WP1 - Task 1.3

Genetic correlations between feed efficiency and production traits

Task leader: SRUC

Involved partners: UNILEON, INRAe, AUTH, NSG, INIA-UY, ICAR

May 2023

Toledo - Final meeting

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement N° 772787

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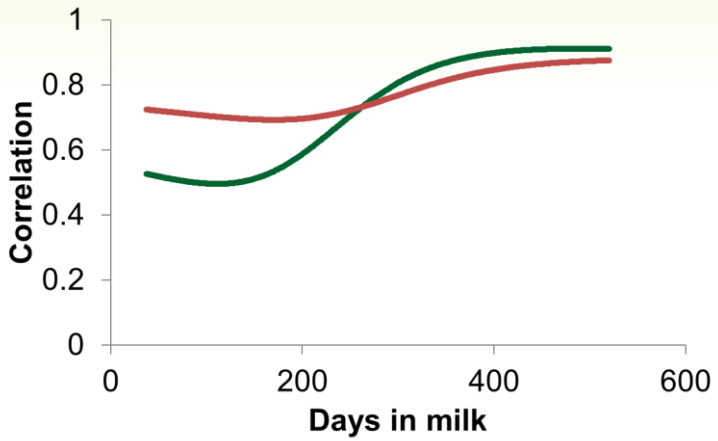
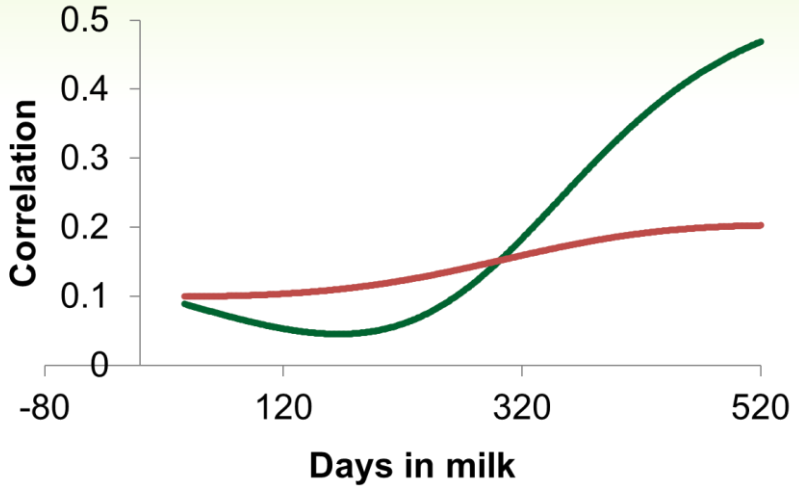
SRUC

Phenotypic
Genetic

Feed intake & milk



Feed intake & live weight



1. Yorkshire Dairy goats
10,000 1st lactation TD records
Pedigree with 6,644 animals
Phenotypes from 1,146 animals on 2 farms

2. Genetic & phenotypic parameters for FI, BW, MY using rr model FE age at first kidding, year-season of birth, herd year test day, DIM (3rd order Legendre polynomial) covars: body wt, milk yield

- Selection for MY results in a rise in feed intake
- Sufficient genetic variation to select for feed efficiency in goats
- Should be incorporated into multi-trait selection index due to positive correlation between feed intake and body weight

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	Heritability
Methane emission (gram/hour) corrected for weight	0.18
Methane emission (mol/hour) corrected for “feed intake proxy”	0.34

1. >6000 animals measured once in 57 flocks
2. GHG, BW
3. Genetic determinism GEI

	Birth Weight	Carcass Weight	EUROPE Carcass Classification	EUROPE Fat Grading	Brith Weight (mat)	42-day Weight (mat)	Carcass Weight (mat)	Fleece Weight	Fleece Classifcation
Methane corrected weight	-0.11	0.02	-0.08	-0.27	0.23	0.32	0.25	0.04	0.07
Methane corrected “feed intake proxy”	-0.08	-0.18	0.04	0.00	0.00	0.16	0.18	0.05	0.05

- Genetic correlations between methane and maternal traits:
  - Corrected for weight, undesirable
  - Corrected for feed intake proxy, uncorrelated

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ARISTOTLE UNIVERSITY OF THESSALONIKI

To estimate genetic and phenotypic correlations of **milk fat and lactose content (indicators of feed efficiency)** with daily **milk yield** in commercial populations of **Chios** and **Frizarta** dairy sheep in Greece

- Commercial populations:
  - 2 dairy sheep breeds (469 Frizarta, 369 Chios)
  - 2 semi intensive + 2 intensive farms (1 of each/breed)
  - 4 farms (2 f/breed)
  - Selection for MY results in a rise in feed intake

