



D P Agroforesterie Cameroun
(Partnership Platform)



Afforestation of savannah using cocoa agroforestry: impacts on ecosystem services and effects of associated tree species on soil fertility

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Preliminary: Natural encroachment of forest into savannah

In the North of the Congo Basin, different past and recent studies showed **natural forest expansion over savannah**

- Gillet et al, 2001. *J Trop Ecol*: 809–832.

<http://journals.cambridge.org/abstract/S0266467401001614>

- Mitchard ETA, 2011. *Remote Sens Environ* 115: 2861–2873.

<https://www.sciencedirect.com/science/article/abs/pii/S0034425711001337>

Mitchard ETA, 2013. *Phil Trans R Soc B* 368: 20120406.

<https://royalsocietypublishing.org/doi/10.1098/rstb.2012.0406>

But this natural expansion of forest over savannah is currently **disrupted and often stopped by human activities**, such as cropping, leading to degraded **gramineous savannah ecosystems which are burned every year and periodically cultivated**.



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Forest and Cocoa agroforest - Savannah boundary in the Bokito area (Cameroun)

Afforestation of savannah with cocoa

- Farmers have proven their ability to create cocoa agroforests on savannah
- What is observed: Full-grown cocoa AFS created on savannah and in forest show comparable multi-strata structures.
- Question : Do cocoa agroforests created on savannah have the same potential of cocoa plantations created in neighbouring forests ?



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Young cocoa plants under plantain and young trees



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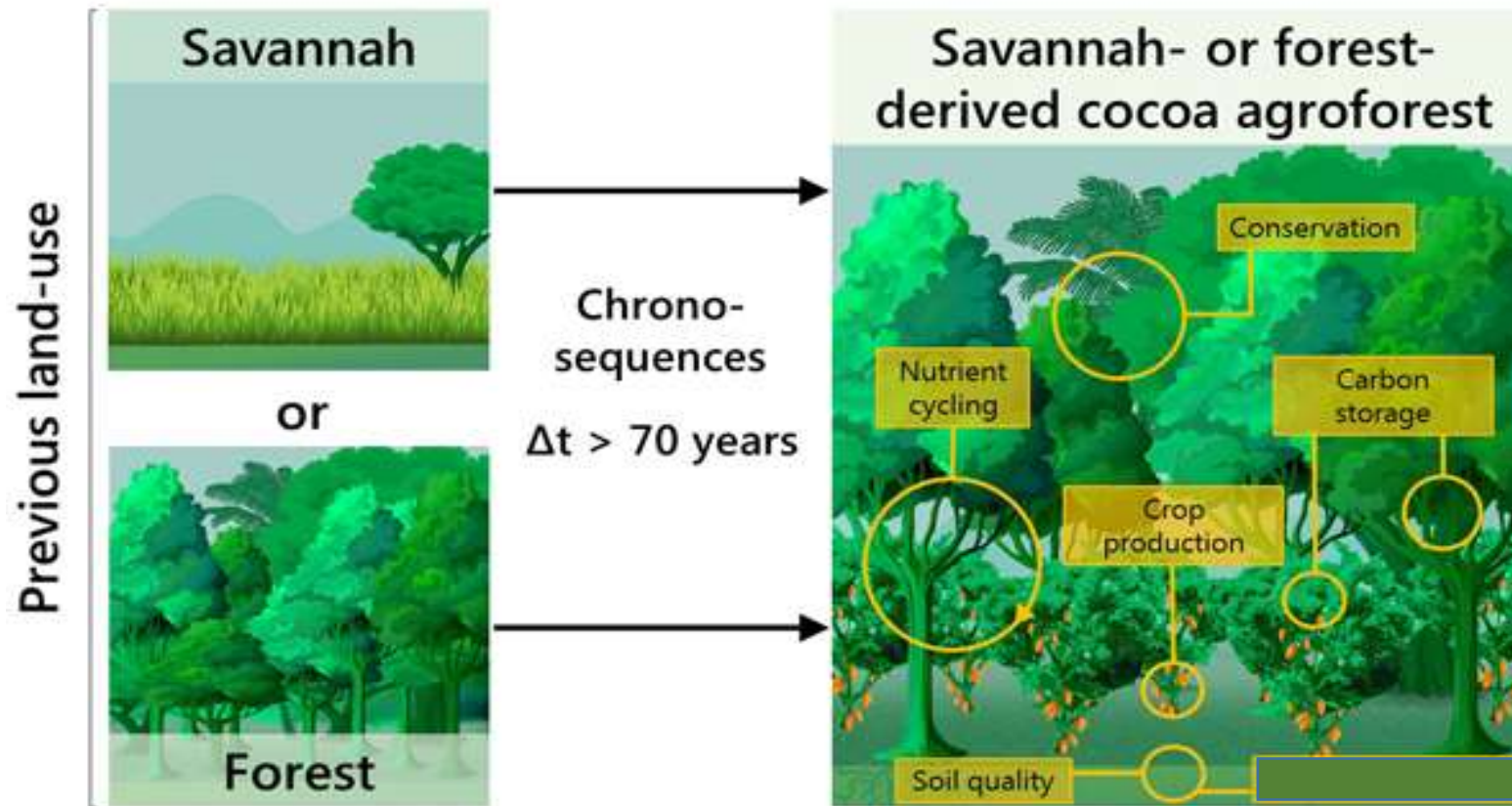
Mature cocoa plantation set up after savannah

