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Indicators for carbon cycling in four different cacao production systems in Bolivia

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Background, Objective & Conclusion

Background Carbon loss of tropical forests by land use change can be reduce by locally adapted agroforestry (AF) systems. Cacao AF systems have higher above- and below-ground biomass in comparison to monoculture systems. The opportunity to increase and sequester organic carbon depends on the composition of shade trees and system management.

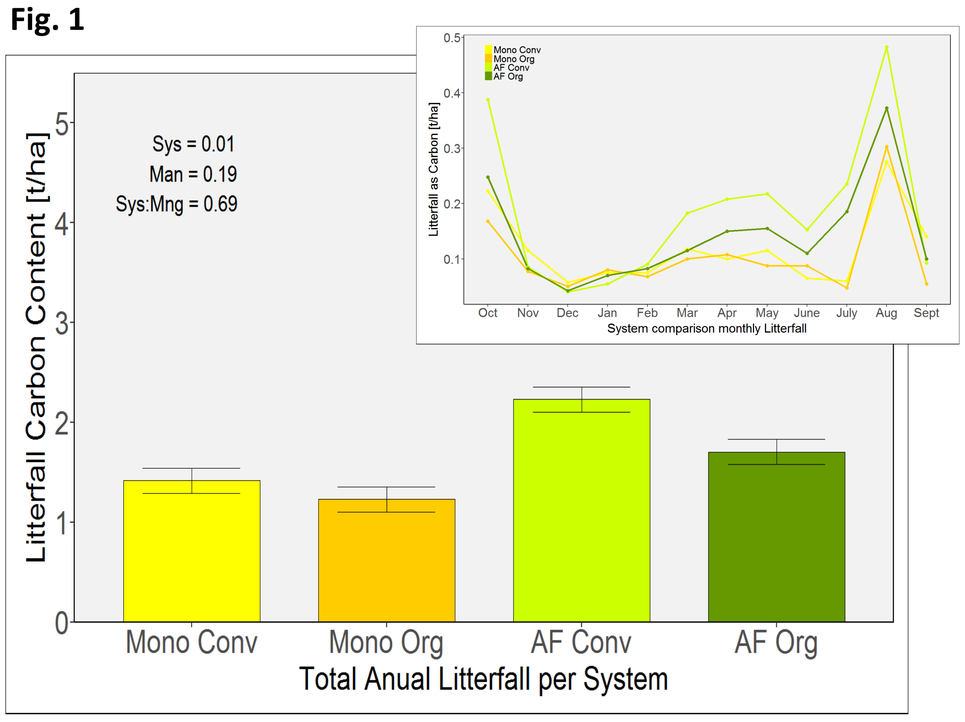
The Research Institute of Organic Agriculture (FiBL) established a cacao long-term field trial in Bolivia in 2008 (http://www.systems-comparisons.fibl.org). The experiment is arranged in a block design with "crop diversity" (monoculture vs. agroforestry) and "management practice" (conventional vs. organic) as factors.

Objective Quantify (1) **litterfall production** and **pruning residuals** for the nutrient dynamic under cacao production systems (2) **litter decomposition**, which may be affected by litter chemistry or microclimate (3) **microbial biomass,** which size and nutrient content indicates integrated environmental conditions and inputs into the systems.

Conclusion Young cacao agroforesty systems shows a benefits for carbon sequestration and storage in comparison to monoculture. Furthermore, the legume shade trees provide greater biomass and faster turnover of litter due to tighter C/N ratios. Organic management provided higher microbial biomass C and N contents indicating a higher potential for nutrient release in plant available form.

Results

Fig. 1



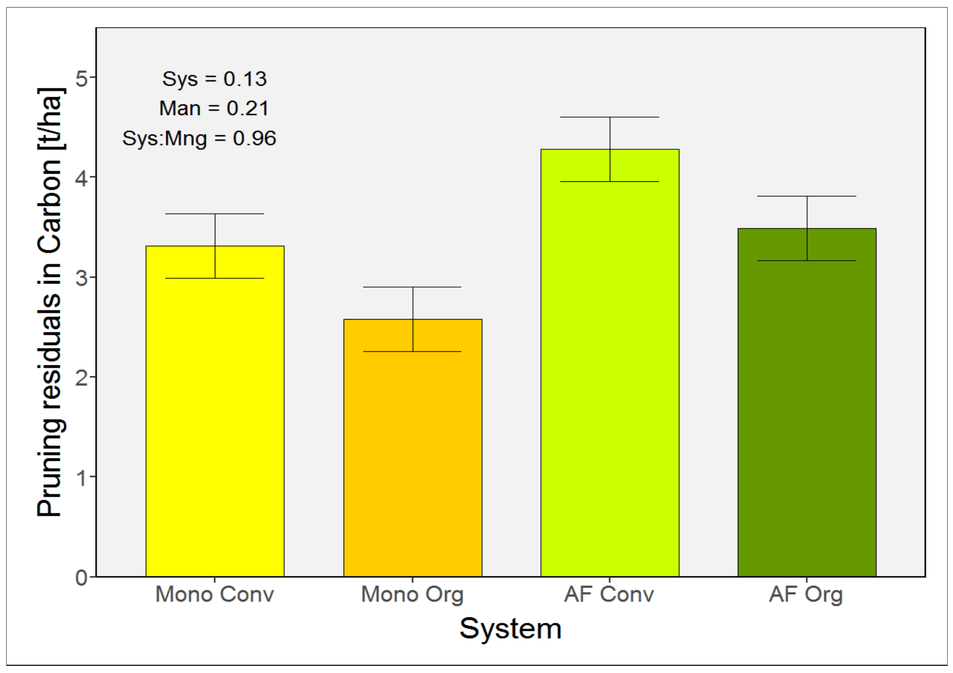
Distribution pattern of litterfall over the year were similar between all production systems.

