Relationship between methane emission, residual feed intake and carcass traits of beef cattle

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Financial support: Sao Paulo Research Foundation (FAPESP) and National Council of Technological and Scientific Development of Brazil (CNPq)

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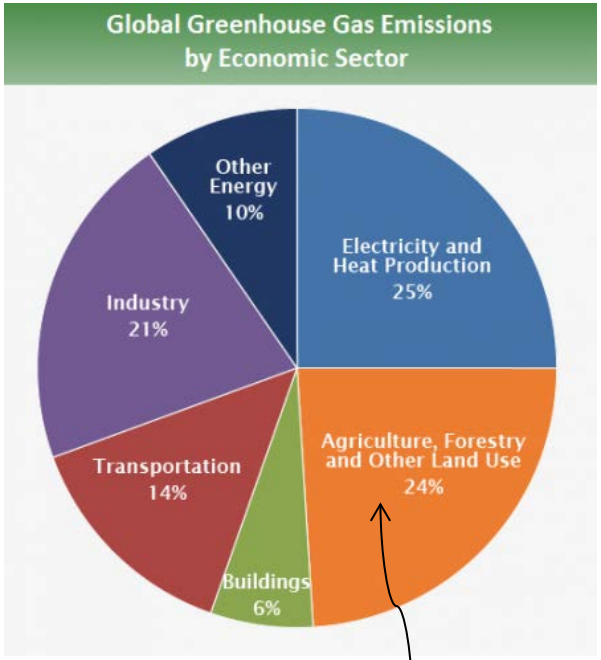
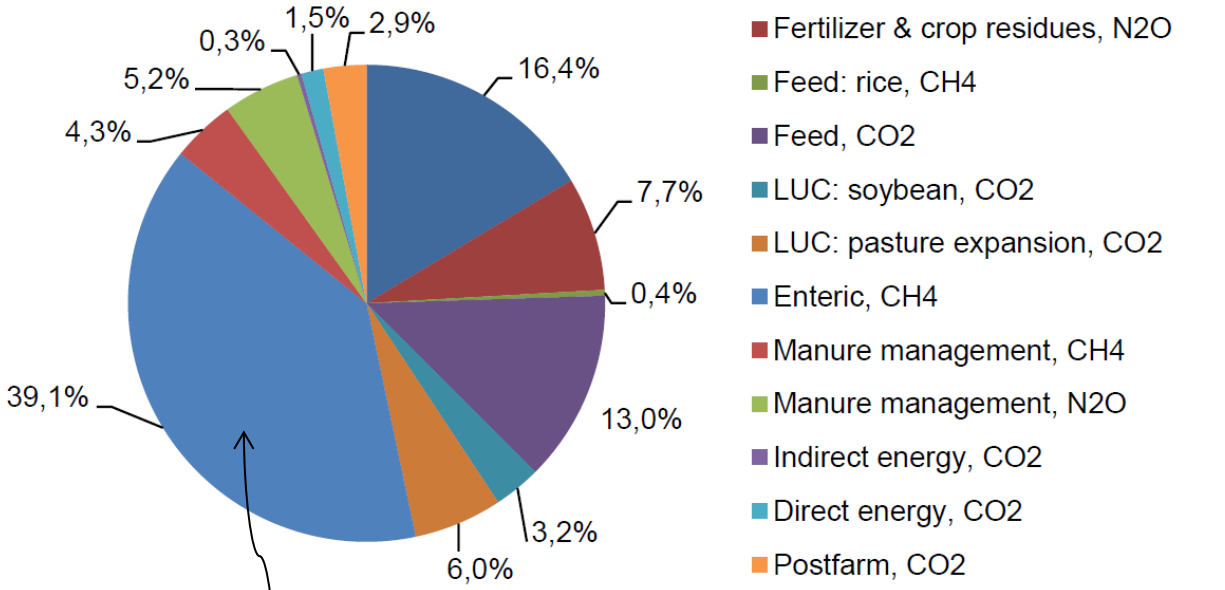
1. BACKGROUND

In 2010, the agriculture, forestry and other land use were responsible for 24% of global grennhouse gas emissions, behind only the eletricity and the heat production sector.



GHG from this sector come mostly from cultivation of crops (9.5%) and livestock (14.5%)



...and the emission of enteric methane produced by the cattle herds is responsible for almost 40% of all GHG emissions from livestock supply chains.

