Breeding for enhancing resistance to gastrointestinal parasites

Ing. Agr. Gabriel Ciappesoni, Ph.D.

Regional Training Course on Genetics of Parasite Resistance in Sheep and Goats:
Sampling, Data Collection, Management and Analyses
December 5, 2016, Uruguay

INIA

Temas a tratar

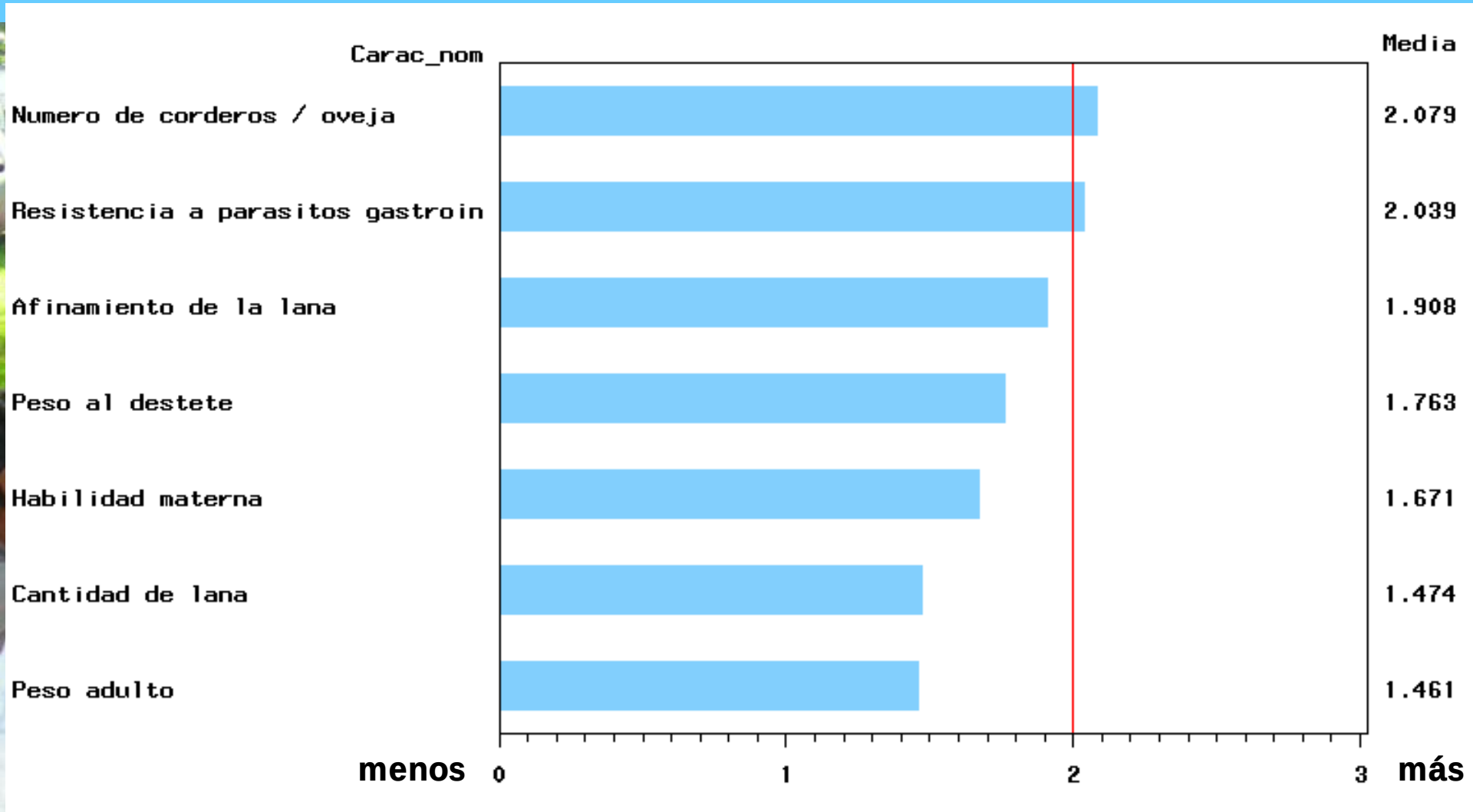
1. Los productores le dan importancia?
2. Objetivo de selección y criterio
3. Evaluaciones genéticas HPG
4. En busca del carnero de oro
5. Herramientas Moleculares

Evaluaciones Genéticas ovinas

1) Los productores le dan importancia?

En que tiene que mejorar la raza hacia el futuro?

