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AGRICULTURAL RESEARCH
FOR DEVELOPMENT

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Managing soil quality to improve sustainability of rubber plantations, what do we know?

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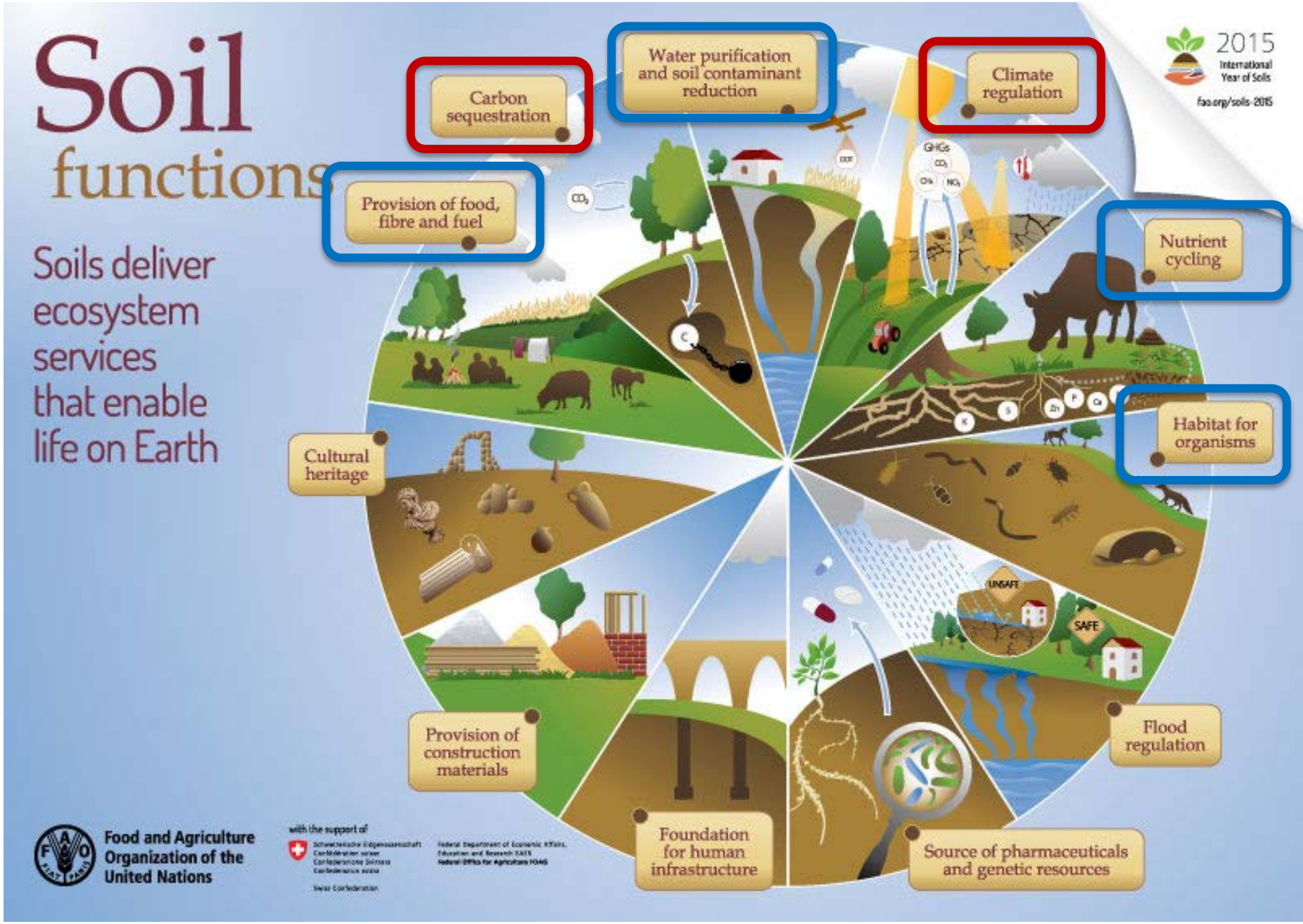
SOILS AND CLIMATE CHANGE

❖ MITIGATION

- Soil carbon Sequestration
- Regulation of GHG flux (N2O)

❖ ADAPTATION

- Provision of food, fiber and fuel
- Regulate nutrient and water cycle
- Habitat for organisms



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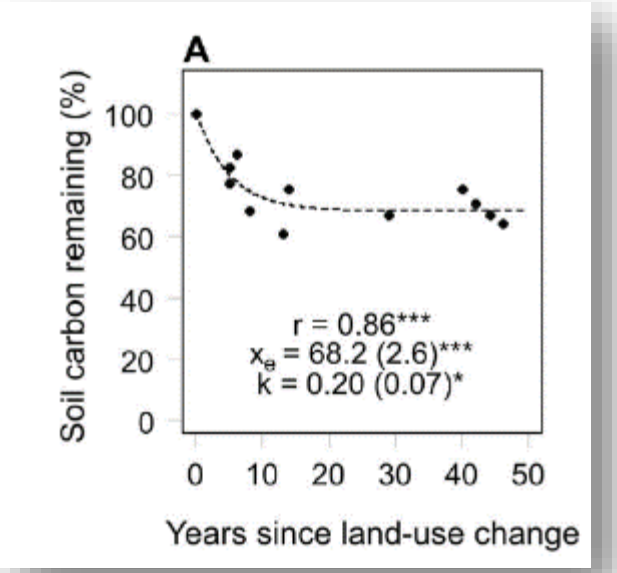
Rubber plantation and soils: after the forest

OPEN ACCESS Freely available online

PLOS ONE

Soil Carbon Stocks Decrease following Conversion of Secondary Forests to Rubber (*Hevea brasiliensis*) Plantations

