Genetic selection of feed efficiency and methane emissions in sheep and cattle in Uruguay: progress and limitations

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URUGUAY

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Uruguay

AREA	176,215 km²
POPULATION	3,4 millions
CATTLE	12 millions
SHEEP	6,6 millions

- **Agricultural country**
- **Beef and sheep industries are strategic**:
  - Land use
  - Employment
  - National economy and future growth (international markets)

- **Responsible for 0.04% of global GHG emissions**
- **National GHG inventory**
- Agriculture: 75% CO_2 emissions
- 55%: enteric methane

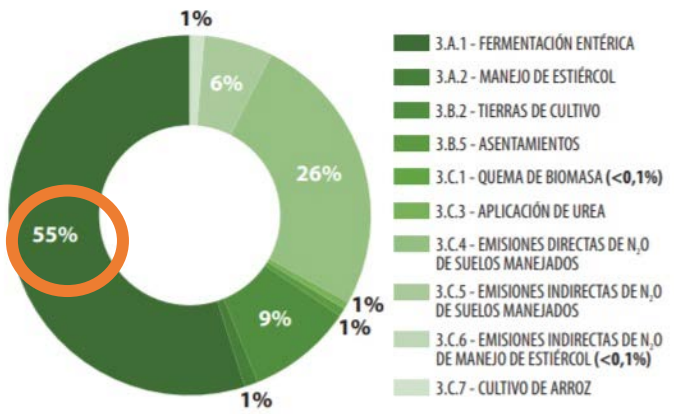
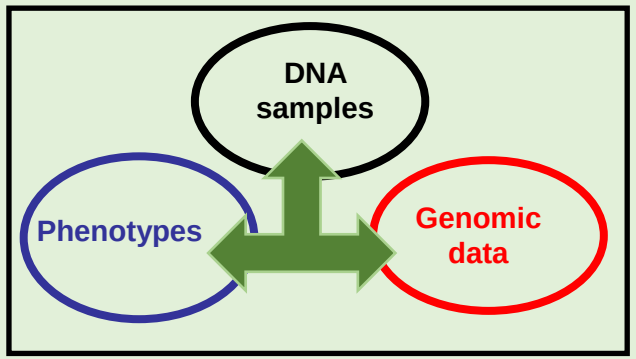


Figura 18. Contribución relativa de emisiones GEI, del sector AFOLU, por categoría, 2017 ($GWP_{100\ AR2}$)

Cattle and sheep genetic evaluations and genomics

- National Genetic Evaluations in place for 30 years
- Public-private collaborations, supported by the academia

2010 – ANIMAL GENOMIC DNA BANK
(INIA – Rural Association Uruguay)



Bovine samples: 17,687
Sheep samples: 24,687

- Pedigree animals
- Breeders & studs
- Selection Nucleus
- Research projects

Reference populations for genomic selection

GENOMIC EVALUATION

- **2016 - Hereford**
  (Pan-American Hereford Evaluation)
- **2021 – Aberdeen Angus**
  Holstein
- **2022 - Merino**

Mitigation of greenhouse gas emissions

Global growing demand for food and fibres

- Increasing agricultural production
- Intrinsic and extrinsic quality

Environmental sustainability

- Responsible use of resources
- Conservation and biodiversity

Climate change and mitigation of greenhouse gas emissions

- Reduction of methane emissions
- International agreements

32% **REDUCTION OF EMISSION INTENSITY**

Animal Breeding

Methane emissions / Production

- ✓ Reproductive performance
- ✓ Growth, finishing
- ✓ Wool production & quality
- ✓ Beef production & quality
- ✓ Animal health

Mitigation of greenhouse gas emissions

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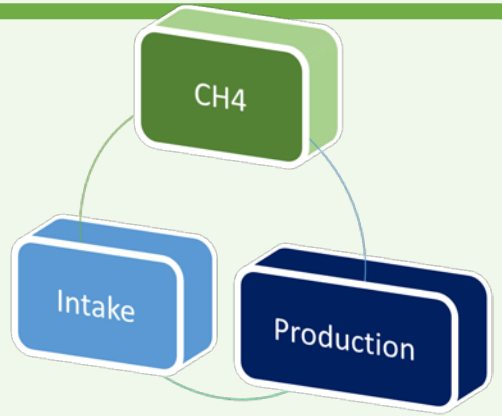
- ➢ **New traits**

