atf animal task force
A European Public-Private Partnership

EAAP European Federation of Animal Science

2nd one-day symposium of the Animal Task Force & the EAAP Commission on Livestock Farming Systems

Research and innovation for climate change mitigation from an animal breeding perspective

Oscar Gonzalez Recio

(INIA-CSIC, Madrid, Spain)

MINISTERIO DE CIENCIA E INNOVACIÓN

INIA Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

Society – genetic solutions to achieve net zero carbon emissions

COP26

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COP26: 105 countries pledge to cut methane emissions by 30 per cent

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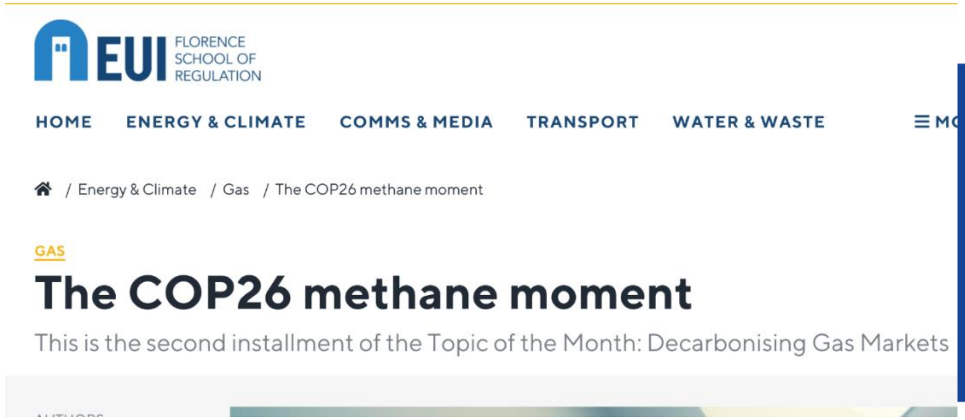
COP26: US and EU announce global pledge to slash methane

2 November 2021



EUI FLORENCE SCHOOL OF REGULATION

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/ Energy & Climate / Gas / The COP26 methane moment

GAS

The COP26 methane moment

This is the second installment of the Topic of the Month: Decarbonising Gas Markets

European Commission

English EN Search

Home > Press corner > Launch by US, EU and Partners of the Global Methane Pledge

Available languages: English

Statement | 2 November 2021 | Brussels

Launch by United States, the European Union, and Partners of the Global Methane Pledge to Keep 1.5C Within Reach

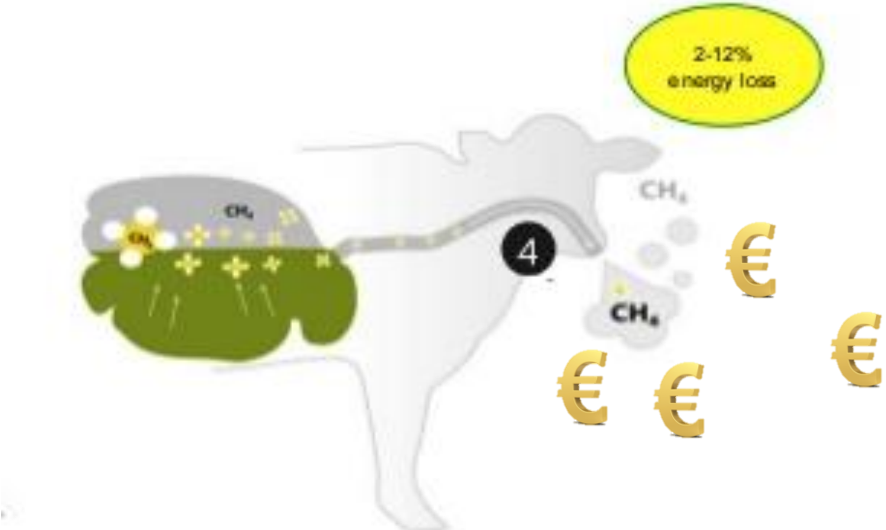
Society – genetic solutions to achieve net zero carbon emissions

Food and Agriculture Organization of the United Nations

About FAO

Sustainable Development Goals

Promote sustainable livestock and achieve food security



Take urgent actions to combat climate change and its impacts

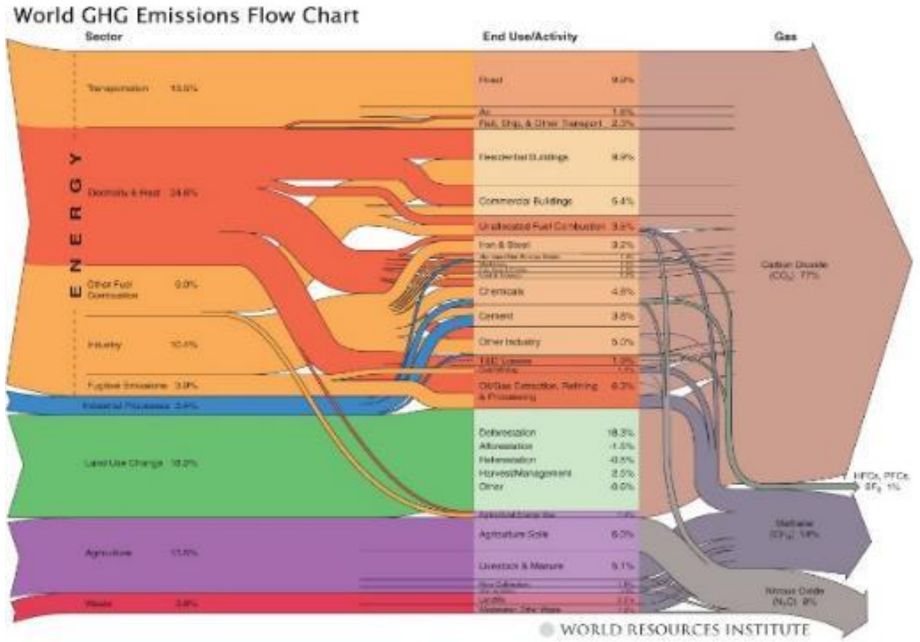
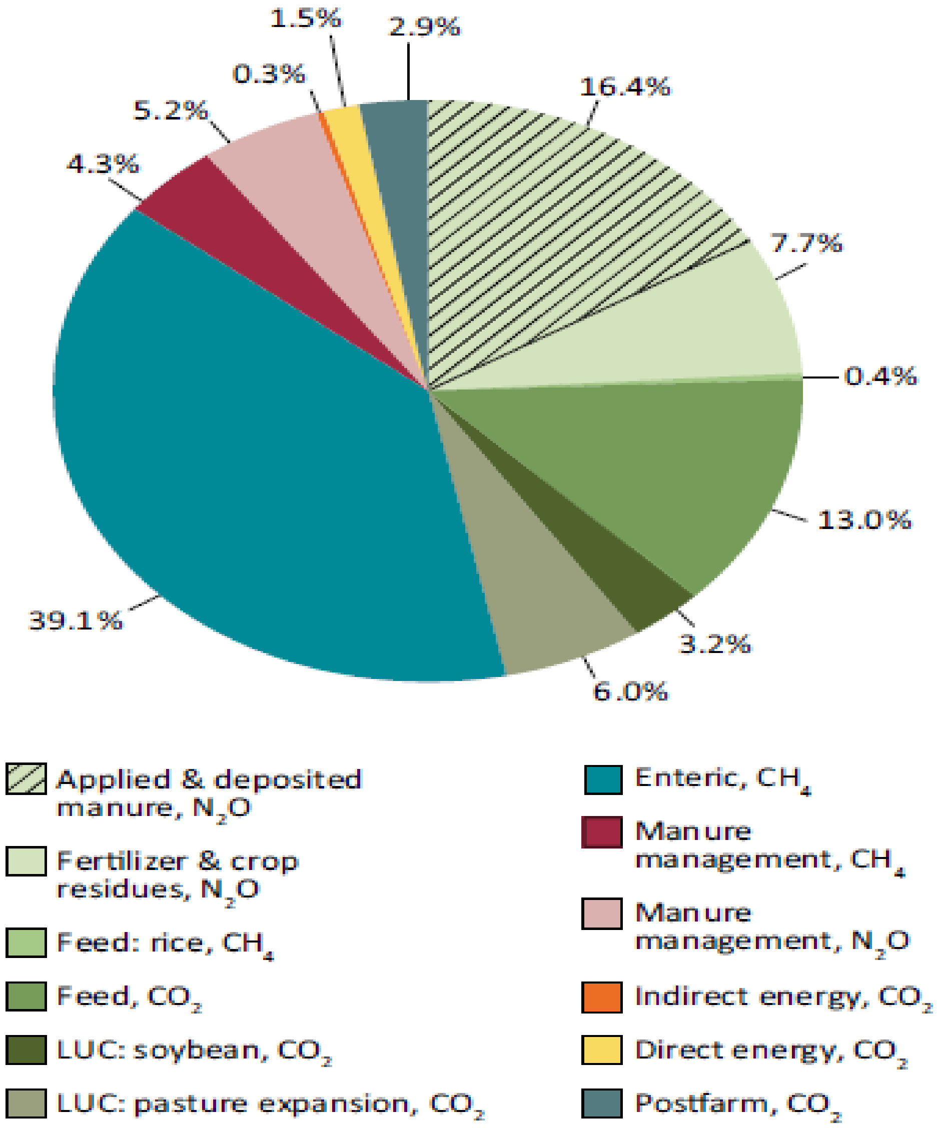


FIGURE 4. Global emissions from livestock supply chains by category of emissions



- Reduce Methane from enteric fermentation
- Reduce Feed associated CO2 from improving Feed Efficiency