Marleen de Blécourt[1]*, Rainer Brumme[1], Jianchu Xu[2], Marife D. Corre[1], Edzo Veldkamp[1]



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Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

ELSEVIER

Soil degradation in oil palm and rubber plantations under land resource scarcity

Thomas Guillaur
Bernhard Brümm

Contents lists available at ScienceDirect

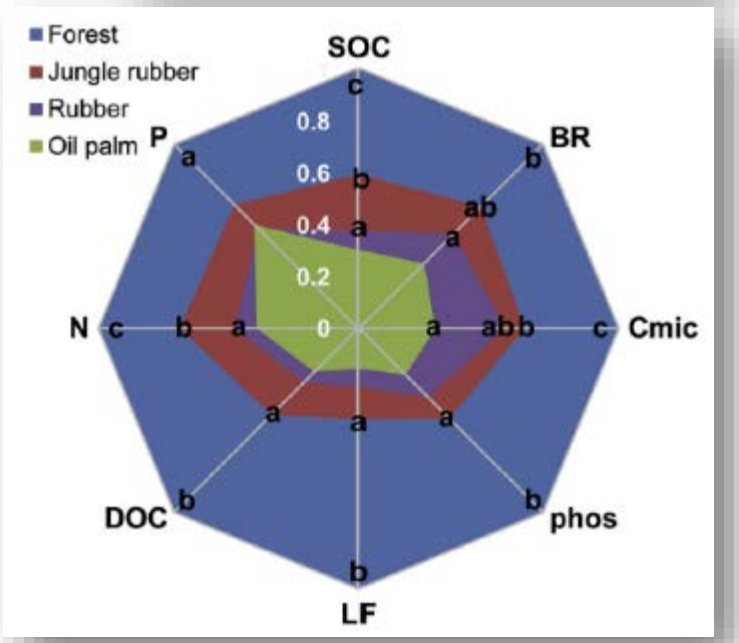
Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

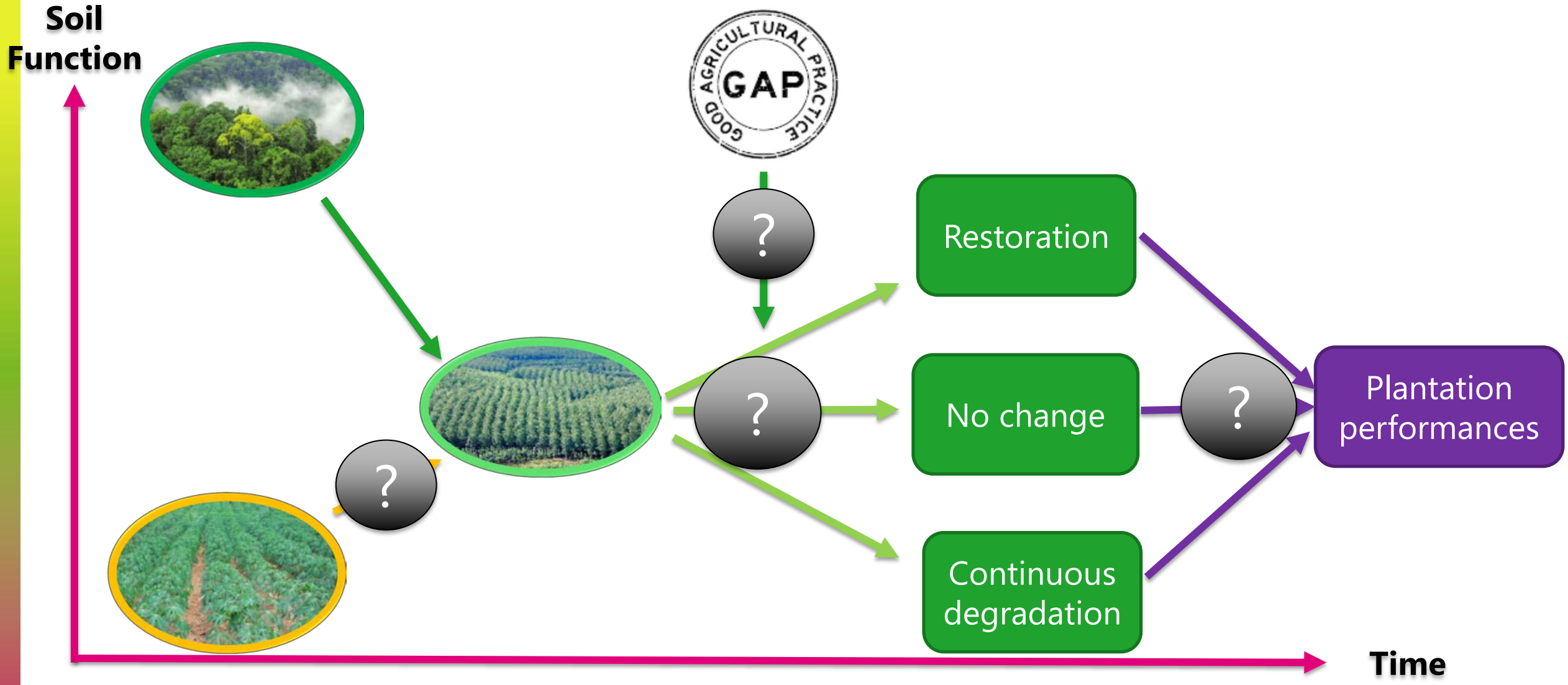
ELSEVIER

Sensitivity and resistance of soil fertility indicators to land-use changes: New concept and examples from conversion of Indonesian rainforest to plantations

Thomas Guillaume[a,b,c,*], Deejay Maranguit[a], Kukuh Murtilaksono[d], Yakov Kuzyakov[a,e]



Rubber plantation and soils, after the forest ?



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How to assess soil quality?