RFI

Global Methane Pledge

30% reduction by 2030



Phenotyping Platforms and Information Nucleus

RFI and CH_4 in Hereford

2014

Reference population for genomic selection

2017

Genomic EPDs for feed efficiency

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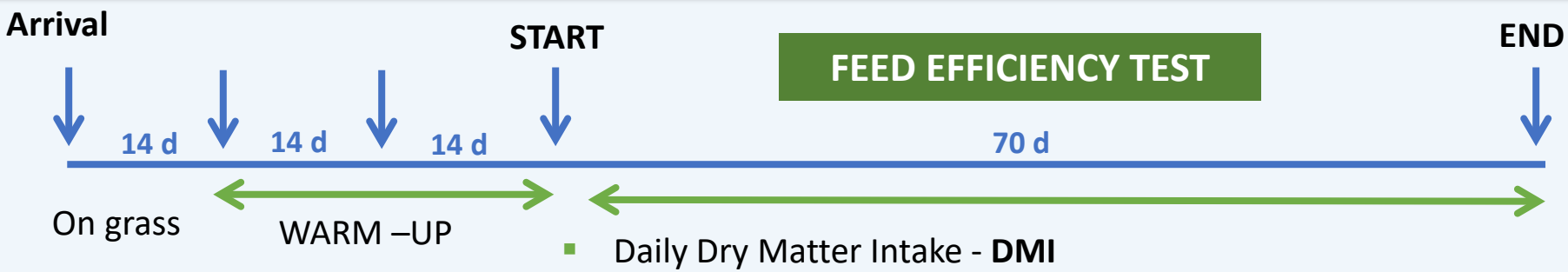
RTS_1_2012_1_3489 (BT10)

Post- weaning RFI in Hereford



3 tests per year
2 pen with 8 feeders

- Daily Dry Matter Intake - **DMI**
- Weighting fortnightly – Average Daily Gain (**ADG**) & weight (**MWT**)
- Ultrasound fat depth (**UFAT**)

Link with breeding population

- 3 or 4 animals per breeder, sired by at least 2 bulls
- Date of birth: 15 Aug – 15 Oct
- Birth and weaning weights in genetic evaluation system

Feeding *(test vs grazing)*

- Ad libitum
- High percentage of fibre:
  - **70% silage (sorghum) + 30% corn grain**

- **1,512 tested animals**
- **70 breeders**

Post-weaning RFI tests		Finishing	Carcass & Meat	Novel traits
Bulls	2014 ---			Rumen sample, CH_4
Steers	2014 - 2018	On pasture	✓	
	2019 -2022	RFI tests	✓	Rumen sample, CH_4