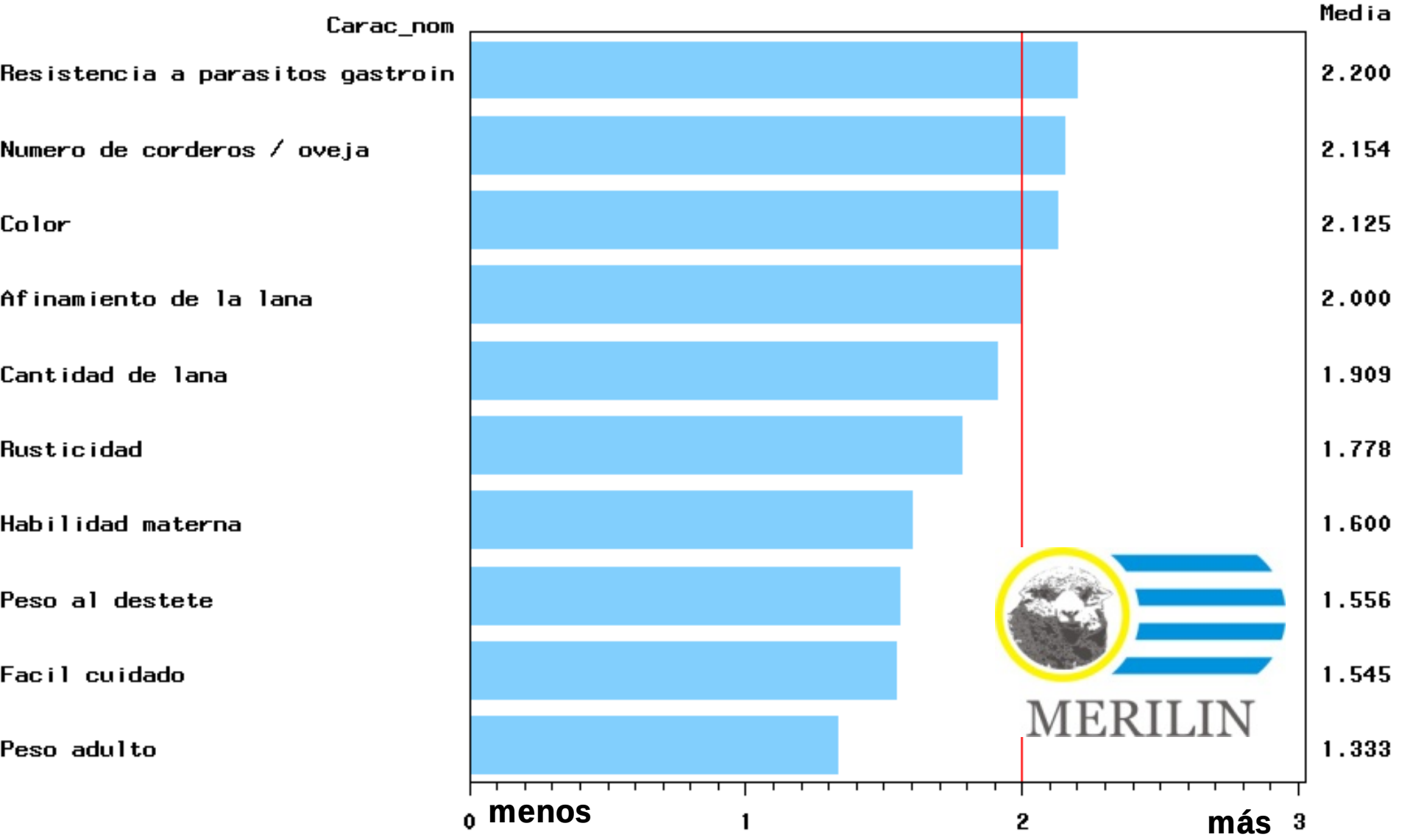
Resultado encuesta: Gira de la raza Corriedale 2011



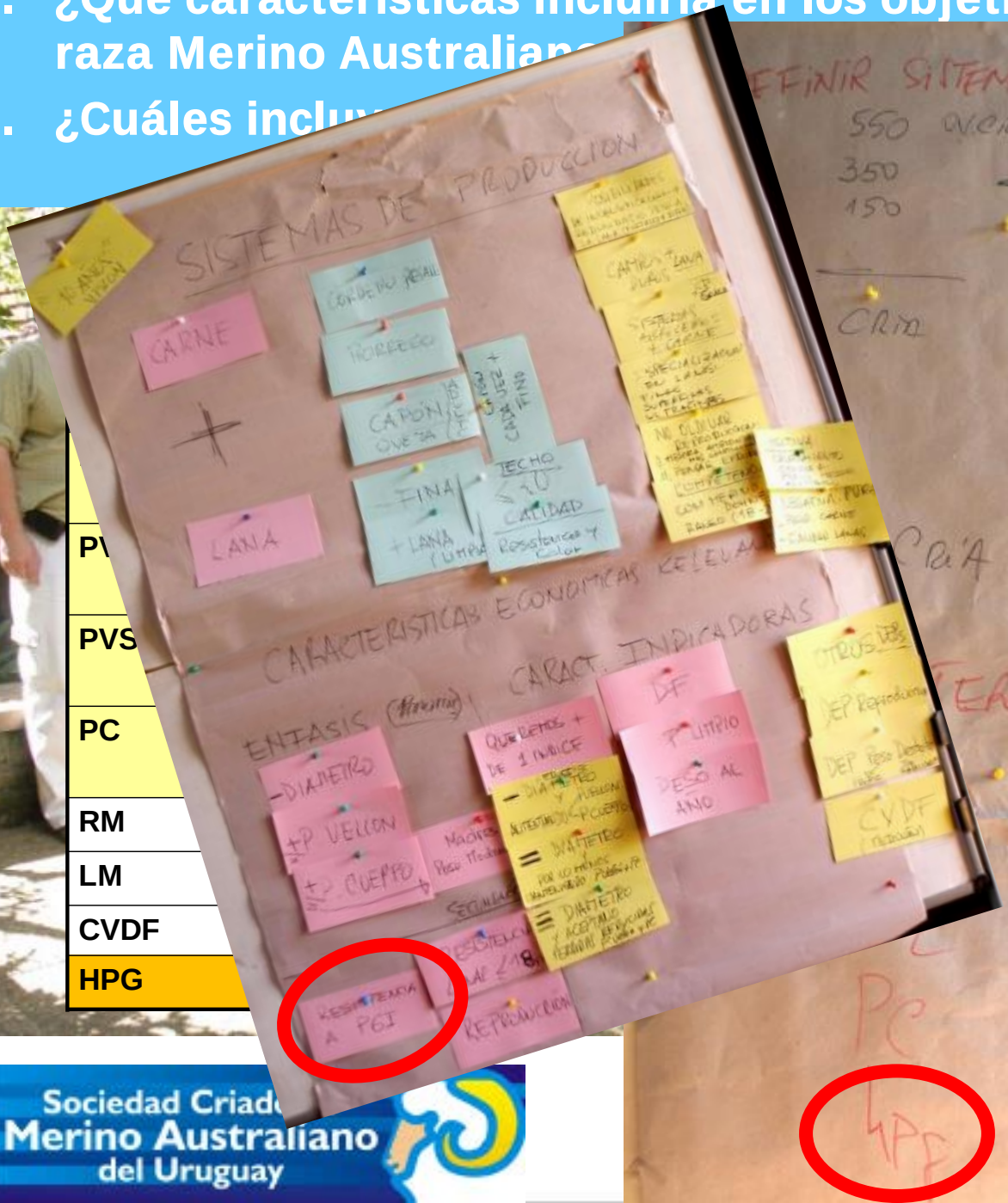
En que tiene que mejorar la raza hacia el futuro?