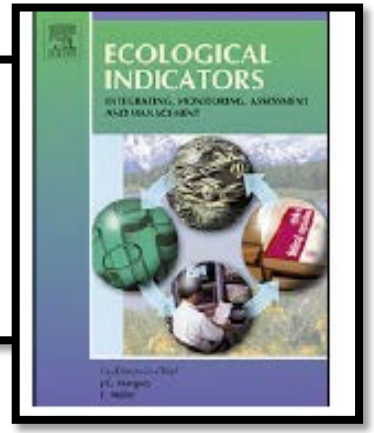
"The capacity of soils to function and provide ecosystem services"

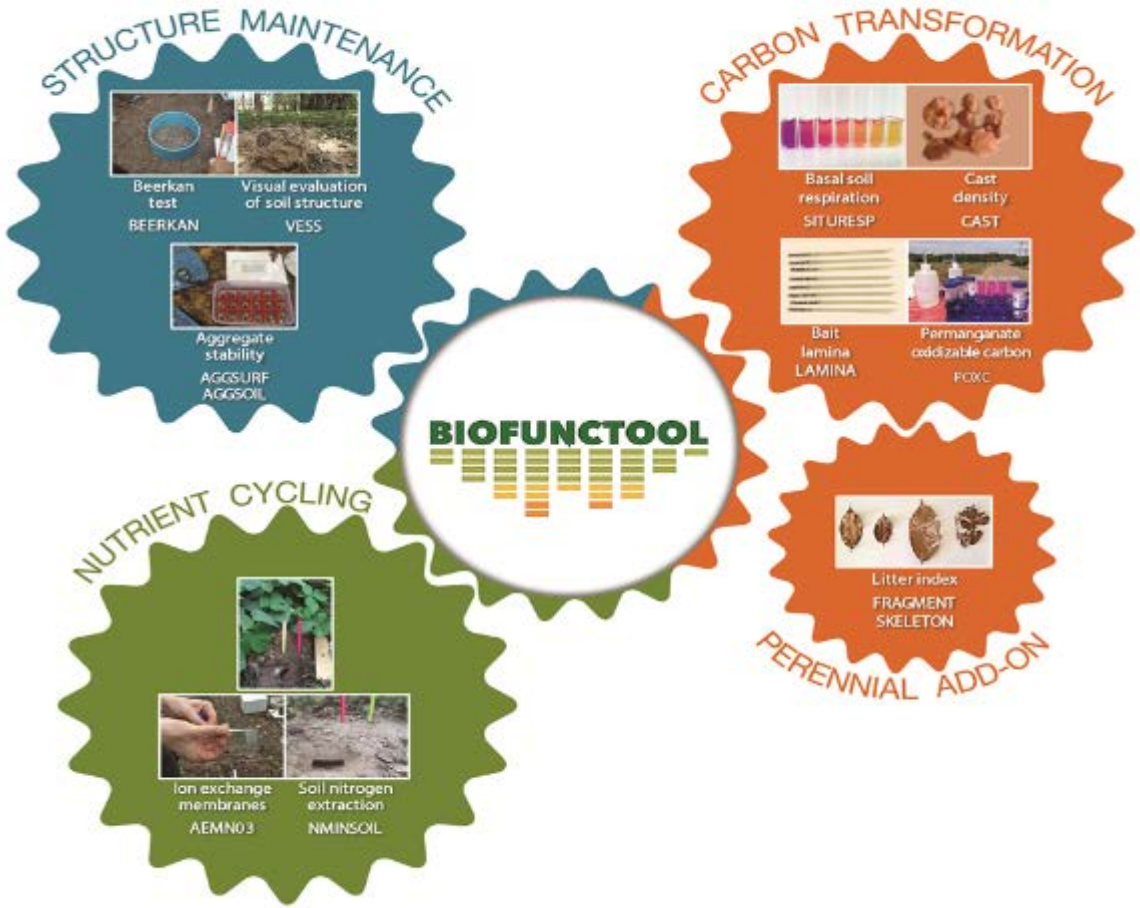
(Karlen et al., 1997; Walter et al. 2015)

Ecological Indicators 97 (2019) 100–110

Biofunctool®: a new framework to assess the impact of land management on soil quality. Part A: concept and validation of the set of indicators

Alexis Thoumazeau[a,b,c,d,*], Cécile Bessou[a], Marie-Sophie Renevier[b,d,e], Jean Trap[b],





- **Conceptual** framework based on Kibblewhite et al., 2008;
- **3 functions** linked to assemblages of soil organisms
- **9** low-costs, in-field **indicators**
- Aggregation into one **Soil Quality Index** (SQI)

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One plantation, Two phases

Immature phase: 0 - 6 years

Rapid growth
High nutrient requirement
Positive response to fertilization
Vrignon-Brenas et al., 2019. Agron. Sust. Dev.

Nutrient management of immature rubber plantations. A review

Sylvain Vrignon-Brenas[1,2] · Frédéric Gay[3] · Sophie Ricard[1] · Didier Snoeck[2] · Thibaut Perron[2] · Louis Mareschal[3] · Jean-Paul Ladau[3] · Éric Gohet[2] · Philippe Malagoli[1]

