

Efficiency and Resilience

De Barbieri, Navajas, Blumetto, Ciappesoni

Visitors: Integrity project

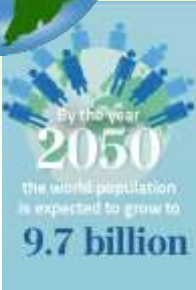
2023



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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Challenges of sustainable production



Growing global demand for food and fibre

- Increased agricultural production
- Intrinsic and extrinsic quality



Environmental care

- Efficient and responsible use
- Conservation of resources and biodiversity



Climate change and GHG mitigation

- Reduction of methane emission
- Mitigation commitments



Genetics + Management

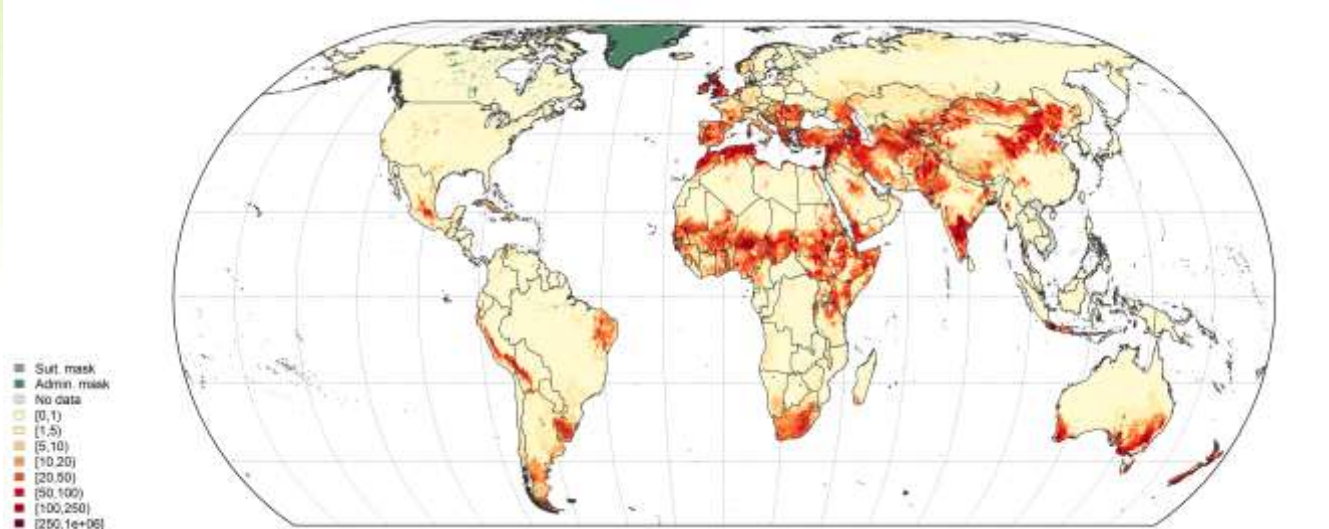


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Sheep production context

Gilbert et al. 2022. Global sheep distribution in 2015, Harvard Dataverse, V1
WWF. 2018. Living Planet Report - 2018: Aiming Higher. 75 p
Mottet et al. 2017. Global Food Security 14, 1–8.
Joy et al. 2020. Animals 10, 867



From wet to arid regions

From grazing outdoors on marginal soils to high controlled intensive indoors production systems

Variable access to food (quantity and quality) and water

Global challenges:

Feed/food competition
Use of arable lands
Contribution to GHG emissions
Coexistence with wildlife
Labour

Being:

A source of fibre and food

Socio-economic relevance (income, food security, human well-being)

Potential to play a role in Biogenic C cycle

Ecosystem services (recycling, biodiversity,...)



El proyecto SMARTER es financiado
por el programa Horizon 2020 de la Unión Europea
(acuerdo N°772787)

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MESA REDONDA
SMARTER EN URUGUAY

