
RESEARCH UPDATE: SOIL N CYCLING IN PERENNIAL FORAGE CROPS IN RWANDA

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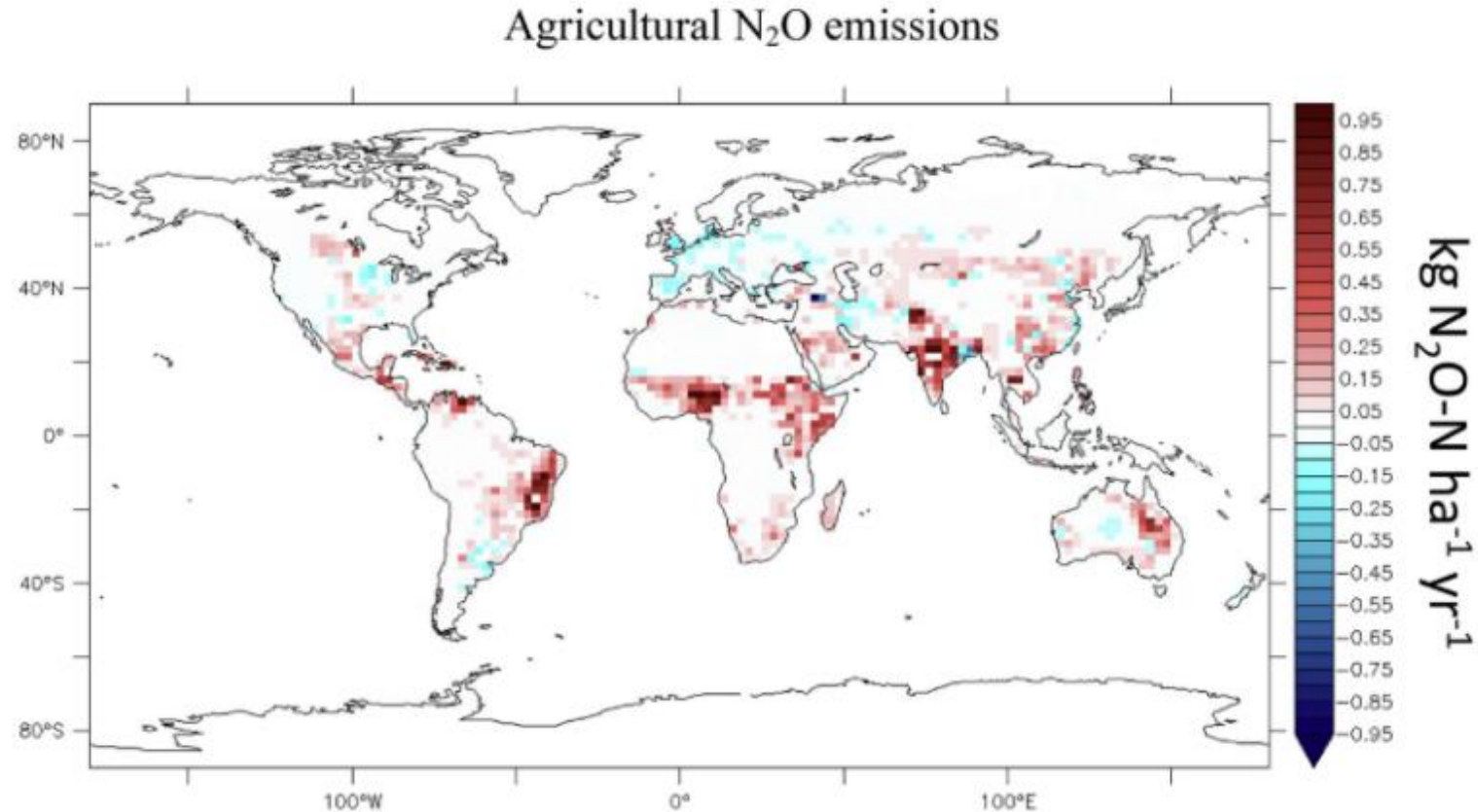
Dec 2, 2020



BACKGROUND

- Alliance/CIAT climate-smart forages project in Rwanda and Tanzania, funded by IFAD
- Meat & dairy production in rainfed systems has disproportional environmental 'hoofprint'

Big-picture question: can 'improved' perennial forages address both declining soil fertility and increasing GHG emission intensities in the East African highlands?



