CIAT

International Center for Tropical Agriculture
Since 1967 Science to cultivate change

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CCAFS

CGIAR RESEARCH PROGRAM ON Livestock

Arbuscular mycorrhizal fungi increase the abundance of ammonia-oxidizing bacteria, but suppress N_2O emissions after fertilization

Nikola Teutscherova, Eduardo Vazquez, Jacobo Arango, Ashly Arevalo, Marta Benito, Mirjam Pulleman

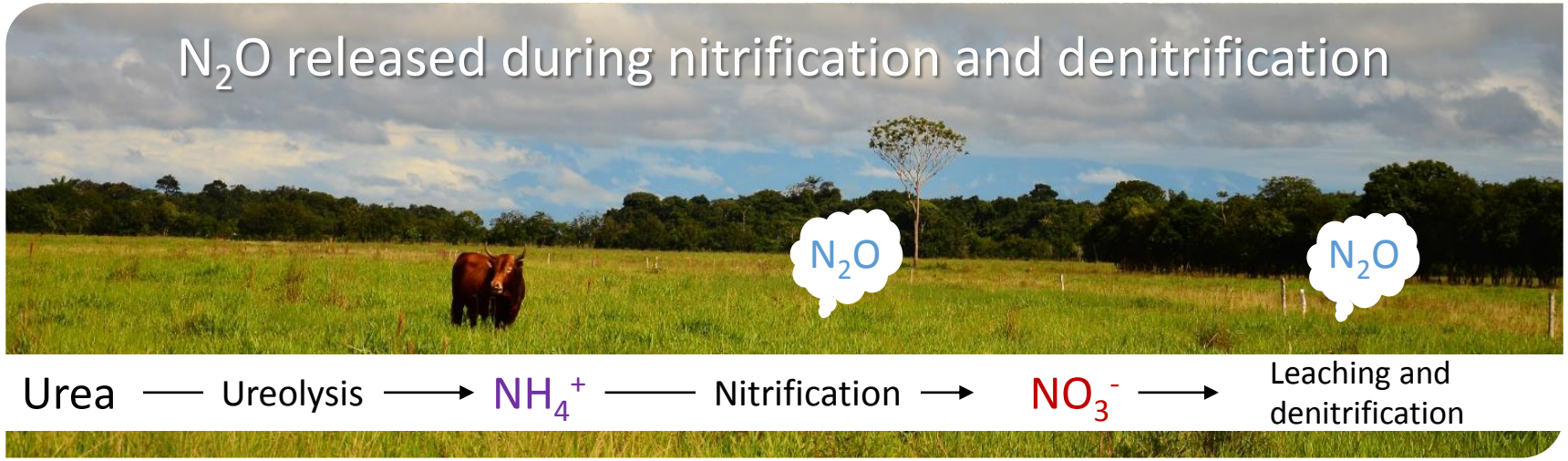
CIAT Tropical Forages & Soils Programs
j.arango@cgiar.org & m.pulleman@cigar.org

Tropentag 2018 September 17–19, 2018
Ghent, Belgium

CGIAR
A CGIAR Research Center

Nitrogen cycling in grasslands

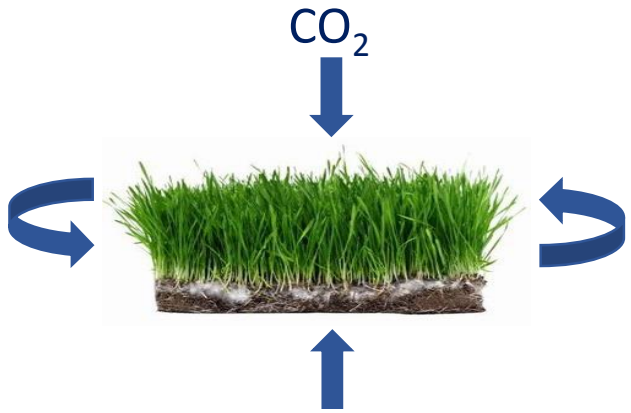
- N_2O is the third most important GHG after CO_2 and CH_4
- Agriculture is the major source of N_2O



- High potential losses of applied nitrogen if N uptake by plants or associated soil biota is reduced.
- Strategies which **increase the nutrient absorption capacity** of grassland plants will likely reduce nutrient losses.