Animals - Traits



Wool traits: FD, yield, SL, colour, FW

BCS

BW, CW

REA - BF

Visual assessment

FEC

FAMACHA



Methane

Feed intake

Foot rot



Behaviour

RFI

Temperament

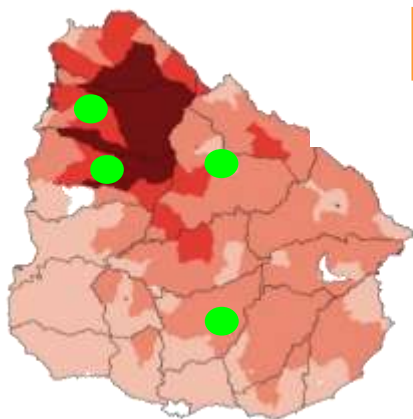
Twinning rate

Lamb-adult survival

Fertility

Scrotal circ

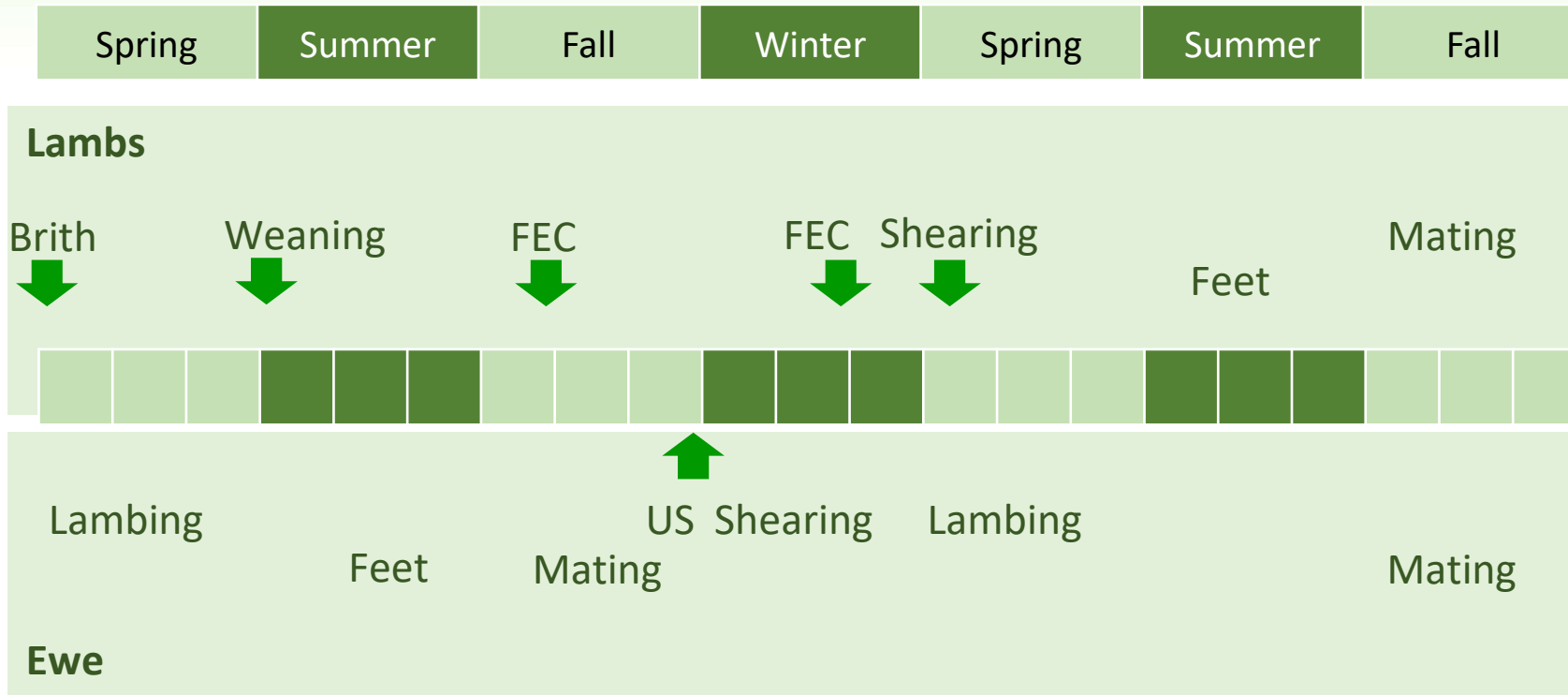
Maternal ability-
Easy lambing



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Calendar



Birth

Weaning



RFI - CH4
J-F



RFI - CH4
F-A



RFI - CH4
A-O

Shearing



RFI - CH4
O-N



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Informative nucleus (3 years)

	MA	Cor	MD
Foetus/ewes (%)	109	135	142
Hogg/ewes (%)	38	35	43
Mortality to docking (%)	10	6	10
Mortality to weaning (%)	12	7	12
Lambing (%)	97	123	126
Weaning (%)	95	122	124

MA Merinos, Cor Corriedales, MD Dohnes



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 Smarter

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MA Merinos, Cor Corriedales, MD Dohnes

		MA	Cor	MD
Ewes	BW mating (kg)	50,8	56,5	59,6
	BCS mating (units)	2,9	3,1	3,3
	Fleece weight(kg)	3,96	4,20	3,51
	Fiber diameter (μ)	15,6	28,2	20,1
Lambs	BW weaning (kg)	23,7	26,0	27,9



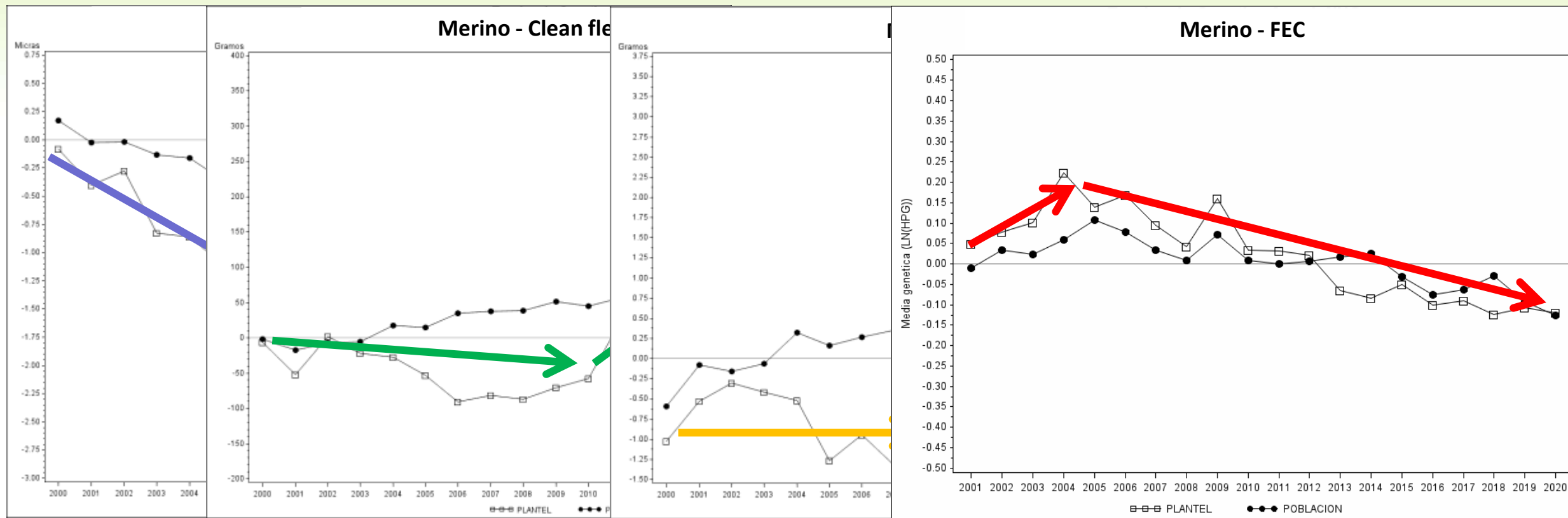
Native pastures									
Summer			Fall			Winter		Spring	
			S					S+PS	
Mating						Lambing			