Jagoret P. et al., 2012. *Agrofor Syst*, 493-504. <https://doi.org/10.1007/s10457-012-9513-9>

Objective of the first study

- Assess the impacts of previous land uses (forest or savannah) of cocoa agroforestry plantations on ecosystem services over time (PhD Annemarijn Nijmeijer).

Rainfall: 1400 mm yr⁻¹ , 3 months of dry season

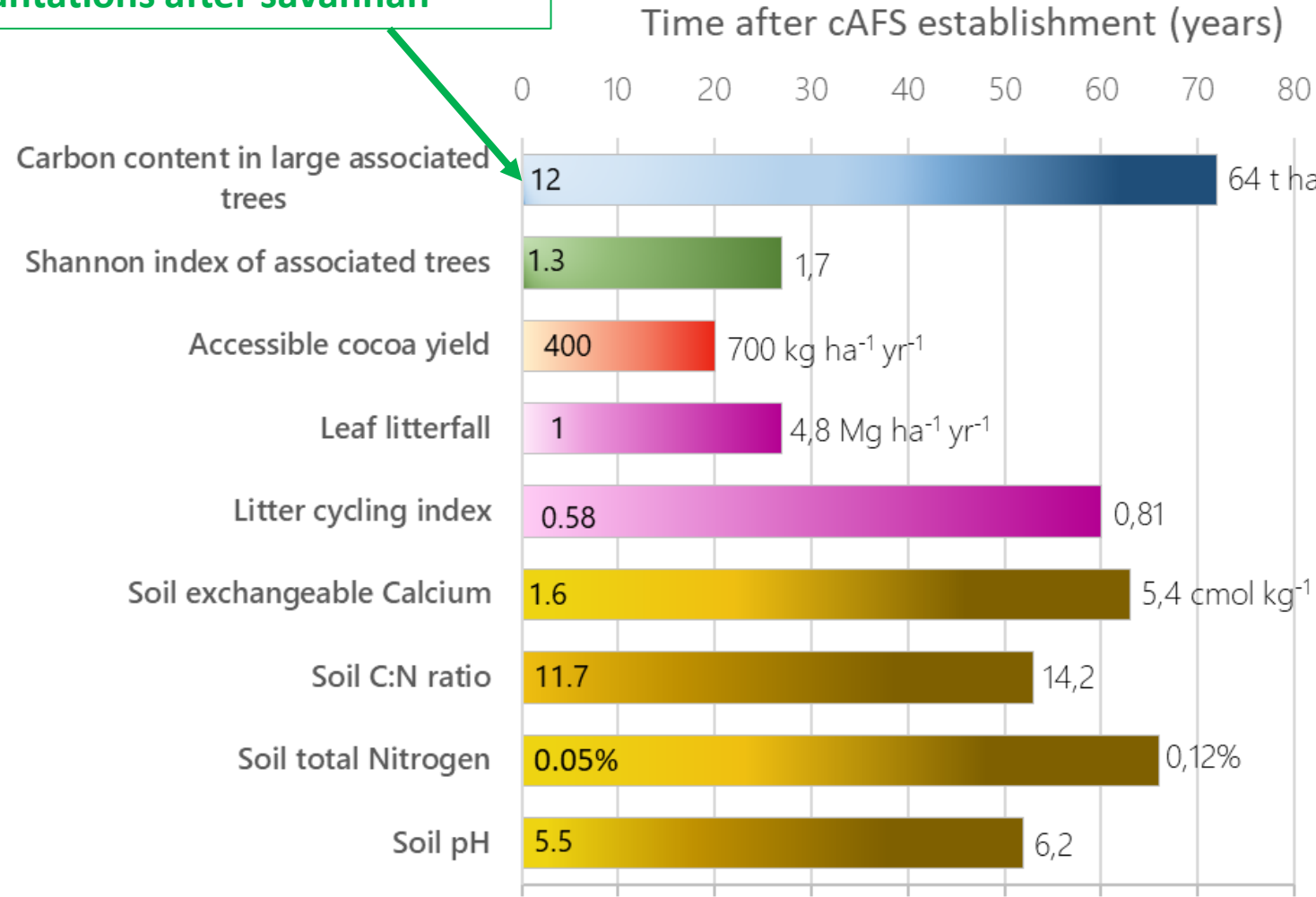


Nijmeijer A, et al 2019. *Agr Ecos Env* 275: 100-111. <https://doi.org/10.1007/s10457-017-0182-6>

Ecosystem attributes (EA) of cocoa agroforests