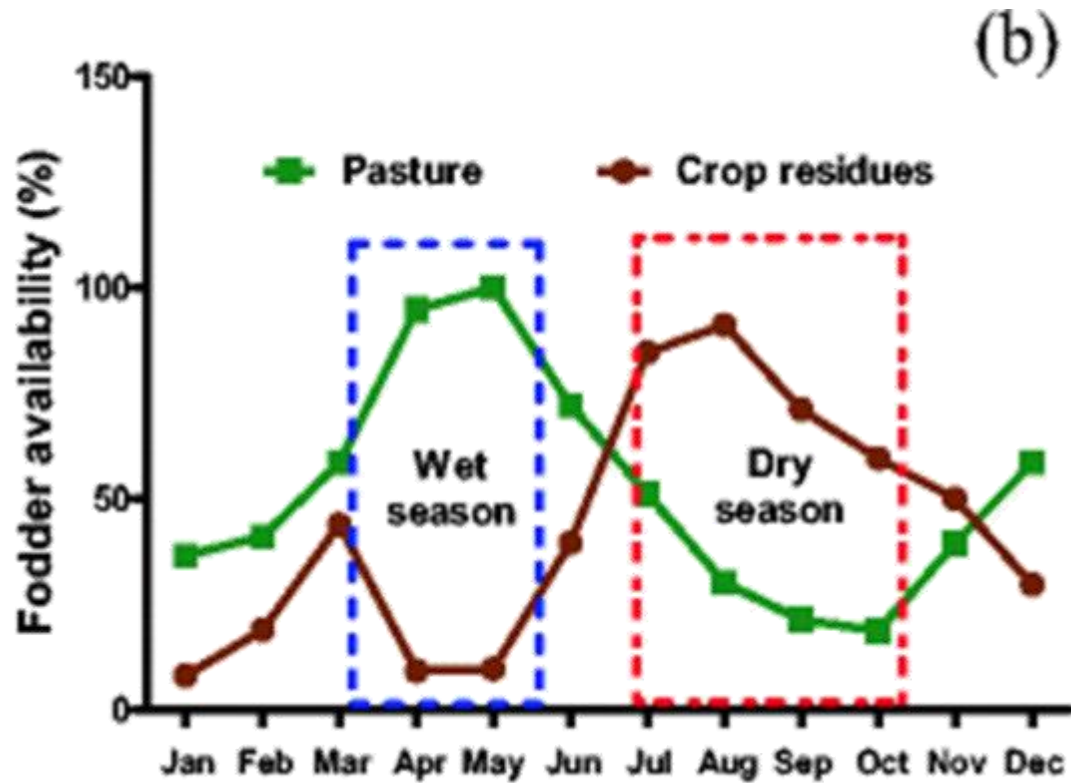
Kanter et al, 2016

DAIRY IN RWANDA

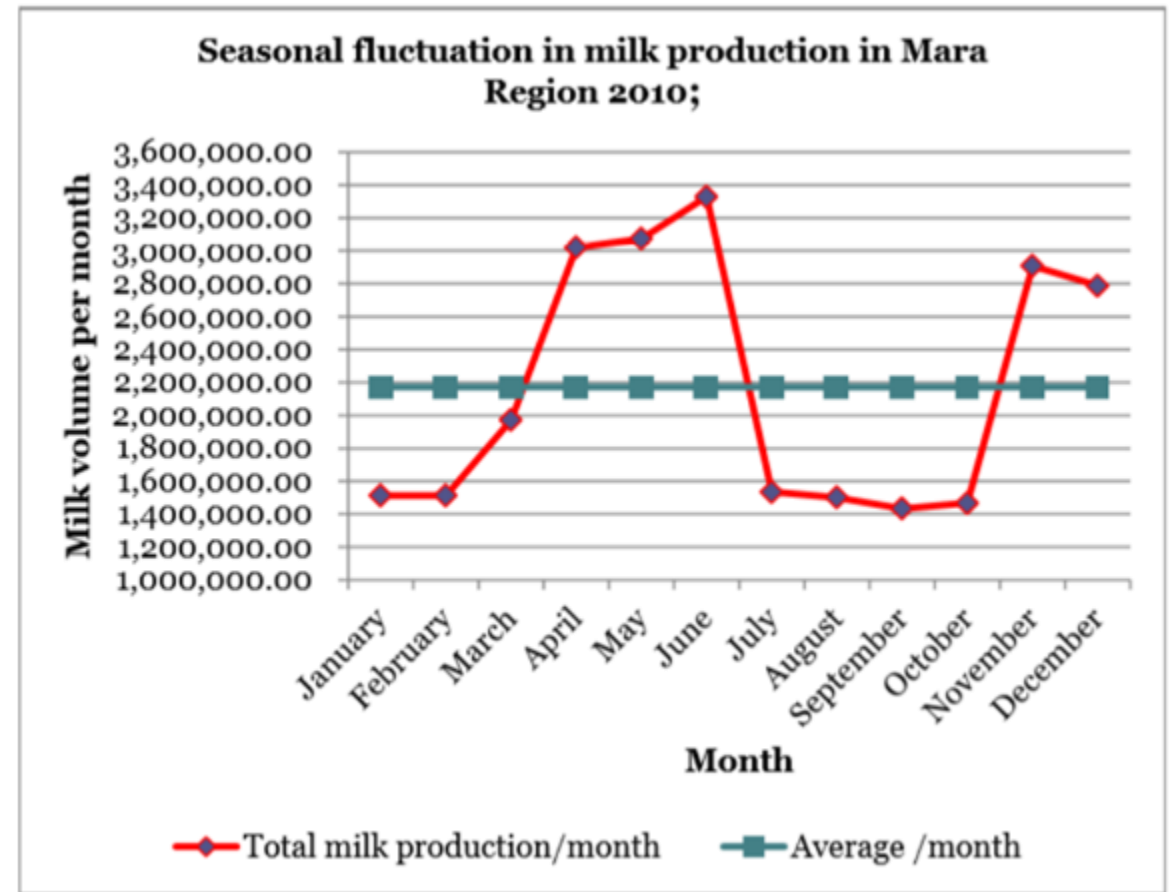
- 15% GDP
- Annual production: 445 million liters
- Longstanding cultural significance
- Pathway out of poverty