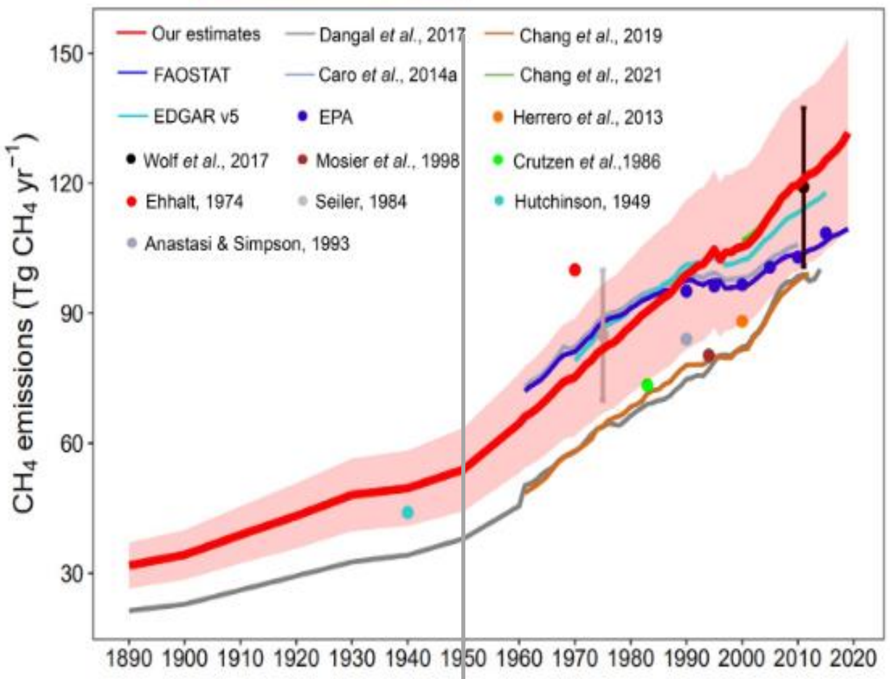
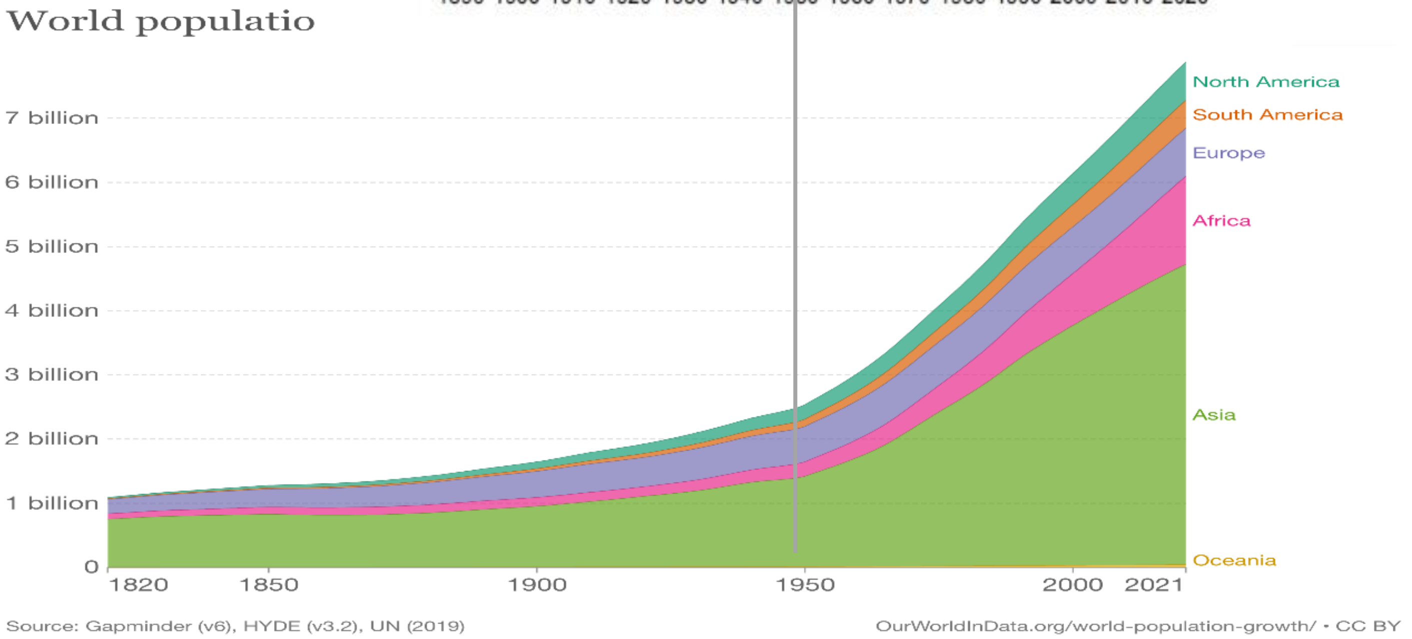


FIGURE 10 Estimates of CH_4 emissions from global livestock during 1890–2019 and comparisons with those reported in other inventories. The shaded area shows the 95% confidence interval of our estimates.



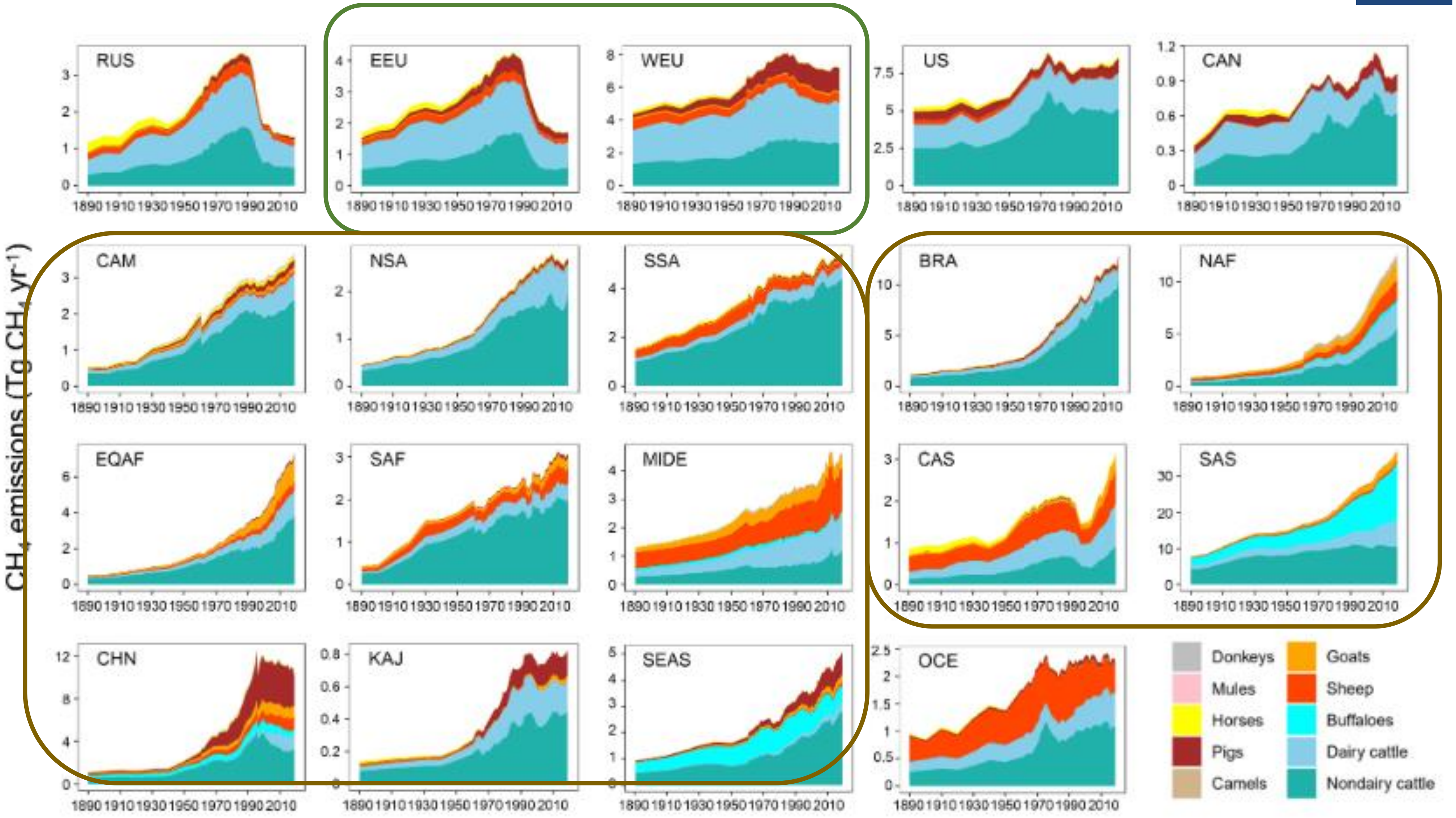


FIGURE 5 Temporal changes in regional CH_4 emissions from livestock during 1890–2019.