Initial value of EA in cocoa plantations after savannah

Similar values of EA in cocoa plantations after savannah and forest some decades after establishment

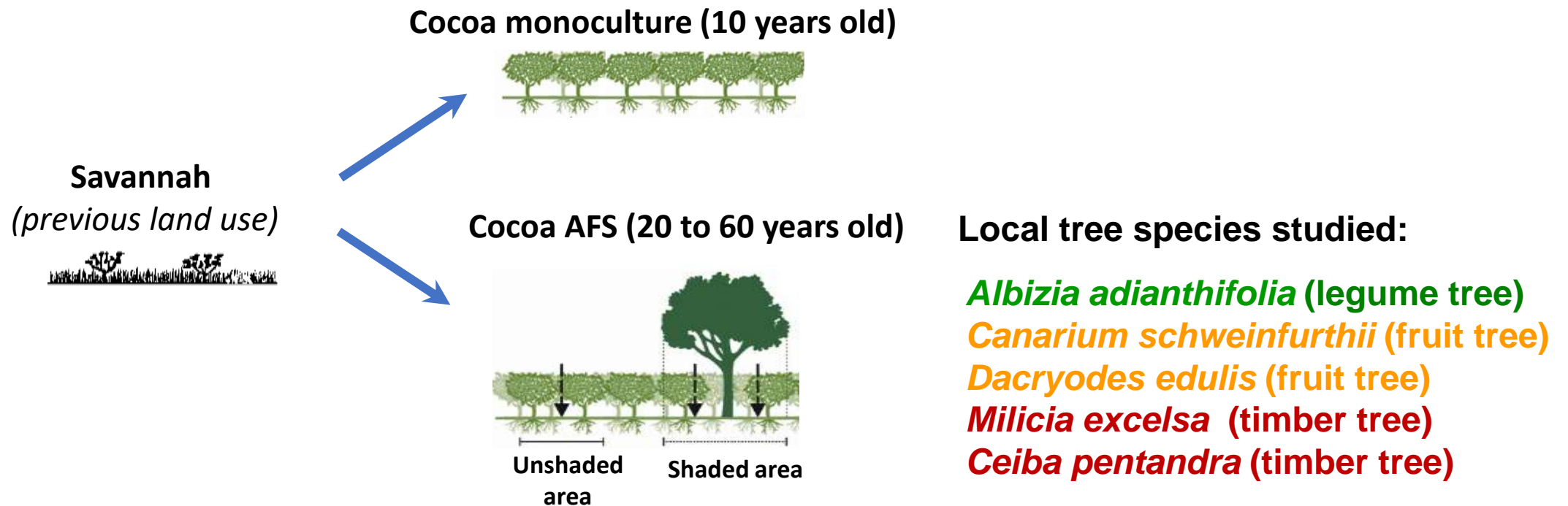


- EA of cocoa plantations set up after savannah increased with time and reached similar levels of EA in cocoa plantations after forest.
- 20 to 30 years to reach the same values for species diversity, cocoa yield, leaf litterfall
- 50 to 70 years to reach the same values for C storage and some components of soil quality.