Mycorrhizal symbiosis

- Mutualistic relationship between vascular plants and fungi
- Exchange of nutrients and photosynthetic assimilates



Management strategies enhancing the growth of mycorrhizal fungi may increase the nutrient use efficiency and reduce N losses

Reduced amount of nutrients available to nitrifiers => reduced risk of losses

NH_4^+ ⟶✕⟶ NO_3^-

Reduced abundance of nitrifiers

Pot experiment

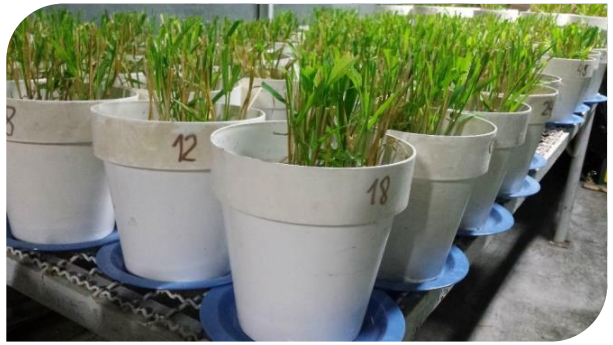
Greenhouse pot experiment with *Brachiaria decumbens* with 2 factors (mycorrhiza and N):

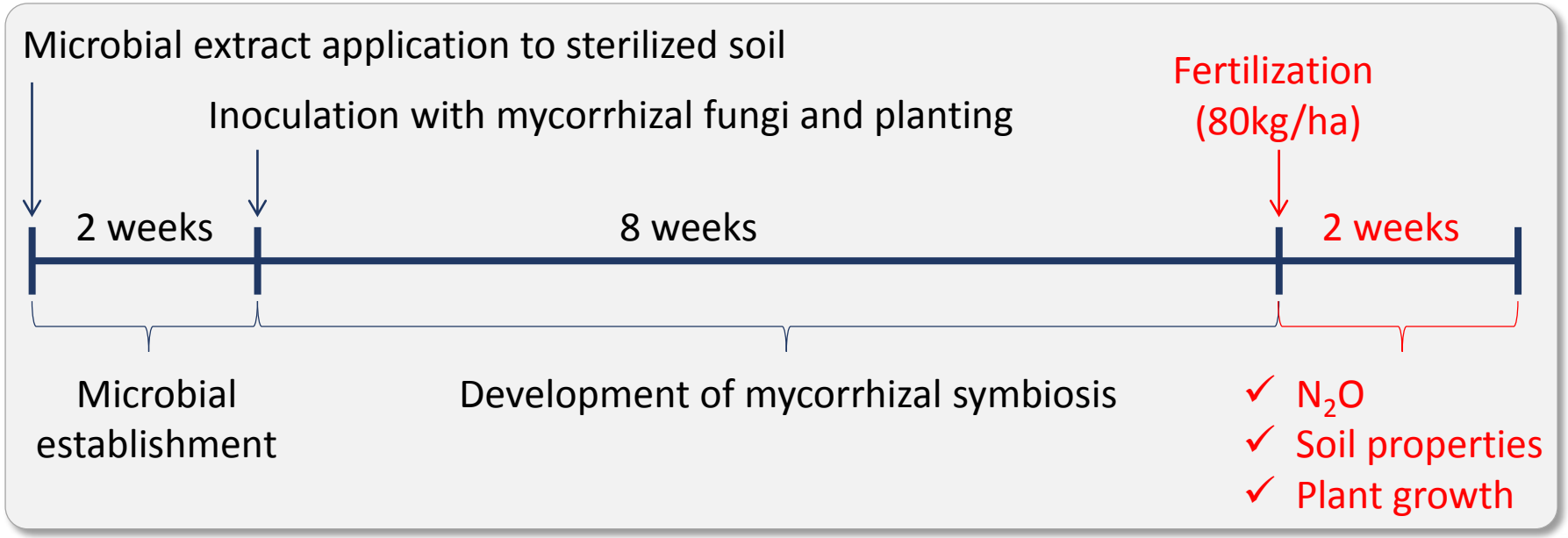
1. Mycorrhiza

- Control plants
- Plants inoculated with mycorrhizal fungi

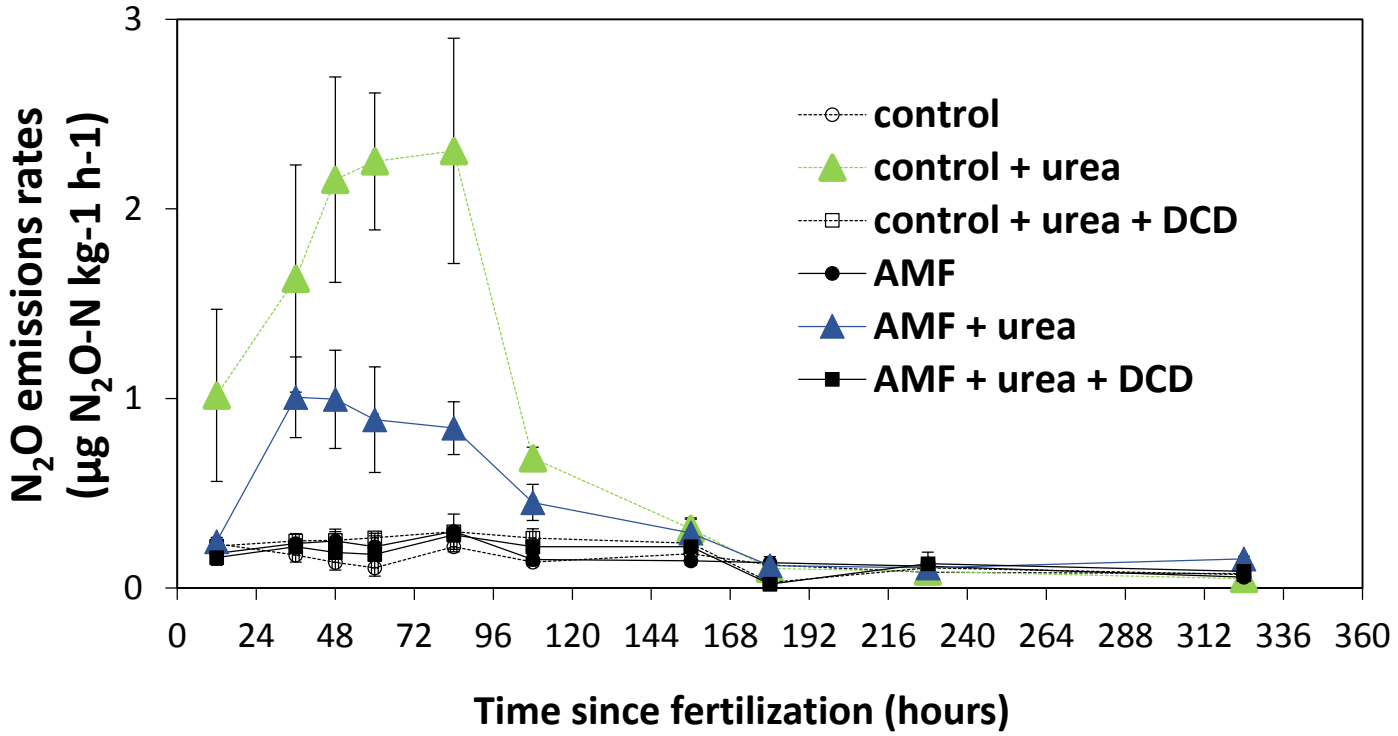
2. N Fertilization

- No fertilization
- Urea
- Urea + DCD (nitrification inhibitor)