Zhang et al. (2022) in GCB

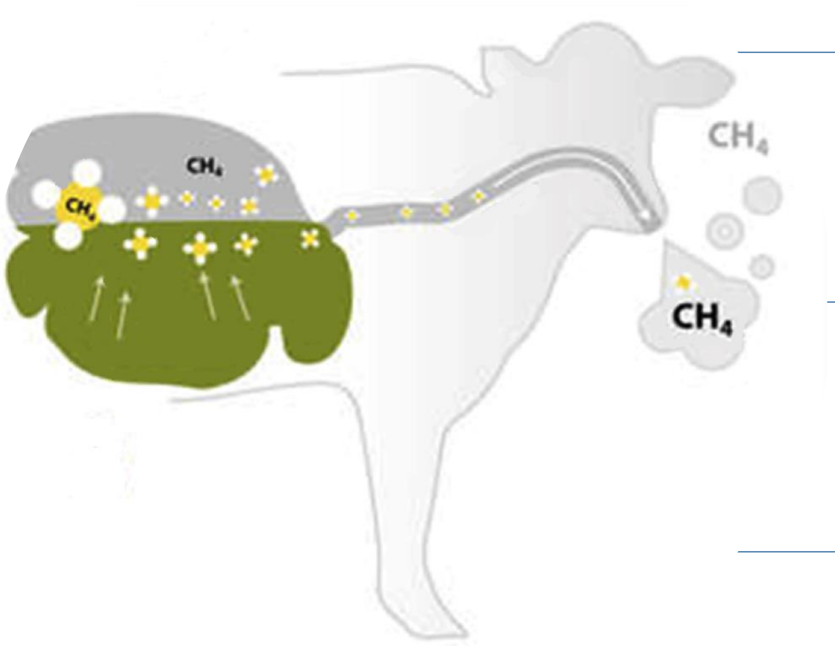
Society – opportunities for mitigation from livestock

- Do we need to reduce the number of livestock?
  - Healthy diet
  - Rural development and landscape maintanance
  - Negative consequences of eliminating livestock

- Evaluate each case scenario

Society – opportunities for mitigation from livestock

- Methane is produced during enteric fermentation by methanogenic microorganisms



28-34x

10-20 yr

Efficient mitigation

COP26


WORLD ASSOCIATION for ANIMAL PRODUCTION

Number 26 2021

www.waap.it

The World Animal Science News

www.waap.it

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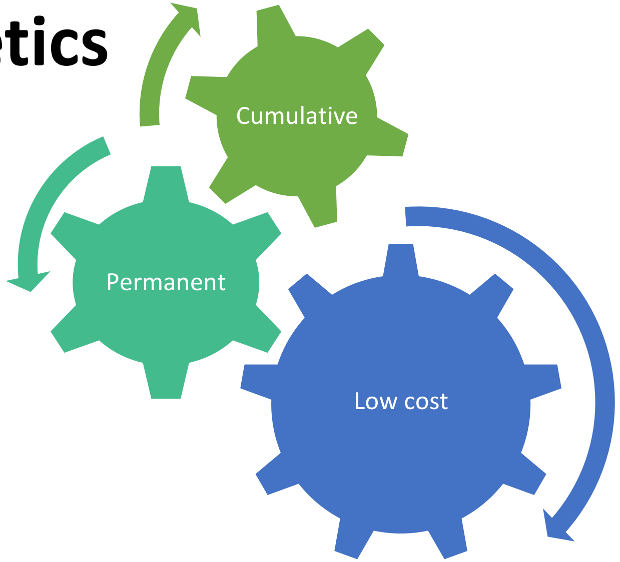
- From WAAP members
- News from Science
- News from Industry
- Job Offers
- Publications
- Meetings and Conferences

EDITORIAL

When methane returns to the forefront of the climate scene, ruminants are in great danger!

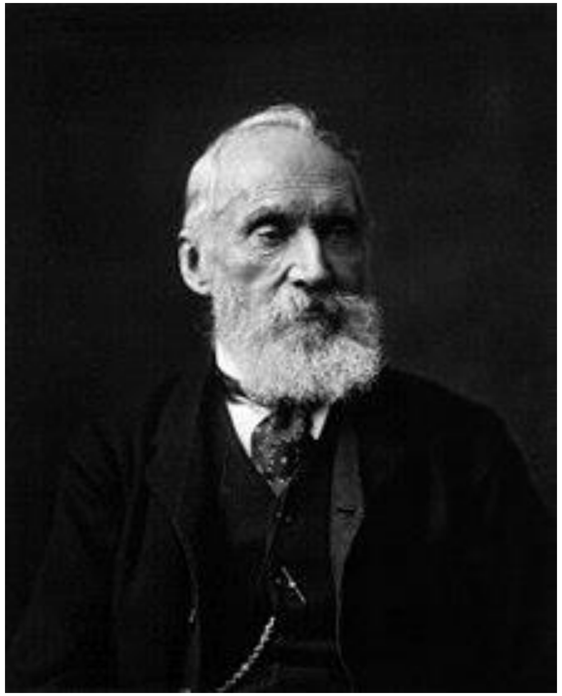
1. Implement proper calculation of GHG emissions*
2. Nutrition
3. Technology: in-farm use of methane
4. **Genetics**



MEASURING METHANE

- If you **cannot measure** it, you **cannot improve** it.

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."



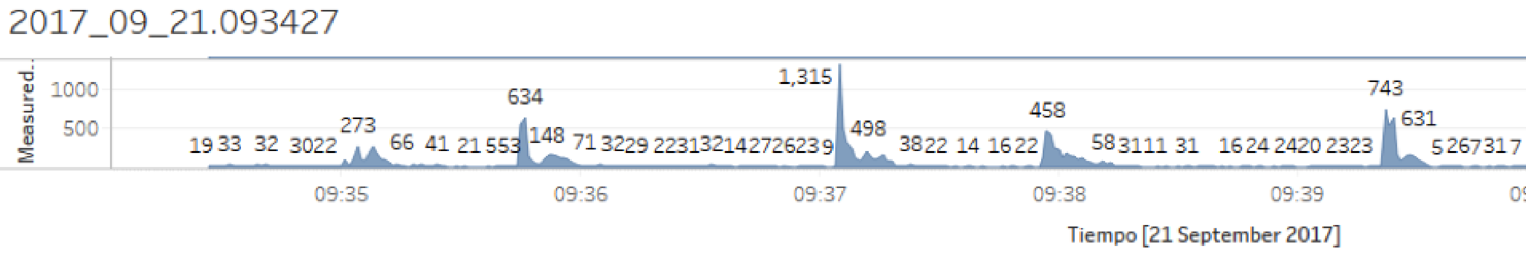
Lord Kelvin (1824 – 1907)

METHANE RECORDING

metalgen
NEIKER
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE
INIA
Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria
CONFEDERACION DE ASOCIACIONES DE FRISONA ESPAÑOLA
CONAFE

Precision farming

Genotypes (50k SNPs)



METHANE RECORDING

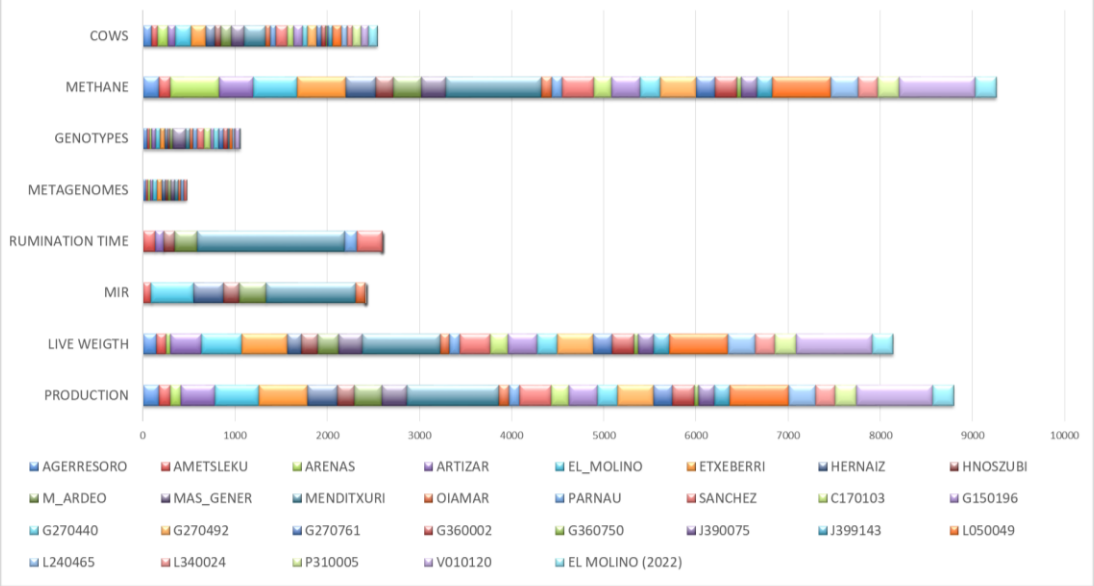
1. **Recording methane in commercial and experimental farms (AUS, CAN, DNK, ESP, GER, NDL, SWI, USA)**

THE Resilient Dairy GENOME PROJECT

METHANE RECORDING

1. **Recording methane and DMI in commercial and experimental farms (AUS, CAN, DNK, ESP, GER, NDL, SWI, USA)**

