# Nitrogen sources of *Brachiaria* spp. in tropical pastures

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Pasture degradation here defined as yield decrease drives deforestation in the Amazon and is mainly caused by a mismanagement such as lack of nitrogen (N) fertilization. The most widespread grass species in this area *Brachiaria* spp.[1], can receive up to 40% of total N uptake from associative N fixation (ANF). However, this is not sufficient to prevent pasture degradation. It has been shown, that integrating N fixing legumes in pastures with *Brachiaria* spp. can increase N uptake and pasture productivity. On the other hand, the risk of N losses increases compared to unfertilized grass monocultures. Here *Brachiaria* spp. with biological nitrification inhibition (BNI) capacity could reduce N losses and increase the N use efficiency by reduced nitrification and/or mineral N immobilization by root exudates. So far, the effect of BNI, symbiotic N fixation (SNF) and ANF on the N nutrition of *Brachiaria* spp. and N fluxes under farmer's field conditions is unknown.

The NiTroLeG project (Nitrogen in Tropical Legume and Grass Pastures), aims to enhance the sustainability of tropical pastures through the integration of nitrogen fixing legumes and *Brachiaria* spp. with BNI capacity. In the study region of Caquetá, smallholder farms characterized by livestock and dairy production form the economic backbone. At the same time Caquetá exhibits one of the highest deforestation rates of South America which is mainly driven by pasture degradation. The project is carried out on seven selected farms around Florencia, the capital of the region. The on-farm approach considers site-specific conditions and will therefore facilitate the propagation of new management methods that are being evaluated and further developed in the project.

The objective of this MSc-thesis, embedded in the NiTroLeG project, was to unravel the N sources of *Brachiaria* spp. of one regrowth. Pastures with *B. brizantha* (low BNI), *B. decumbens* (intermediate BNI) and *B. humidicola* (high BNI) present in monoculture (GA) and grass legume mixtures (GL) were evaluated. Harvested plant samples of fenced plots (Figure 1) were separated into different botanical fractions, dried and analyzed for dry weight, N concentrations and $\delta^{15}N$. Topsoil layer (0-10 cm) was analyzed for mineral and total N concentrations and bulk soil $\delta^{15}N$.

**Figure 1:** Fenced plot (2 $m^2$) to avoid cattle grazing

[1] *Urochloa* spp.

Our results confirmed increased N uptake and yield in GL compared to GA pastures and showed a higher increase in yield under high BNI. Contrary to our expectations, fixation rates of legumes were not affected by BNI capacity of the grass.

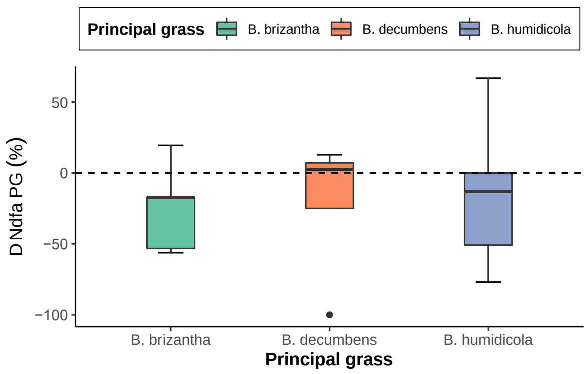


**Figure 2:** Δ nitrogen derived from the atmosphere Ndfa (%) of the principal grass as the difference of Ndfa of the principal grass species in monoculture and in grass-legume mixtures

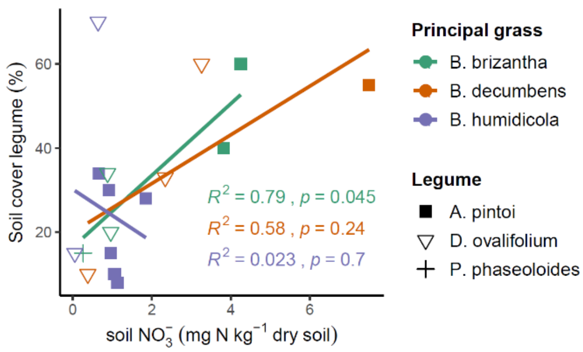


**Figure 3:** Soil cover legume (%) at harvest and soil $NO_3^-$ (0-10 cm)

The decrease in ANF (Figure 2) implies a shift in the N source of B. *brizantha* and *B. humidicola* if associated with legumes due to an increase in available soil mineral N. Moreover, our results showed that BNI activity resulted in: **(i)** constant soil $NO_3^-$ under increasing soil legume cover (Figure 3); **(ii)** lower soil mineral $NO_3^-$:$NH_4^+$ ratio due to reduced nitrification; **(iii)** stimulated N immobilization what led to lower mineral N concentrations and higher $\delta^{15}N$ of bulk soil and a lower C:N ratio of the microbial biomass; **(iv)** constant plant $\delta^{15}N$ with increasing soil mineral N concentrations.

From a methodical perspective, this thesis pointed out the limits of plant and bulk soil $\delta^{15}N$ to derive N sources of *Brachiaria* spp. due to an overlap of BNI, SNF and ANF and probably direct N transfer through mycorrhiza. Whether BNI activity resulted in N immobilization or reduced nitrification remains to be shown. To disentangle the N sources or *Brachiaria* spp. in the context of BNI and N fixing legumes, a selection of following methods could additionally be applied: **(i)** $\delta^{15}N$ of leached nitrate; **(ii)** $\delta^{15}N$ of adsorbed $NH_4^+$ by resin probes; **(iii)** B value of *Brachiaria* spp. to sharpen ANF estimate; **(iv)** nitrate reductase activity in plant tissue; **(v)** quantify importance and effect of mycorrhiza on N uptake and plant $\delta^{15}N$.

The results of this thesis are promising. The BNI activity of *B. humidicola* in GL mixtures led to increased yield. Moreover, the stable $NO_3^-$ concentrations with increasing legume proportion suggested reduced losses compared to GL mixtures with grasses lacking BNI activity. However, the complexity and interaction of effects under field conditions as well as the possibly dual mechanism of BNI are challenging. As next steps of the project, information on pasture management practices at different sites will be collected and combined with soil data as covariates in statistical models. Furthermore, a balanced experimental design will be introduced. This will not only refine statistical power, but also facilitates site-specific adaptation of management practices to increase the sustainability of pastures in the Colombian Amazon.