Adapted from: Nijmeijer A, et al 2019. *Agr Ecos Env* 275: 100-111. <https://doi.org/10.1007/s10457-017-0182-6>

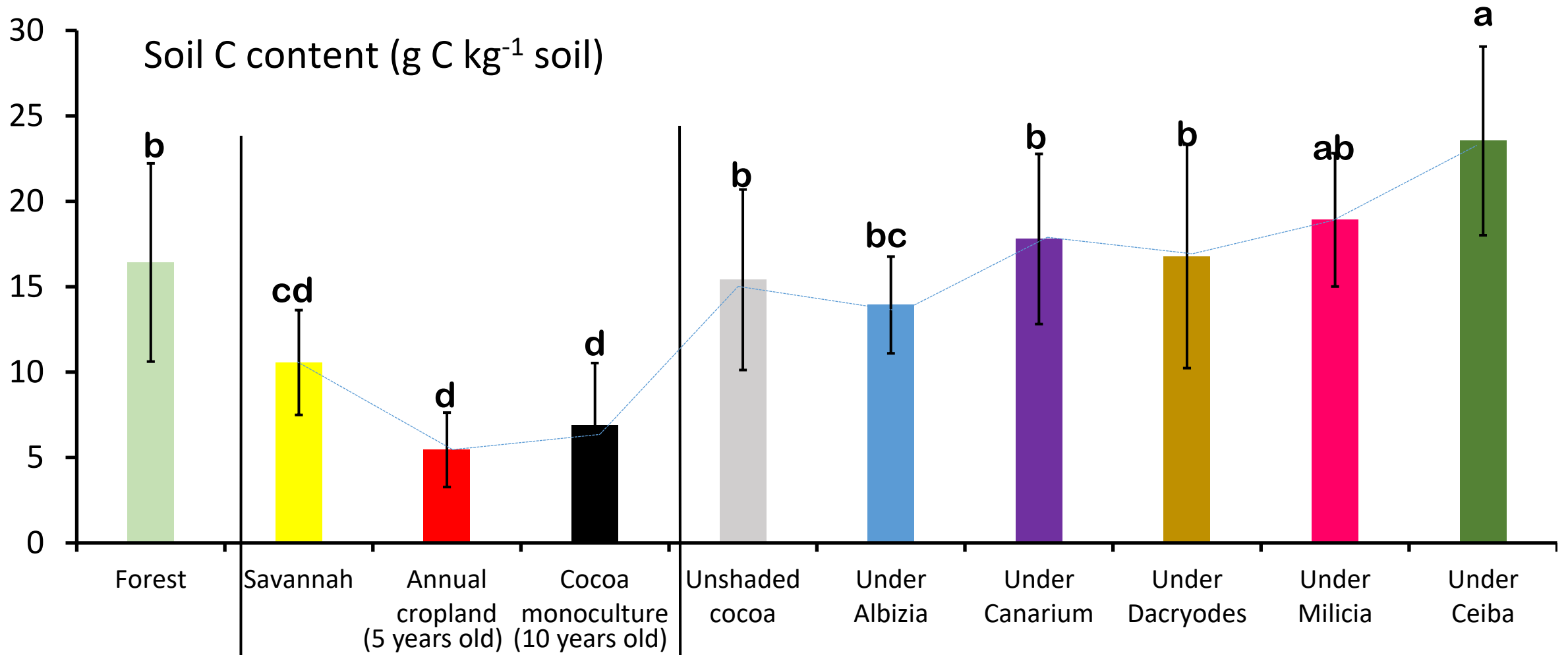
Objective of the second study

- Assess the impacts of agroforestry and different shade trees on soil fertility (top 10 cm soil layer) and cocoa yield in relation to tree functional traits



Sauvadet M et al, 2020. *J Applied Ecol* 57 (3):476-487. <https://doi.org/10.1111/1365-2664.13560>