2. **Genomic selection (genotyping, phenotyping)**



METHANE & GENETICS

A. Saborío-Montero et al. Livestock Science 263 (2022) 105023

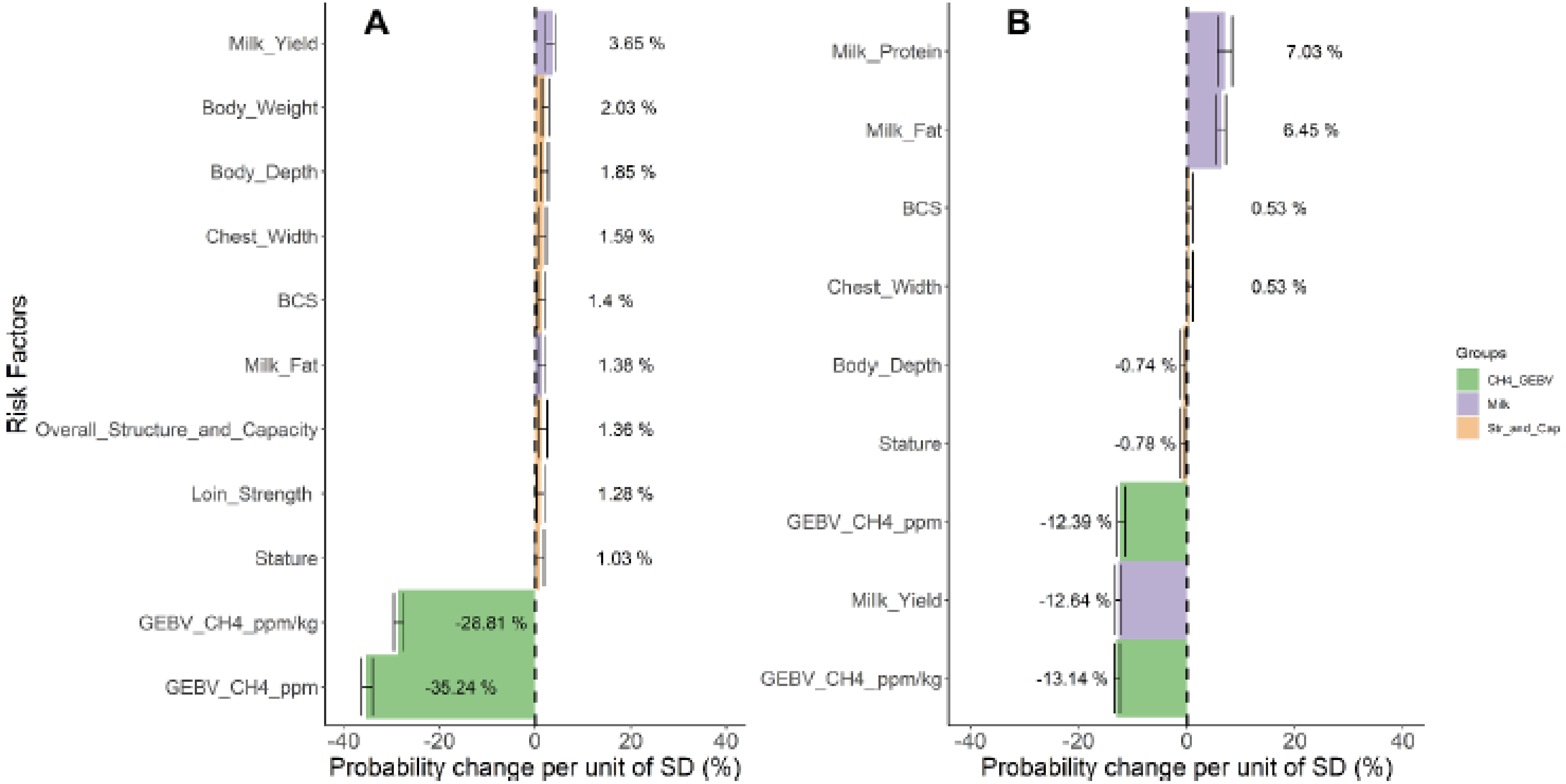


Fig. 1. Change in the probability of a cow being classified in the upper quartile for methane concentration (ppm CH_4) and methane intensity (ppm CH_4 / kg milk) per unit of increment in the risk factor corrected for standard deviation for methane concentration (A) and methane intensity (B). Black dashed lines indicate the baseline probability of being classified in the upper quartiles without any variable effect. Probability intervals are depicted for each risk factors. BCS=Body condition score, GEBV_CH4_ppm/kg= Genetic merit for methane intensity (MI), GEBV_CH4_ppm=Genetic merit for methane concentration (MET), CH4_GEBV=Genetic merit for methane traits, Milk=Milk related traits, Str_and_Cap= Structure and capacity related traits.

METHANE

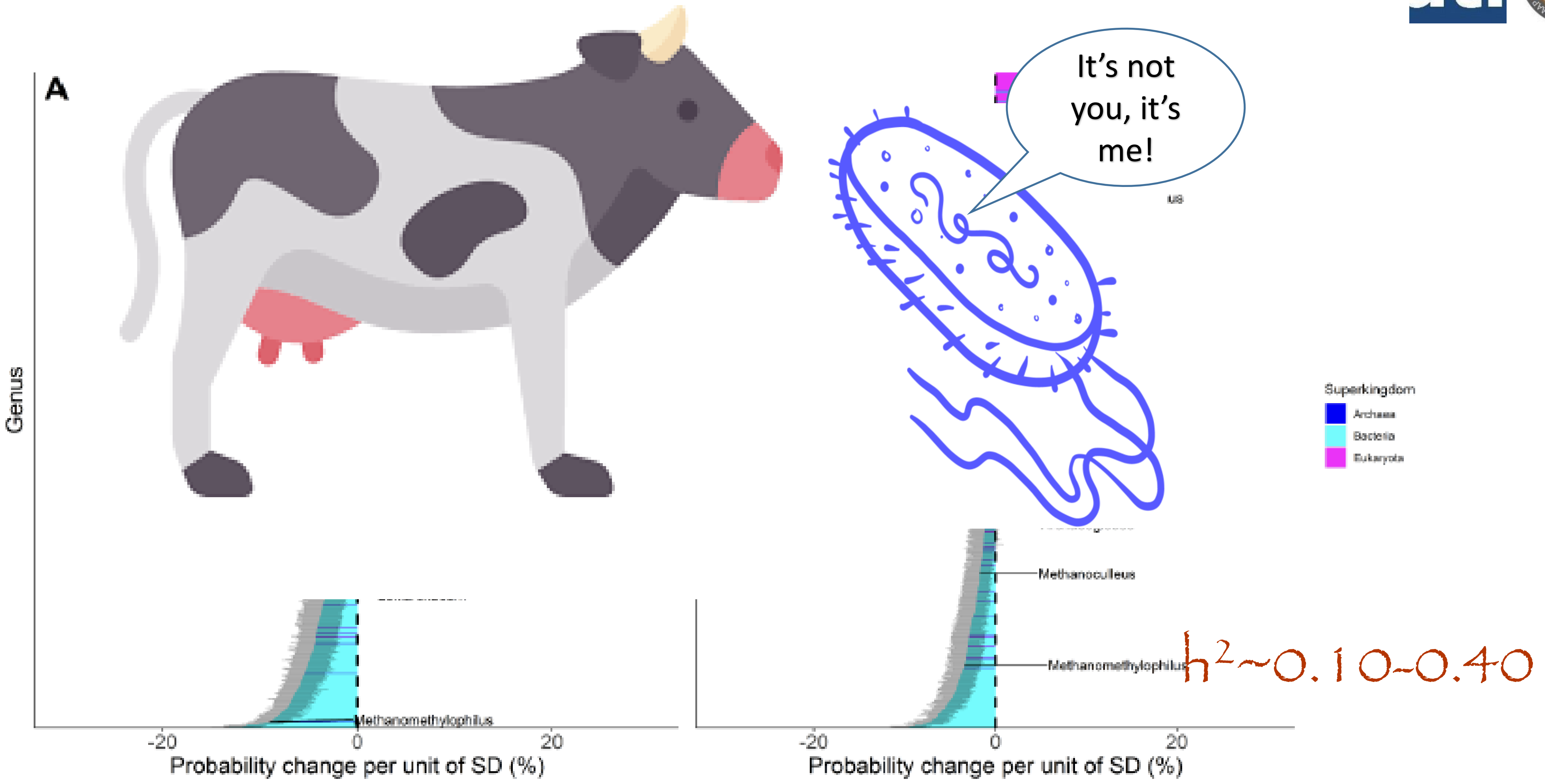
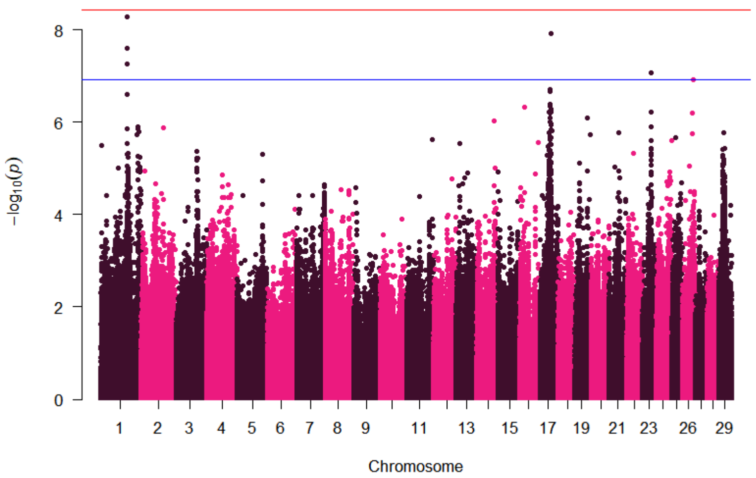
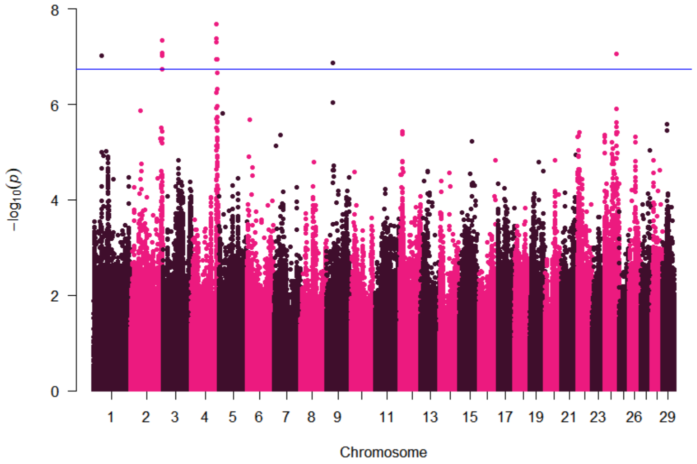
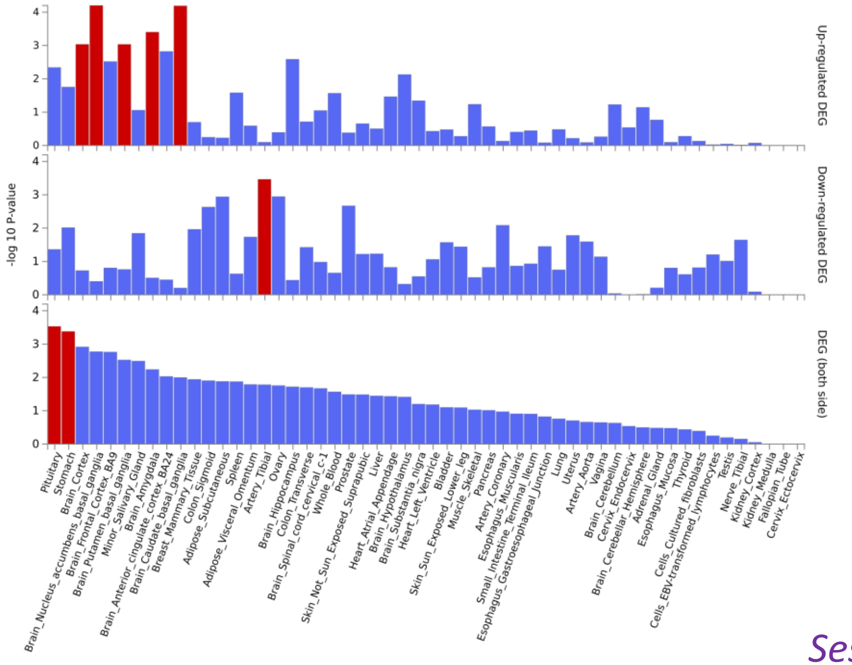