IPCC 2014 by US EPA 2016, FAO 2013

1. BACKGROUND

During the last decade studies have highly recommended THE SELECTION OF MORE EFFICIENT ANIMALS as an indirect approach to reducing enteric CH_4 emissions by cattle

- Net feed efficiency
- Feed conversion rate
- **RESIDUAL FEED INTAKE**
- Residual weight gain

- **Low-RFI animals eat less** than predicted for their ADG and $BW^{0.75}$
- ~~**High-RFI animals eat more** than predicted for their ADG and $BW^{0.75}$~~

HYPOTHESIS: It would be expected that animals with low RFI would release less enteric methane proportionally to their lower feed intake...

.... there are inconsistencies among research results on the correlation between feed efficiency and cattle CH_4 emission

• Nkrumah et al. (2006): Low-RFI animals produced 28% less CH_4 (L/kg of $BW^{0.75}$) than High-RFI animals. No differences were reported in ADG and $BW^{0.75}$.

RFI 70 d. – HIGH-GRAIN DIET

• Hegarty et al. (2007): Low-RFI animals ate 41% less DM and produced 25% less CH_4 (g/day) than High-RFI animals. No difference was reported in ADG.

RFI 15 d. – HIGH-GRAIN DIET

• Jones et al. (2011): cows with Low-RFI EBV produced 26% less g of CH_4/day/kg BW than cows with High-RFI EBV

grazing HIGH-QUALITY PASTURE (81% digestibility).

.... there are inconsistencies among research results on the correlation between feed efficiency and cattle CH_4 emission

- Jones et al. (2011): No difference of g CH4/day/kg BW between cows with Low-RFI EBV and cows with High-RFI EBV

  grazing LOW-QUALITY PASTURE (55% digestibilty).

- Freetly et al. (2013): CH_4 production (g/day) (adjusted for DMI of a day before CH4 measurements)

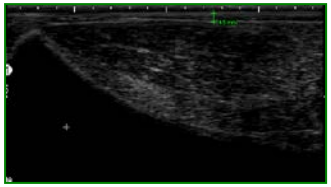
  steers on HIGH-GRAIN DIET was not related to RFI_{64d} and G:F

  heifers on HIGH-ROUGHAGE DIET was negatively related to $RFI_{64\ d}$ and G:F

.....suggesting that CH_4 production may increase with increased feed efficiency.

2. OBJECTIVE

The objective of our study was to estimate the relationship of enteric methane emission (CH_4 g/d) with the residual feed intake and the ultrasound carcass composition assessed in previous performance test in Nellore cattle fed high roughage diet



Residual Feed Intake

- ✓ Data were obtained in 2 consecutive years (n=118 in 2011; n=159 in 2012)
- ✓ 277 (males and females) were evaluated for RFI $_{84\ days}$, after weaning .
- ✓ High-roughage diet

2011 (45%grass hay:53% ground corn + cottonseed meal). CP=13% TDN: 70.5%
2012 (64%corn silage+grass hay: 33%ground corn + soybean meal). CP=14% TDN=70%

- ✓ 2 facilities to register dry matter intake

Individual pens + collective pens with 10 nodes of GrowSafe Systems

- ✓ Final age: 12±1.1 months; weight: 324±51 kg.

ADG and ultrasound carcass traits

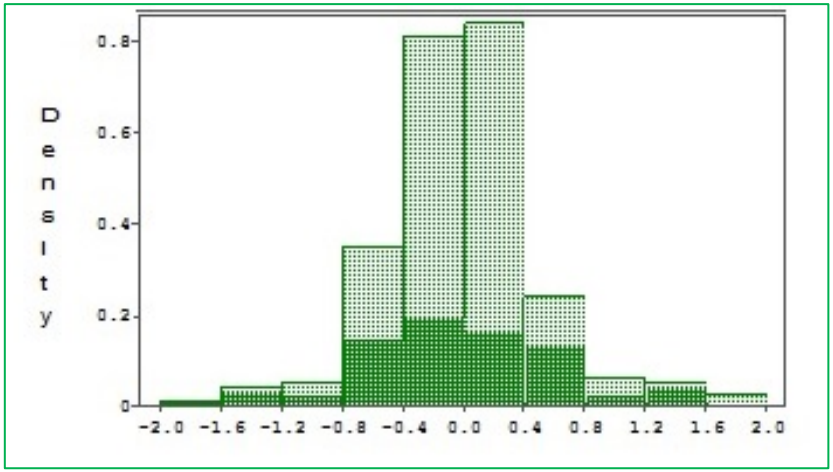
- ✓ **ADG was estimated by the regression of body weights on the days of the test (84 days) within animal.**
- ✓ **Longissimus muscle area (LMA), backfat (BFT) and rump fat thickness (RFT) were obtained by ultrasound (Pie Medical 401347-Aquila, 3.5-MHz linear probe) at the end of the performance test.**