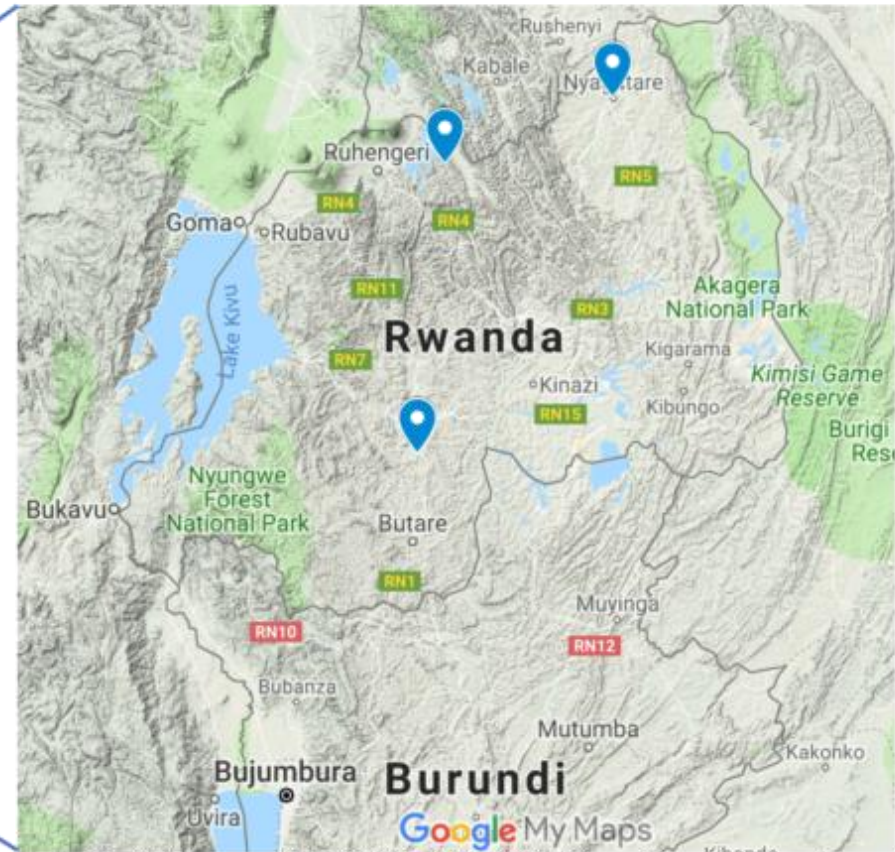


Adapted from Maleko, 2018



Adapted from
Tanzania Dairy Industry Overview, 2012

STUDY LOCATIONS

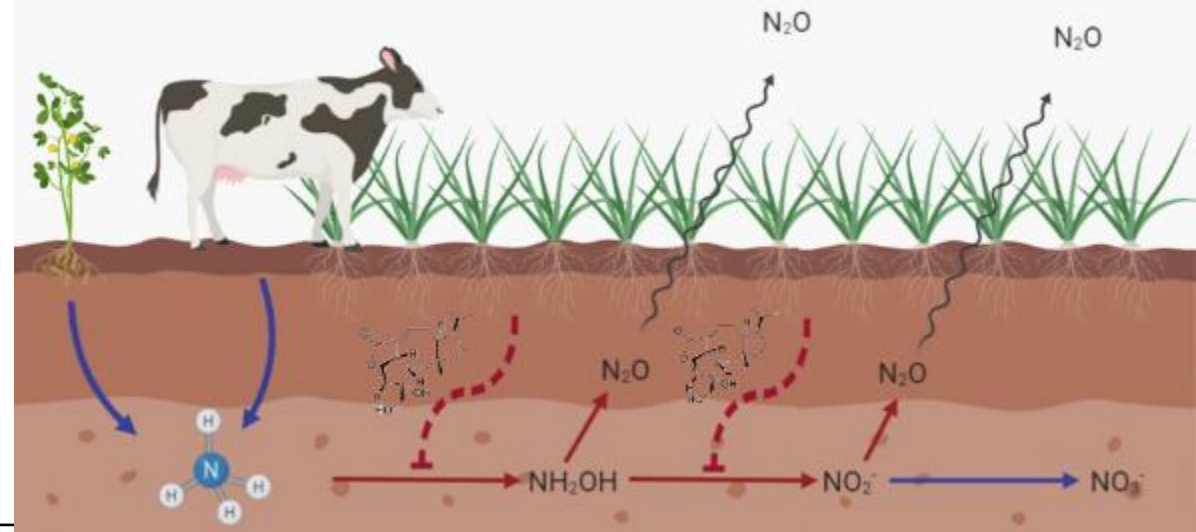


TWO N COMPETITION STRATEGIES WITH IMPLICATIONS FOR SOIL FERTILITY

Legumes: **Biological nitrogen fixation (BNF)**



Grasses: **Biological nitrification inhibition (BNI)**



How do perennial forage cropping systems with different N competition strategies...

...contribute to soil N fertility?

...influence potential sources of N loss, especially via nitrification & denitrification?

...impact soil microbial N cyclers during critical stages of crop growth?

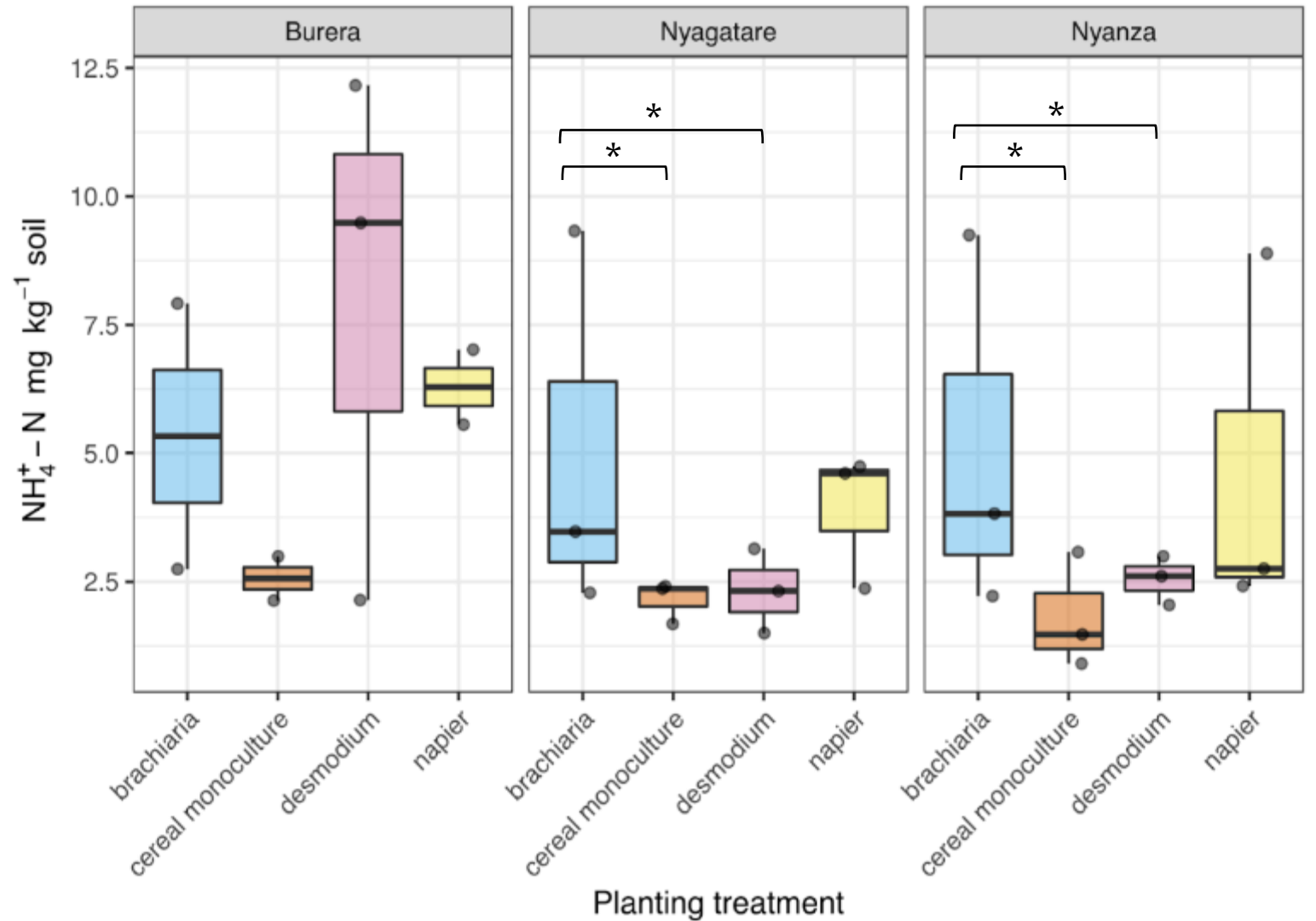
...respond to seasonal changes in soil moisture?



Ultimately, can perennial forages contribute to soil fertility with concomitant environmental benefits?