RFI and CH4 in Hereford

2014

Reference population for genomic selection

2017

Genomic EPDs for feed efficiency

- **Impact of RFI on perfomance of breeding herd in grazing conditions**

2021

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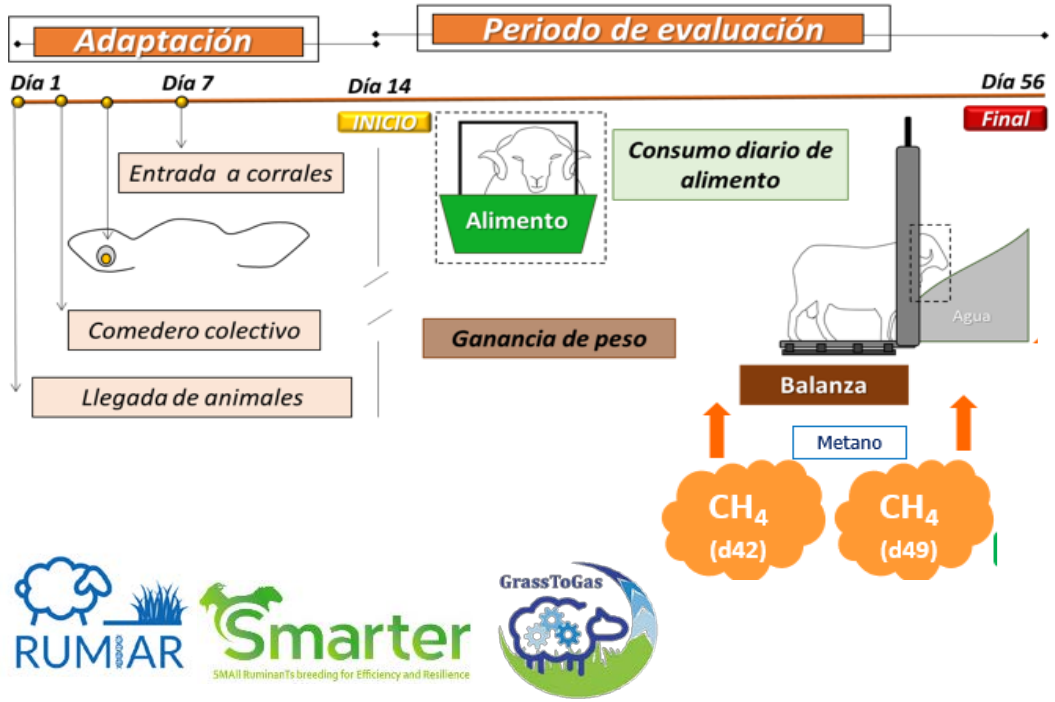
RFI and CH4 in sheep

2018

Automatic weighting platforms

Automatic recording of individual feed intake

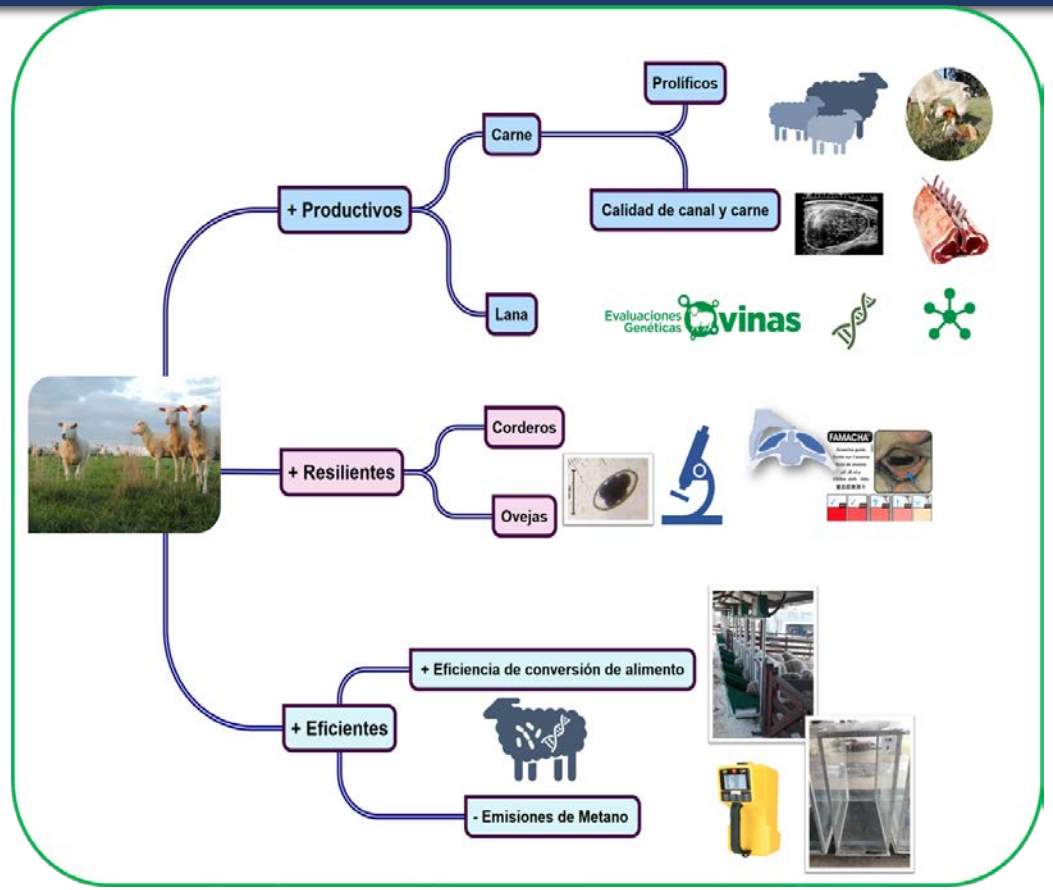


Portable Accumulation Chambers

New Traits: Number of animals recorded per trait and breed (2019-2022)

