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Report on the determination of the variability in the nutritional characteristics of tropical grass and legume species caused by variety, season, and growth stage, with common availability in different geographical locations in Colombia.

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Report on the determination of the variability in the nutritional characteristics of tropical grass and legume species caused by variety, season, and growth stage, with common availability in different geographical locations in Colombia.

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Understanding the main drivers shaping the nutrition profile of forages is key for the development of efficient and profitable livestock management systems. Nowadays, it is well known that adequate animal nutrition is critical to achieve high rates of gain, ample meat and milk production, efficient reproduction, and sufficient profits. Nevertheless, despite significant efforts have been undertaken all around the world to find feed options for specific regions and animal races, the vast diversity of germplasm resources, environmental, and socioeconomic conditions, have made this a difficult task.

Originally, forage quality was considered a trait comprised by only plant biomass and nutrient content. Now, with the rapid evolution of this field, this paradigm has shifted towards the recognition of animal performance as the ultimate measure of forage quality, and the complexity of this trait, integrating palatability, intake, digestibility, nutrient content, and even, anti-quality elements; which could be affected by intrinsic factors, like plant species, maturity stage, leaf-to-stem-ratio, and daily fluctuations but also by external factors, such as fertilization, harvesting and overall management. This latter is of particular importance. Grazing is considered as a relatively low cost source of nutrition, since livestock, rather than expensive machinery, harvest the forage. However, if not well managed, can led to significant feed and environmental losses. Thus, over-grazing reduces plant growth, whereas under-grazing can lower quality and increase forage waste. The maintenance of feed quality high has several benefits, favoring animal health, resistance to parasites and diseases, and more efficient enteric fermentation, which is then translated in reduced methane emissions.

Further insights on the mechanisms and compounds affecting forage quality would facilitate the design of feeding strategies matching forage quality to animal needs (reproduction, growth, health, fattening and lactation) and reducing environmental pollution. Under this context, during 2018 and in the frame of the Livestock CGIAR Research Program we have conducted research for development determining the variability in the nutritional characteristics of important tropical forages caused by variety, season, and growth stage, with common availability.

Source:

Ball, D. M., Collins, M., Lacefield, G. D., Martin, N. P., Mertens, D. A., Olson, K. E., ... & Wolf, M. W. (2001). Understanding forage quality. American Farm Bureau Federation Publication, 1(01).

Submitted manuscripts:

a. Manuscript #1.

Nutritional quality, fermentation and in vitro methane production from native and improved tropical grasses:

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ABSTRACT: The nutritional quality of forage grasses affects cattle productivity and enteric methane (CH4) production and emission. The objective of this study was to compare the nutritional quality, dry matter degradability (DMD) and CH4 emissions of the most commonly grown tropical grasses in four regions of Colombia. These included the improved tropical *grasses Brachiaria decumbens, B. humidicola, B. brizantha, Megathyrsus maximus, Cynodon nlemfuensis*, and *Axonopus purpusii*. These were first characterized for their nutrient composition. Subsequently, a randomized complete block design incubation experiment was used to determine DMD following 24, 48, 72, and 96 h of in vitro incubation. In addition, in vitro gas and CH4 emissions were quantified. Crude protein content ranged from 41 to 127 g/kg DM. On average, B. humidicola and B. brizantha produced 187 mL of gas per g of organic matter (OM), which was 24% higher than the rate observed *for A. purpusii, M. maximus*, *and C. nlemfuensis. A. purpusii* produced 0.43 times less CH4 than *C. nlemfuensis* (15.0 vs 34.7 mg CH4/g DOM, respectively). Taken together, these results suggest that the utilization of improved forages, such as those of the *Brachiaria* or *Megathyrsus* genera, have potential to reduce the negative environmental impact of tropical ruminant agriculture.

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Corresponding Author	Dr. Jacobo Arango (j.arango@cgiar.org) (International Center for Tropical Agriculture (CIAT))
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Abstract	The nutritional quality of forage grasses affects cattle productivity and enteric methane (CH4) production and emission. The objective of this study was to compare the nutritional quality, dry matter degradability (DMD) and CH4 emissions of the most commonly grown tropical grasses in four regions of Colombia. These included the improved tropical grasses Brachiaria decumbens, B. humidicola, B. brizantha, Megathyrsus maximus, Cynodon nlemfuensis, and Axonopus purpusii. These were first characterized for their nutrient composition. Subsequently, a randomized complete block design incubation experiment was used to determine DMD following 24, 48, 72, and 96 h of in vitro incubation. In addition, in vitro gas and CH4 emissions were quantified. Crude protein content ranged from 41 to 127 g/kg DM. On average, B. humidicola and B. brizantha produced 187 mL of gas per g of organic matter (OM), which was 24% higher than the rate observed for A. purpusii, M. maximus, and C. nlemfuensis. A. purpusii produced 0.43 times less CH4 than C. nlemfuensis (15.0 vs 34.7 mg CH4/g DOM, respectively). Taken together, these results suggest that the utilization of improved forages, such as those of the Brachiaria or Megathyrsus genera, have potential to reduce the negative environmental impact of tropical ruminant agriculture.
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b. Manuscript #2.

Evaluation of tropical forage grass alone and grass-legume diets to improve animal nutrition and reduce enteric methane production

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ABSTRACT: The nutritional quality of forage grasses has a direct effect on animal feed voluntary intake, productivity, and enteric methane (CH4) emissions. This study evaluated the nutritional quality, in vitro enteric CH4 emission potential, and forage diet optimization in two different silvopastoral systems. The systems were based on the grasses *Brachiaria* hybrid cv. Cayman (BHC) or *B. brizantha* cv. Toledo (BBT), both associated with the legumes, *Canavalia brasiliensis* (CB) and *Leucaena diversifolia* (LD). In the in vitro gas production experiment, forage samples were incubated, both individually and in different mixtures, for 96 hours. Substitution of 30% of the grass dry matter (DM) with CB or LD (15% each) reduced both gas production and DM degradability (DMD). The amounts of CH4 that accumulated following 96 h of incubation were 87.3 mg CH4 g-1 DM and 107.7 mg CH4 g-1 DM for BHC and BBT grasses respectively, and 100.7 mg CH4 g-1 DM and 113.2 mg CH4 g-1 DM for the combined diets (70% grass, 15% CB, and 15% LD) based on BHC and BBT, respectively. The diet optimization modelling process, for high crude protein (CP) and low gas production, suggested that for a diet comprising 60% grass, 30% CB and 10% LD, as CP increased 0.87 and 1.14 x original value for the BBT and BHC diets respectively, and total gas production decreased by about 14.5%. We concluded that the inclusion of legumes in the diet would provide potential nutritional and environmental benefits to cattle offered tropical grasses.

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Research papers published:

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b. Karwat, H., Egenolf, K., Nuñez, J., Rao, I., Rasche, F., Arango, J., Moreta, D., Arevalo, A., & Cadisch, G. (2018) Low 15N Natural Abundance in Shoot Tissue of *Brachiaria humidicola* Is an Indicator of Reduced N Losses Due to Biological Nitrification Inhibition (BNI). Front. Microbiol. 9:2383. DOI: 10.3389/fmicb.2018.02383

c. Núñez, J., Arévalo, A., Karwat, H., Egenolf, K., Miles, J., Chirinda, N., Cadisch, G., Rasche, F., Rao, I., Subbarao, G. V., & Arango, J. (2018). Biological nitrification inhibition activity in a soil-grown biparental population of the forage grass, *Brachiaria humidicola*. Plant and Soil. 426(1-2), 401–411. DOI: 10.1007/s11104-018-3626-5.