PREVIOUS FINDINGS: ON-FARM TRIALS 2019

Forage functional group impacts soil mineral N in a site-dependent manner, irrespective of farmer management



REPLICATED TRIAL TREATMENTS



D. distortum



Brachiaria cv. Mulato II



Napier (*Pennisetum purpureum*)



Continuous maize

'Farmer practice'



D. distortum + *Brachiaria* cv. Mulato II



D. distortum + Napier grass



D. distortum + Maize

REPLICATED TRIAL STUDY DESIGN

Treatments:

1. *Desmodium intortum*
2. *Brachiaria* cv. Mulato II
3. *Pennisetum purpureum*
(Napier)
4. Maize monoculture
5. *D. intortum* + Mulato II
6. *D. intortum* + maize
7. *D. intortum* + Napier

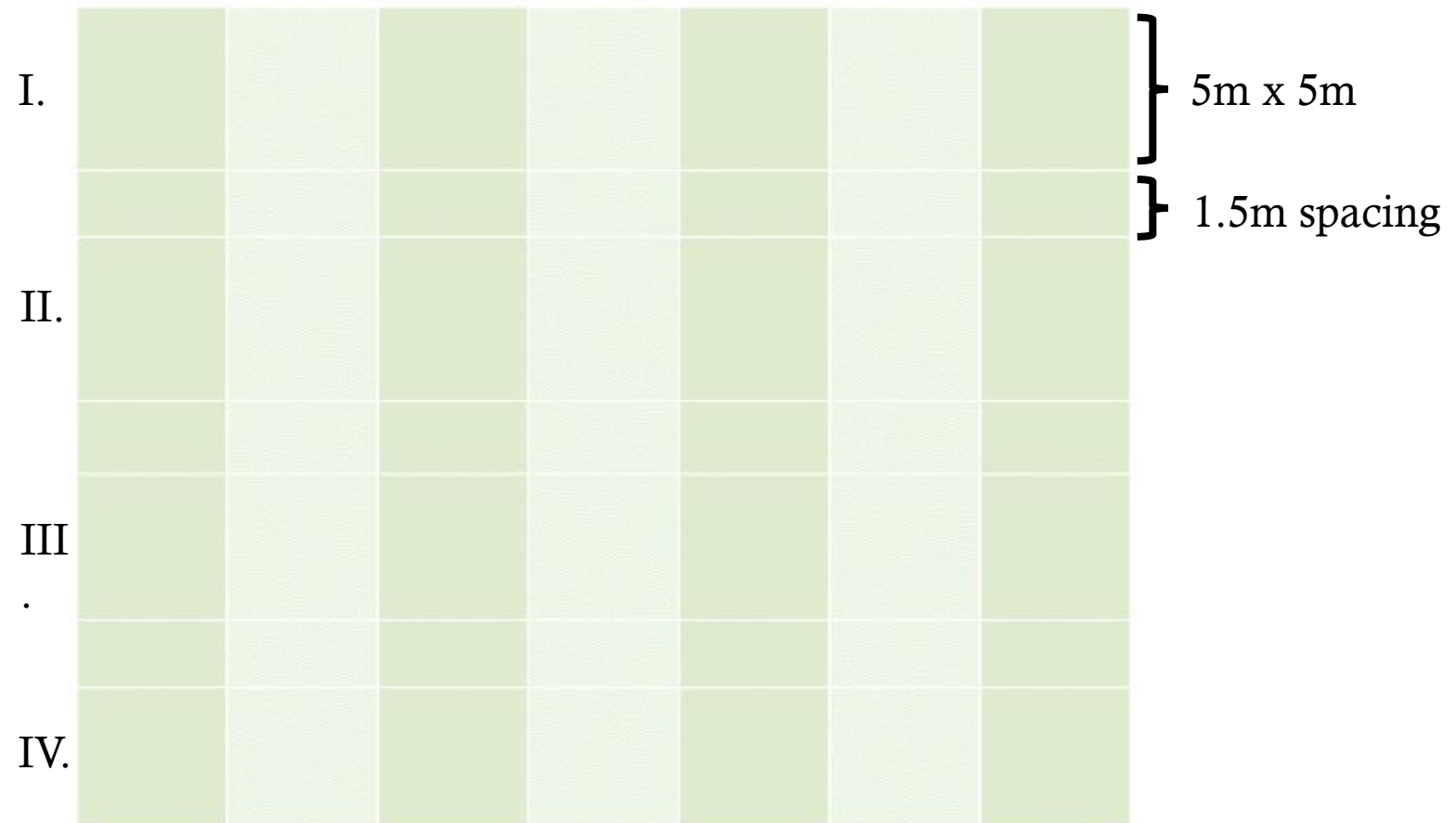
Harvest and data collection:

Nyanza & Nyagatare

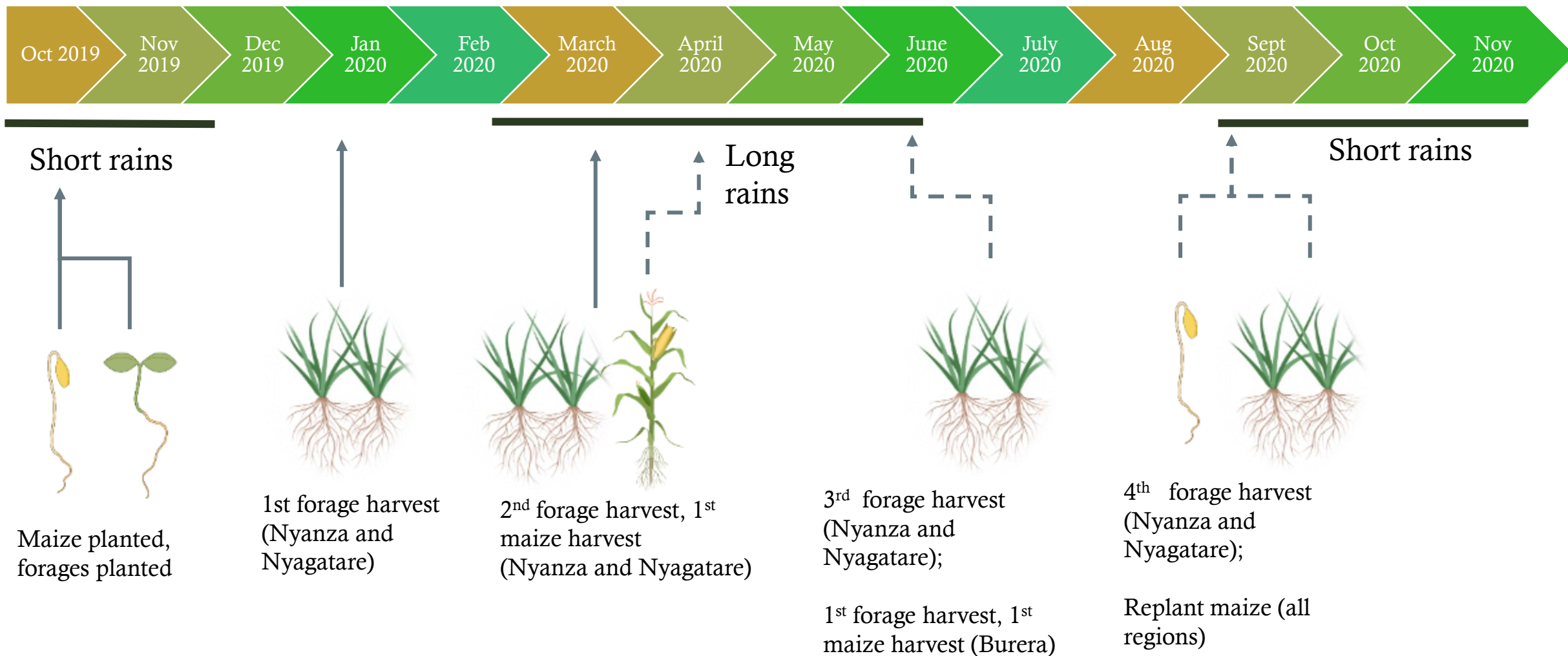
- First harvest at 12 weeks
- Subsequent harvests every 8 weeks