Resultado encuesta: Gira de la raza Merilín 2011

"Néstor Da Silveira y Dr. Hugo Echenagusía"



1. ¿Qué características incluiría en los objetivos de selección de la raza Merino Australian
2. ¿Cuáles inclu



Sociedad Criadores
Merino Australiano
del Uruguay

2) Objetivo de selección y criterio

1. **Corderos resistentes a PGI**
2. **Ovejas resistentes** (menor alza de lactación)

Parámetros genéticos: Merino

Caract.	Parámetro	Mediana
Log_e(HPG+100)	h^2	**0.182**
	pe^2	**0.109**
	RD	-0.060
PVL	h^2	0.459
	r_A HPG	0.061
DF	h^2	0.732
	r_A HPG	**-0.176**
	RC	0.017
PC	h^2	0.487
	r_A HPG	-0.142
	RC	-0.011
LM	h^2	0.440
	r_A HPG	-0.101
	RC	-0.008

16.000 animales

11.000 HPG

Ciappesoni et al. 2010

9th WCGALP

Parámetros genéticos: Merino

Estimates of genetic parameters for worm resistance, wool and growth traits in Merino sheep of Uruguay

G. Ciappesoni [a,*], V. Goldberg [a], D. Gimeno [b]

Livestock Science 157 (2013) 65–74

Contents lists available at ScienceDirect

Livestock Science

Correlaciones geneticas

Trait	Log FEC	
GFW	−0.03 (0.04) [−0.11; 0.06]	∅
CFW	0.02 (0.05) [−0.07; 0.11]	∅
FD	−0.18 (0.03) [−0.23; −0.12]	!
CVFD	0.18 (0.04) [0.10; 0.27]	+
SL	−0.14 (0.04) [−0.21; −0.07]	+
CF30	0.01 (0.03) [−0.06; 0.06]	∅
WWT	−0.06 (0.06) [−0.19; 0.06]	∅
YWT	−0.23 (0.04) [−0.30; −0.15]	+

44.000 animales

30.000 datos de lana

15.000 HPG1

13.000 HPG2

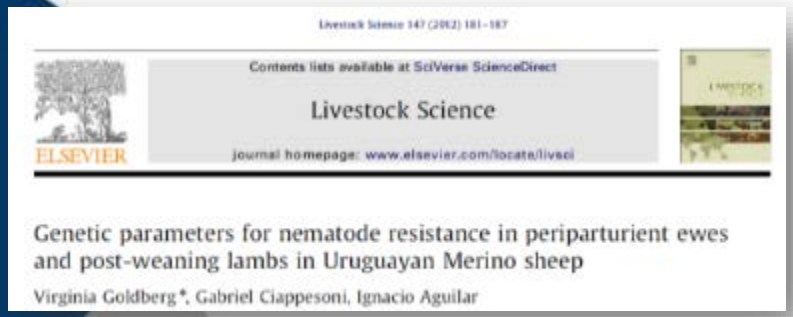
Parámetros genéticos: Corriedale

r_G	HPG	
PVS	-0.15	
PVL	-0.08	
DF	-0.16	
PC	-0.35	

Castells, 2009

5.000 HPG1 y HPG2

Alza de lactación


Livestock Science 147 (2012) 181–187

Contents lists available at SciVerse ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

ELSEVIER

Genetic parameters for nematode resistance in periparturient ewes and post-weaning lambs in Uruguayan Merino sheep

Virginia Goldberg*, Gabriel Ciappesoni, Ignacio Aguilar

Estimación de parámetros genéticos de la resistencia a nematodos en el período del periparto y pos-destete en ovinos Merino del Uruguay

Master Thesis: **Virginia Goldberg Bianchi**
Director: Ph.D. Gabriel Ciappesoni
Codirector: Ph.D. Ignacio Aguilar
Codirector: Ph.D. Agustín Blasco

UNIVERSIDAD POLITECNICA DE VALENCIA

CIHEAM

UAB

Más eficiente seleccionar por HPG cordero (2.02)