- Phenotypes:
  - 2 consecutive milking periods
  - Individual monthly records: milk yield, fat content, lactose content
  - 3-7 milking recordings/milking period/farm

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Frizarta sheep → lactose content could be used to select for improved feed efficiency without compromising milk yield

Frizarta and Chios sheep → Selection for higher feed efficiency using milk fat content as a proxy trait might unfavourably affect milk yield

FRIZARTA	DMY	FT	LC
Daily milk yield		**-0.81 (0.25)**	**0.50 (0.52)**
Fat content	-0.26 (0.03)		**-0.53 (0.31)**
Lactose content	0.23 (0.03)	-0.39 (0.02)	

CHIOS	DMY	FT	LC
Daily milk yield		**-0.66 (0.28)**	**NA**
Fat content	-0.43 (0.03)		**NA**
Lactose content	0.22 (0.03)	-0.21 (0.03)	

Bold, genetic correlations

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INRAE

951 Romane male lambs, 3-5 month old fed *ad libitum* with low-energy concentrated pellets

Individual feed intake recorded over 6 weeks
Pedigree with 4,894 animals

- ✓ RFI is genetically independant of production traits (except Muscle Depth)
- ✓ FCR is genetically independant of production traits (except Backfat Thickness)
- ✓ Efficient animals eat less per day, but more at each visit, and they do less visit per day to the feeder

Genetic correlations	FI	RFI	FCR
Body weight	0.60 (0.13)	-0.03 (0.19)	-0.77 (0.09)
Backfat Thickness	0.31 (0.16)	0.00 (0.16)	0.01 (0.18)
Muscle Depth	-0.12 (0.19)	**-0.30 (0.15)**	-0.15 (0.18)
Av. Daily Gain	0.59 (0.13)	-0.03 (0.20)	-0.77 (0.09)
Feed Intake		**0.78 (0.08)**	0.10 (0.21)
RFI	0.78 (0.08)		0.65 (0.12)
FCR	0.10 (0.21)	0.65 (0.12)	
Feed. Duration / day		0.41 (0.13)	
Nb. Visits /day		0.51 (0.14)	
Feed Intake /visit		-0.33 (0.14)	
Feed Duration /visit		-0.22 (0.17)	
Time between visits		-0.56 (0.13)	

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Lacaune
Dairy Breed

On-farm datasets

!! Group feed intake mainly for forages and concentrates

Alpine and
Saanen breeds

Genetic correlations	Net Energy converted in milk ratio	Residual energy intake (REI)
Daily Milk Yield	0.74 (0.04)	-0.79 (0.04)
Fat Content	0.11 (0.07)	0.46 (0.06)
Protein Content	-0.18 (0.07)	0.75 (0.04)
Net Energy converted in milk ratio		-0.63 (0.06)
Residual Energy Intake	-0.63 (0.06)	

Heritabilities and Repetabilities		Alpine	Saanen
Residual energy intake	h^2	0.18 (0.08)	0.20 (0.07)
Residual energy intake	r	0.31 (0.08)	0.13 (0.06)
Milk yield	h^2	0.19 (0.09)	0.20 (0.07)
Milk yield	r	0.37 (0.09)	0.38 (0.07)

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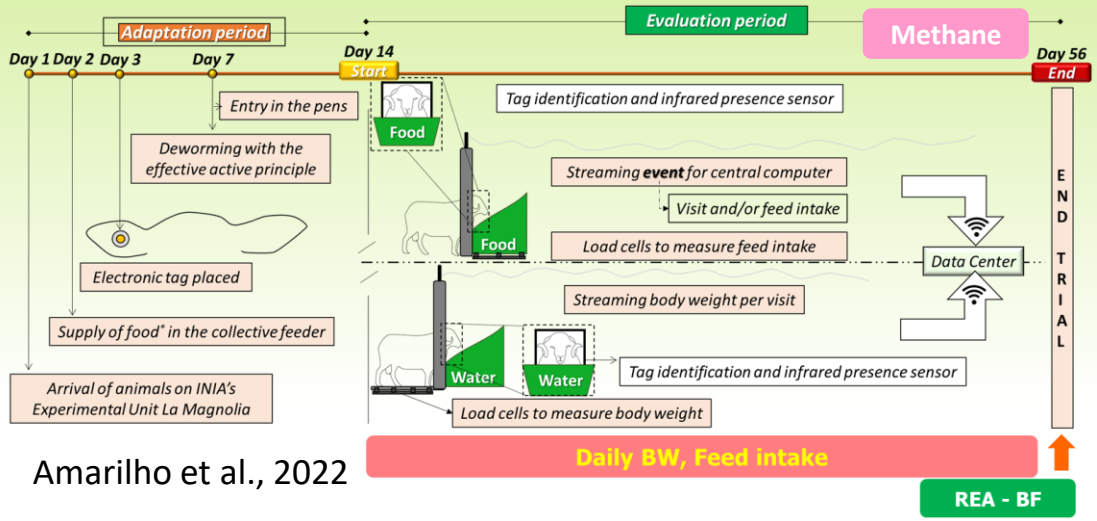
INIA URUGUAY