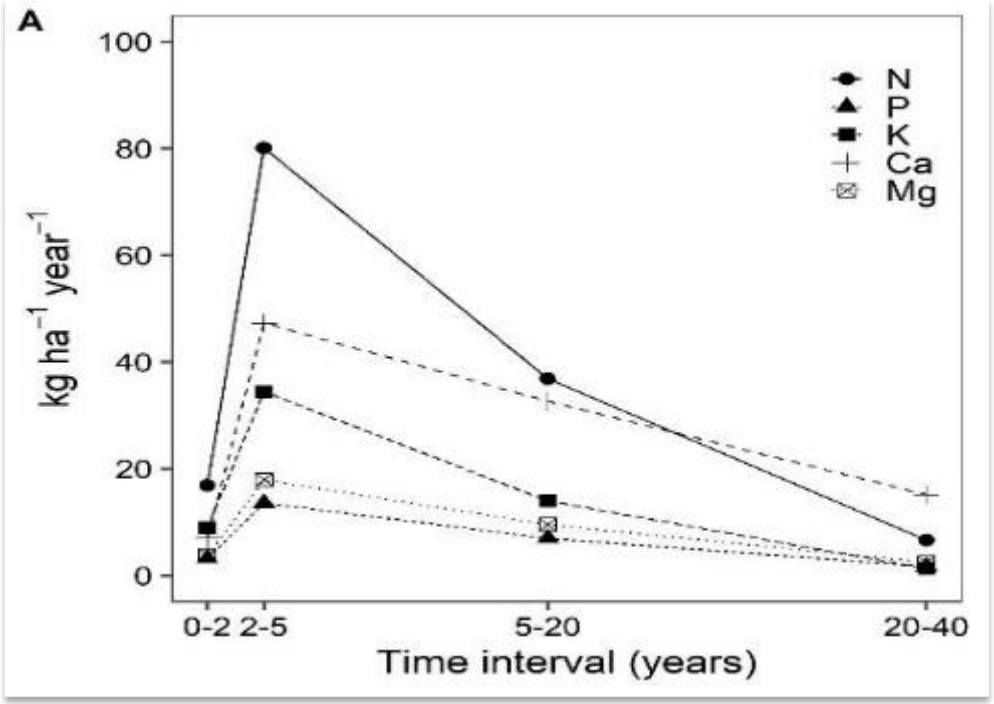
Mature phase: 6 years – clear felling

Slow growth after opening of the trees
Low nutrient export
Unclear response of yield to fertilization
Chotiphan et al., 2019. Ind. Crop Prod.

Can fertilization be a driver of rubber plantation intensification?

Rawiwan Chotiphan[a,b], Laurent Vaysse[c,d], Regis Lacote[d,e], Eric Gohet[e], Philippe Thaler[d,f], Kannika Sajjaphan[a], Celine Bottier[c,d], Christine Char[c], Siriluck Liengprayoon[g], Frederic Gay[f,d,*]

One plantation, Two phases



Nutrient accumulation rate throughout the life span of a rubber plantation

(*Perron et al., in prep*. FERTIM project, Ivory Coast)

5 YEARS experiment on effect of mineral fertilizers on rubber tree productivity and functioning (% of unfertilized control-T1; in bold, significant effects at p=0.05)			NPK FERTILIZER APPLIED PER TREE PER YEAR		
			T2: 75/45/100 g/tree/yr NPK	T3: 180/80/170 g/tree/yr NPK	T4:306/136/289 g/tree/yr NPK
Production	Yield	p=0.051	+8%	+8%	+8%
Tree functioning (growth, nutrition, latex metabolism)	Basal area	p=0.001	+6%	+7%	**+9%**
	N leaves	p=0.0003	+2%	+2%	**+12%**
	N latex	p=0.0289	+6%	+8%	**+12%**
	Pi latex	p=0.005	**+8%**	**+18%**	**+21%**
Latx and rubber quality	MST latex	p=0.0915	-7%	-16%	-20%
	PRI rubber.	p=0.0752	+6%	+6%	+6%

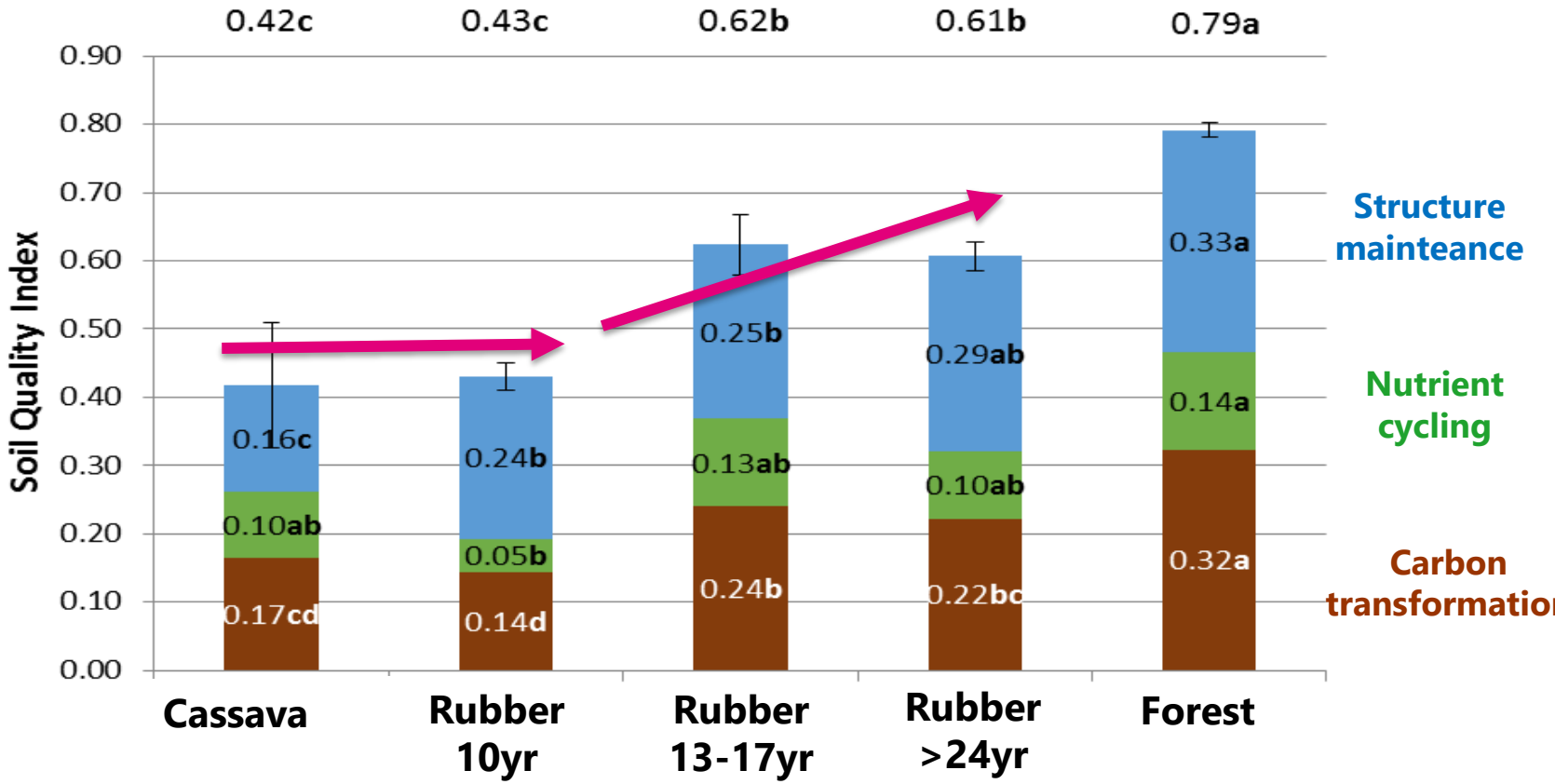
Long-term effects of mineral fertilization on rubber yield and tree functioning