N_2O emissions suppressed when mycorrhiza is present

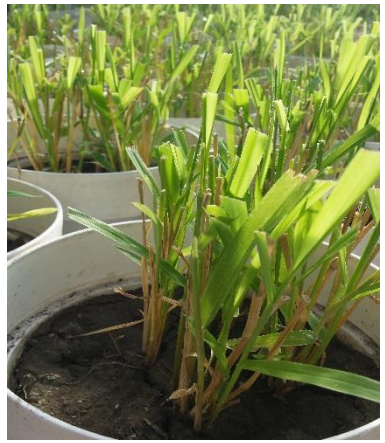


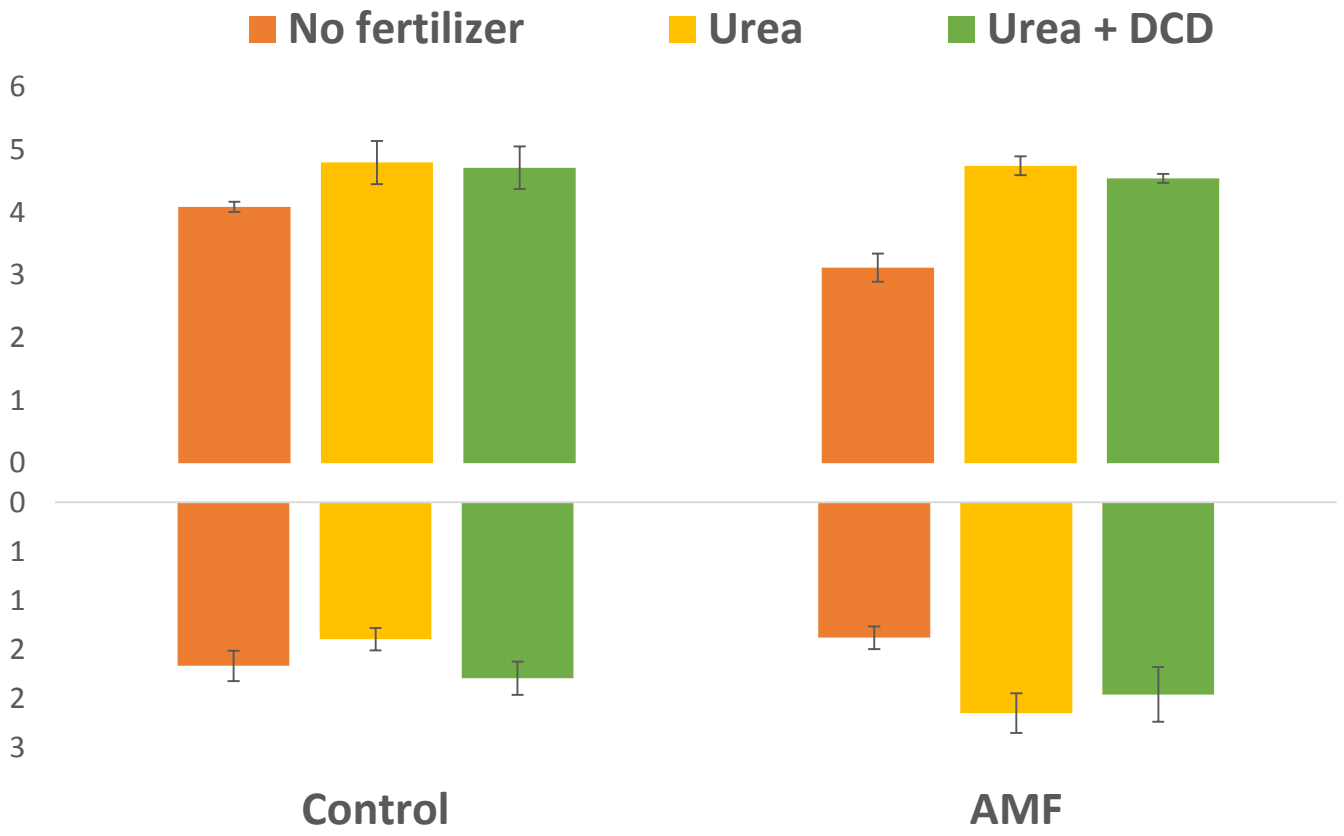
No emissions when urea was applied with DCD