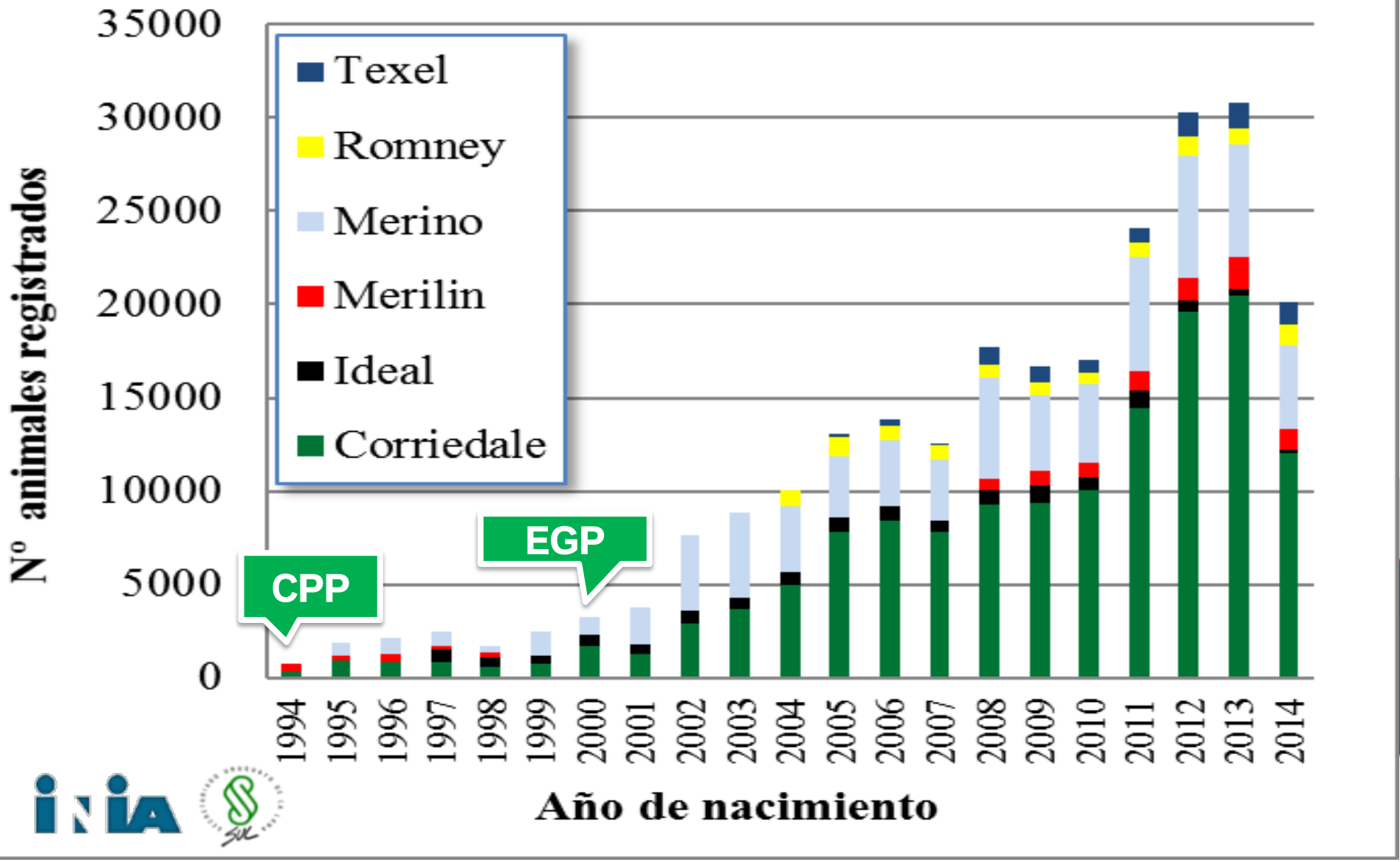
	mediana	PSD
h^2 cordero	**0.25**	0.025
h^2 oveja	**0.08**	0.027
r_g	**0.81**	0.113