Traits	Merino	Dohne	Corriedale	Texel	Total (end 2022)
Individual intake (kg/a/d) Wool data Rib eye area + Backfat Condition score Faecal egg count (FEC) DNA	981	357	368	129	2,189
Methane (g/a/d)	981	357	298	129	2,119
Genotype (50 K)	x		x	x	1,762
Rumen samples	609		152	22	783

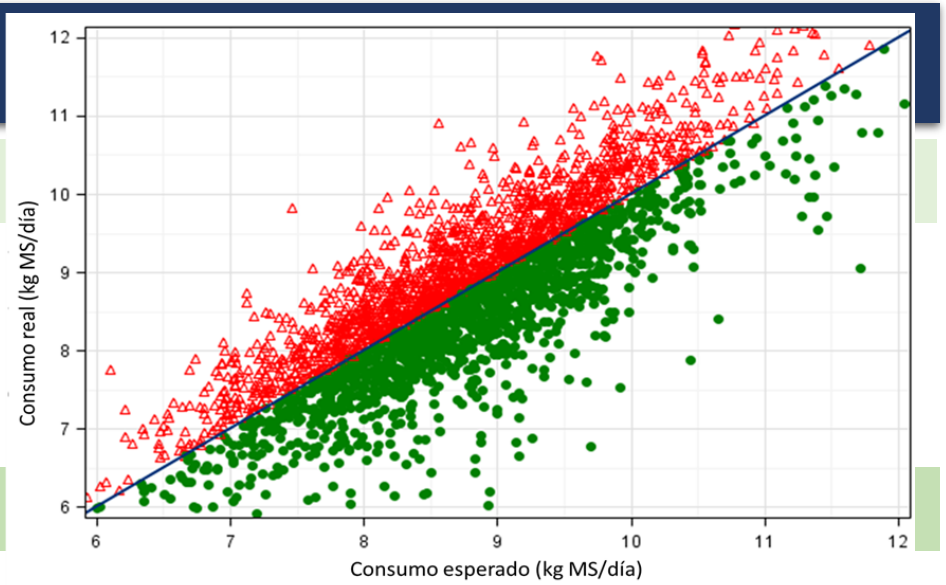
Genetics of RFI and associations with productive traits



Current RFI genomic evaluation in Hereford

➢ Estimation of RFI

DMI = CG + b1 ADG + b2 MWT + b3 UFAT + RFI
where CG is the feed intake test contemporary group



➢ Genomic evaluation – binational reference population

Information	UY	CAN	Total
Phenotypes	1,317	1,623	2,940
Genotypes	2,691	2,763	5,454
Pedigree			446, 486

Ravagnolo et al. (2018) – WCGALP

Single-step GBLUP (Aguilar et al., 2010)

- ➢ RFI = Xb + Zu + e
  - Fixed effects: animal age and age of dam
- ➢ Individual accuracies
  - $r = \sqrt{1 - PEV/(1+F)\ \sigma_g^2}$

➢ Observed accuracies with genomics

Group of animals	Individual accuracies		Increase (%)
	EPD	GEPD	
Animals with phenotype	0.305	0.334	10%
Animals without phenetype and genotypes	0.095	0.152	60%

Genetics of RFI and associations with productive traits

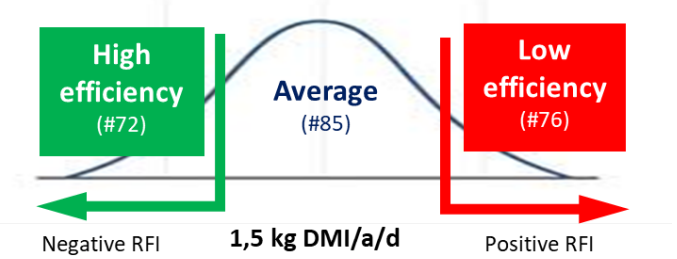
- Heritability of RFI : **0.25**
- Correlated with DMI
- Independent of other traits

