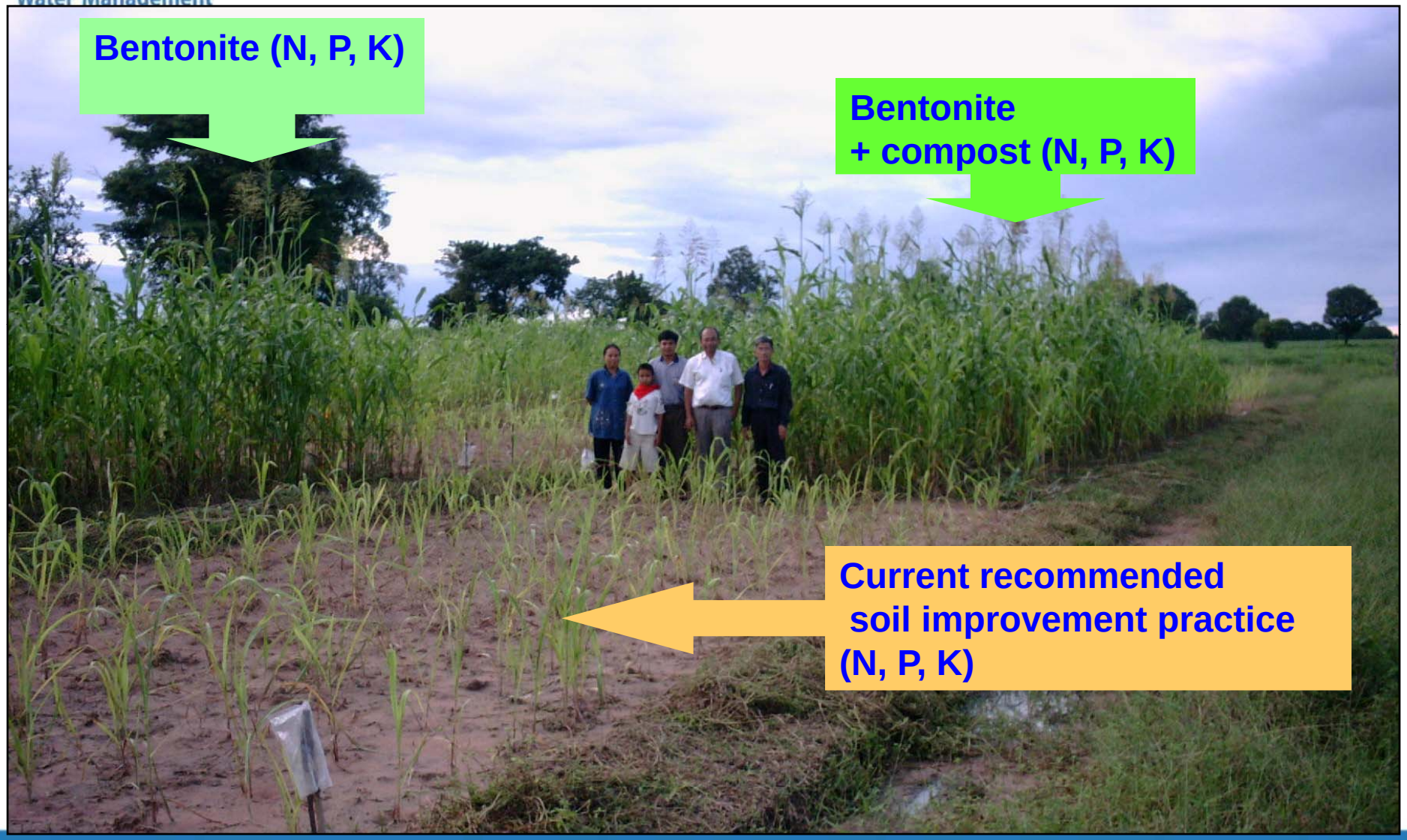
Fine root biomass below 100 cm: >30% of the overall fine root biomass.
(note: the deepest sampled soil depth is not the trees maximum rooting depth)

