ASSOCIATION BETWEEN EXHALED METHANE CONCENTRATION AND CONCENTRATE COMPOSITION AND RUMINATION IN HOLSTEIN DAIRY COWS

Rey, J., Atxaerandio, R., Ruiz, R., Ugarte, E., González-Recio O., Garcia-Rodriguez, A. and Goiri, I.

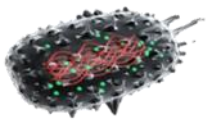
jrey@neiker.eus

70th Annual Meeting of the
European Federation of Animal Science
Ghent (Belgium), 26 - 30 Aug 2019

INTRODUCTION

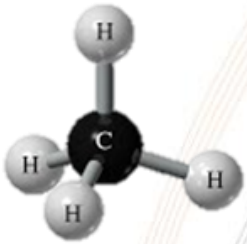
- Agriculture accounts for 14.5% of greenhouse gases emission (Gerber et al., 2013).
- Livestock accounts for 23% of CH_4, of which 39% comes from enteric fermentation (IPCC., 2014).

Feed gross energy intake loss


+

= VFA H+

$CO_2+8H \rightsquigarrow CH_4+2H_2O$



- To reduce CH_4 →handling strategies, nutritional and genetic improvement.

DATABASE

A large number of accurate measurements of methane emissions, measured individually and under farm conditions.

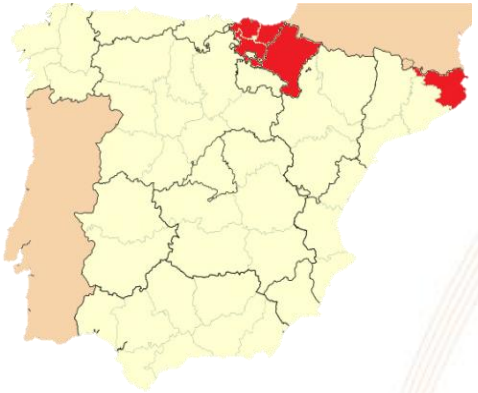
Information about the factors potentially associated with these emissions, such as feed, production, behavior and environmental factors. (Pszcola et al., 2018).

OBJECTIVE

To study the association between methane concentration and nutritional components of concentrate, ruminal activity and productive traits of dairy cows.

MATERIAL AND METHODS

- Data was collected in 10 commercial farms.
- A total of 1,264 cows.
- Non-dispersive infrared sensor (NDIR, Special Guardian NG, Edinburgh Instruments Ltd., Livingston, UK).



How was it done?

- The NDIR sampling tube is placed in the AMS feeder
- Records the concentration of CH_4 exhaled by the cow at each visit
- 14 days / farm period

DETERMINATION OF CH_4

- Calibration and dilution factor with known reference gases: 0.25- 0.5-0.75 and 1% CH_4 in nitrogen.
- Baseline: average of the 10 lowest records in each visit.
- The CH_4 data was recorded at 1 s intervals and stored using a datalogger.
- [CH_4]: sum of the maximum of peaks divided by number of peaks.
- Processed with an *ad hoc* designed program + cow traffic report.
- To validate data, minimum of: 10 days, 50 peaks and 15 visits to AMS.

FEEDING COMPONENTS

Feeding survey + individual intake report →

FEEDING COMPONENTS	
DMI	DMICU
DMIP	DMICO
DMIASH	DMII
DMICEL	DMISE
DMIEE	DMIZN
DMICA	DMIMN
DMINA	DMIFE
DMIUREA	

BEHAVIOUR

AMS reports ↓

BEHAVIOUR
RUMINATION
CHEWING

PRODUCTION VARIABLES

AMS reports and the official milk control →

PRODUCTION VARIABLES
LACTATION Nº
KG MILK
% FAT
% PROTEIN
% LACTOSE
BHB
SCC
DIM
305-D
MILKING MEAN
BODY WEIGHT

STATISTICAL ANALYSIS

Spearman correlation with SAS, $P<0.05$.