Mean (sd) (n)			
	Merino		
Body weight (kg)	40.9	6.4	1195
Intake (kgDM/a/d)	1.4	0.3	1195
Methane (g/a/d)	22.3	5.6	1195
REA (cm^2)	7.5	1.5	1195
FAT (mm)	1.9	0.7	1195
Body CS	2.8	0.4	1217
Fleece weight (kg)	3.1	0.9	73968
Fiber diameter (µ)	16.3	1.7	73744
FEC	1298	1905	35399

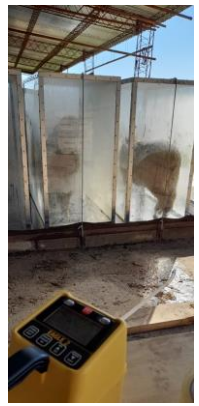
Genotyped Corriedale 1056; Merino 3179; Dohne (DNA stored)

2016 (IN) - 143 (commercial) = 2159



Amarilho et al., 2022

RFI model: age, pen-trial, average daily gain, mean metabolic body weight



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URUGUAY

Preliminary results: Marques et al. 2022. 12th WCGALP. 160-163
New analyses: Marques et al, in preparation

Merino

Heritability (sd) - diagonal - bold

G correlation (sd)

	FW	FD	BW	FEC	CH4	FI	RFI	REA	BF
FW	**0.30 (0.01)**	0.35 (0.02)	0.29 (0.02)	*0.03* (0.05)	*0.17* (0.15)	*0.18* (0.12)	*0.02* (0.15)	*0.07* (0.08)	*0.15* (0.11)
FD	0.13	**0.64 (0.01)**	0.25 (0.02)	-0.08 (0.04)	*0.17* (0.17)	*0.20* (0.14)	*0.15* (0.15)	*0.13* (0.08)	0.40 (0.08)
BW	0.45	0.13	**0.41 (0.01)**	*-0.07* (0.04)	0.58 (0.15)	0.68 (0.09)	*-0.22* (0.14)	0.50 (0.06)	0.44 (0.08)
FEC	*-0.02*	-0.05	-0.07	**0.20 (0.01)**	*-0.20* (0.20)	*-0.06* (0.22)	*0.13* (0.19)	*-0.21* (0.11)	*-0.02* (0.15)
CH4	0.15	*0.09*	0.30	*0.08*	**0.34 (0.09)**	0.75 (0.12)	0.43 (0.19)	0.37 (0.17)	0.36 (0.15)
FI	0.34	*0.14*	0.48	*-0.04*	0.29	**0.41 (0.08)**	0.79 (0.09)	0.39 (0.14)	0.34 (0.12)
RFI	*0.00*	*-0.01*	*-0.02*	*-0.08*	*-0.02*	0.63	**0.37 (0.08)**	*-0.15* (0.20)	*-0.17* (0.16)
REA	0.23	0.18	0.47	*-0.02*	0.13	0.30	*-0.02*	**0.39 (0.04)**	0.53 (0.10)
BF	0.10	*0.03*	0.24	-0.09	*0.04*	0.11	*0.01*	0.21	**0.32 (0.04)**

P correlation

FW fleece weight, FD fibre diameter, BW bodyweight, FEC faecal egg count, CH4 daily methane, FI feed intake, RFI residual feed intake, REA rib eye area, BF backfat thickness

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Final comments

1. Genetic correlations for meat sheep (3), dairy sheep (3) and dairy goats (3) between feed efficiency and production traits have been estimated

2. Increase in production (milk yield, BW) associated with an increase in feed intake
3. Increase in production (BW) associated with an increase in methane emissions
4. Selecting against feed intake/methane emissions will have undesirable consequences on production - Multi-trait selection index is suggested

5. Lactose content can be used to select for more efficient goats, without unfavourably affecting MY. Fat content can be used, however unfavourably correlated with MY
6. REI (on-farm) positive correlated with MY and negatively with FC and PC

7. **RFI** not unfavourably related with most (MD) of production traits in meat sheep, and favourably correlated with methane and feed intake.

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SMAll RuminanTs breeding for Efficiency and Resilience

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¡Gracias por su atención!