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Info Note

Grazing management innovation as a strategy to improve animal production and reduce GHG emissions

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Key messages

- Colombian dairy systems are characterized by Friesian cattle fed with a mixture of kikuyu grass (*Cenchrus clandestinus, Hochst. ex Chiov*) and supplement, in different proportions. This system varies substantially in terms of level of intensification and grazing management.
- Improving grazing management is an effective approach for increasing animal productivity and reducing GHG emissions (particularly CH_4) per unit of animal product or per unit area.
- *"*Rotatinuous*"* is an innovation in grazing management that optimizes dry matter intake rate by improving nutrient consumption per unit eating time.
- *"*Rotatinuous*"* is a grazing management concept based on animal behavior that promotes both primary (plant) and secondary (animal) production and contributes to food security by enhancing the amount and quality of food products, while mitigating impacts of grazing ruminants by decreasing GHG emissions and benefiting farmers by reducing their dependence on external inputs.

Introduction

Livestock farming has had a significant influence on Colombian landscapes, ecosystems, and societies for nearly 5 centuries and plays an important role in culture, food production, the economy, and livelihoods. Colombia has a cattle inventory of approximately 22,689,420 heads distributed in 494,402 farms, most of which (80%) are medium and small farms (ICA, 2016). The latter are typically family-owned, subsistence operations characterized by poor animal and ecosystem management and inefficient pasture use.

Grasslands, including sown pastures and rangelands, are among the largest land use in the country, covering around 34 million hectares. However, the vocation of Colombian soils for livestock is estimated to be about 15 million hectares, this is, less than a half of what today it is intended for the sector (MinAgricultura, 2014).

On the other hand, it is estimated that the global livestock sector is responsible for approximately 14.5% of all anthropogenic greenhouse gas (GHG) emissions (Gerber et al. 2013). Approximately 44.0% of the livestock sector's emissions are in the form of methane (CH4) from enteric fermentation, manure, and rice paddy management. For Colombia, the methane from enteric fermentation corresponds to 27.6% of all emissions from livestock production (IDEAM, 2016). Beside these statistics is the expectancy that the production and consumption of meat will continue to grow towards 2050 (Alexandratos and Bruinsma, 2012). Innovative strategies are needed to make Colombian livestock systems more efficient, reducing the negative impact of livestock farms on ecosystems while simultaneously promoting rural development and economic growth.

Currently, Colombia is a leader in efforts to mitigate and adapt to climate change. The country has committed to reduce its projected GHG emissions by 20% by 2030 in comparison the BAU scenario, under the United Nations Framework Convention on Climate Change (UNFCCC) (Garcia et al., 2015). Among mitigation opportunities, sustainable livestock farming (silvopastoral systems, grazing management, and sustainable land use) is highlighted as a priority for achieving the reductions. Various initiatives, including the LivestockPlus project, aim at the

identification of mitigation actions in the livestock sector.

Because livestock growth appears to be not only inevitable but also desirable for the economy, jobs, and nutrition (FCRN, 2017), grazing systems are now being re-designed to conciliate production with environmental management and improve overall efficiency (Carvalho, 2013). Intensification of cattle production systems is considered as an important strategy for mitigating anthropogenic GHG emissions (Gerber et al. 2013), and improving grazing management is an effective approach for increasing animal productivity while reducing GHG emissions (particularly CH4) per unit of animal product or per unit area. To accomplish these goals, grazing management targets to optimize nutrient consumption per unit of eating time and increase pasture utilization efficiency should be redefined.

Innovation in grazing sciences: the "Rotatinuous" grazing concept

"Rotatinuous" is an innovation in grazing management based on ingestive behaviour that aims to enhance animal nutrient consumption per unit of eating time (Carvalho, 2013).

Whereas in typical grazing systems management targets are plant oriented and focused on harvesting efficiency, the "Rotatinuous" concept includes the "animal perspective" with the intent of conciliating plant and animal relationships. The current paradigm is that quality and quantity of herbage are the main constrains to animal production on pasture, but "Rotatinuous" also emphasize sward structure as an important determinant of pasture productivity as it is the link between plant composition and animal grazing behaviour (Carvalho, 2013).

Based on these concepts, optimal pre- and post-grazing pasture heights are defined to increase herbage intake per unit eating time, which is particularly important in dairy production systems where cows have restricted time to graze. In general, pre- grazing sward heights are lower, and post-grazing are higher, compared to current grazing management. The consequence is a low intensity – high frequency grazing system when the concept is applied to rotational stocking. Some management targets have already been defined as a tool to be applied at farm level for tropical pastures based on grazing behavior and intake rate maximization (see Table 1).

Table 1. Pasture height targets based on "Rotatinuous" concept as to be applied at farm level in a rotational stocking.