[CH_4](PPM)

BEHAVIOUR
RUMINATION
CHEWING

PRODUCTION VARIABLES
LACTATION Nº
KG MILK
% FAT
% PROTEIN
% LACTOSE
BHB
SCC
DIM
305-D
MILKING MEAN
BODY WEIGHT

FEEDING COMPONENTS	
DMI	DMICU
DMIP	DMICO
DMIASH	DMII
DMICEL	DMISE
DMIEE	DMIZN
DMICA	DMIMN
DMINA	DMIFE
DMIUREA	

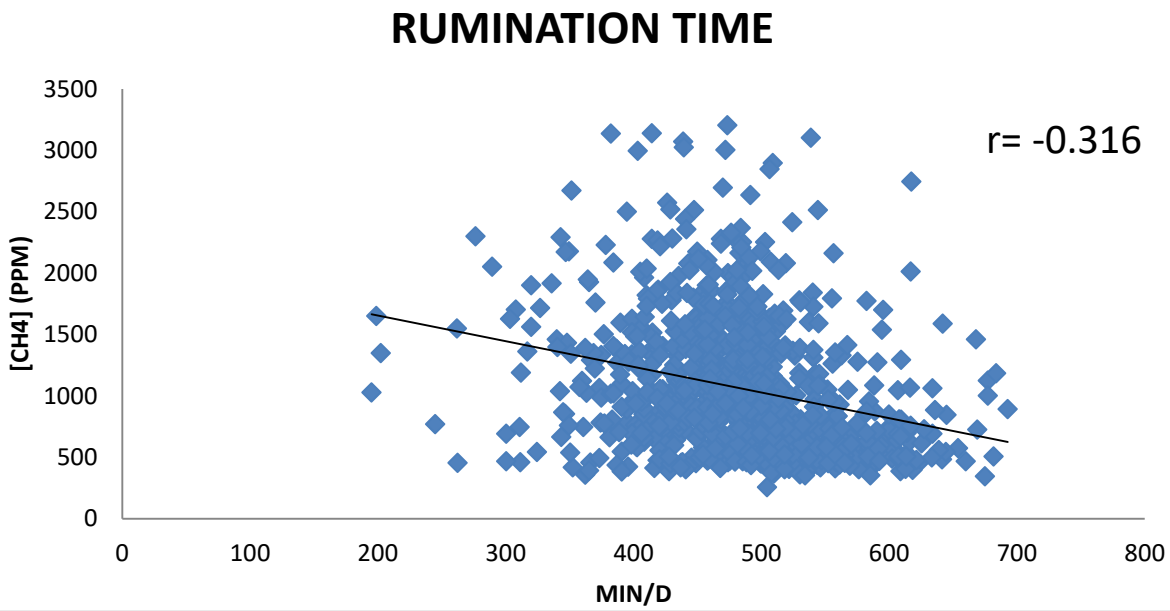
RESULTS

Start: 1,264 cows → 13% remove → End: 1,109 cows

$[CH_4]$(PPM)
- Mean: 822
- Max: 3,256
- Min: 258

VARIABLE	N	MEAN	STD	Minimum	Maximum
RUMINATION TIME (MIN/D)	939	482	68	195	693
BHB (MMOL/L)	849	0.03	0.034	0	0.29
BODY WEIGHT (KG)	331	586	100.8	354	840
MILKING MEAN (MM/D)	1038	2.8	0.8	1.1	6
305-D (KG)	972	11426	2290	4299	19010
FAT (%)	1109	3.55	0.914	1.6	6.4
PROTEIN (%)	1109	3.25	0.498	1.7	4.9
DMI (KG)	1067	5.13	1.71	0.96	9.5
DMIP (G)	707	24.64	9.49	0	55.1
DMIFE (G)	691	0.4	0.344	0	1.4
DMIZN (G)	846	0.51	0.382	0.0002	1.5
DMICU (G)	846	0.13	0.097	0.00004	0.4
DMICO (G)	846	0.01	0.023	0.0002	0.1
DMII (G)	846	0.03	0.047	0.00007	0.2
DMISE (G)	846	0.02	0.022	0.0004	0.001
DMIMN (G)	846	0.39	0.323	0.0003	1.3