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Production, health



Efficiency, Emissions, Reproduction



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Efficiency

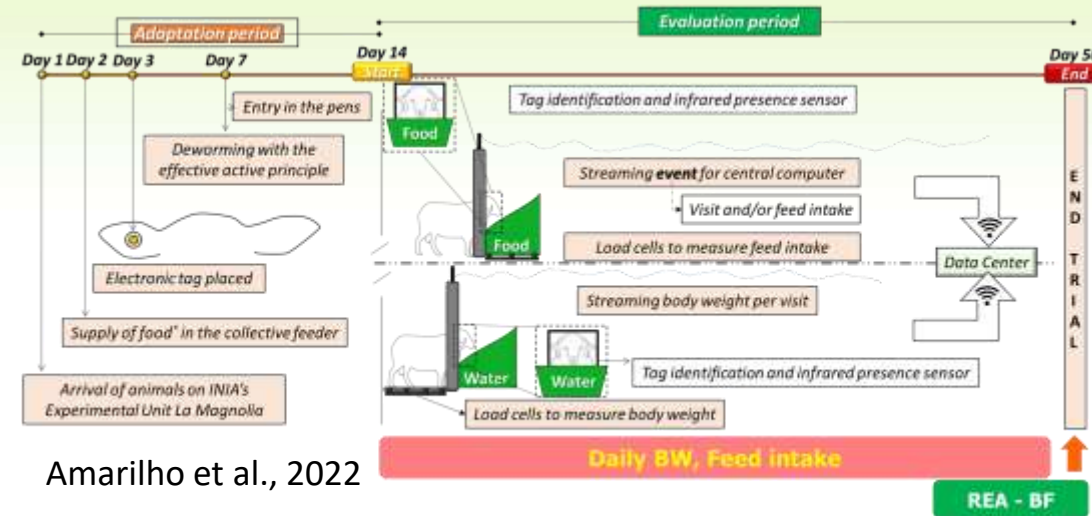


Mean (sd) (n)

	Corriedale			Merino			Dohne		
BW (kg)	42.9	23.3	464	40.9	6.4	1195	50.2	5.5	357
Intake (kgDM/a/d)	1.4	0.6	464	1.4	0.3	1195	1.5	0.3	357
Methane (g/a/d)	20.3	9.5	464	22.3	5.6	1195	26.8	5.7	357
REA (cm ²)	8.2	4	464	7.5	1.5	1195	10	2	357
FAT (mm)	2.7	1.6	464	1.9	0.7	1195	2.5	0.9	357
BCS	3.3	0.7	5242	2.8	0.4	1217	3.1	0.6	1616
Fleece weight (kg)	3.8	1.3	139971	3.1	0.9	73968	3.0	0.9	5960
Fiber diameter (μ)	25.6	3.1	139307	16.3	1.7	73744	18.2	1.4	5834
FEC	1543	2493	28075	1298	1905	35399	1815	2789	2870