Pravia et al. (2022) in press

Correlations	DMI	ADG	MWT	UBF
Phenotypic	0.63	-0.003	-0.001	- 0.01
Genetic	0.40 (0.11)	0.07 (0.14)	-0.12 (0.12)	-0.08 (0.13)

- Non significant trade-off were found between feed efficiency and carcass and meat quality

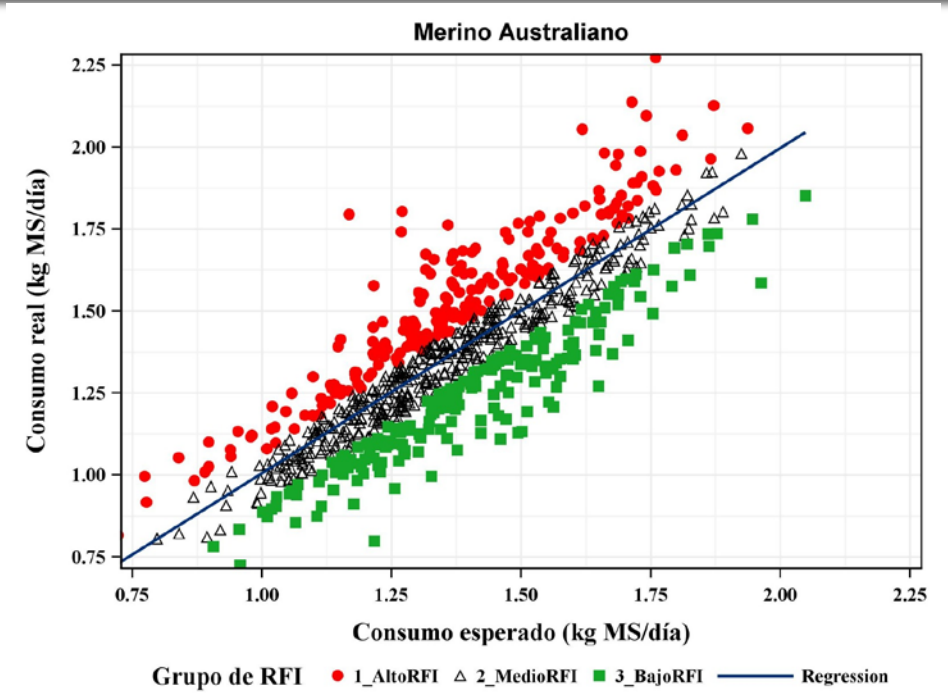
Pravia et al. (2018) - WCGALP



- Carcass weight and composition
- High-Price cuts
- Tenderness
- Intramuscular fat
- Fatty acid profile

- RFI assessed at post-weaning is a good predictor of feed efficiency in feedlot conditions (r_P=0.72)
  - DMI differences between high and low efficient animals were **2.2 kg DMI/a/d**
  - Achieved **similar final weight to slaughter with no differences in UFAT**

RFI and performance in Australian Merino



Production traits
- ✓ Live weight
- ✓ Fleece weight
- ✓ Diameter
- ✓ Condition score

Reproductive performance
- ✓ Fertility
- ✓ Prolificity
- ✓ Kg weaned lamb/ewe joined

No differences between high and low efficiency:
- ✓ Rib eye area or backfat
- ✓ ADG (200 g) or body weight (41 kg)
- ✓ Condition score
- ✓ Fleece weight (4.1 kg), diameter (14.9 microns)
- ✓ FEC (2700)