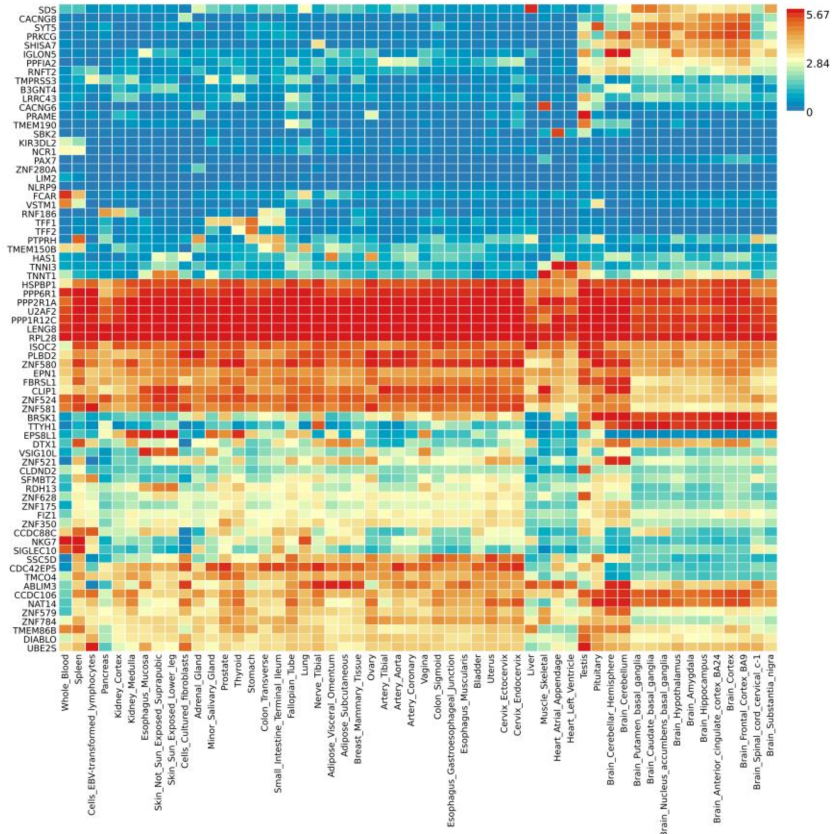
Fig. 3. Change in the probability of being classified in the upper quartile for (A) methane concentration (ppm CH_4) and (B) methane intensity (ppm CH_4/kg milk) per unit of standard deviation for relative abundance (%) of 1240 genera colored by superkingdom. Black dashed line indicates the baseline probability of being classified in the upper quartiles without any genus effect. All the archaea genera are explicitly indicated. Probability intervals based on posterior standard deviations are depicted in gray for all genera.

METHANE & GENETICS









Session 45: Breeding for environmentally important traits

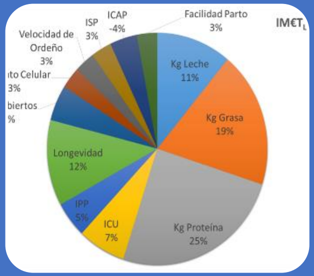
METHANE & GENETICS

1. **Recording methane in commercial and experimental farms (AUS, BEL, CAN, DNK, ESP, NTH, USA)**

2. **Genomic selection (genotyping, phenotyping)**

3. **Implement selective breeding (20-40%)**

Potential reduction from selective breeding



Benchmark - current ICO

Carbon prices

- €43.37/t of CO_{2e}
- Moderate scenario from BEIS, (2017)

Desired gains

- 20% reduction of CH_4 in 10 years

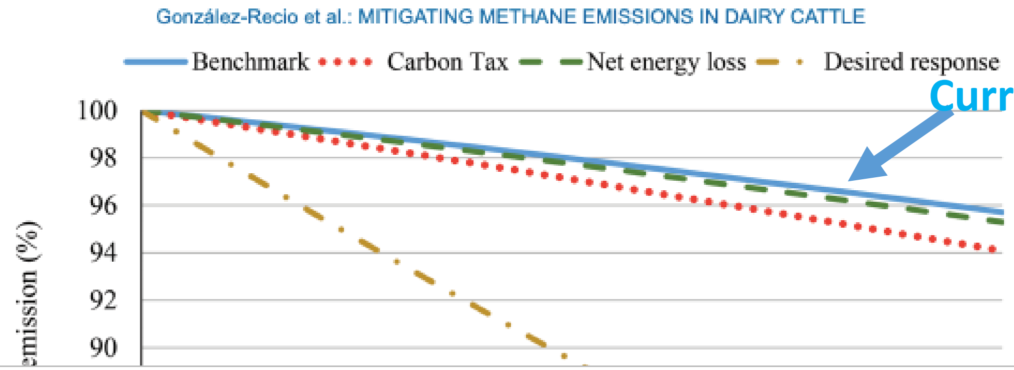
J. Dairy Sci. 103:7210–7221
https://doi.org/10.3168/jds.2019-17598

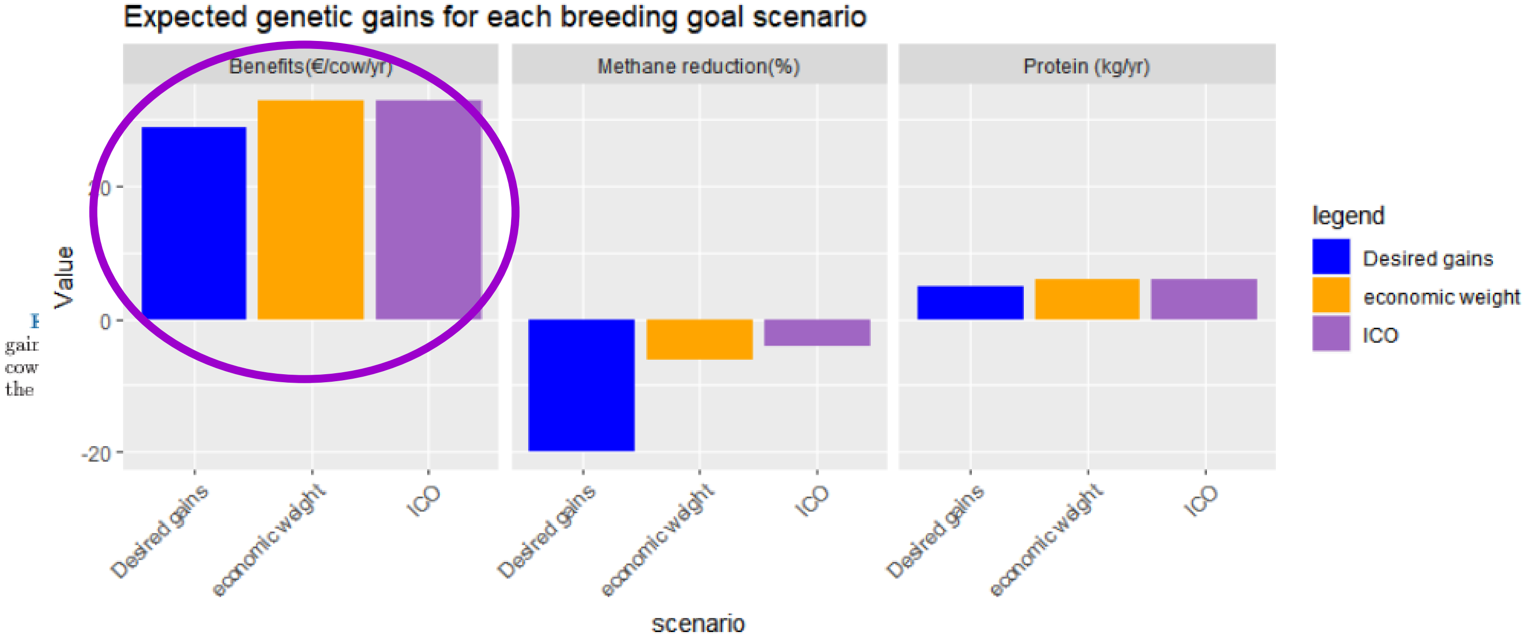
Mitigation of greenhouse gases in dairy cattle via genetic selection: 2. Incorporating methane emissions into the breeding goal