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

2016 (IN) - 143 (commercial) = 2159



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

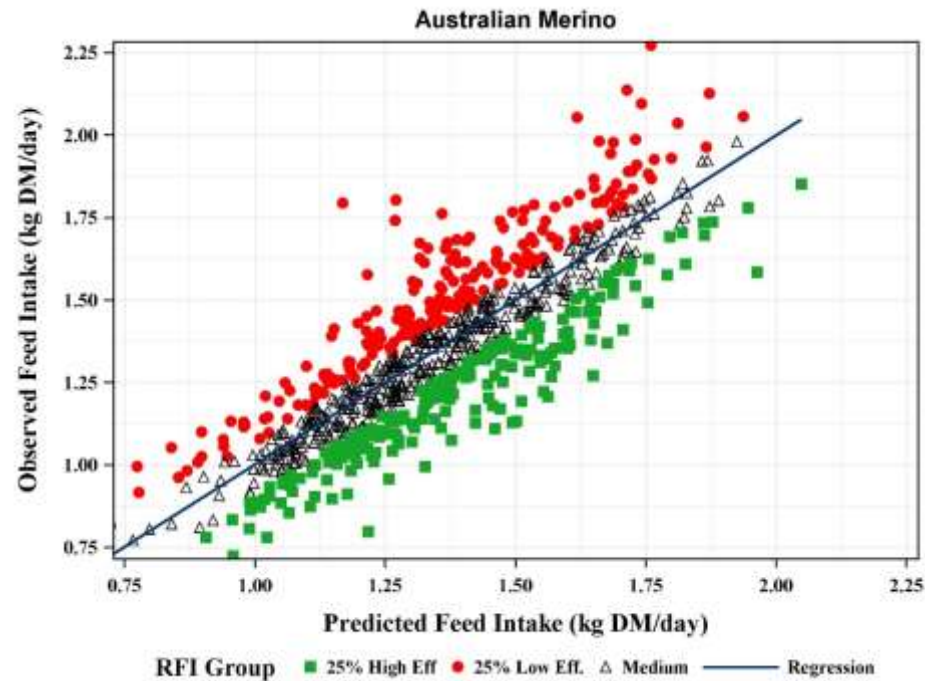


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Efficiency - contrasting groups

De Barbieri et al. 2020, EAAP 71, 560



	High eff	Medium	Low eff
RFI (kgDM/d)	-0.17 c	-0.01 b	0.15 a
Feed intake (kgDM/d)	1.2 c	1.3 b	1.5 a
Feed conversion ratio	6.4 c	7.4 b	8.5 a
N° of meals	54 c	60 b	73 a
Methane (g/d)	22.6 b	22.9 b	24.1 a
Methane yield (g/kgDM)	7.1 a	6.4 b	5.9 b
Methane intensity (g/kgBWG)	6.9 b	7.1 b	7.5 a

= REA / FAT
 = BW gain/ BW
 = BCS
 = Fleece weight (4,1 kg), fibre diameter (14,9 µm)



More efficient 20-23 % < intake

More efficient 6 % < methane (g/d)



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Efficiency - contrasting groups

De Barbieri et al. 2022. EAAP 73, 674



261 Hoggets

Born in 2018 & 2019

first mated at 17 months of age

$y = \text{RFI group} + \text{year} + \text{pregnancy rank} + e$

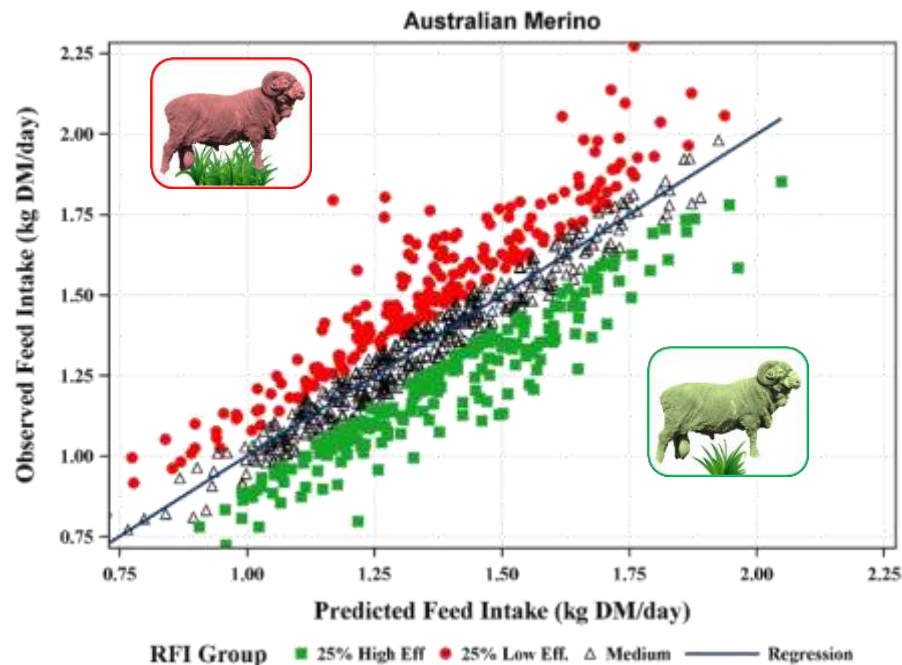


Production:

- ✓ Body weight (cycle)
- ✓ BCS
- ✓ Wool: FD & GFW

Reproduction:

- ✓ Fertility. Prolificacy. Lambing %
- ✓ kg of weaned lambs/mated or lambed ewe



	High efficiency	Low efficiency
Lamb (kg weaned/mated ewe)	20.8	19.1
Body weight at mating (kg)	45.6	44.3
Greasy Fleece Weight (kg)	2.8	2.8
Fibre diameter (µm)	15.5	15.7
Fertility (%)	91	79
Prolificacy (%)	120	110
Weaning (%)	100	79



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Trade off

Navajas et al. 2022. Proceedings of the 12th WCGALP. 195-198
Ferreira et al. 2021. Animal Production Science, 61, 754–760



**Health
(nematodes)**



GHG emissions

Feed efficiency

Wool and Growth



Pearson correlation coefficients of feed efficiency and GHG emissions with EPD of production traits and FEC