261 Hoggets
Born in 2018 & 2019
first mated at 17 months of age
y = RFI group + year + pregnancy rank + e

RUMIAR Smarter GrassToGas

De Barbieri et al. 2020, Navajas et al. 2021, De Barbieri et al. 2022

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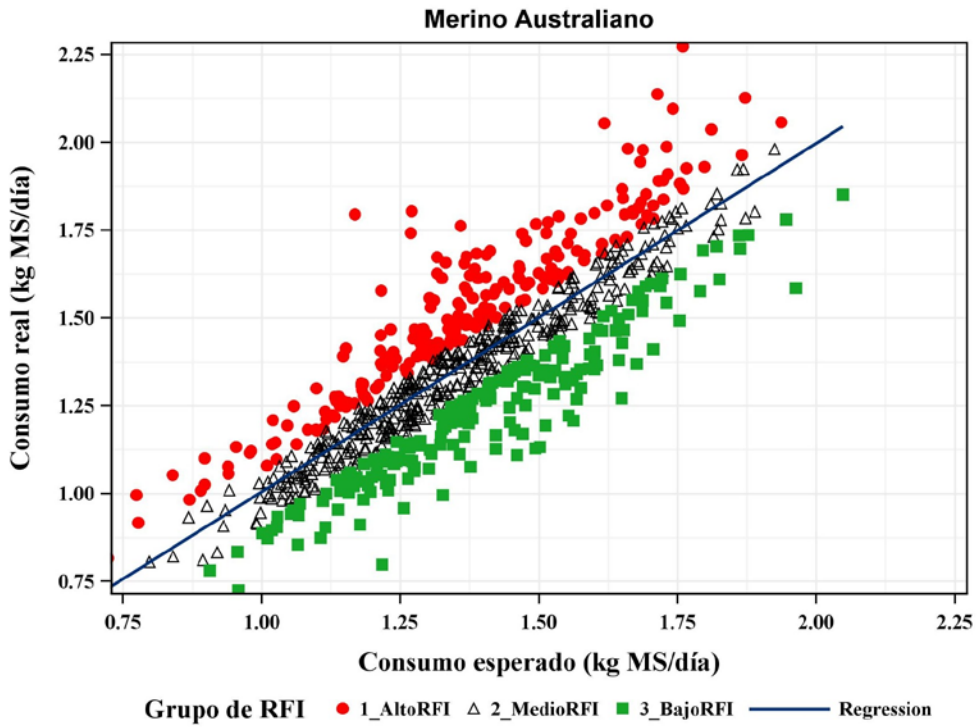
Methane emissions

Does high feed efficiency mean lower methane emissions?



	High eff	Average	Low eff
RFI (kgDM/d)	-0.17 c	-0.01 b	0.15 a
DMI (kgDM/d)	1.2 c	1.3 b	1.5 a
Methane emission (g/d)	22.6 b	22.9 b	24.1 a
Methane/DMI (g/kgDM)	7.1 a	6.4 b	5.9 b
Methane /ADG (g/kgBWG)	6.9 b	7.1 b	7.5 a

Efficient lambs

- ✓ **20-23 % lower DMI**
- ✓ **6 % lower methane emissions**

De Barbieri et al. 2020, Navajas et al. 2021, De Barbieri et al. 2022

Genetic and phenotypic associations in sheep

Sociedad Criadores Merino Australiano del Uruguay

930 records - Merino
Progeny 2019-2021
19 rams

	RFI	DMI	CH_4	GFW
RFI	**0.27**	**0.79**	**0.64**	0.05
DMI	**0.75**	**0.38**	0.88	0.13
CH_4	-0.02	**0.28**	**0.23**	0.06
GFW	0.01	**0.24**	**0.18**	**0.39**

- High feed efficiency is explained by lower DMI
- Methane emissions:
  - Independent of RFI at phenotypic level
  - Positive genetic association with RFI
  - ❖ Lower emissions linked to lower DMI

217 female Corriedale lambs
Progeny 2018-2020

CORRIEDALE

	DMI-A	RFI
CH_4-A	**0.26**	-0.04
CO_2-A	**0.42**	-0.03

EPD

Adjusted phenotypes

	WWT	YWT	FEC	GFW
RFI	-0.05	-0.04	0.08	0.10
DMI-A	**0.19**	**0.20**	0.07	**0.23**
MWT-A	**0.43**	**0.44**	0.07	**0.35**
ADG-A	0.05	0.05	-0.08	-0.07
CH_4-A	**0.15**	**0.16**	0.05	0.07
CO_2-A	**0.24**	**0.24**	0.04	0.07

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- High efficiency is explained by lower DMI
- Methane emissions:
  - Independent at phenotypic level
  - Favourable association genetically

217 female Corriedale lambs
Progeny 2018-2020

CORRIEDALE

	DMI-A	RFI
CH_4-A	**0.26**	-0.04
CO_2-A	**0.42**	-0.03

➢ Low CH_4 emitters

- Eat less
- Lower body weights and growth rates
- No clear effect on:
  - FEC
  - Other performance traits (body composition, wool production)
- Maybe less efficient ??