Burera

- First harvest at 21 weeks



REPLICATED TRIALS: FORAGE AND CROP GROWTH TIMELINE



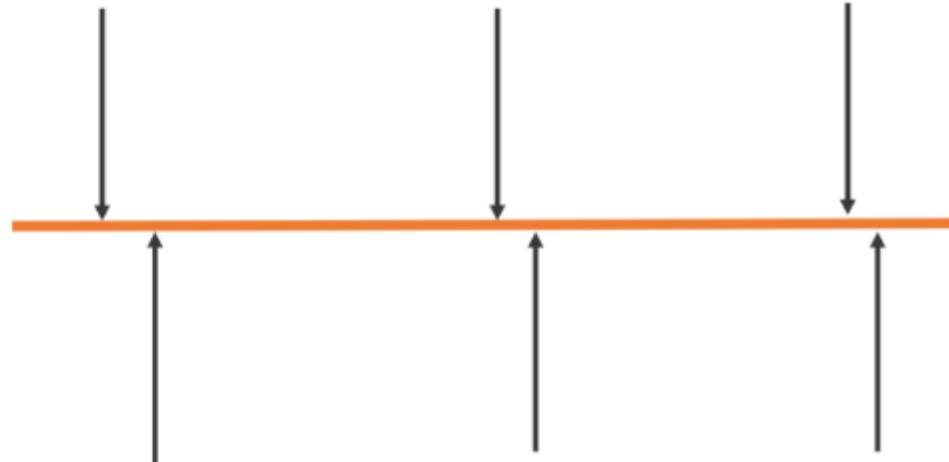
SOIL SAMPLING



Sept 2020:
Soil shipment
(pre-harvest)

Nov 2020:
Soil shipment
(pre-harvest)

Jan 2021:
Soil shipment
(pre-harvest)



Sept/Oct 2020:
Soil shipment (2-
weeks)

Nov/Dec 2020:
Soil shipment (2-
weeks)

Jan/Feb 2021:
Soil shipment (2-
weeks)



Early-stage regrowth
(~2 weeks post-harvest)

2-3 days before harvest
(8 weeks)