		FEC line		
		Resistent	Susceptible	p
GIN free	RFI (kgDM/d)	0,02	-0,02	0,116
	Feed intake (kgDM/d)	0,97	0,98	0,969
	Feed conversion ratio	9,0	7,6	0,161
	BW gain (g/a/d)	123	143	0,168
GIN	RFI (kgDM/d)	0,01	-0,01	0,334
	Feed intake (kgDM/d)	1,13	1,12	0,849
	Feed conversion ratio	8,0	11,1	0,074
	BW gain (g/a/d)	144	123	0,144

	Expected progeny difference			
	Weaning weight	Yearling weight	Gastrointestinal nematodes	Fleece weight
Residual feed intake	-0,05	-0,04	0,08	0,10
Dry matter intake adjusted	0,19	0,20	0,07	0,23
Methane adjusted	0,15	0,16	0,05	0,07
CO ₂ adjusted	0,24	0,24	0,04	0,07

High emitters (Marques et al., 2022, GGAA, 189-190):

- ✓ Heavier, and larger BWG
- ✓ Eat more, May have lower RFI



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Genetic parameters - Merino

Marques et al. 2022. 12th WCGALP. 160-163



Heritability (sd) - diagonal - bold

	RFI	Intake	CH ₄	CO ₂	GFW
RFI	0.27 (0.09)	0.79 (0.10)	0.64 (0.22)	0.50 (0.20)	0.05 (0.18)
Intake	0.75 (0.05)	0.38 (0.12)	0.88 (0.10)	0.77 (0.11)	0.13 (0.18)
CH ₄	-0.02 (0.10)	0.28 (0.13)	0.23 (0.12)	0.66 (0.18)	0.06 (0.20)
CO ₂	0.11 (0.08)	0.44 (0.09)	0.64 (0.05)	0.27 (0.09)	-0.15 (0.18)
GFW	0.01 (0.07)	0.24 (0.07)	0.18 (0.07)	0.27 (0.07)	0.41 (0.03)

G correlation (sd)

2023 analyses update
Including:
BW, FD, FEC, REA, BF
(Ciappesoni)

P correlation (sd)