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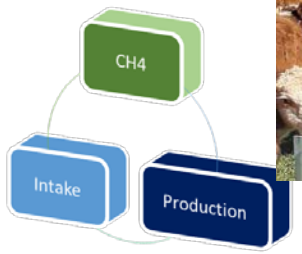
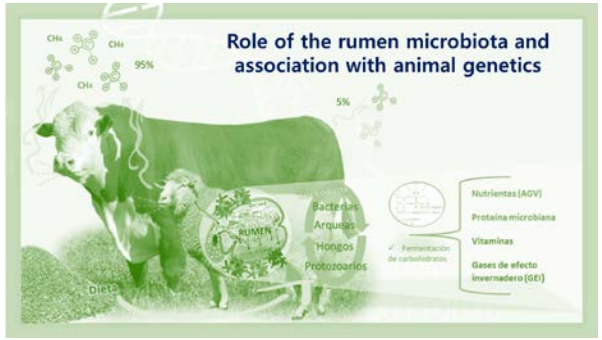
In summary ……

- Optimising mitigations strategies relies on new phenotypes and on a better understanding of associations among traits
  - Phenotyping in grazing conditions

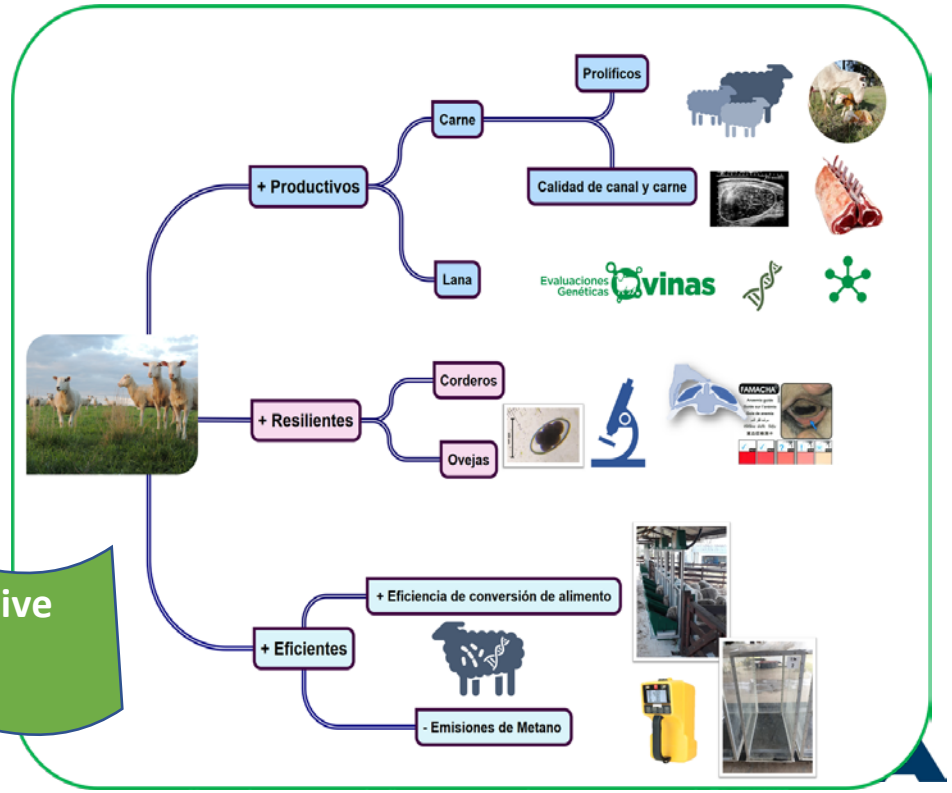


- Improving feed efficiency and reducing methane emissions are possible
  - Reference population for genomic selection
  - International collaborations

- Identification and quantification of trade-off



Comprehensive approach



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S.C.C.U. - desde 1935
CORRIEDALE
Moneda fuerte de la majada nacional

MERINO DOHNE
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Many thanks!

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