BEHAVIOUR



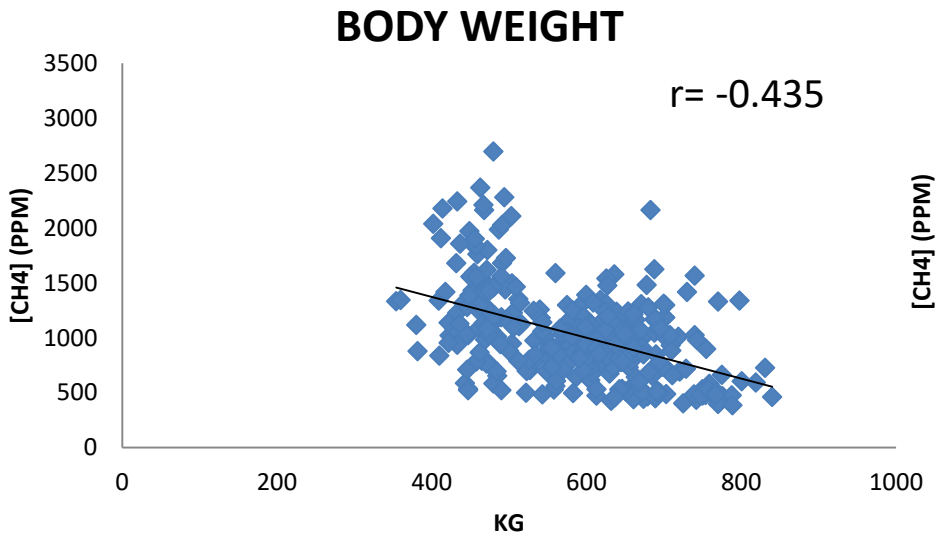
Negative correlation.
Reason:

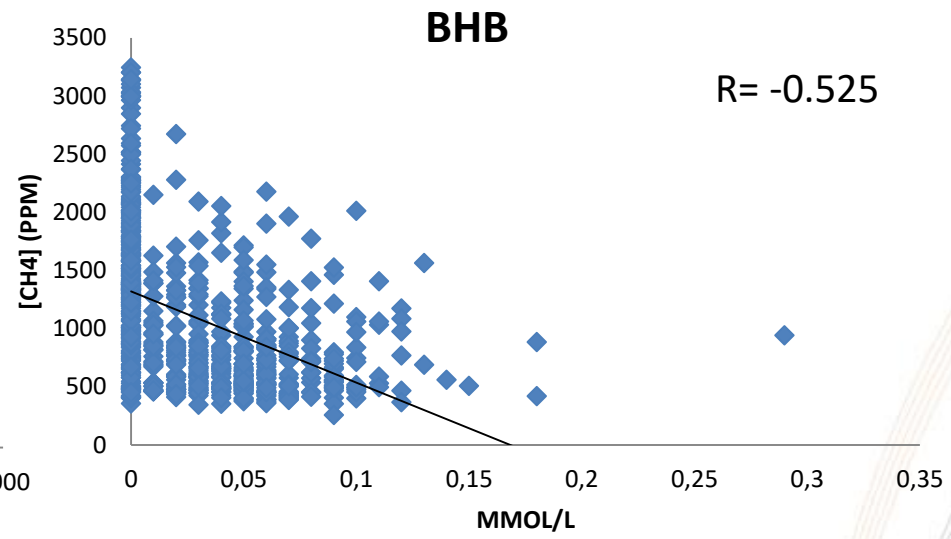
Quality of forages

- ↓ Digestibility → ↓fermentation → ↓[CH_4]
- ↑ Rumination time

PRODUCTION VARIABLES

RESULTS





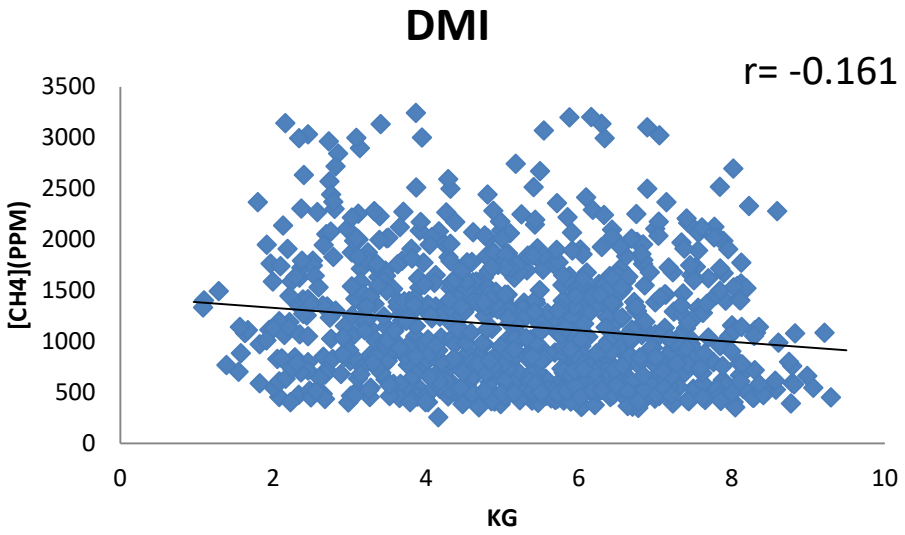
Negative correlation.
Reason:

↑ greater tidal volume → ↑ dilution → ↓ $[CH_4]$

Negative correlation.
Reason:

Negative energy balance → ↓ fermentation → ↓ $[CH_4]$

FEEDING COMPONENTS

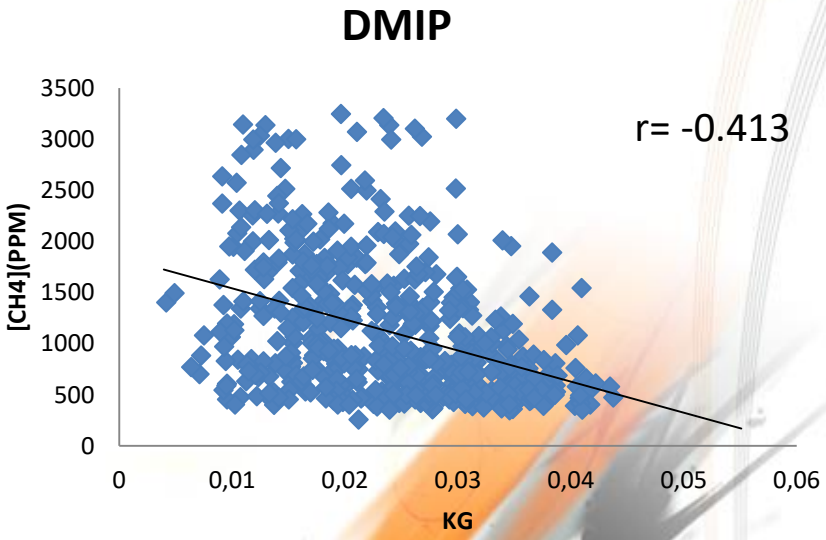


Negative correlation
Reason:

↓ Concentrate → ↑ forage → → ↑ Acetic. A → ↑ $[CH_4]$

Negative correlation
Reason:

↑ Phosphate → ↓ CO_2 → ↓ $[CH_4]$



CONCLUSION

- ✓ Significant correlations have been found between methane concentration and behavioral, production and feeding factors.
- ✓ A negative and low correlation was found with the rumination time.
- ✓ A low and negative correlation with the body weight and with the BHB.
- ✓ A low negative correlation with different microelements, especially with phosphorus.

THANK YOU

Funding

This research was financed by RTA2015-00022-C03-02 (METALGEN) project from the national plan of research, development and innovation 2013-2020 and the Department of Economic Development and Competitiveness (Basque Government, Vitoria-Gasteiz, Spain). The first author of this paper was granted a scholarship from the Department of Agriculture of the Basque Country.

Acknowledgements

The authors of this project would like to thank all the farmers of the commercial dairy farms that have collaborated in this study, as well as everyone who has participated in this work.