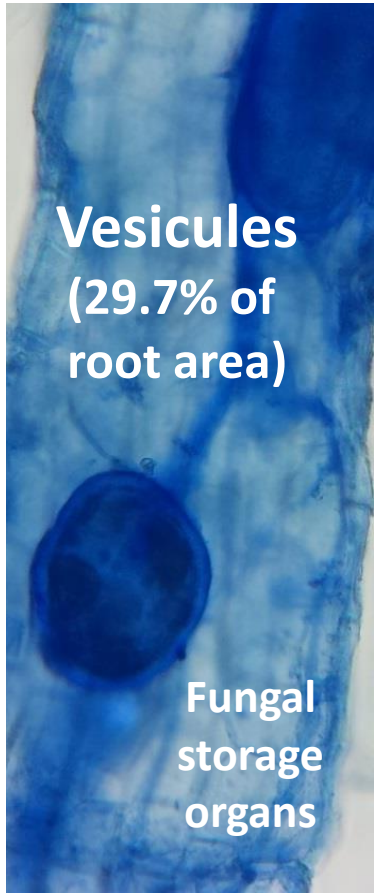
Mycorrhiza reduced N_2O emissions by 46%

- ✓ Reduced amount of substrate for nitrifiers
- ✓ AMF reduced the abundance/activity of nitrifiers