INIA

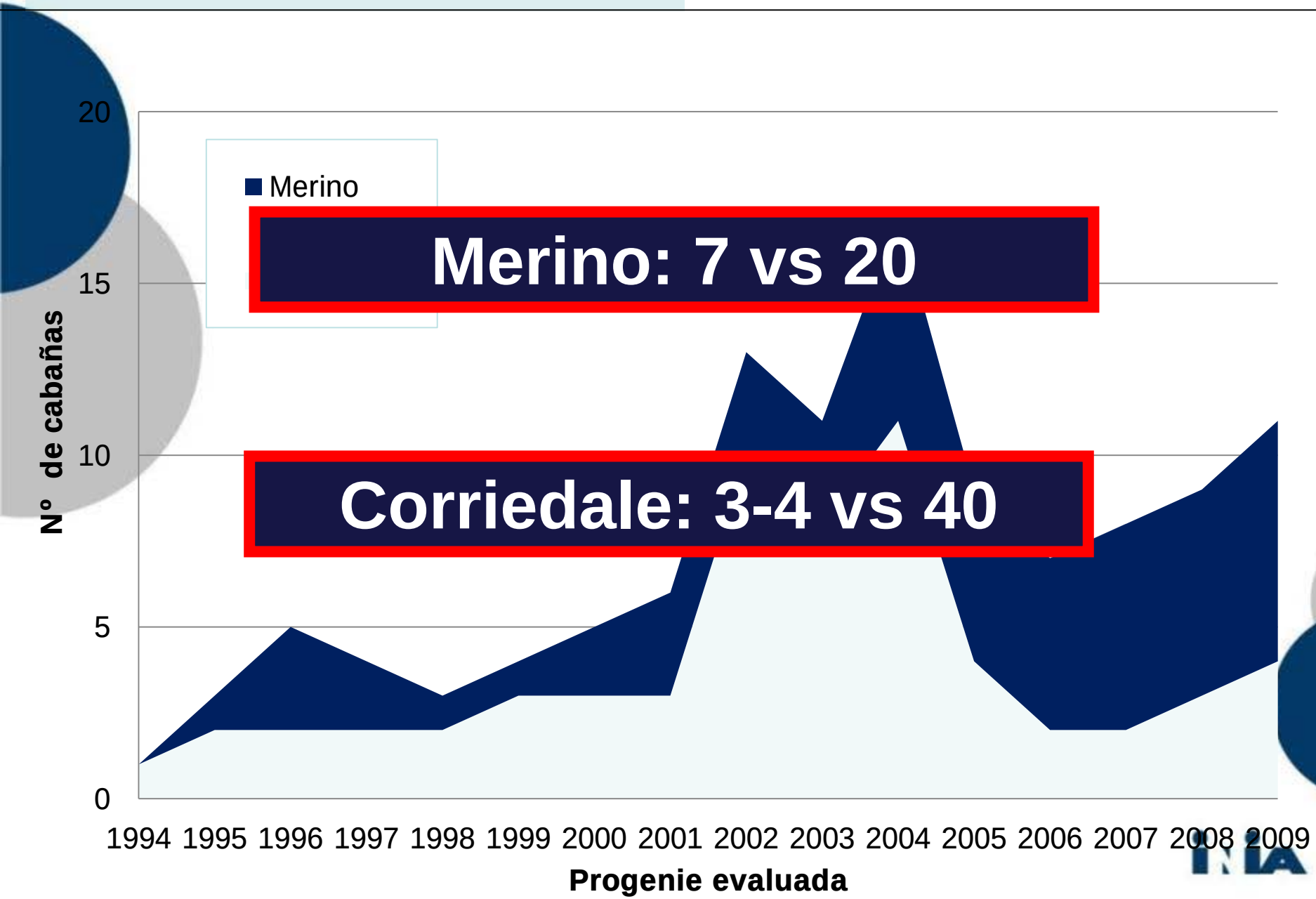
3) Evaluación Genética de HPG

Animales por año y raza

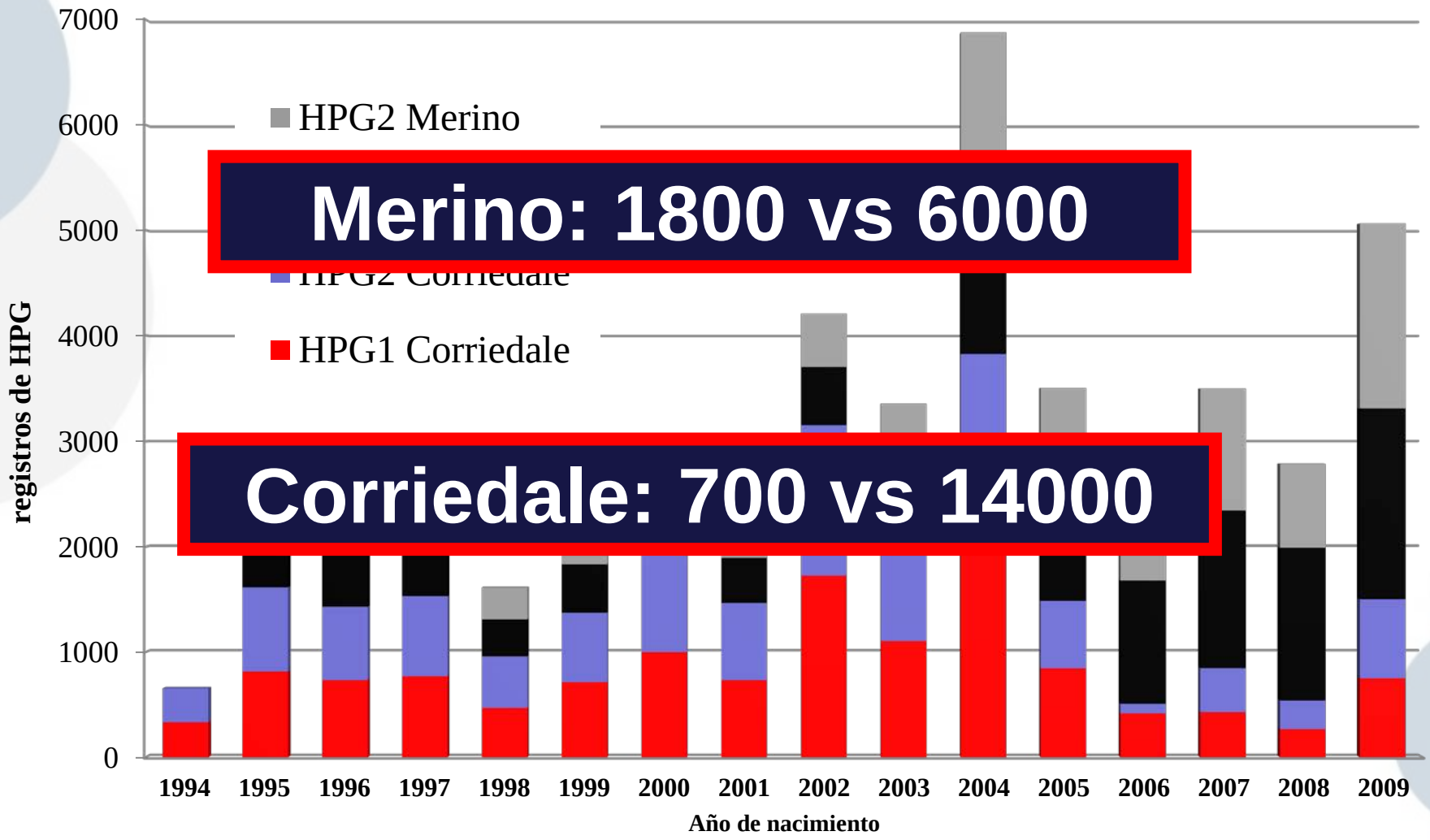
Evaluaciones Genéticas



Nº de cabañas con HPG