$$DMI = intercept + \beta_1 ADG + \beta_2 BW^{0.75} + \varepsilon$$

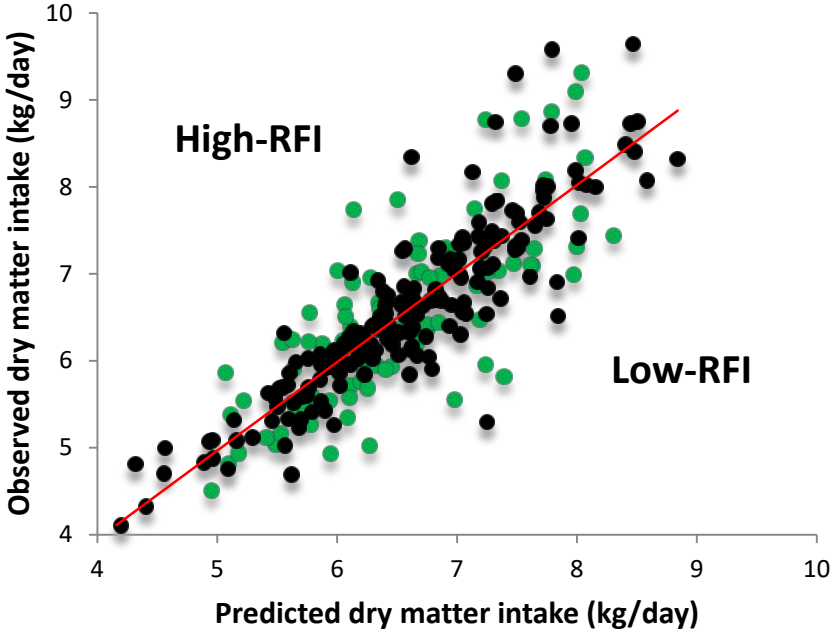
observed DMI - estimated DMI = RFI

Enteric methane emission

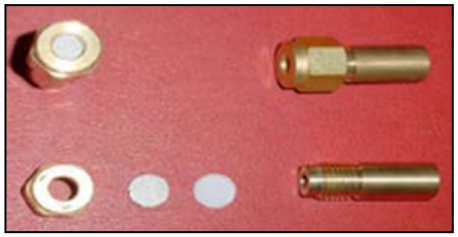
- ✓ CH_4 emission was measured in part of the animals (n = 88; 44/year).
- ✓ 27 days after the end of the performance test (14 days of animals' adaptation to the collection devices).
- ✓ Animals were sampled from Low-RFI and High-RFI classes within the contemporary groups (year-sex-facility).



RFI

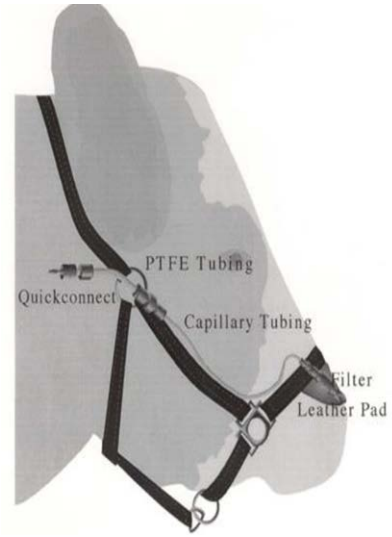


3. MATERIAL AND METHODS



Enteric methane emission was measured using the sulfur hexafluoride (SF6) tracer gas technique (Johnson and Johnson, 1995)

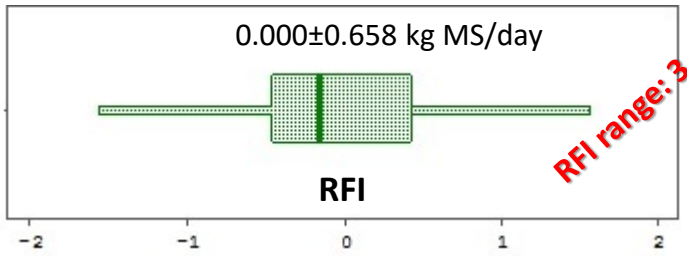
- ✓ **The permeation tubes with known release rate of SF6 was introduced in the rumen.**
- ✓ **Expired and eructated gas samples (CH4 and SF6) were stored in collection canisters for 6 days over 24 h (144 h of continuous sampling).**
- ✓ **To correct for background CH_4 and SF_6 concentrations, ambient air samples were collected with two collection canisters/day (basal).**