Plant biomass production

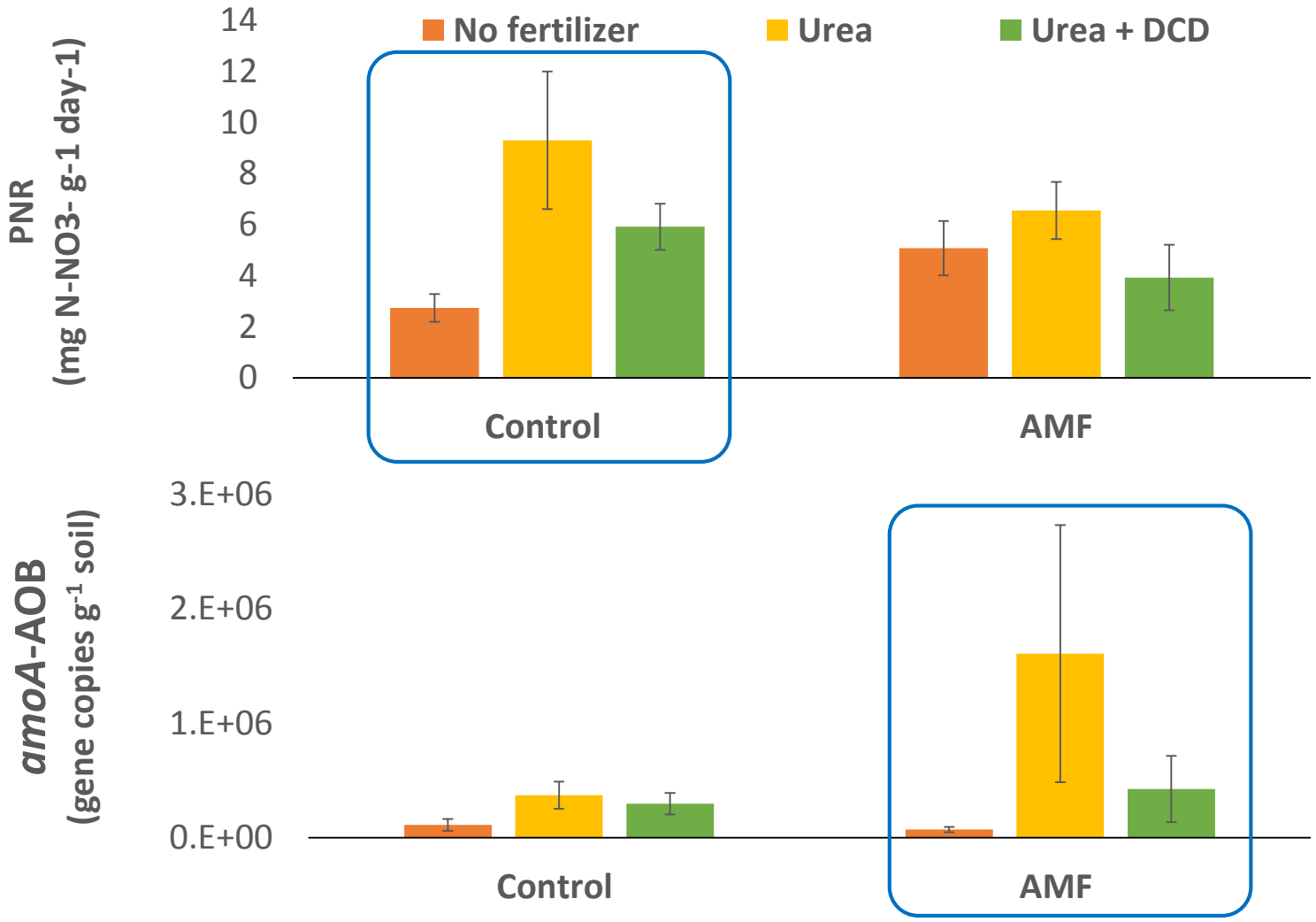


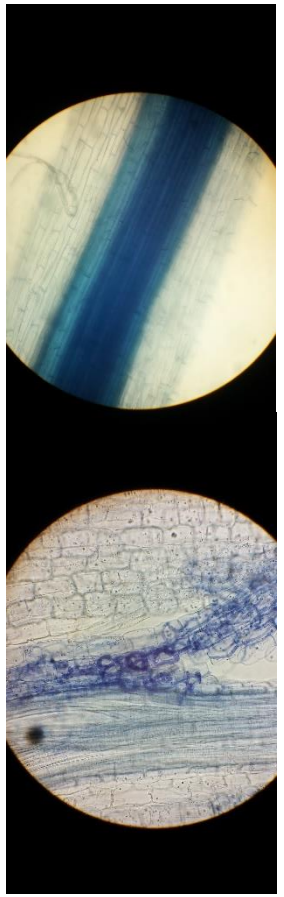




- ✓ Slight reduction in aereal growth of mycorrhizal plants when compared to control
- ✓ Increase of root:shoot ratio => stress from competition?