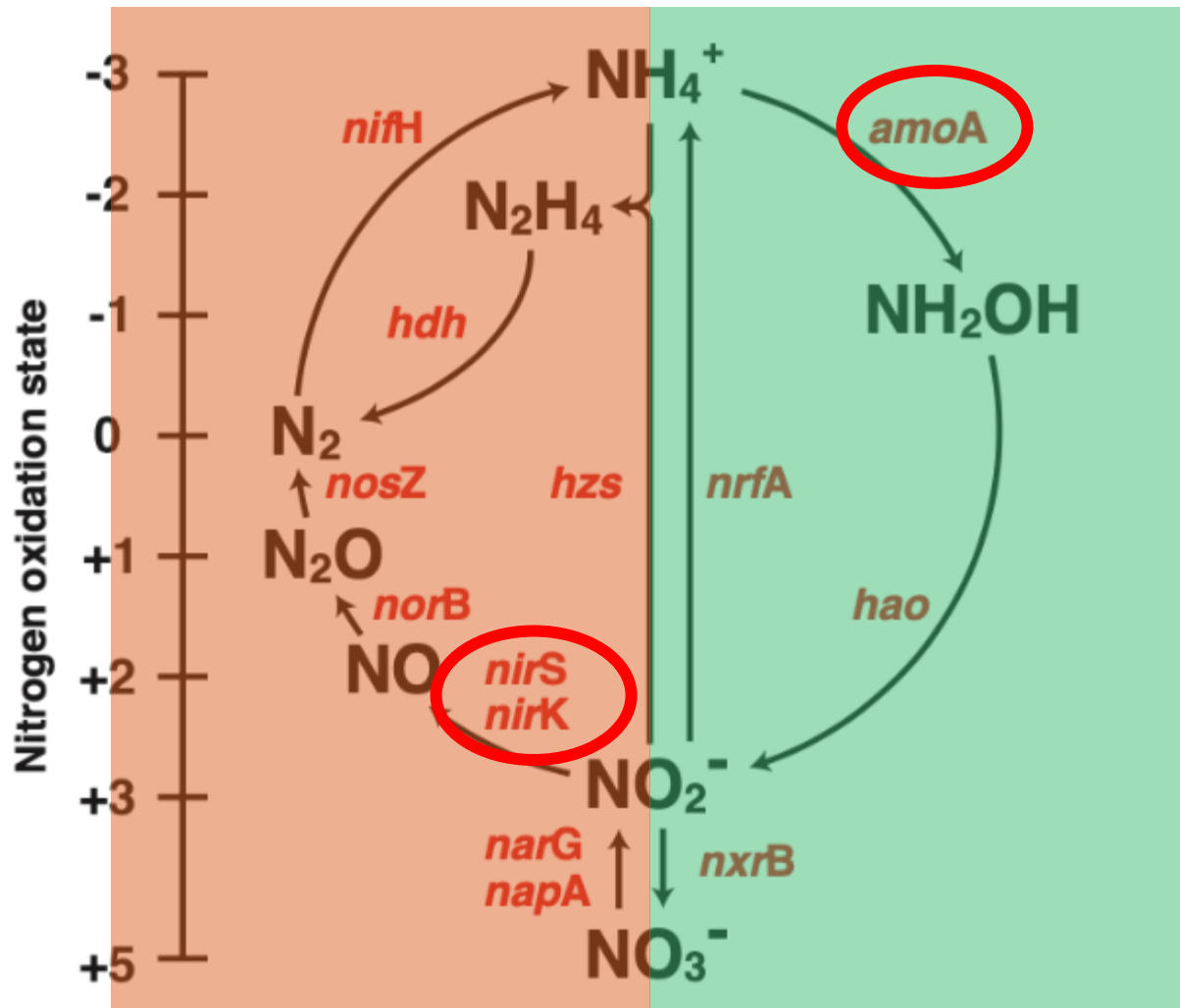
SOIL SAMPLING METHODS

- Sterile collection using one falcon tube per plot, 10 cores/plot
- 2 mm sieving in field
- Kept at 4C until moment of shipping
- Shipped in Styrofoam box with 28 samples/box and 2 ice packs/box

ASSAYS & SOIL METRICS

- Nitrification Potential (NP)
- Denitrification Enzyme Activity (DEA)
- Potential Mineralizable Nitrogen (PMN)
- GWC
- pH
- Nitrate/ammonium
- NiCE chip qPCR






Nitrification

- Bacteria
- Archaea

Denitrification

- Bacteria
- Fungi

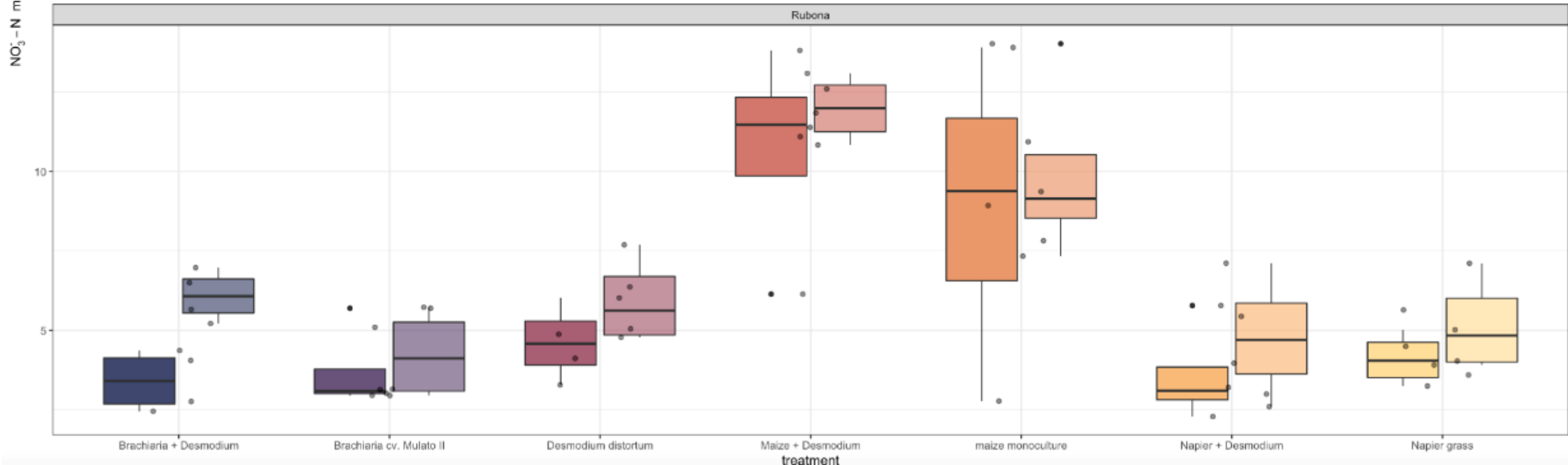
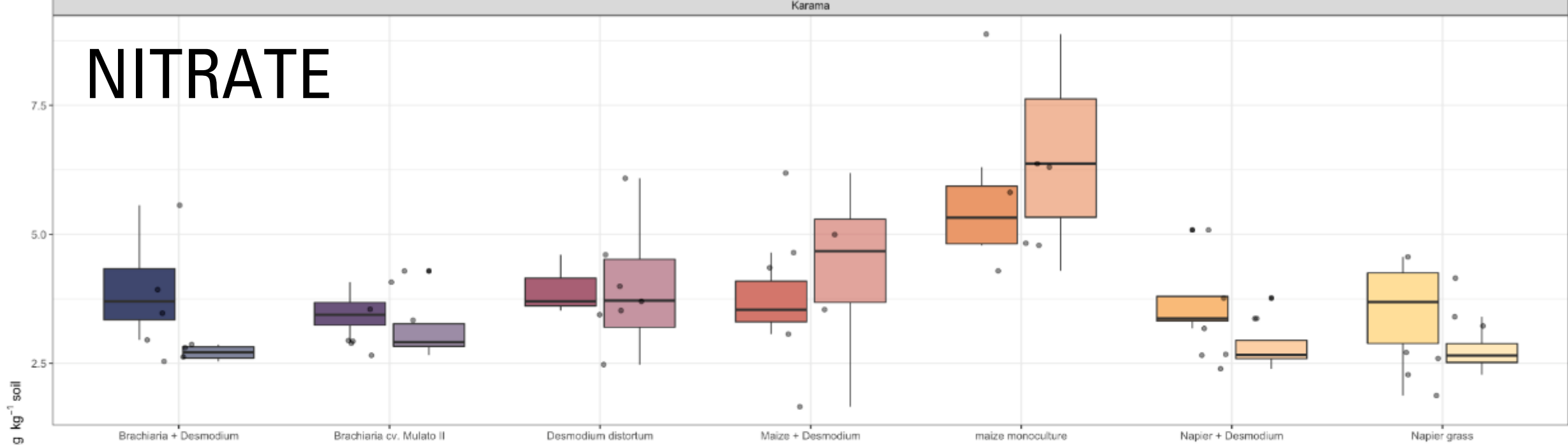
 = rate-limiting