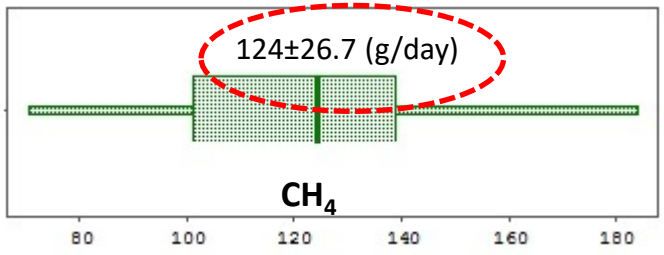
Statistical analysis

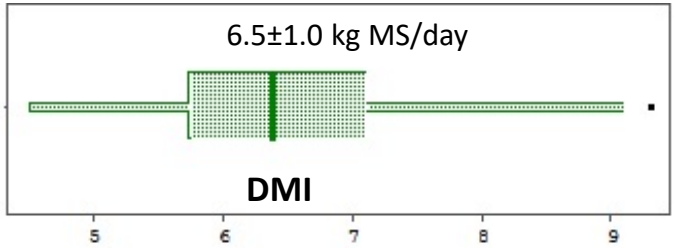
- ✓ **Partial correlations (adjusted for year and adjusted for year and DMI_{84d}) were estimated.**
- ✓ **A principal components analysis was performed to analyze the data in a multivariate approach.**
- ✓ **Variables for the principal components analysis were firstly standardised to mean zero and variance one.**

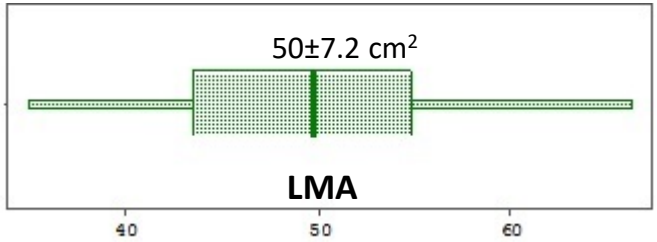
4. RESULTS

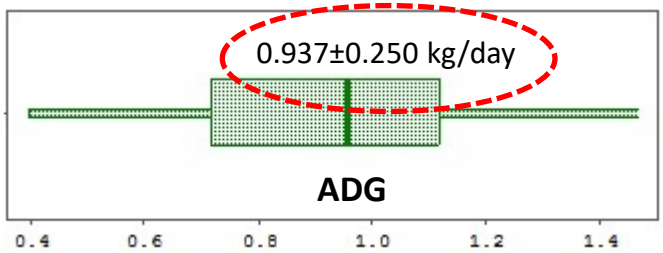


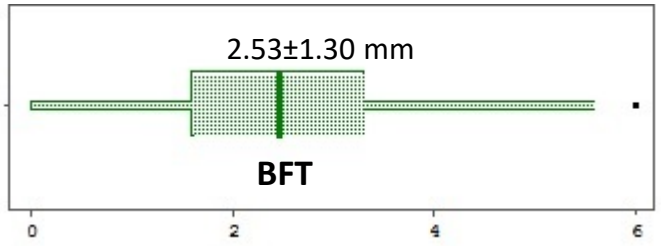
RFI range: 3.124 kg DM/day

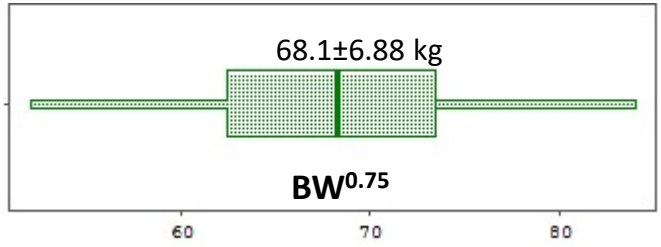


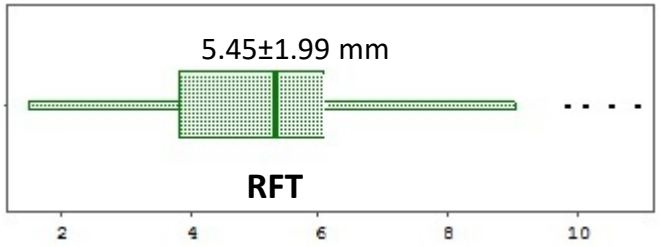












4. RESULTS

The effect of year (or diet) was significant for all of the variables, except for RFI.