Dynamic of soil C of the top 10 cm for different land uses



Cocoa agroforestry system (20-60 years old)

See poster of Eltson Fonkeng (PhD student) on soil C and nutrients dynamics in the different land uses

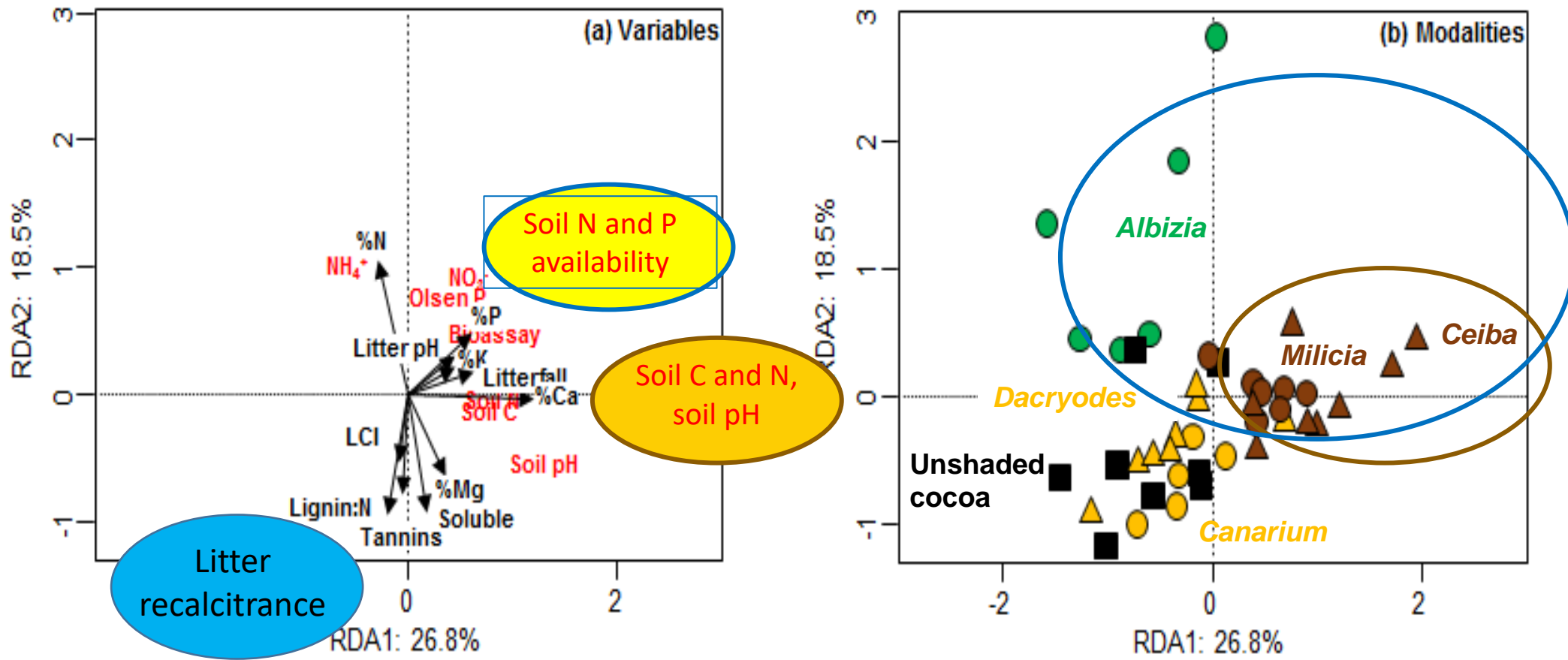
Improving soil fertility in cocoa agroforests using the most suitable shade tree species



