Isotopic δ^{15}N signature of grass-alone and grass-legume tropical pastures to estimate sources of nitrogen to grasses in farmer managed pastures

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Introduction

Livestock production in deforested Amazon of Colombia relies on grazing of pure grass pastures, which are already degraded due to depletion of N and P reserves, and promotes further forest cutting.

Different mechanisms of nutrient acquisition and utilization have been reported for *Urochloa* grasses that may affect the δ^{15}N signature of its biomass, namely, associative N_2 fixation and suppression of soil nitrification [biological nitrification inhibition (BNI), Reis et al. 2001; Subbarao et al. 2009].

Objective

To determine the isotopic ^{15}N signature of grass alone (GA) and grass-legume (GL) pastures to estimate sources of N to grasses in **farmers' fields** in the Amazon region of Colombia.

Materials and Methods

We analyzed 10 paired grass-alone (GA) and grass-legume (GL) pastures in 6 farms in the Caquetá department of Colombia, with ages between 16 to 32 years since establishment.

Samples taken in each pasture after 45 days of regrowth:

1) Principal grass
2) Secondary grass
3) Legumes
4) Forbs
5) Plant litter
6) Soil

Analysis:

- Plant biomass: Dry matter production
- Total N and δ^{15}N: Dry combustion/NCS elemental analyzer
- Total P: Nitric acid digestion, malachite green staining, and spectrophotometry determination.

Results

GL pastures produced 74% more plant biomass and showed two times greater N and P uptake compared to the GA.

N fixation by legumes was estimated in 80%.

Table 1. Plant biomass production, nutrient uptake and N isotopic signature in grass-alone and grass-legume pastures. Different letters denote statistical differences (TukeyHSD test, α = 0.05).

Pasture type	Dry matter productivity (kg m^{-2})	N uptake (g m^{-2})	P uptake (g m^{-2})	Total N in principal grass (g kg^{-1})	Total N in legume (g kg^{-1})	Weighted δ ^{15}N (‰)
Grass-alone	62.4 (43.2)a	0.8 (0.5)a	0.07 (0.05)a	14.9 (3.5)a	-	4.6 (2.9)a
Grass-legume	107.8 (41.8)b	2.2 (1.3)b	0.14 (0.08)b	14.8 (3.5)a	27.8 (3.3)	2.1 (1.7)b

Significant differences were observed in the δ^{15}N signature among plant species.

Variation of the δ^{15}N signature of grasses was higher in the grass-alone than in grass-legume pastures. This may indicate that grasses exploit different N sources when they are cultivated alone, than when associated with legumes.

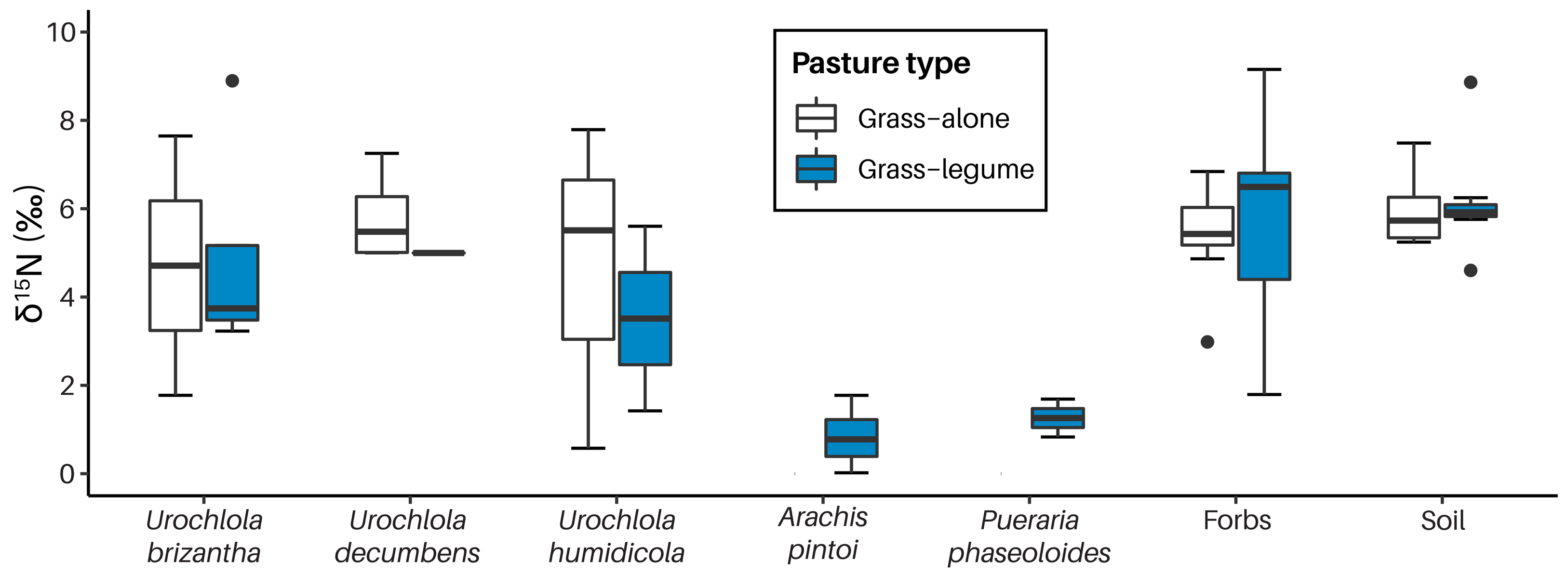

Figure 1. δ^{15}N signature of principal grasses, legumes, forbs and soil in grass-alone and grass-legume pastures.

Conclusions

Grass-legume associations are an alternative to grass-alone pastures towards more sustainable pasture management.

Grasses in the grass-legume plots might have benefited from atmospheric-N fixed by legumes to cover N demand.

To elucidate the specific N sources used by grasses depending on pasture composition, the role of BNI, associative N fixation, and mycorrhizal association should be further studied.

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