(*Gay et al., 2019*., *CID 2019,* YARA project, Thailand)

One plantation, Two phases

Thoumazeau et al., 2019, Ecol. Indic.

Biofunctool®: a new framework to assess the impact of land management on soil quality. Part B: investigating the impact of land management of rubber plantations on soil quality with the Biofunctool® index



➔Immature phase: **low soil quality**, depend on the previous land use

➔Mature phase: **improvement** of soil functions with time

How to manage soils in rubber plantation?

Soil cover management

Logging and replanting management

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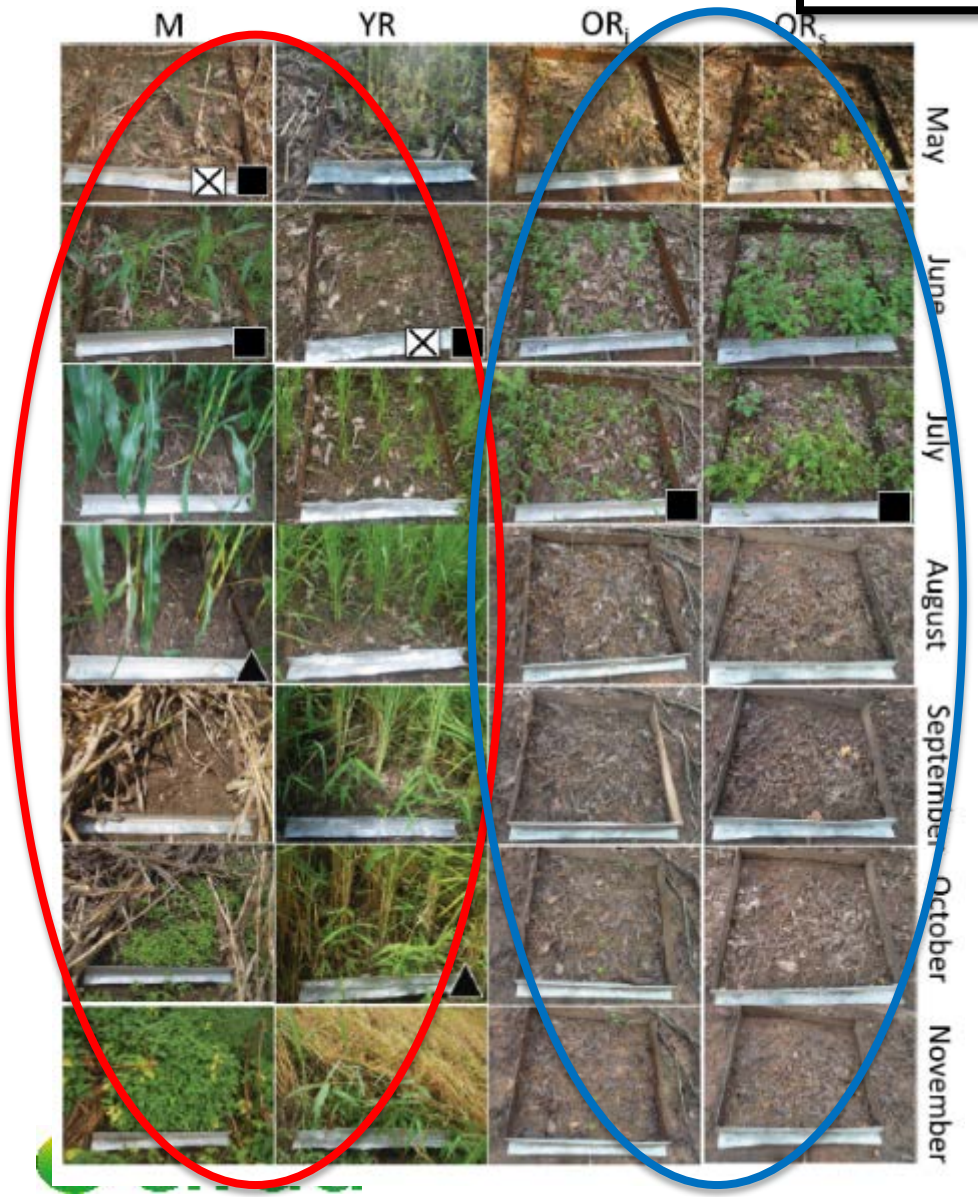
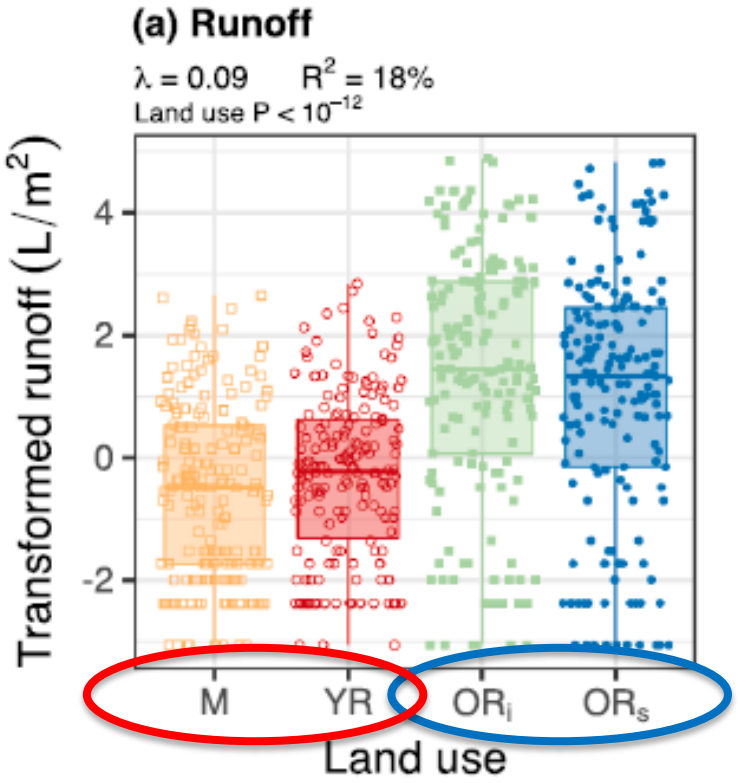
Soil cover management