THE APPLIED ECOLOGIST'S BLOG

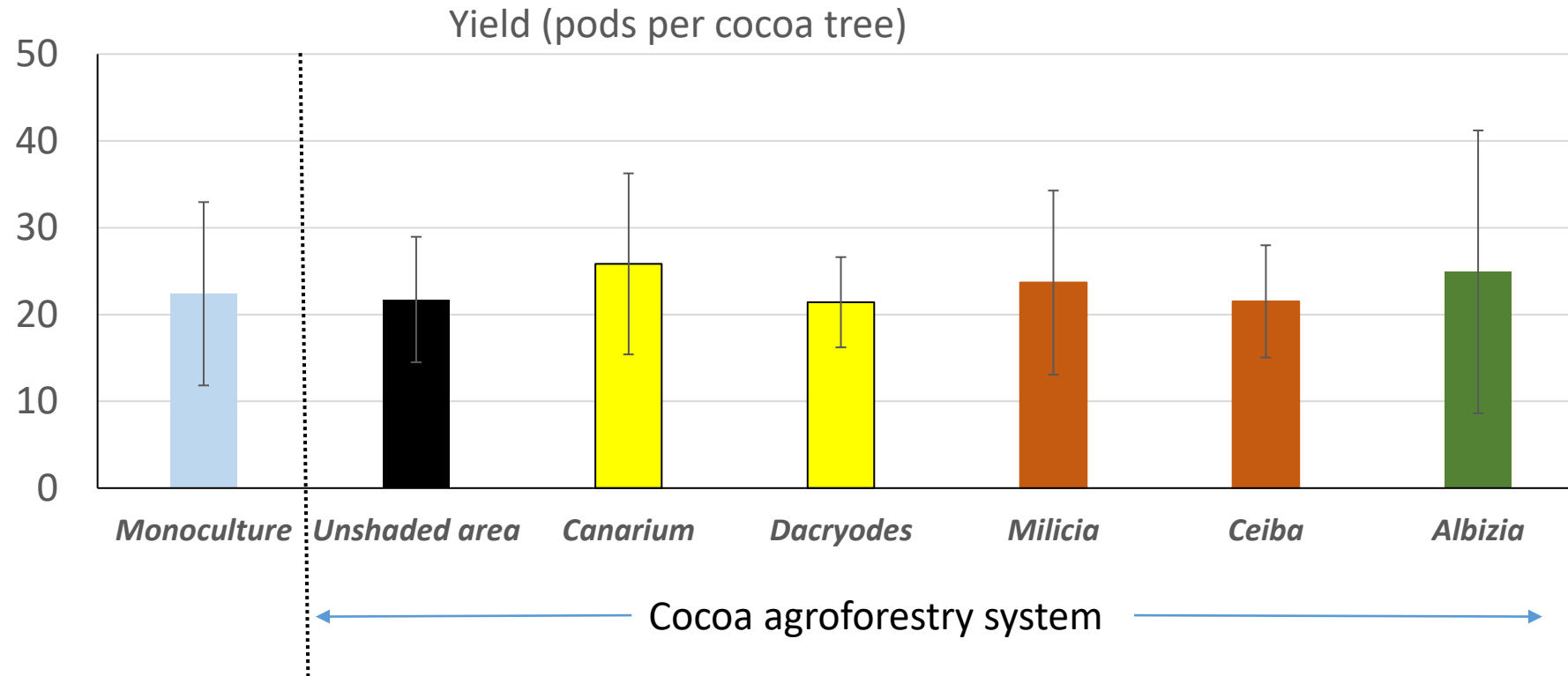
Bridging the gap between researchers, practitioners and policymakers

<http://appliedecologistsblog.com/2020/02/18/improving-soil-fertility-in-cocoa-agroforests-using-the-most-suitable-shade-tree-species>