Potential soil nitrification and abundance of soil ammonium oxidizers

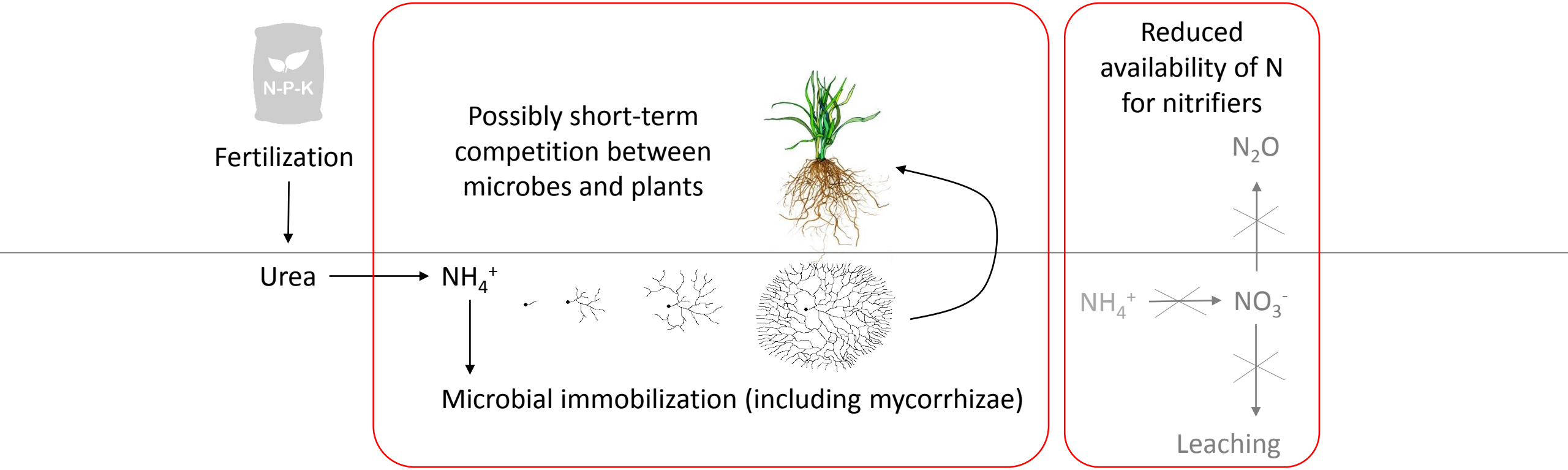




The activity more than abundance could be more indicative of potential N_2O emissions originating from nitrification

Conclusions

✓ **Mycorrhiza can reduce the N_2O emissions** shortly after fertilization independently of plant growth.



✓ **Plant-microbe interactions are important when developing sustainable production systems with high nutrient use efficiency.**

Future directions and remaining questions

- ✓ Explore the possibility to include mycorrhizal affinity as trait for *Brachiaria* or other tropical grasses breeding programs and/or germplasm exploration efforts.
- ✓ Investigate the impact of grazing and animal incidence on plant-fungus interaction.
- ✓ Identification of management practices that favor plant-soil associated microbes (e.g. mycorrhiza) is key in the process of sustainable intensification.

- ✓ Nitrogen immobilized in mycelium would be released after mycelium senescence? *Extend the monitoring time.*
- ✓ The increased abundance of AOB is an indication of potentially higher emissions when N is repeatedly added? *Extend the monitoring time, including activity and diversity determinations.*

Thank you!

ACKNOWLEDGEMENTS

This work was undertaken as part of the ***LivestockPlus*** project from the **CGIAR Research Program on Climate Change, Agriculture and Food Security** (CCAFS), which is carried out with support from CGIAR Fund Donors and through bilateral funding agreements. For details please visit ccafs.cgiar.org/donors.

This work was done as part of the **CGIAR Research Program on Livestock**. We thank all donors that globally support our work through their contributions to the CGIAR system.

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CCAFS

CGIAR RESEARCH PROGRAM ON Livestock

CIAT 50 1967-2017

WE'RE PROUD TO HAVE CELEBRATED 50 YEARS OF AGRICULTURAL RESEARCH FOR DEVELOPMENT

International Center for Tropical Agriculture - CIAT

Headquarters and Regional Office
for South America and the Caribbean

+57 2 445 0000
Km 17 Recta Cali-Palmira
A.A. 6713, Cali, Colombia

ciat@cgiar.org
ciat.cgiar.org

CGIAR

CIAT is a CGIAR Research Center