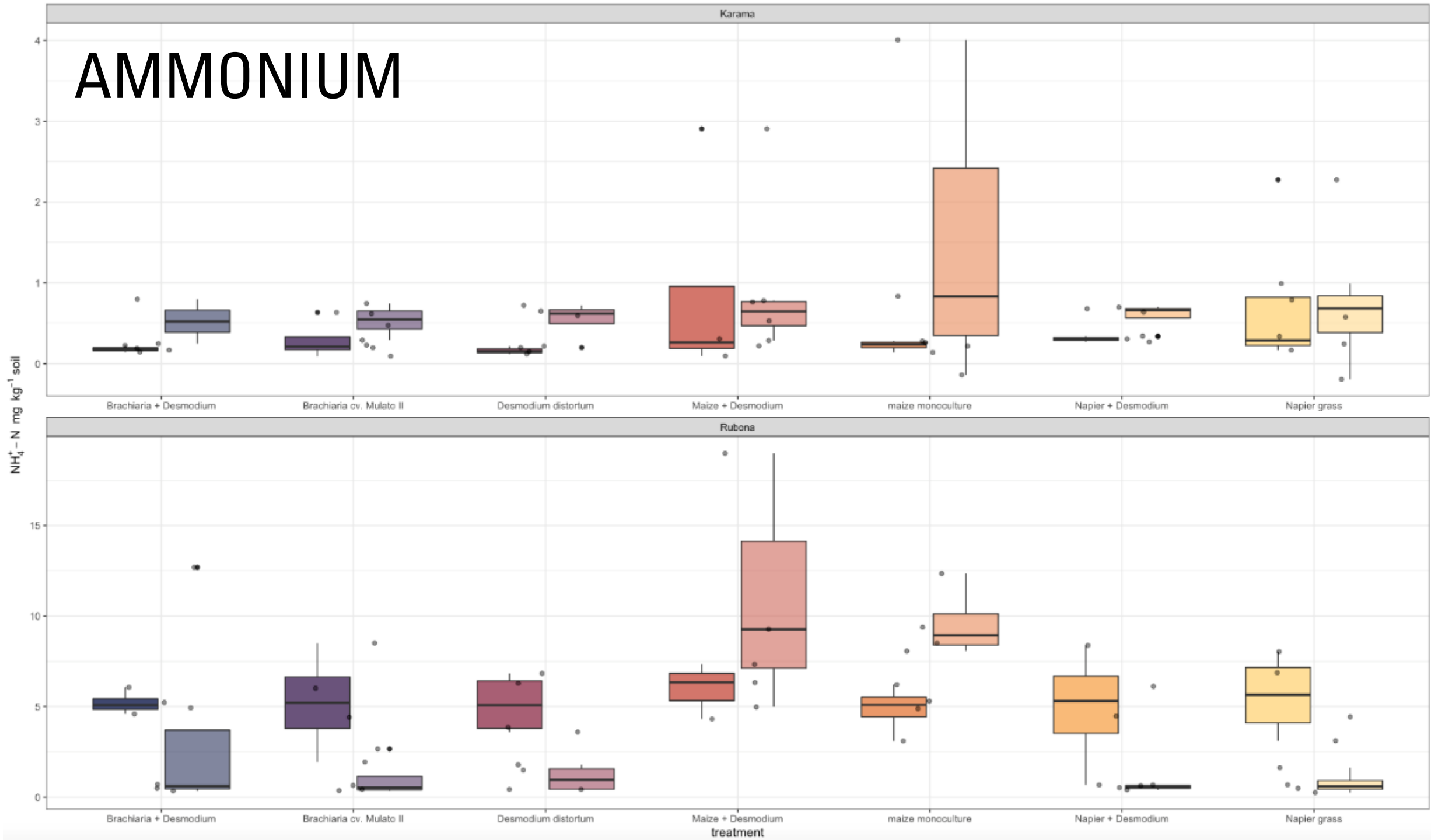
PRELIMINARY RESULTS 2020

Forage functional group and
intercropping arrangement impact
mineral nitrogen soil levels, with
pH and moisture as potential site-
specific drivers