Addressing soil fertility decline – learning from traditional approaches

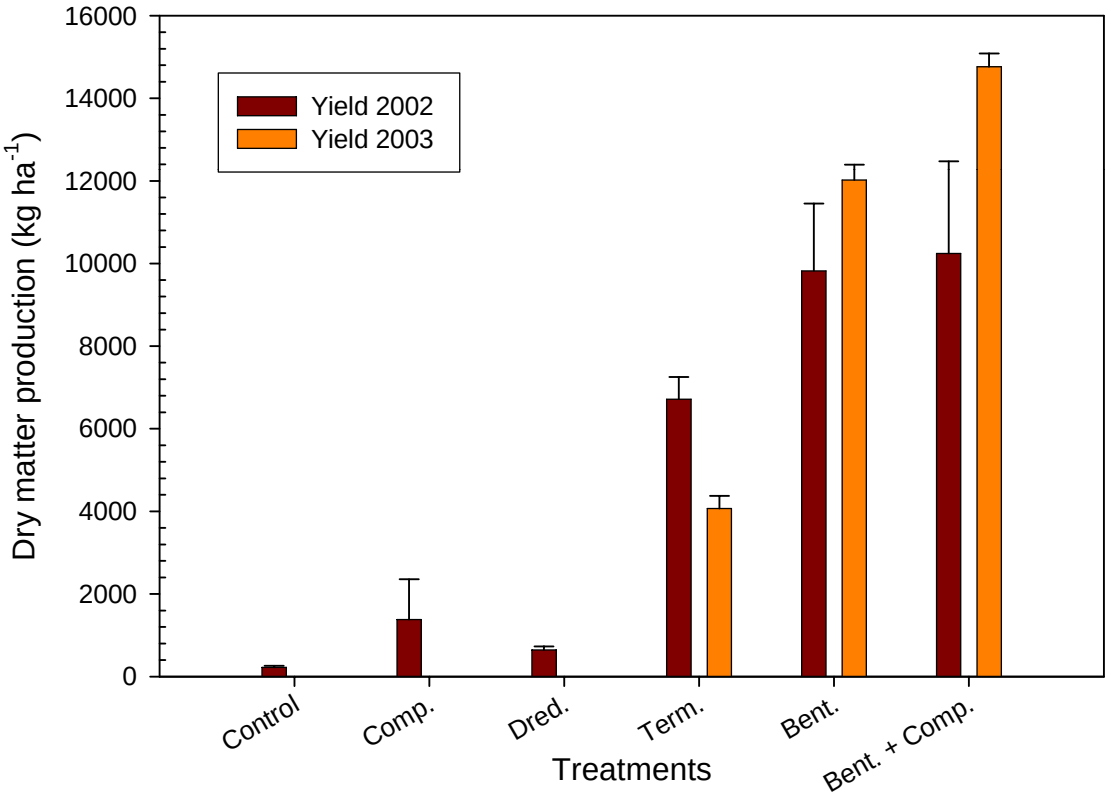
Farmers are able to recognize that soils are degraded.
They address the problem through the application of of termite mound (*Macrotermes sp.*) material.

Termite mound material high in Ca, Mg and OC.
Dominated by kaolinite clay.
Applied at rates of 7200 t/ha.
Vegetable crops grown.
Ecologically unsustainable

Increasing biomass production



Yield response forage sorghum 2002 and 2003 growing seasons



- Degree of degradation of these systems is extreme.
- Significant increase in productivity over 2 years to clay based amendments.
- Responses have **persisted** and **increased** in bentonite treatments.

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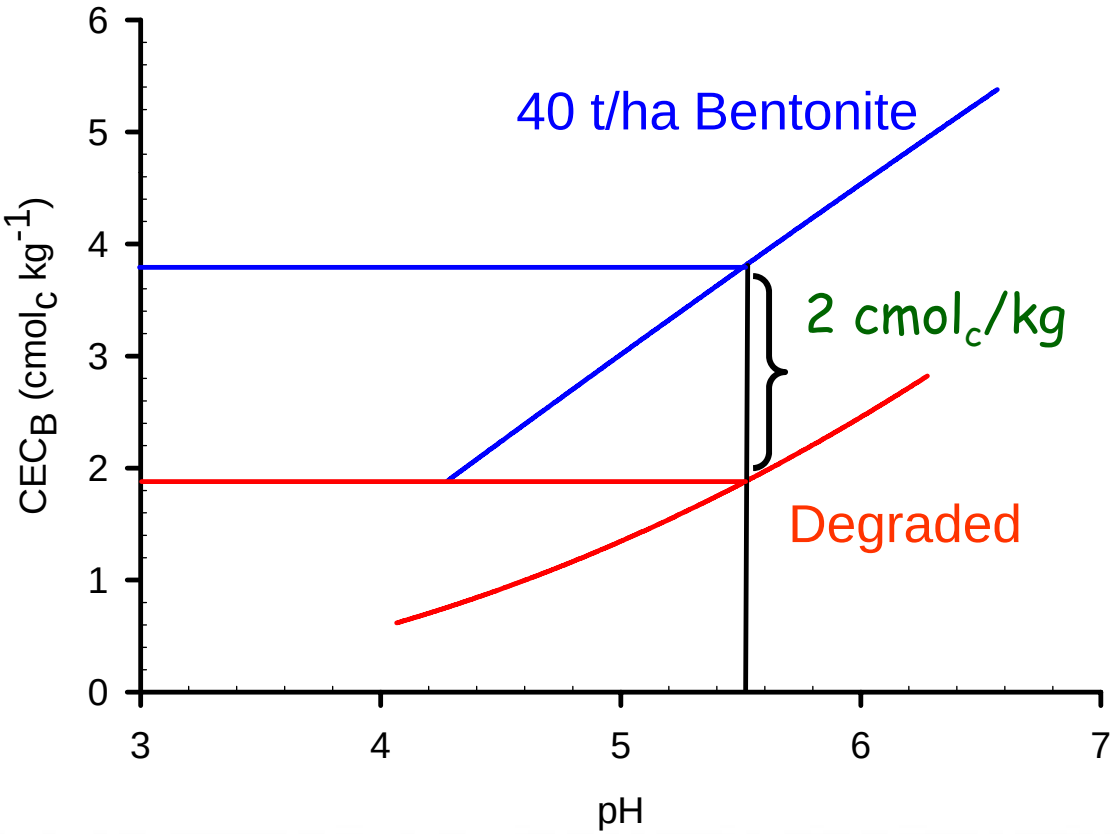
Charges in soil CEC associated with clay



Driver of response associated with increased charge generation through the addition of permanently charge clay.

Food for thought

Diets and Water

Between 2,000 and 5,000 liters per person per day – depending on type and amount of food eaten and how it is produced.

Developed ⟷ ***Developing***



International Water Management Institute

Thank you

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