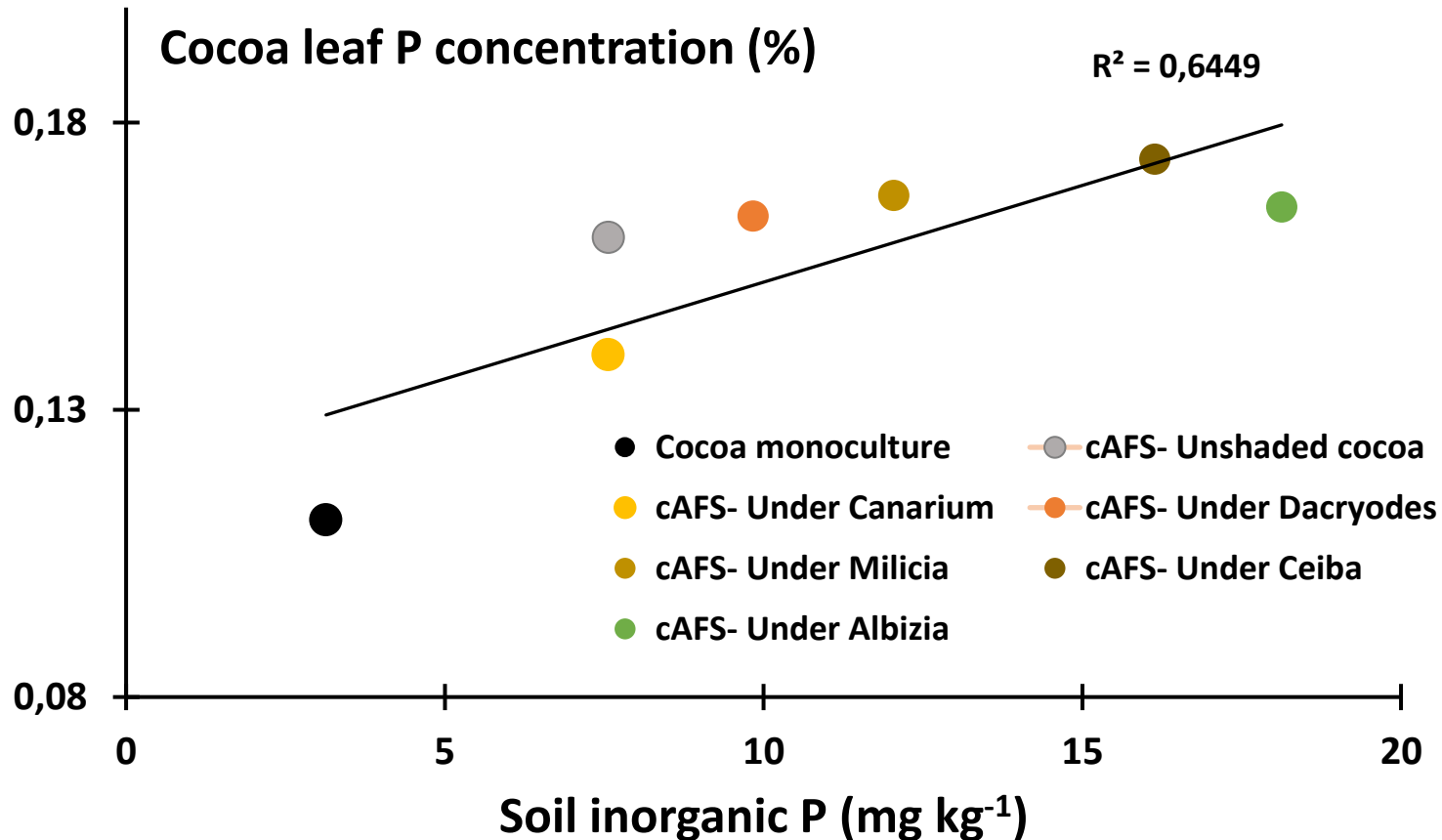
Sauvadet M et al, 2020. *J Applied Ecol* 57 (3):476-487. <https://doi.org/10.1111/1365-2664.13560>

Cocoa yield



- No visible impact of shade on yield (high variability of data);
- Young cocoa monoculture of 10 years old not more productive than old cocoa agroforestry system

Cocoa nutritional status



In comparison to cocoa monoculture:
- soil inorganic P,
- and cocoa leaf P concentration
were increased in cAFS with
differences between tree species.

Conclusions

- Planting cocoa trees together with shade trees in savannah **can increase soil fertility, species diversity and carbon storage in biomass and soil** over time;
- Cocoa-based AFS set up after forest or after savannah display with time **convergent profiles of ecosystem attributes** (including cocoa production);
- Tree species effects on **soil properties** can be explained by **leaf litter traits**;
- Our results suggest that **deep uptake of nutrients by associated tree species** and their recycling through litterfall (data not shown) **increase top soil nutrient contents and contribute to nutrient export by cocoa harvest**;
- Using specific shade **trees for the provision of goods**, and other **trees for soil quality**, both compatible with cocoa, can **ensure multifunctionality and sustainability of cocoa systems**;
- Further studies are necessary to understand **how plant diversity can help to adapt to climate change** in the context of the forest-savannah transition zone.

Acknowledgements



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Thank you for your attention