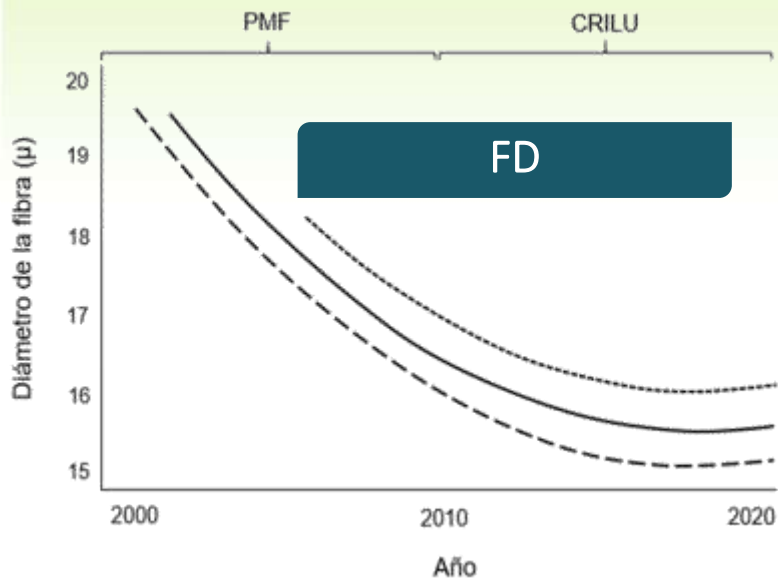


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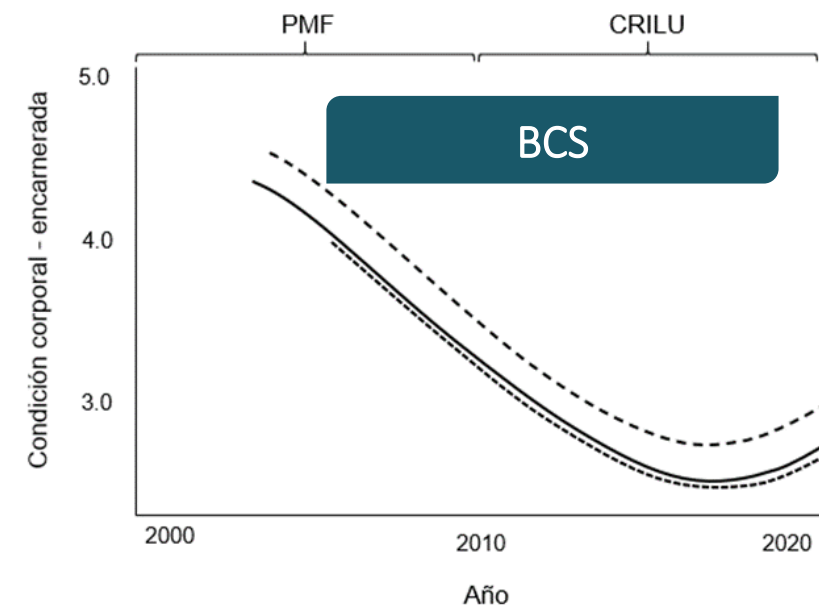
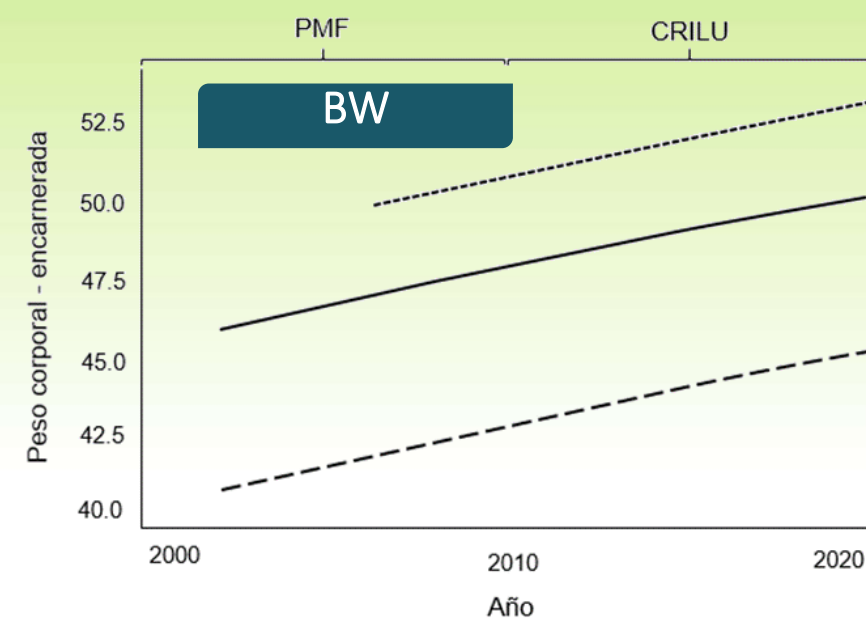
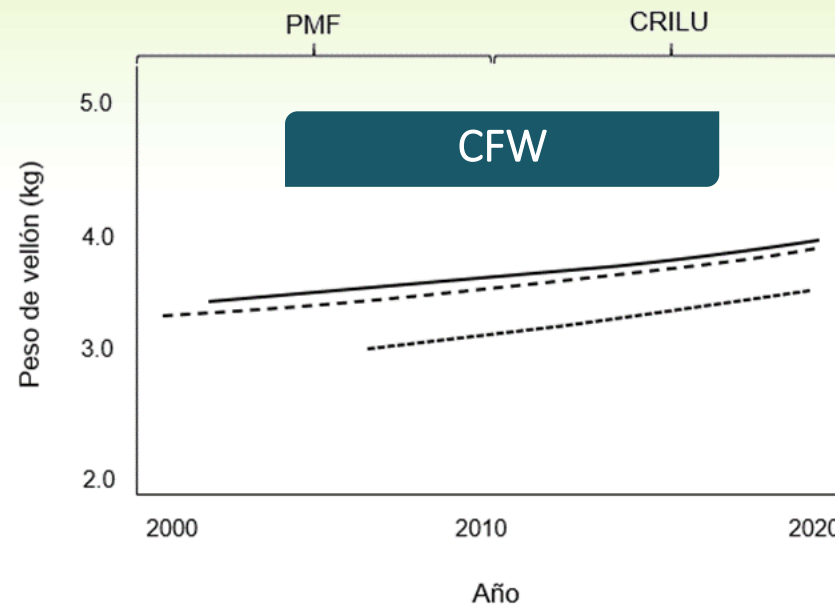


Production and resilience?

Ramos et al. 2021a, 2021b



2 años (---) 3 a 6 años (—) ≥ 7 años (·····)



Relevance to estimate potential trade-offs

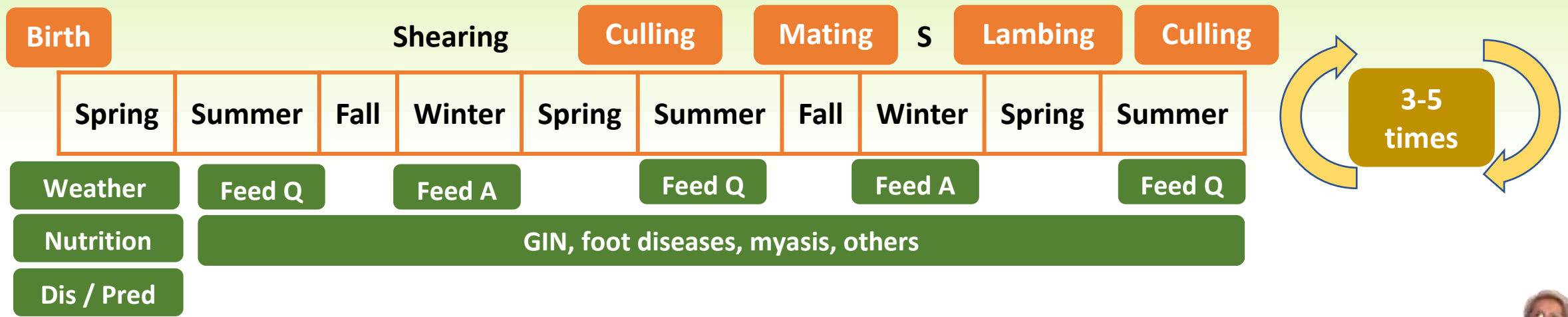


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Lifetime reproduction

Ramos et al. 2023. Journal of Animal Science, skad071



- **Reproduction traits, low heritability** (Fertility: 0.14 ± 0.03 , Lambing pot: 0.11 ± 0.02 , Rearing ability: 0.04 ± 0.01 and NLWEJ: 0.08 ± 0.02)
- Finner wool / not negatively affect reproduction
- **Heavier fleeces / unfavourably on reproduction (CFW/LW, environment) - trade off**
- Heavier animals / positive effect on reproduction

Trait	NLWEJ	TLW	TLWW
A_FD	-0.04 ± 0.10	-0.09 ± 0.09	-0.03 ± 0.09
A_GFW	-0.18 ± 0.11	-0.30 ± 0.09	-0.30 ± 0.08
LWM	0.06 ± 0.11	-0.03 ± 0.08	0.21 ± 0.09
LWPL	0.18 ± 0.11	0.15 ± 0.09	0.36 ± 0.08

Genetic trend?