Higher values of litterfall in the agroforestry systems are due to the higher tree density, including shade trees.

Total amount of carbon which was pruned was slightly (p=0.13) higher in the agroforestry then in monoculture.

Pruning residues of cacao were higher in monoculture then in agroforestry (data not shown).

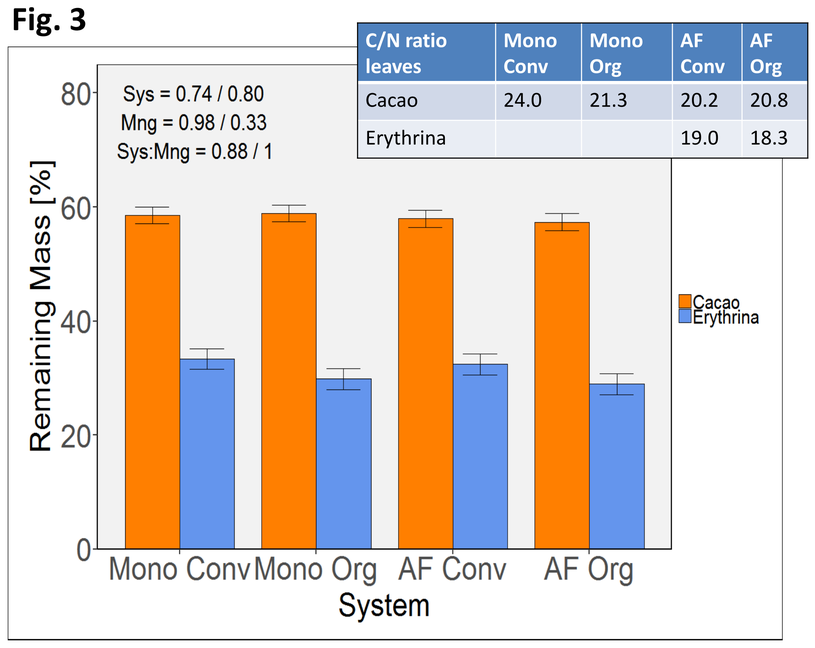
Fig. 2



1) Total average anual litterfall per system and distribution pattern over a period of one year (2014/15) (mean values, n = 4, standard errors).
2) Total amount of carbon which was pruned. Pruning residuals of the main anual pruning includes cacao and *Erythrina fusca* spp. (mean values, n = 4, standard errors).
3) Remaining mass of cacao and erythrina leaves after 290 days in four different production systems. (mean values, n = 12 (8), standard errors)
4) Microbial Carbon contents in the observed cocoa production systems in the O horizon. Black points: Results from one plot; Red points: Means; Whisker: SE (n=4)
5) Microbial Nitrogen contents in the observed cocoa production systems in the O horizon. Black points: Results from one plot; Red points: Means; Whisker: SE (n=4)

Fig. 3

C/N ratio leaves	Mono Conv	Mono Org	AF Conv	AF Org
Cacao	24.0	21.3	20.2	20.8
Erythrina			19.0	18.3