O. González-Recio,[1,2]* J. López-Paredes,[3] L. Ouatahar,[1] N. Charfeddine,[4] E. Ugarte,[5] R. Alenda,[2] and J. A. Jiménez-Montero[4]
[1]Departamento de Mejora Genética Animal, Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, Crta. La Coruña km 7.5, 28040 Madrid, Spain
[2]Departamento de Producción Agraria, Escuela Técnica Superior de Ingeniería Agronómica, Alimentaria y de Biosistemas, Universidad Politécnica de Madrid, Ciudad Universitaria s/n, 28040 Madrid, Spain
[3]Federación Española de Criadores de Limusín, C/Infanta Mercedes, 31, 28020 Madrid, Spain
[4]Spanish Holstein Association (CONAFE), Ctra. Andalucía km 23600 Valdemoro, 28340 Madrid, Spain
[5]Department of Animal Production, NEIKER—Tecnalia, Granja Modelo de Arkaute, Apdo. 46, 01080 Vitoria-Gasteiz, Spain

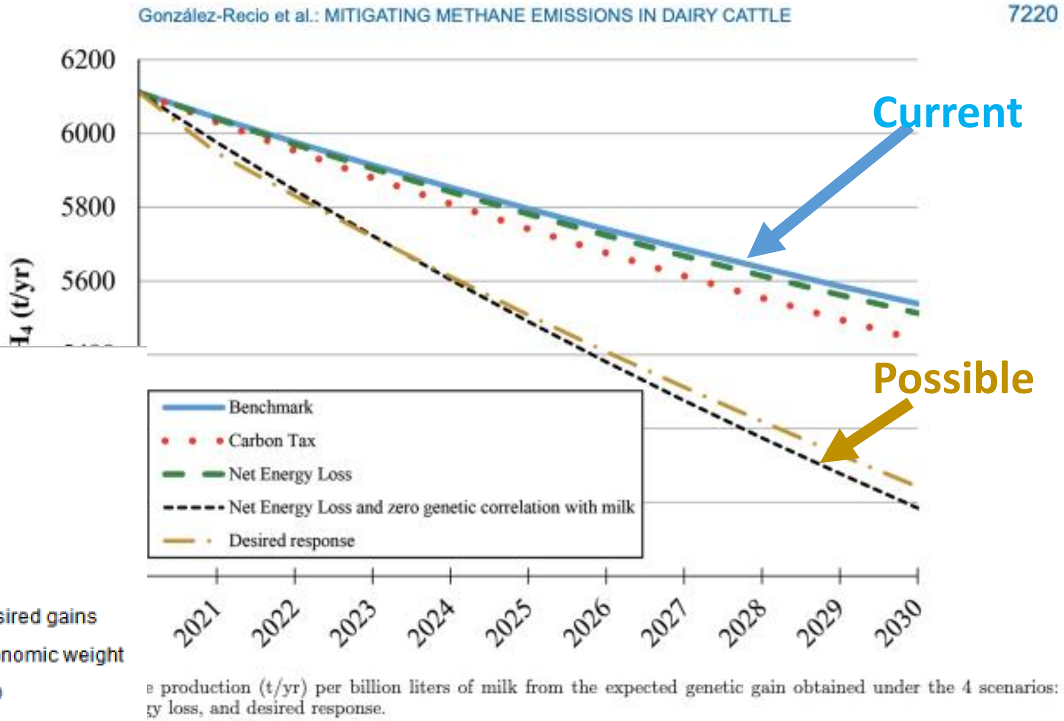
Potential reduction from selective breeding

Total methane reduction from dairy cattle in Spain under considered scenarios





Projected enteric methane per billion liters of milk in Spain



J. Dairy Sci. 103:7210–7221
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[5]Department of Animal Production, NEIKER—Tecnalia, Granja Modelo de Arkaute, Apdo. 46, 01080 Vitoria-Gasteiz, Spain

TAKE HOME MESSAGE

01

Measure, measure, measure

Also in beef and small ruminants

02

Reducing methane emission via selective breeding can have a great impact if, and only if, farmers are encouraged to breed for lower emissions

03

Genomic selection is the most efficient genomic tool to implement selective breeding

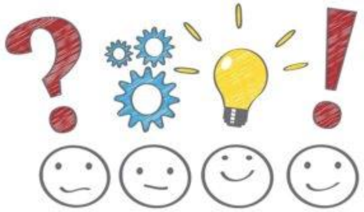
Grow private & public acceptance and understanding of this technique (EFFAB).


SCIENCE!!!

Acknowledgments

Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

A. Saborío-Montero
A. López-García
M. Gutiérrez-Rivas
C. González-Verdejo



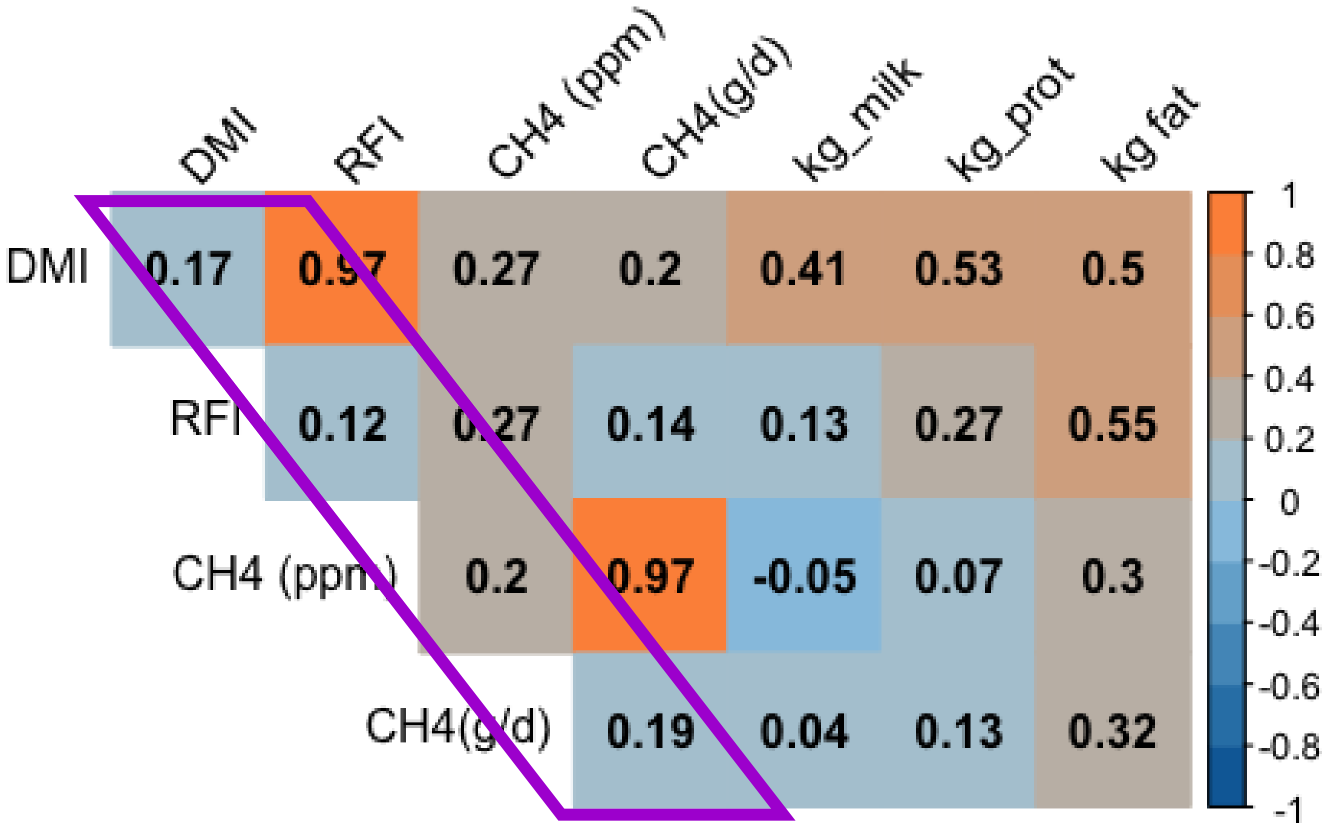
neiker tecnalia

I. Goiri
R. Atxaerandio
E. Ugarte
A. García-Rodríguez

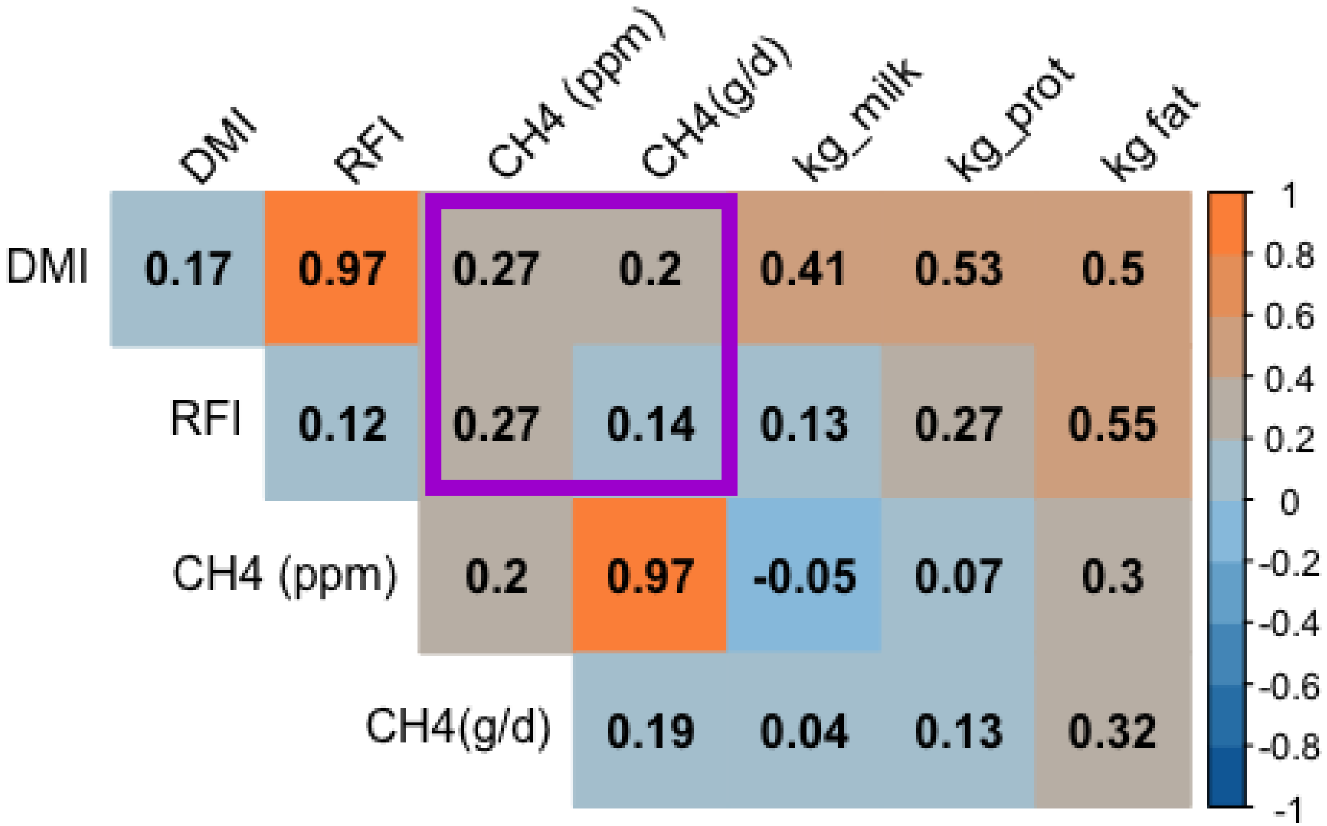
J. López-Paredes
N. Charfeddine
J.A. Jiménez-Montero