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Environmental analysis (O. Blumetto)

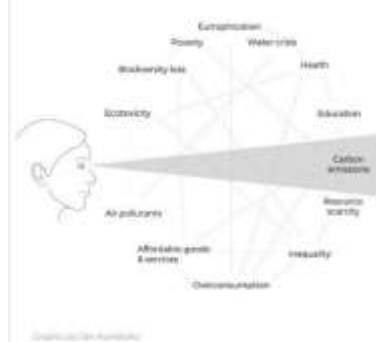
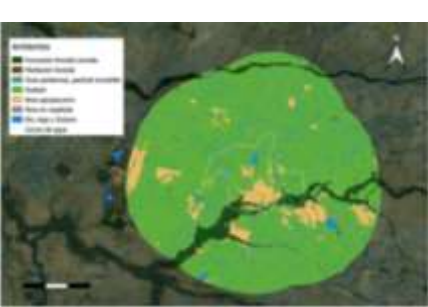
- Lifecycle assessment for carbon footprint**
- Biodiversity: ecosystem level**
- Biodiversity: community level**
- Carbon stock**
- Water quality**

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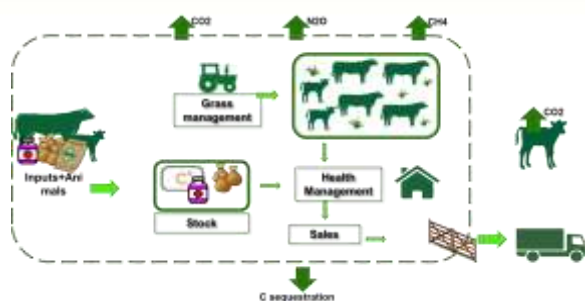
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Análisis de ciclo de vida - emisiones GEI



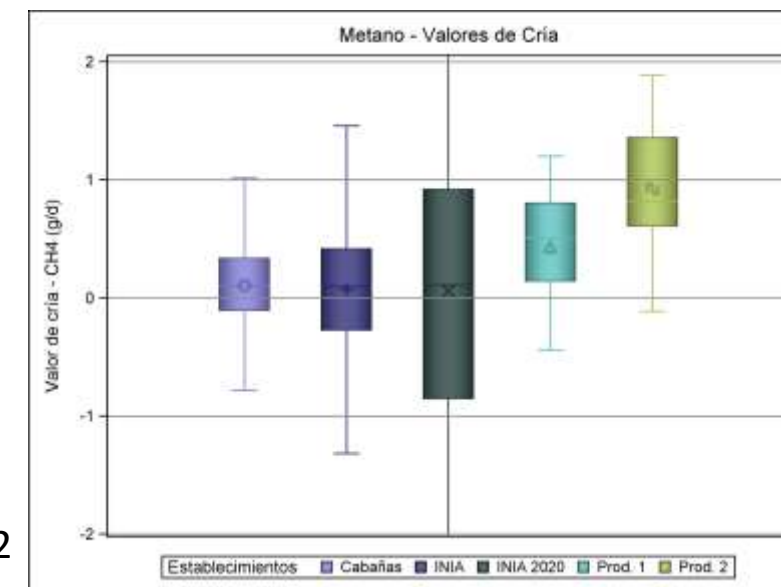
	Media	Min-Max
Área (ha)	2075	480-5300
Carne bovina (kg/ha)	102	63-170
Carne ovina (kg/ha)	28	17-41
Lana (kg/ha)	6.2	4.7-10
kg CO ₂ eq kg/ha	2214	1880-2469
kg CO ₂ eq kg/bovina	16	11.4-19.9
kg CO ₂ eq kg/ovina	11	7.6-13.6
kg CO ₂ eq kg/lana	49	35.7-63.6

75-80% metano

Simulación con Mejoramiento genético:



- Diferentes escenarios utilizando carneros superiores (1-5%):
 - 15 % menos consumo EM (animales más eficientes)
 - 17 % menos emisión (animales que emiten menos)
 - 13 % mayor producción de lana (animales más productivos)
- Impacto en intensidad de emisión:
 - Escenario 1: 20%
 - Escenario 2: 13%
 - Escenario 3: 6%
- Promisorio: genética cuantitativa y genómica



Vera et al., 2022

Agregado de
valor

Certificación de productos y procesos

- Grifa verde (SUL)
- RWS (Textile Exchange)
- Lanas orgánicas (GOTS)
- Nativa (Chargeurs)
- Origen (Engraw)
- Nativa Regen (Chargeurs, LTSA)



Trabajo conjunto:
ganadero - empresas



UY:

- Estrategia nacional de biodiversidad 2016
- Plan nacional de ACC 2018
- Plan nacional de agroecología 2022
- Informe huella ambiental ganadera 2022
- Contribuciones determinadas a nivel nacional
- Proyecto ganadería y clima



Premio Acción Climática (SFA)



VIDEO

Gaurela Bortolone gana el premio Acción Climática de los Sustainable Fashion Awards



Uruguay
Wools

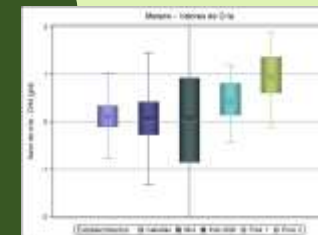


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**Phenotype
Genetics - Genomics
(Nutrition, Health,
Management)**



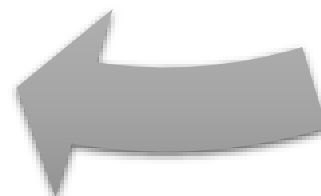
Production

Resilience

Efficiency



**The sheep of
tomorrow**



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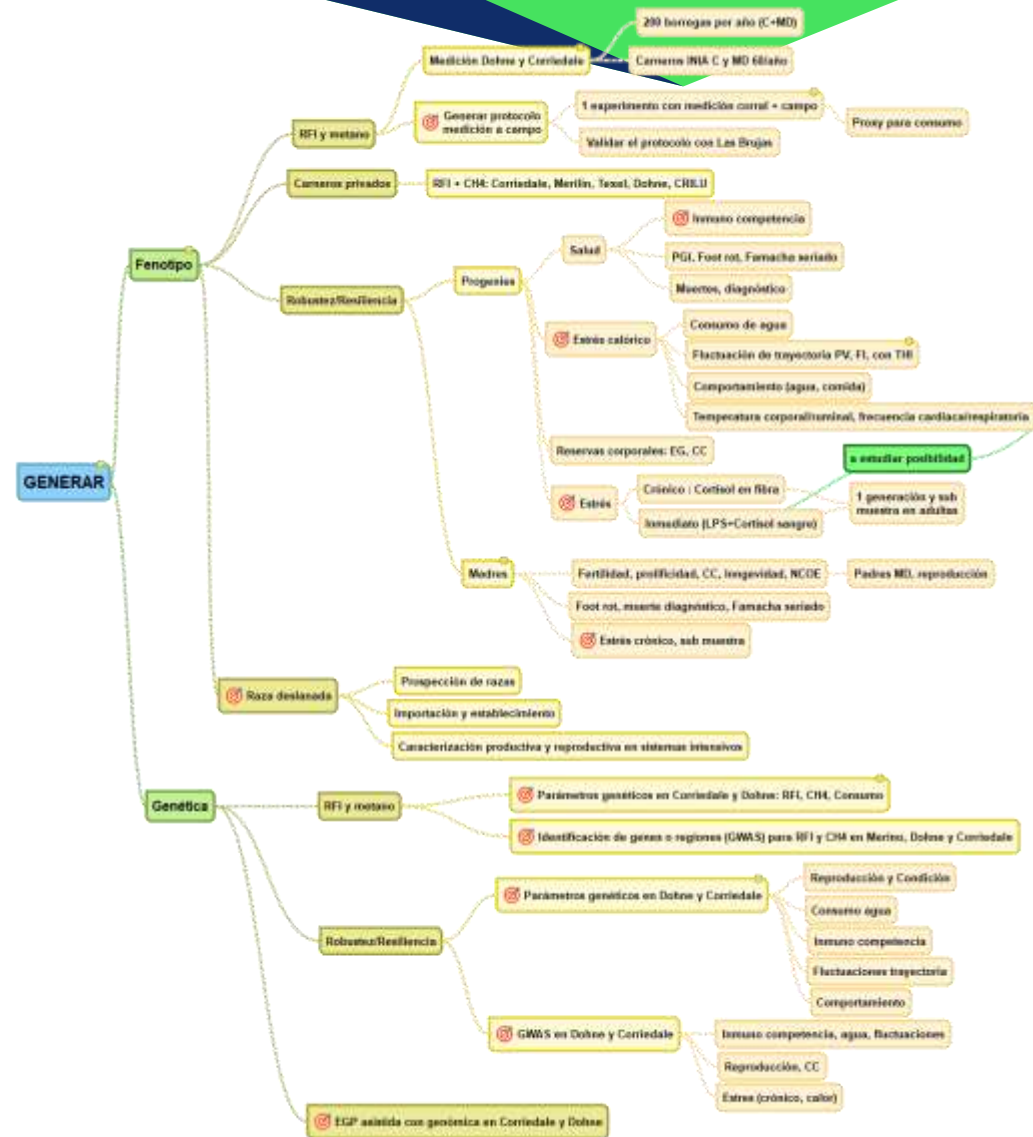
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Next steps

Continue working on data bases: genetic parameters, proxies,

New project (draft level): "GENERAR"

- Focused on robustness and resilience without excluding production, efficiency, reproduction and emissions
- New traits:
 - Immune competence
 - Response to stress
 - Tolerance to heat stress
 - Water consumption
 - New breeds



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PROJECT PARTICIPANTS

SMALL RuminanTs breeding for Efficiency and Resilience



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www.smarterproject.eu

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PROJECT PARTNERS

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