Higher runoff and soil detachment in rubber tree plantations compared to annual cultivation is mitigated by ground cover in steep mountainous Thailand *Neyret el al. 2020 Catena*



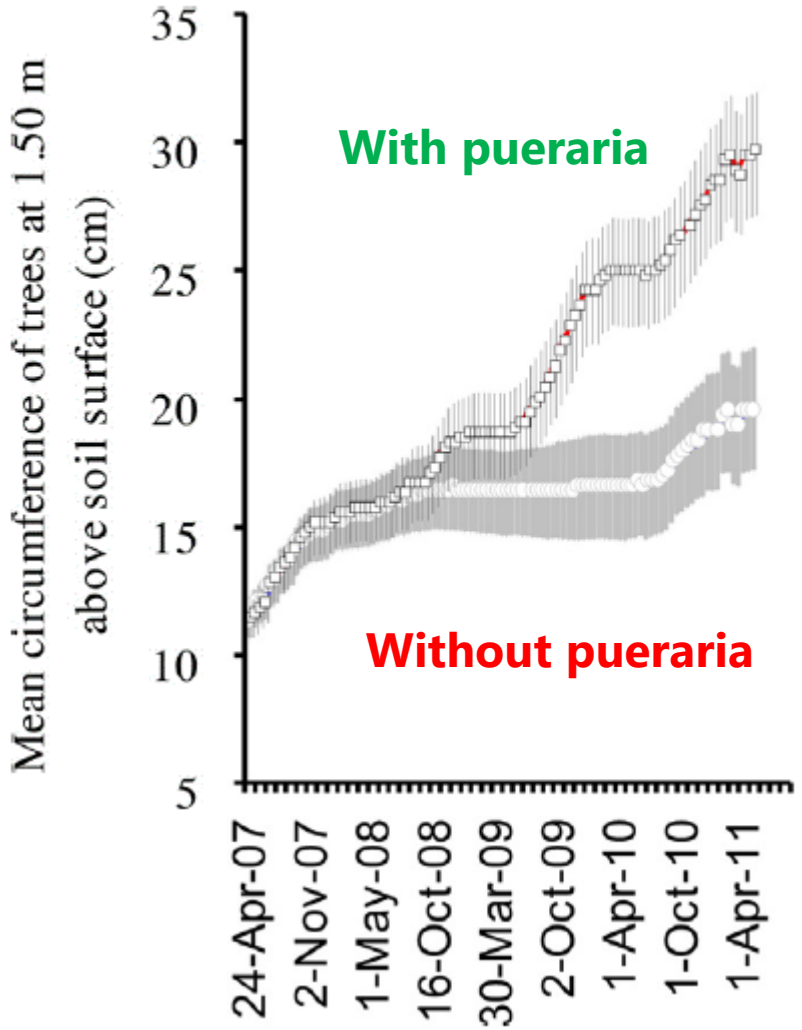


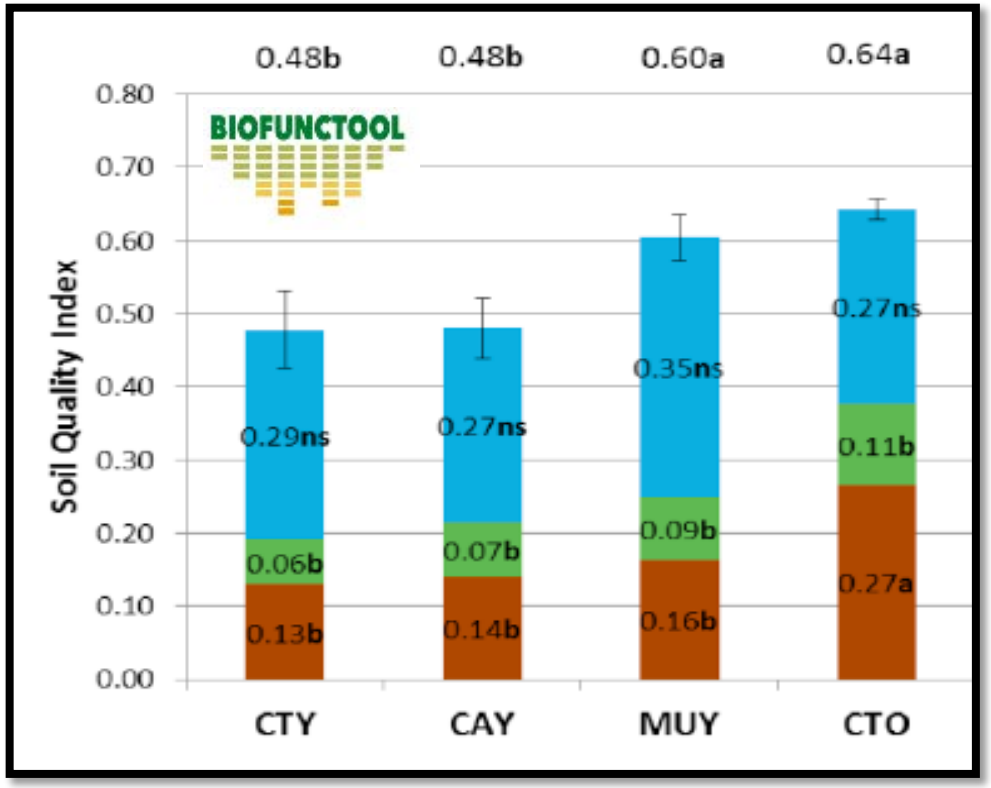
GOOD AGRICULTURAL PRACTICE GAP

- ✓ **Intercropping** during immature phase
- ✓ **Limited chemical weeding** during mature phase

Soil cover management

Dinitrogen fixation by the legume cover crop *Pueraria phaseoloides* and transfer of fixed N to *Hevea