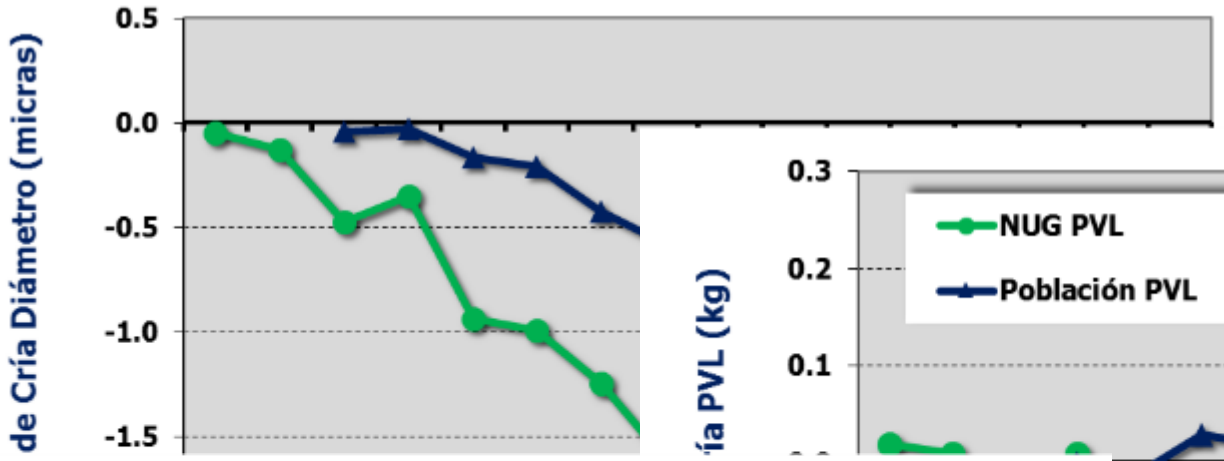


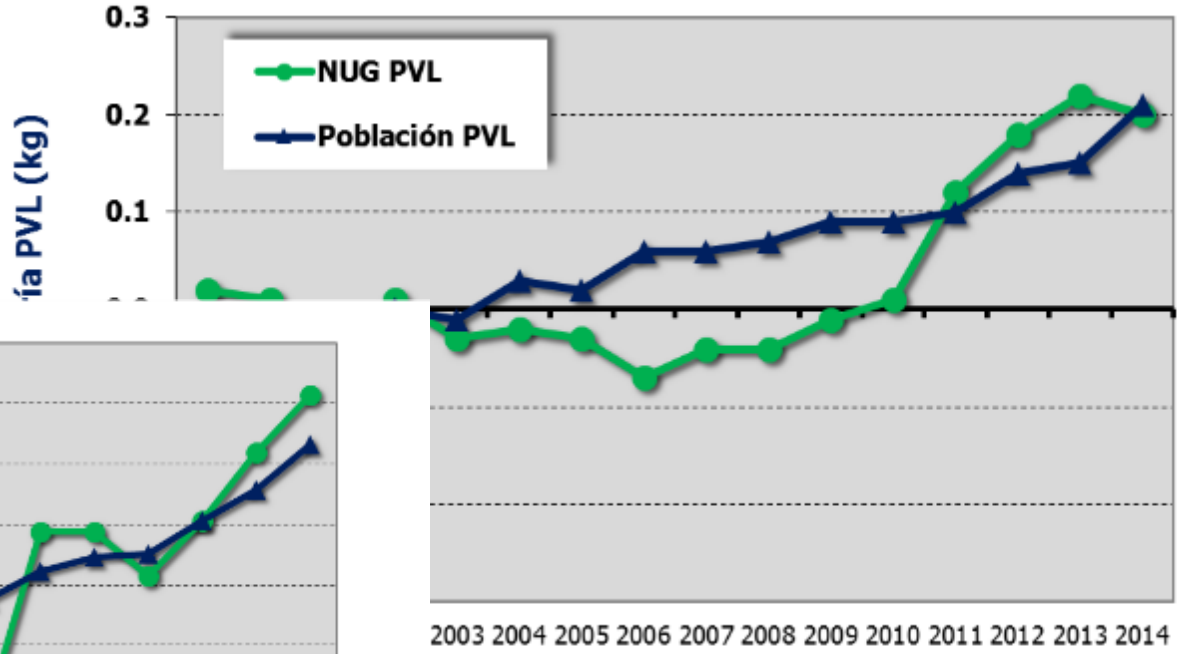
Datos HPG

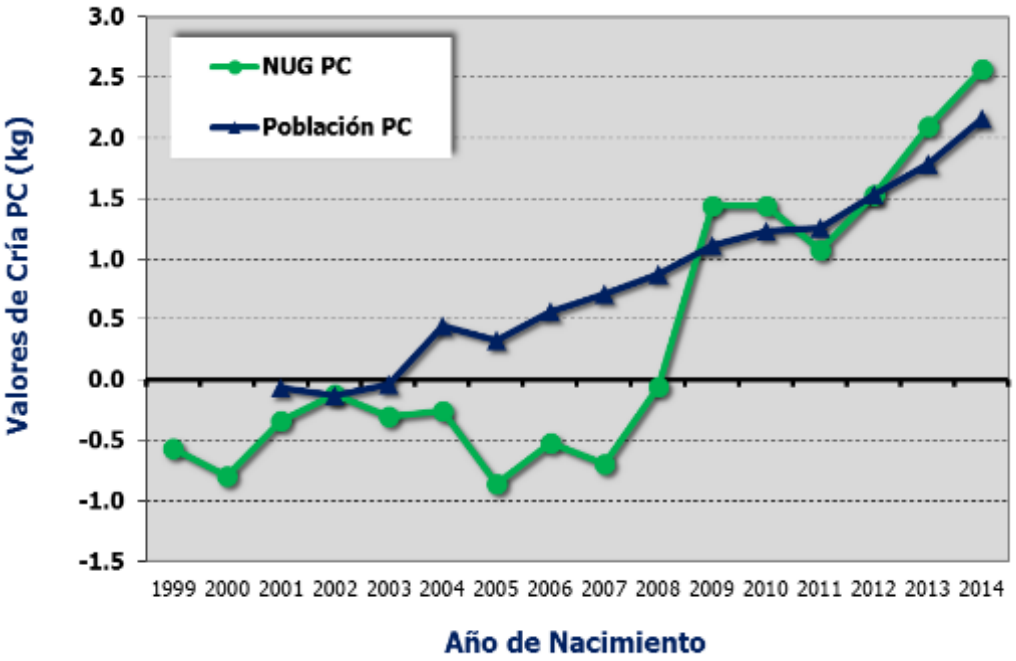

7000
6000
5000
4000
3000
2000
1000
0
registros de HPG
HPG2 Merino
HPG1 Corriedale
Merino: 1800 vs 6000
Corriedale: 700 vs 14000
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Año de nacimiento

¿Qué se selecciona en Merino y Corriedale?