Pearson partial correlations (adjusted for year).

	DMI	ADG	RFI	LMA	BFT	RFT
CH_4	0.34*	0.59*	0.07^{ns}	0.34*	0.20^{ns}	0.00^{ns}
DMI		0.36*	0.73*	0.50*	0.27*	0.26*
ADG			0.08^{ns}	0.31*	0.02^{ns}	-0.20^{ns}
RFI				0.11^{ns}	-0.20^{ns}	-0.12^{ns}
LMA					0.40*	0.23*
BFT						0.54*

1. Enteric CH4 emission increases with increased feed Intake and ADG. These correlations were not so high since the DMI was measured during the performance test which ended 27 days before the CH_4 collection period

2. As RFI is DMI adjusted for ADG and $BW^{0.75}$, the correlation between RFI and DMI was high.

3. In this analysis we did not find any relationship between CH_4 emission (g/day) and RFI.

4. As we expected, the correlation between DMI and ADG, LMA, BFT and RFT were significant.
Considering these correlations .....we estimate the correlations between CH4 adjusted for DMI and all variables (ADG, LMA, BFT and RFT) adjusted for DMI as well.

4. RESULTS

Pearson correlations . R_CH4, R_ADG, R_LMA, R_BFT and R_RFT are the residual of the same variables adjusted by year and DMI.

Significant effect of DMI for CH4, ADG, LMA, BFT and RFT was observed.

****We assumed that DMI is a highly repeatable trait, so the DMI obtained during the performance test will be the same during the CH4 collection period**

	R_ADG	RFI	R_LMA	R_BFT	R_RFT
R_CH_4	0.53^{*}	-0.19^{ns}	0.20^{ns}	0.12^{ns}	-0.10^{ns}

Enteric CH4 emission adjusted for DMI increases with increased ADG adjusted for DMI.

After adjusting CH4 emission for DMI, there was also no relation between CH_4 and RFI.

4. RESULTS

The principal component analysis was performed to analyze the data in a multivariate approach.

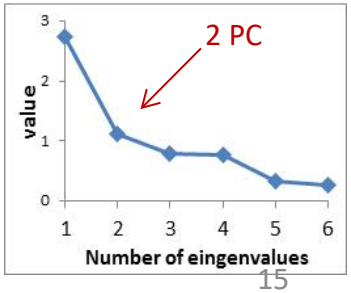
Results for the 6 principal components

PC	Eigenvalue	% of variance	Cumulative variance (%)
1	2.72	45.4	45.4
2	1.12	18.7	64.1
3	0.80	13.4	77.5
4	0.76	12.6	90.1
5	0.33	5.4	95.5
6	0.27	4.5	100

Considering the Kaiser criterion, we should retain only factors with eigenvalue greater than 1,

...thus, only 2 principal components were necessary to explain 64% of the total variability

The *scree* test is a graphical method (Cattell, 1966). Find a place where the smooth decrease of eigenvalues appears to level off to the right of the plot.



...so, we would probably retain 2 principal components to explain 64.1% of the growth and feed efficiency

The coefficients in the eigen vectors (loadings) for the first 2 principal components

Trait	PC 1	PC 2
CH4	0.54	0.15
ADG	-0.71	0.36
RFI	0.10	0.87
LMA	-0.81	0.31
BFT	-0.87	-0.15
RFT	-0.72	-0.29

PC 1 ➡ CH4 emission and production traits (ADG, LMA, BFT, RFT) were more effective to define **the first principal component** .

PC 2 ➡ residual feed intake (RFI) was more effective to define **the second principal component**.

5. CONCLUSION

- ✓ The results from both analyses, the univariate and the multivariate approach, showed a weak relationship between the enteric methane emission and the feed efficiency in Nellore cattle fed high roughage diets.

- ✓ Therefore, it was not possible to confirm the hypothesis that animals with low RFI would release less methane proportionally to their lower feed intake...

Thank you for your attention

Acknowlegments for the whole team envolved in these experiments

Renata Helena Branco
Sarah Figueiredo Martins Bonilha
Alexandre Berndt
Rosa Toyoko Shiraishi Frighetto
Elaine Magnani
Tatiana Lucila Sobrinho
André Luiz Grion
Ana Paula de Melo Caliman
Olinta Cota
Cleisy Ferreira do Nascimento
Gustavo Eimar de Oliveira Lara