Forage species	Pre-grazing pasture height target* (cm)	Post-grazing pasture height target (cm)	Reference
Sorghum *(Sorghum bicolor)*	50	30	(Fonseca et al. 2012)
Avena (Avena strigosa)	29	17	(Mezzalira et al. 2013)
Millet *(Pennisetum glaucum)*	40	24	(Carvalho, pers com)
Cynodon sp. cv. Tifton 85 (Cynodon sp.)	20	12	(Mezzalira et al. 2013)
Native grassland *(*mainly *Paspalum notatum, Axonopus affinis, Desmodium incanum* and *P. plicatulum)*	12	7	(Gonçalves et al. 2009)
Mombasa *(Panicum maximum)*	75	45	(adapt. Palhano et al. 2006)
Tanzania *(Panicum maximum)*	50	30	Carvalho pers. com.
Italian ryegrass *(Lolium multiflorum)*	18	11	Da Silva et al, (2016)
Tall Fescue *(Schedonorus arudinaceus [Schreb.] Dumort)*	22	13	Szymczak pers com.
Hemartria *(Hemarthria altíssima)*	22	13	R. Moraes pers com.
Arachis (*Arachis pintoi)*	13	8	Silva et al. (2018)
Kikuyu *(Cenchrus clandestinus* (Hochst. ex Chiov.)	20	12	Marin et al. (2017)

* Pre-grazing pasture height target is considered as the pasture structure where intake rate is maximized. Post-grazing pasture height should not exceed ~40% of the pre-grazing height. These pasture height targets could also be applied to continuous stocking systems, in which case they would refer to optimal pasture height at the patch being grazed (average pasture height being lower) (adapted from Carvalho et al., 2013).

"Rotatinuous" grazing represents a technological innovation based on concepts (process), not on inputs, which can be implemented equally well in rotational or continuous stocking. Benefits to the farmer include lower dependence on external inputs and lower labor requirements.

Advances in Colombia

Colombian dairy systems are characterized by Friesian cattle fed with a mixture of kikuyu grass (*Cenchrus clandestinus* - Hochst. ex Chiov.) and supplement in different proportions. This system varies substantially in terms of level of intensification and grazing management, but in general the traditional rotational stocking method predominates. Rotational stocking is defined by large resting periods (high pre-grazing herbage mass) and high grazing pressure to harvest all herbage in the strip (low post-grazing herbage mass), and related to the classical concept of herbage harvesting efficiency (Hodgson, 1979).

The management strategy proposed by "Rotatinuous" entails the creation of sward structures leading to increased herbage intake per unit eating time and, as a result, maximized animal nutrient consumption, with the ultimate goal of making the most efficient use of the pasture, reconciling animal production and forage utilization.

Accordingly, we hypothesized that there is an optimal pre-grazing sward height of kikuyu grass that maximizes animals' short-term herbage intake rate (STIR). The study was conducted at Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (EPAGRI) in Lages, Santa Catarina state, Brazil, between December 2016 and April 2017, through an international cooperation project. The treatments consisted of 5 pre-grazing heights of kikuyu grass (10, 15, 20, 25, and 30 cm) organized in a randomized complete block design with four replicates (two replicates of area, and two times of day). The blocking criterion was the time of day for the evaluation (morning or afternoon). STIR was determined using the double weighing technique corrected for metabolic weight losses (Penning and Hooper, 1985). Three Holstein heifers (22 ± 2 months and 440 ± 42 kg) were used in the experiment. The effective eating time was measured with the IGER-Behavior recorder (IGER) and data were analyzed with the Graze animal behavior software (Rutter, 2000).

Preliminary results showed that maximization of STIR of kikuyu grass is reached at sward height 20 cm (Figure 1).

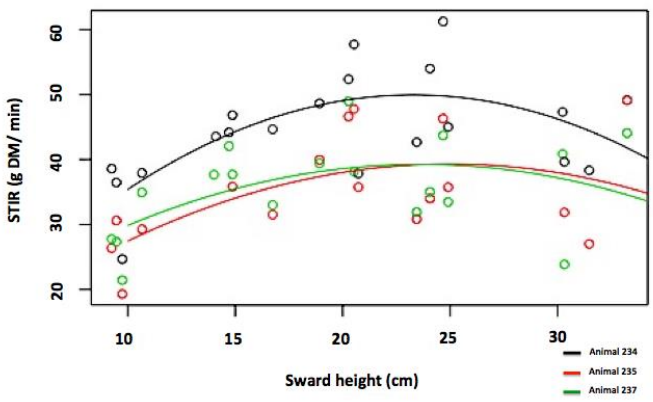

Figure 1. Short-term intake rate (STIR) of Holstein heifers as a function of sward height (SH) in kikuyu (*Cenchrus clandestinus* - Hochst. ex Chiov.) (y= 7,6 + 2,98*SH – 0,062*SH^2) (Marín et al, 2017).

Maximum STIR can be reduced by >30% in very low swards, and also can be reduced on taller ones. Assuming maximum STIR leads to higher daily intake and animal performance, which in turn improves GHG emissions intensity per unit of animal product or per area, we expect that this new pasture management targets can conciliate animal performance and low environmental impacts, as it has already been registered elsewhere in experiments with "Rotatinous" (Schons, 2015; Savian, 2017).

Based on this expectancy, we propose a new management target for Colombian dairy cattle systems based on kikuyo grass (pre 20 – pos 12 cm) to comply with its sustainable livestock farming policy commitments.

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