RTA2015-00022-C03

Heritabilities

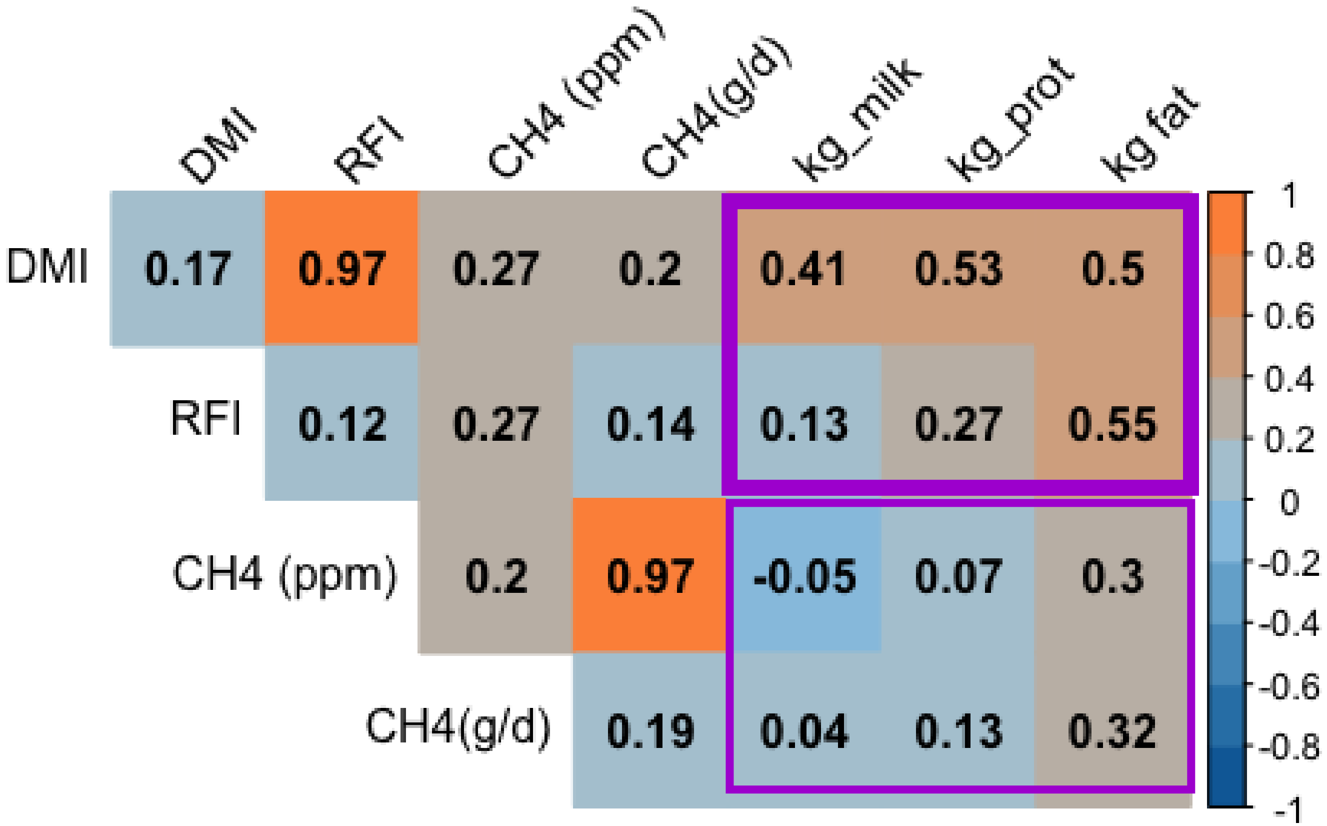


Genetic correlations



- Positive correlation between methane and feed efficiency.
- Larger intake levels →more methane emisions → less efficiency
- But different energy sinks

Genetic correlations

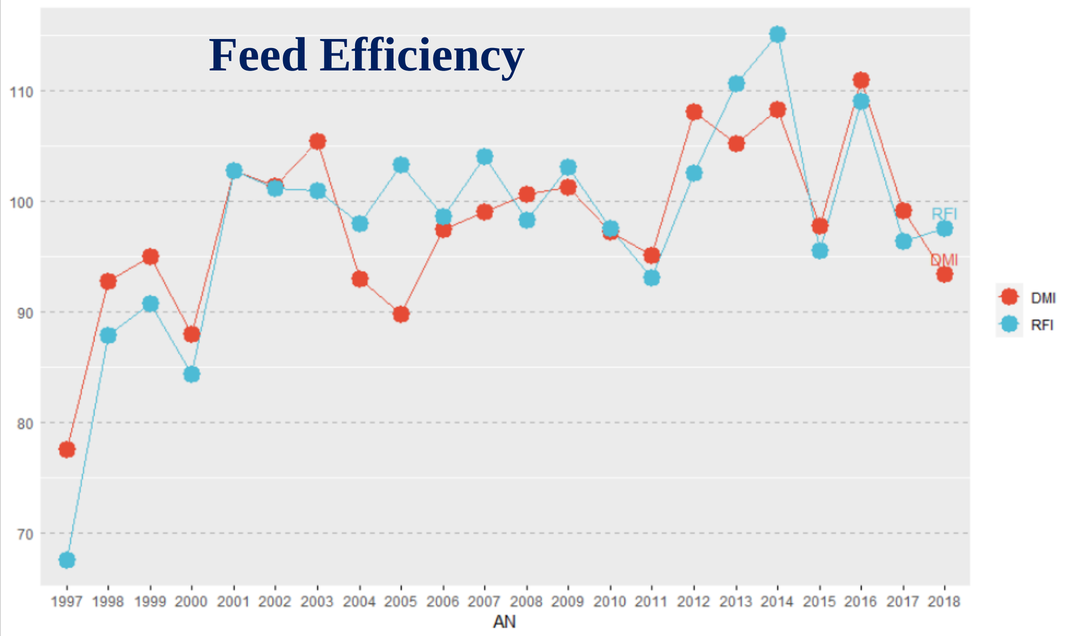


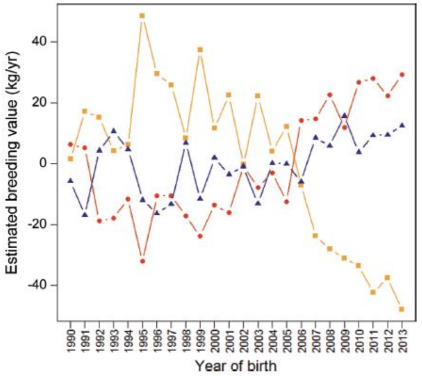
- More feed intake, more milk, but less efficiency.
- Methane is correlated with Fat yield (not prot or milk yield)

Genetic correlations

	DMI	RFI	CH4 (ppm)	CH4(g/d)	kg_milk	kg_prot	kg fat
DMI	0.17	0.97	0.27	0.2	0.41	0.53	0.5
RFI		0.12	0.27	0.14	0.13	0.27	0.55
CH4 (ppm)			0.2	0.97	-0.05	0.07	0.3
CH4(g/d)				0.19	0.04	0.13	0.32

Genetic trends





J. Dairy Sci. 98:7340–7350
http://dx.doi.org/10.3168/jds.2015-9621

Hot topic: **Definition and implementation of a breeding value for feed efficiency in dairy cows**