NITRATE

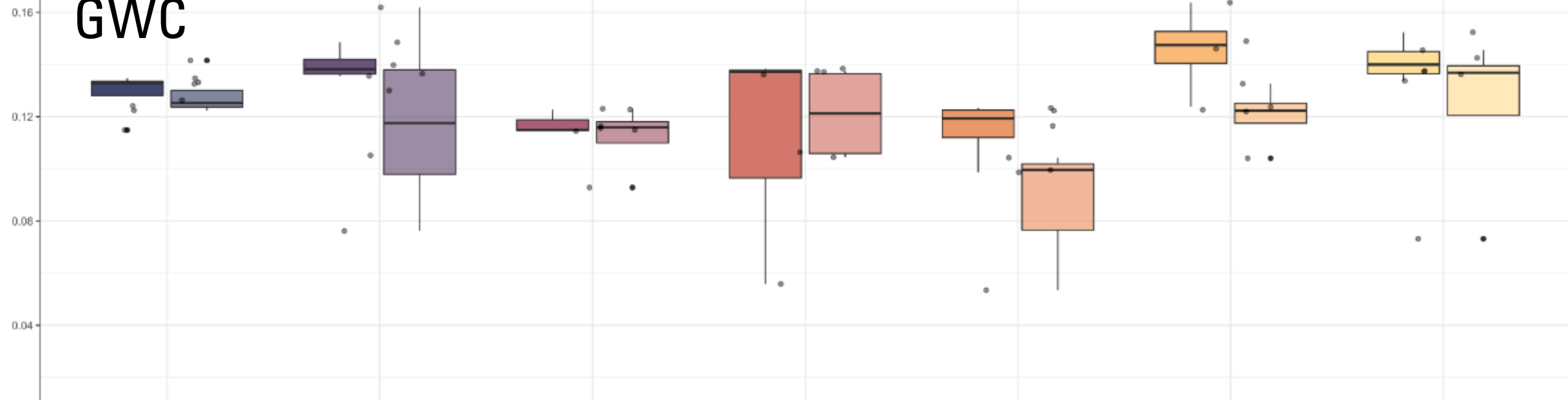


AMMONIUM

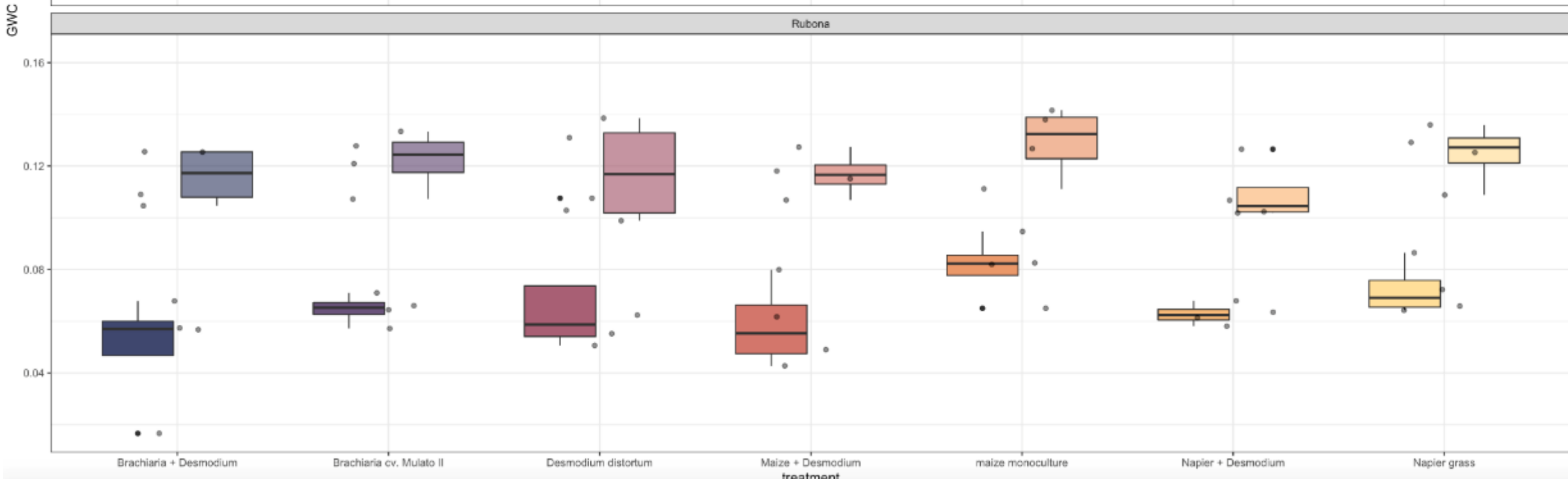


GWC

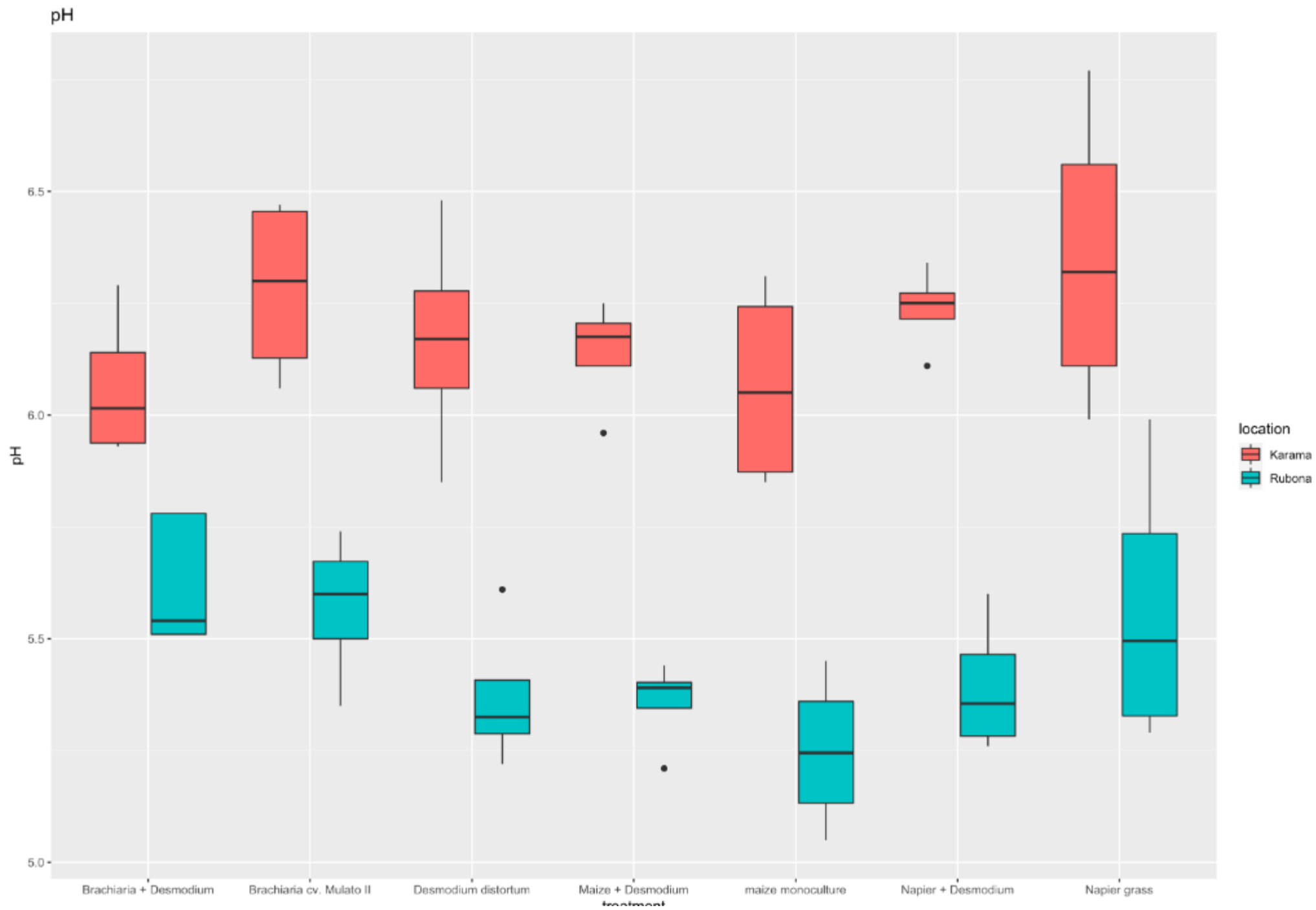
Karama



Rubona



PH



PRELIMINARY FINDINGS

- During rapid growth phase of forages (2-weeks post-harvest) there is evidence of planting treatment effects on soil N transformations
 - These trends in soil N transformation following forage harvest are heavily site-dependent
 - Dramatic differences in soil water content (GWC) and pH between Karama and Rubona may explain these preliminary observations
 - Lab work to understand the contribution of microbial abundances and enzymatic activity to soil N fertility and N loss are ongoing
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ACKNOWLEDGEMENTS

Grossman Lab

Dr. Adria Fernandez
Dr. Vivian Wauters
Sharon Perrone
Rebecca Fudge
Naomy Candelaria
Gabriela Hidrobo
Madison Moses
Harrison Reed

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Danilla

INTERDISCIPLINARY
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Alliance



*More meat milk and eggs by and for
the poor*