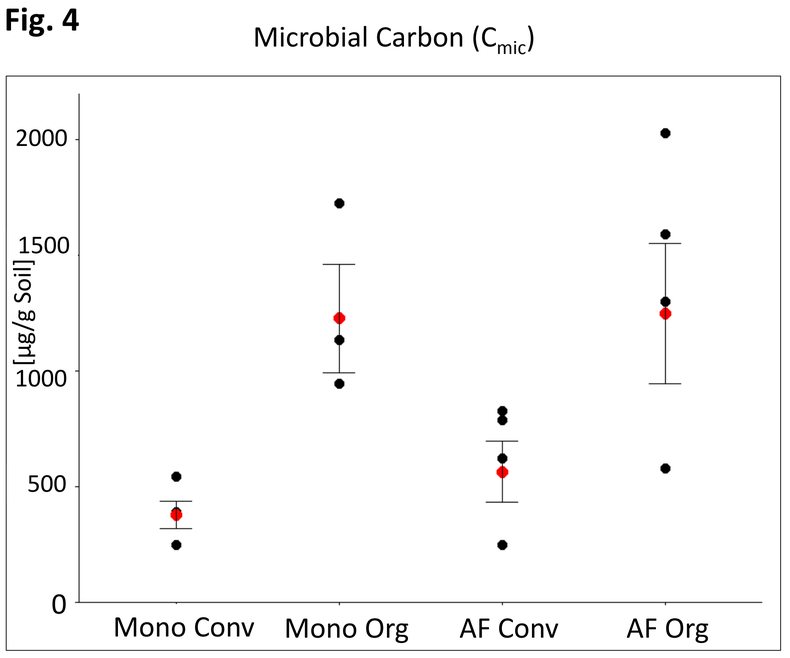


Leave litter of Erythrina decomposed faster then cacao leaves.

Erythrina leaves showed a trend for a slower decomposition in the conventional systems.

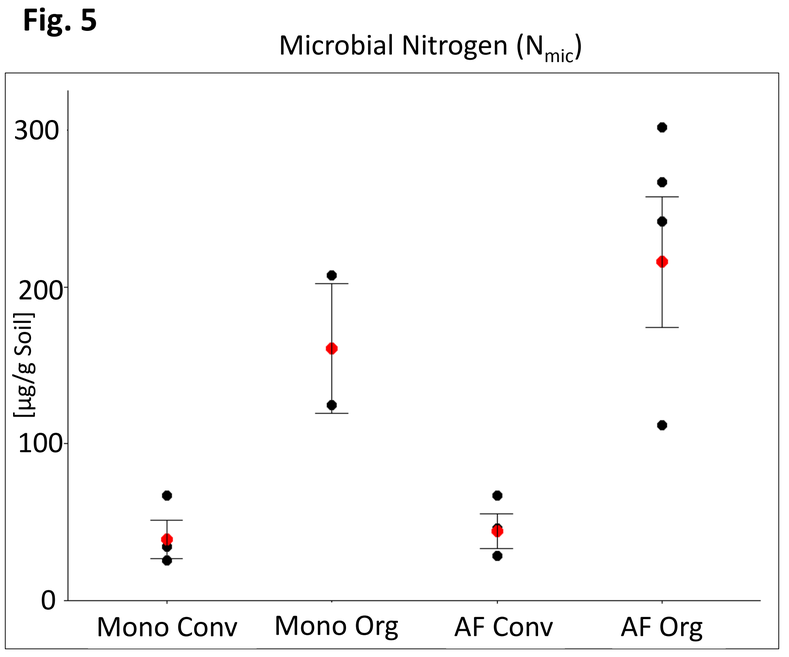
The C/N ratio in cacao leaves increased from AF to Mono.

Fig. 4



Effects in microbial carbon content could be mainly seen in the surface layer. C_{mic} content is affected by management practices with lowest values in Mono conv.

Fig. 5



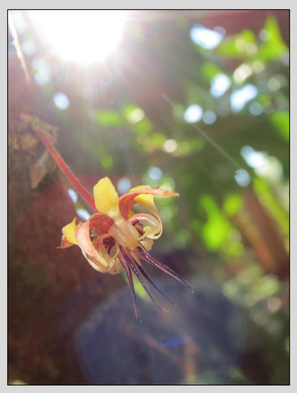
Mikrobial Nitrogen showed the same trend like C_{mic} contents. Organic managed systems had the highest levels of N_{mic} ($p<0.001$). Mono conv showed the lowest values.

Material & Methods

Analysis of **Litterfall, pruning residuals and Litter decomposition**:

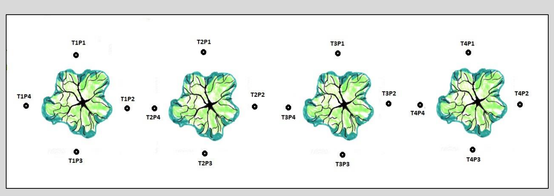
(1) Litter-traps: Mass analysis of litterfall
(2) Pruning residuals: Mass and nutrient analysis (leaves and branches)
(3) Litter-bags: Determination of litter-decomposition



Analysis of **microbial biomass**:

(1) Soil sampling of O horizon
(2) Analysis of C_{org} and N_t contents through infrared spectrometry
(3) Analysis of C_{mic}, N_{mic} contents through chloroform-fumigation-extraction method



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