J. E. Pryce,*†[1] O. Gonzalez-Recio,* G. Nieuwhof,*‡ W. J. Wales,§ M. P. Coffey,# B. J. Hayes,*† and M. E. Goddard*‖

Genetic correlations

	DMI	RFI	CH4 (ppm)	CH4(g/d)	kg_milk	kg_prot	kg fat
DMI	0.17	0.97	0.27	0.2	0.41	0.53	0.5
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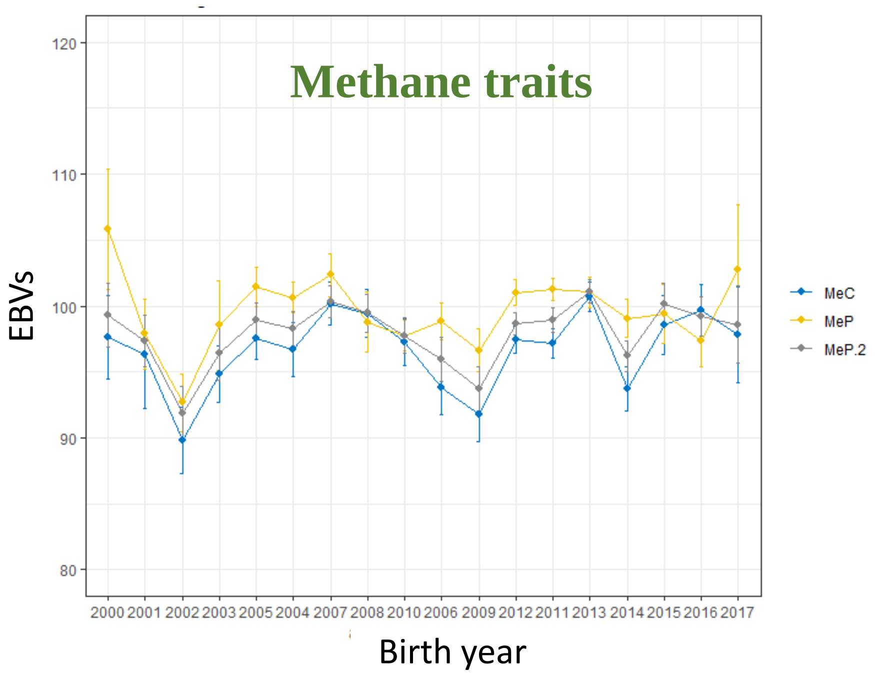
Genetic trends



Genetic correlations

	DMI	RFI	CH4 (ppm)	CH4(g/d)	DA	BCS	STAT
DMI	0.17	0.97	0.27	0.2	0.09	0.22	0.34
RFI		0.12	0.27	0.14	-0.05	0.27	0.31
CH4 (ppm)			0.2	0.97	0.02	0.25	0.21
CH4(g/d)				0.19	0.02	0.32	0.45

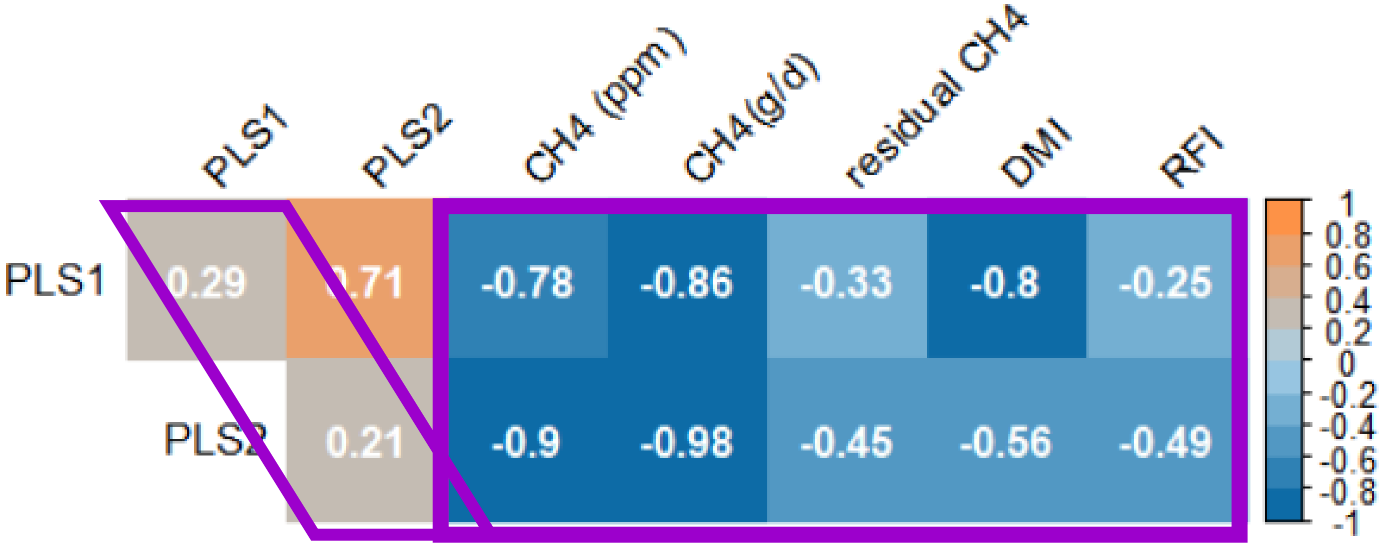
- Bigger cows tend to be less efficient and produce more methane

Microbiome- heritabilities

J. Dairy Sci. 104:8135–8151
https://doi.org/10.3168/jds.2020-20005

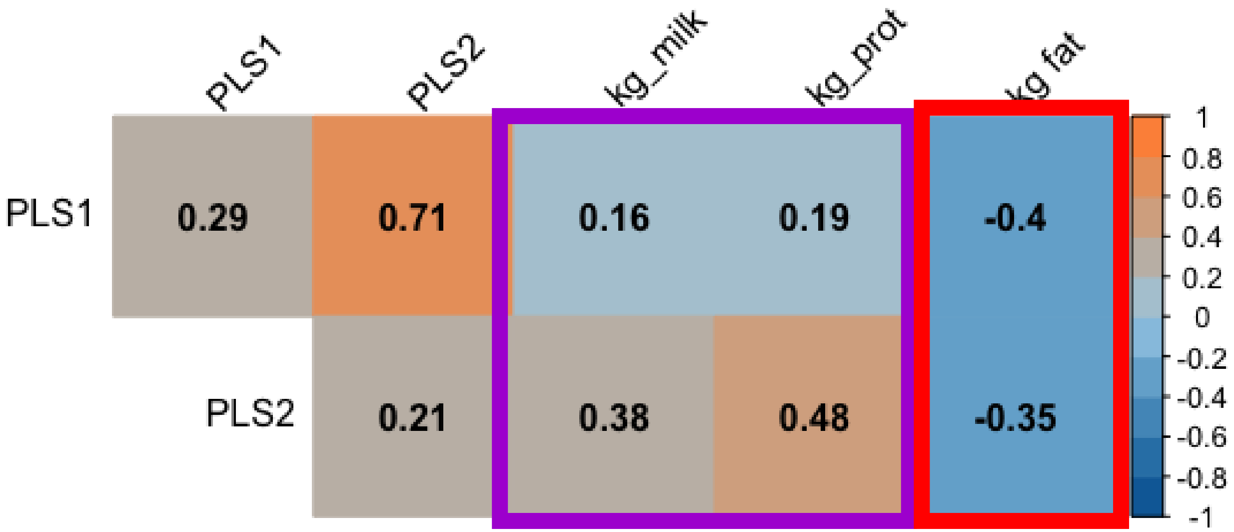
A dimensional reduction approach to modulate the core ruminal microbiome associated with methane emissions via selective breeding

Alejandro Saborío-Montero,[1,2] Adrían López-García,[1] Mónica Gutiérrez-Rivas,[1] Raquel Atxaerandio,[3] Idoia Goiri,[3] Aser García-Rodriguez,[3] José A. Jiménez-Montero,[4] Carmen González,[1] Javier Tamames,[5] Fernando Puente-Sánchez,[5] Luis Varona,[6] Magdalena Serrano,[1] Cristina Ovilo,[1] and Oscar González-Recio[1,7*]



- The core composition of the microbiome is heritable (0.20-0.30)
- Is highly genetically correlated with Methane, and Feed Efficiency

Microbiome- heritabilities



- Favorable correlation with Milk and Protein Yields. But no with Fat ⚠️

Genetics	Breeding for environmentally important traits (e.g. methane emission, feed efficiency etc.)

- **Green Feed vs RC**

Validating short-term enteric methane measurements

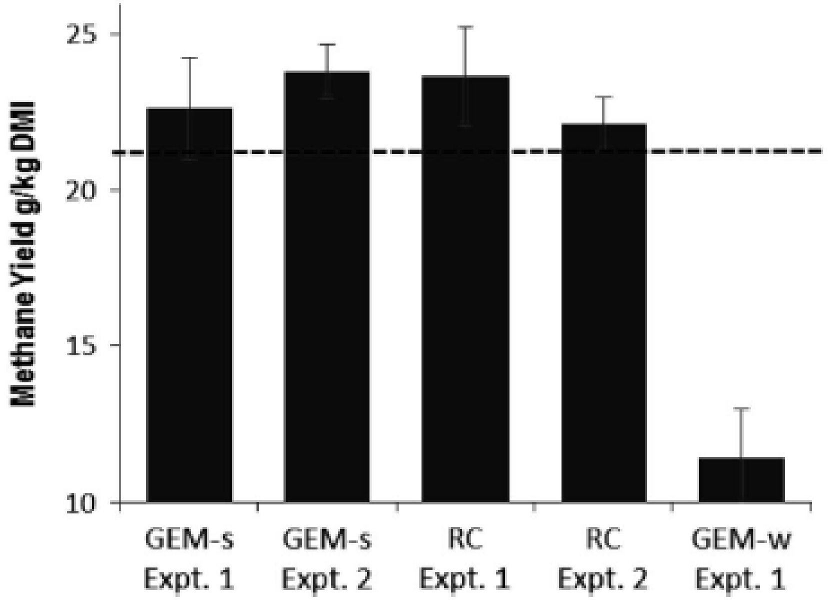


Figure 4 Methane yield results (g/kg dry matter intake (DMI)) by method (GreenFeed Emission Monitors (GEM) dispensing supplement (GEMs) or water (GEMw) or respiration chamber (RC)) and by experiment with 95% confidence interval. Dotted line corresponds to the predicted methane yield based on IPCC, 2006.

Velazco et al. (2016) Animal