

# Nutrient release from litter under five cacao cultivation systems in a long term field experiment in Sara Ana (Alto Beni, Bolivia)



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## INTRODUCTION

- Cocoa serves as a primary source of income for smallholder farmers in the Alto Beni region (Bolivia)
- Cultivating cacao within agroforestry systems can benefit from ecosystem services, including nutrient cycling, which may reduce the need for external fertilizers.
- Nutrient cycling includes litter decomposition processes and depends on many factors

Conventional Monoculture (CM)

Organic Monoculture (OM)

Use of compost and no chemical pesticides

Organic

Agroforestry (OA)

Soil covered with Meonotonia wightii



## RESULTS





Use of chemical fertilizers and pesticides

Conventional Agroforestry (CA)



Use of chemical fertilizers and pesticides Shade trees (*Inga* sp*, Erythrina* sp) in 8x8 m grid Use of compost and no chemical pesticides Shade trees (*Inga* sp*, Erythrina* sp) in 8x8 m grid Soil covered with *Neonotonia wightii*  Natural regrowth of trees No external inputs Shade trees (*Inga* sp, *Erythrina* sp) in 8x8 m grid Additional crops: coffee, turmeric, ginger

- The long-term SysCom cacao trial in Alto Beni (Bolivia) compares cacao cultivation under five different cultivations systems
- Regular pruning is part of the management practices in these systems and pruning residues are placed near the tree's trunks
- We aimed to determine the effects of five different cacao cultivation systems on the decomposition of litter from pruning

Succesional Agroforestry (SA)



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Fig. 1. Changes with time in carbon (A,B) and phosphorous content (C,D) in litterbags containing cacao leaves(A, C) and mixtures of leaves (B,D). Clear boxes: large mesh bags



### residues, nutrient release and carbon accumulation





Fig.2. Changes with time in nitrogen (A,B), potassium (C,D), cellulose (E, F) and lignin content (G,H) in litterbags containing cacao leaves(left) and mixtures of leaves (right). Clear boxes: large mesh bags

Table 1. Grams (mean+sd) of carbon and nutrients released from 1 Kg (dry weigth) of cacao litter. E small mesh bags, I large mesh bags

Conventional Monoculture	Organic Monoculture	<b>Conventional Agroforestry</b>	Organic Agroforestry	Sucessional Agroforestry
	4			

- We placed litterbags containing cacao leaves or mixtures of cacao and shade tree leaves across the different cultivation systems
- Two mesh sizes were used for the litterbags: 2 mm mesh that allowed the entry of mesofauna and 0.2 mm mesh that excluded them
- After 4, 8, and 12 months of decomposition, we collected the litterbags for chemical analysis
- We determined organic carbon, nitrogen, phosphorous, potassium, cellulose and lignin (acid detergent fiber) in the litterbags

	E	l I	E	l I	E	I	E	l l	E			
	After four months of decomposition											
Carbon	113±79	147±94	190±98	185±47	139±65	172±76	158±60	207±50	168±65	196±128		
Nitrogen	1±2	-1±3	1±4	2±2	-7±2	-5±4	-2±4	1±4	0±5	2±3		
Phosphorous	0,8±0,3	0,9±0,4	0,9±0,3	0,8±0,5	0,9±0,3	1,2±0,1	0,8±0,1	1,3±0,3	1,1±0,2	1,2±0,3		
Potassium	26±17	32±16	32±17	36±15	28±17	38±8	24±19	41±13	42±9	39±11		
	After twelve months of decomposition											
Carbon	344±53	335±120	399±42	404±45	382±32	371±68	409±26	423±46	402±38	393±64		
Nitrogen	7±3	4±5	7±2	6±2	7±1	2±5	9±1	8±1	8±3	4±7		
Phosphorous	1,8±0,1	1,7±0,2	1,8±0,1	1,8±0,1	1,8±0,1	1,7±0,1	1,8±0	1,8±0,1	1,8±0,1	1,7±0,2		
Potassium	54±2	54±1	55±0	54±1	54±1	54±0	55±1	53±2	55±1	54±1		

### **CONCLUSIONS**

- After 4 months of decomposition, there was approximately a 40% loss of carbon, 30% loss of nitrogen, 65% loss of phosphorus, and 70% loss of potassium
- By 12 months, samples lost on average 82% of carbon, 60% of nitrogen, 95% of phosphorus, and 98% of potassium
- The percentage of cellulose in the samples remained relatively constant, while lignin content tended to increase
- At four months, carbon and nutrient contents in larger mesh litterbags were significantly lower than in smaller mesh litterbags
- In general, there was no significant effect of the cultivation system on decomposition except for nitrogen and lignin
- No significant difference in the decomposition of samples that only contained cacao leaves compared to those with leaf mixtures was observed.
- The relationship between increase in acid detergent fiber content and carbon buildup in soil should be further investigated