brasiliensis*—Impact on tree growth and vulnerability to drought *Clermont-Dauphin el al. 2016 Agr. Ecos. Env.*





Thoumazeau el al. 2019b.

CTY: 4y plant. with natural soil cover

CAY: 4y. plant. with cassava intercrop.

MUY: 4y. plant. with Mucuna cover crop

CTO: 9 year-old plant.

GOOD AGRICULTURAL PRACTICE GAP

✓ **Cover cropping** with a N-fixing specie during immature phase

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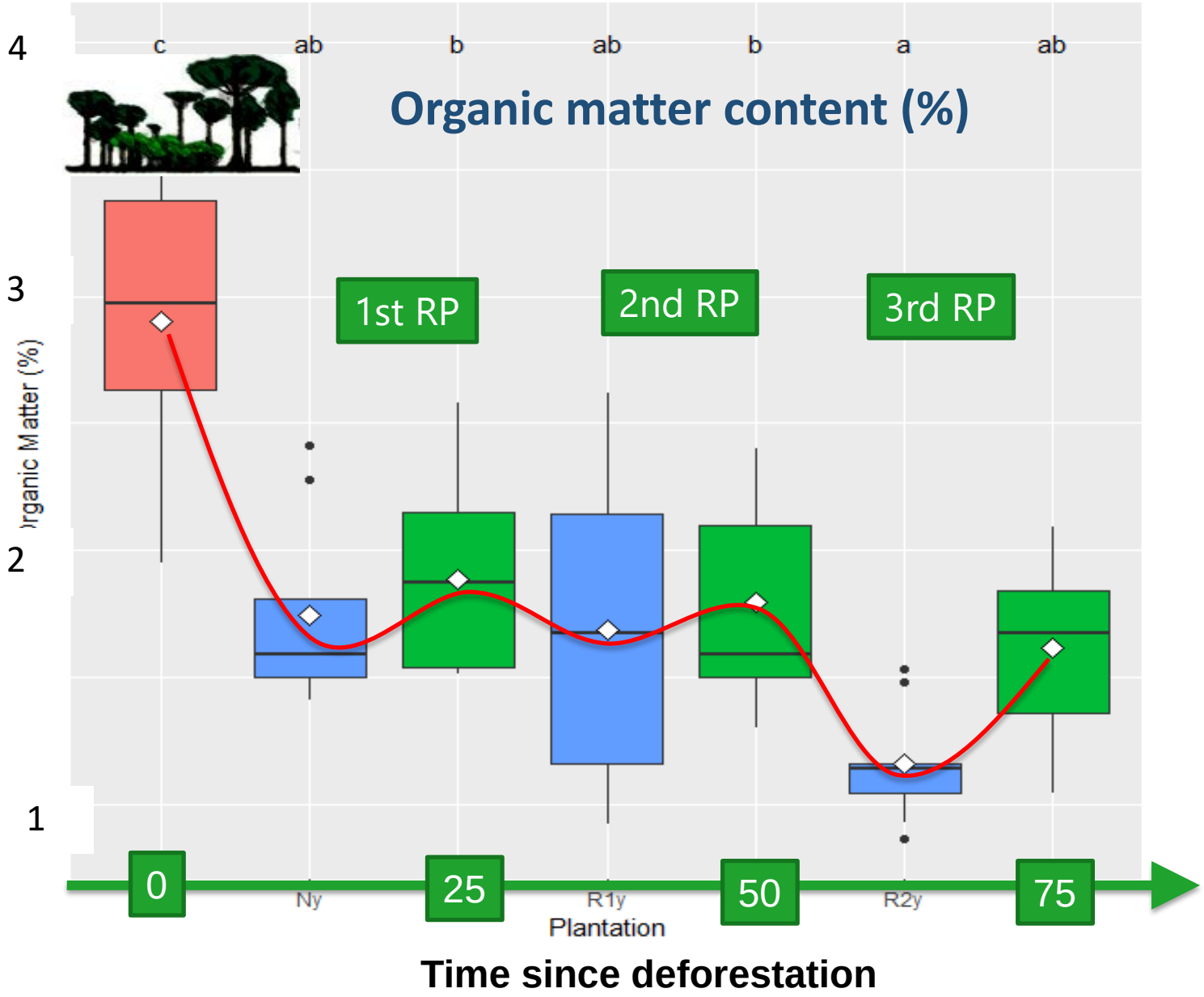
Logging and replanting management

Paklang et al., *in prep*



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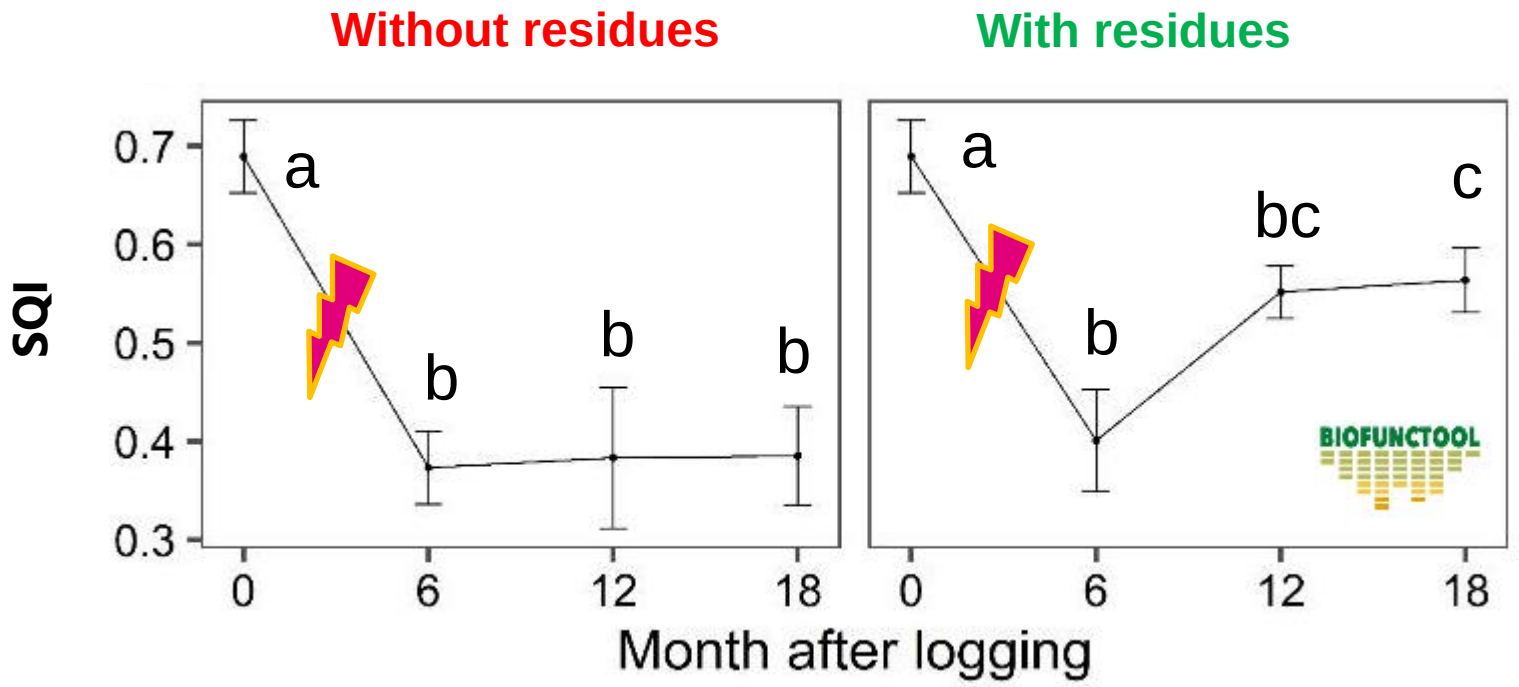
Logging and replanting management



✓ **Logging residues** management

Effect of residues

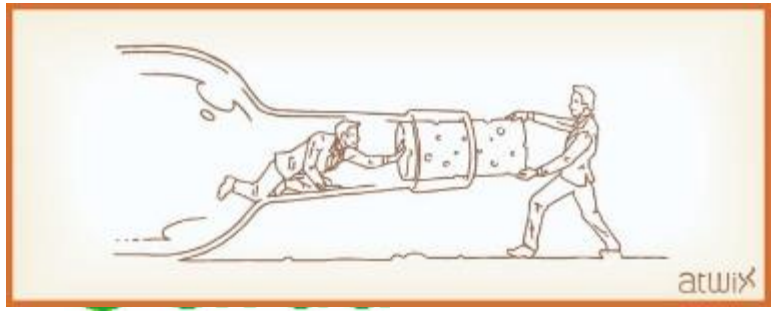
✓ **Partial restoration** of soil functions

✓ **Positive effect** on tree growth

Perron et al., *in prep,* FERTIM project, Ivory Coast

Take Home Messages

- ✓ **Soil quality** is an important factor in the sustainability and resilience to CC of rubber plantations
- ✓ Soil quality **naturally improves** along the life cycle of a rubber plantation
- ✓ **GAP** with regard to soil quality in rubber plantations must consider:
  - ❑ **Revisiting fertilizer** applications to match the dynamics of tree requirements.
  - ❑ **Logging residues** management
  - ❑ **Soil cover** management: limited weeding, cover cropping with legumes, intercropping



Adoption of alternative practices by smallholders!

Acknowledgments

- « **Towards the sustainability of rubber production in Thailand »,** Thai International Cooperation Agency
- **HEVEADAPT « How tree-based family farms can adapt to global changes? »,** French National Research Agency (ANR)
- « **Fertilization of Mature Rubber Plantation »,** Yara International
- « **Fertilization and fertility of immature rubber plantation », « Hevea Biodiversity** » French Rubber Institute (IFC), SOCFIN, SAPH, Michelin company