Tendencias genéticas

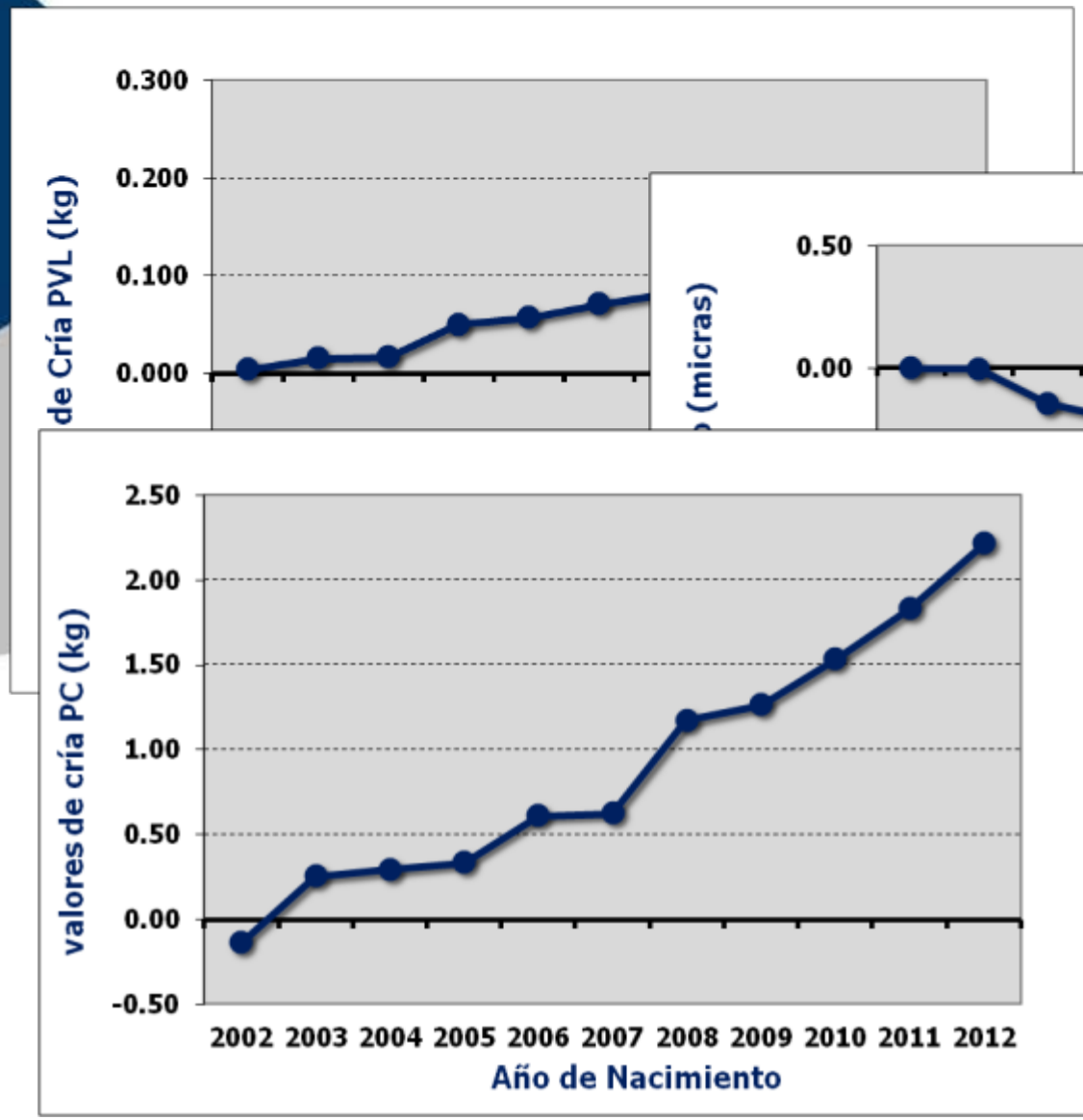






Sociedad Criadores Merino Australiano del Uruguay

Tendencias genéticas

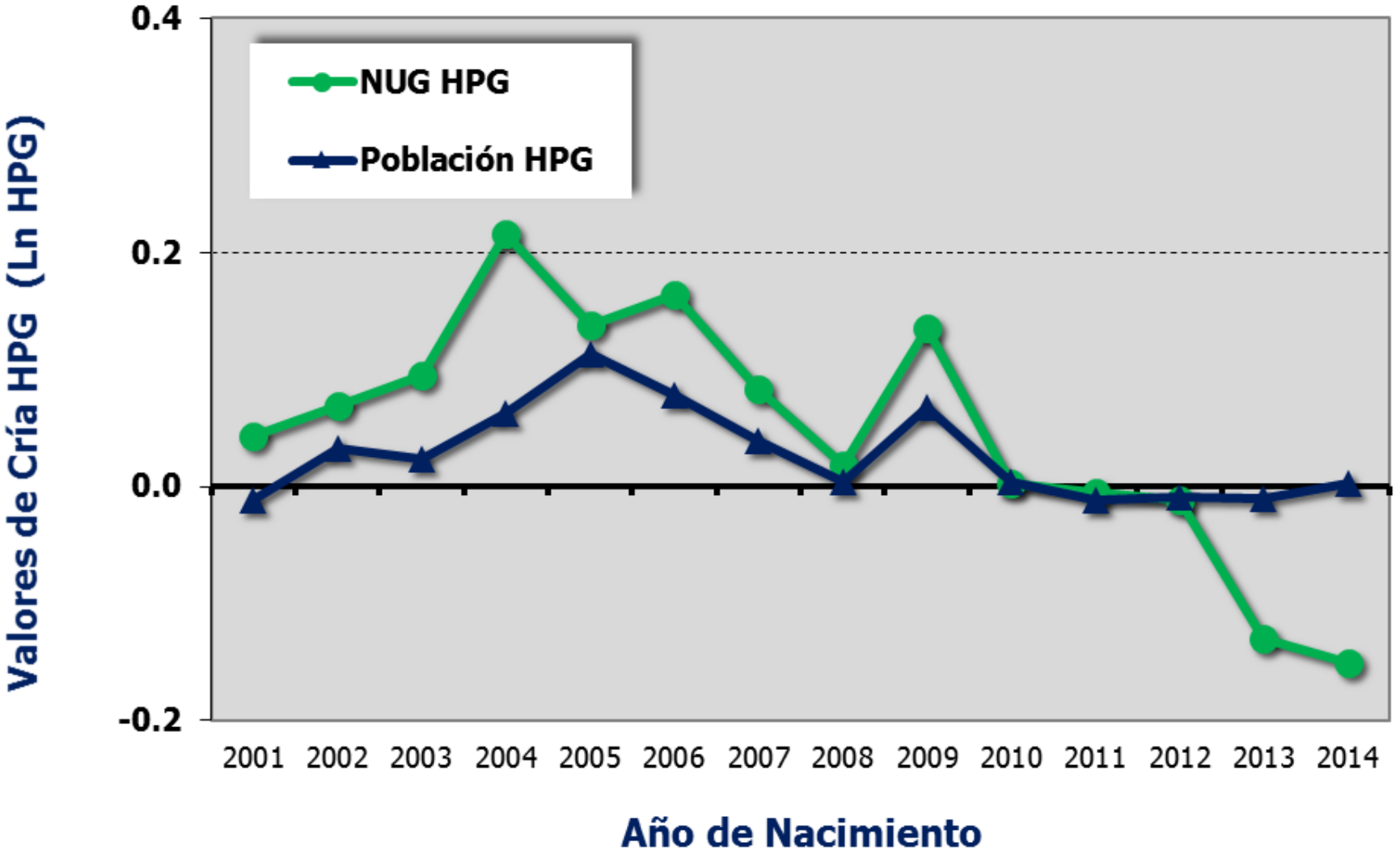


Tendencias genéticas

Ganancia genética anual en % de la media poblacional - principales características

Caract.	Corriedale	Merino
PVD	**+0.75**	
PVE	**+0.64**	+0.39
PVS	+0.31	+0.37
PVL	+0.41	**+0.54**
DPF	-0.48	**-0.64**
LM	-0.09	+0.38

Tendencias genéticas



4) En busca del carnero de oro

The Golden ram "Goldie"

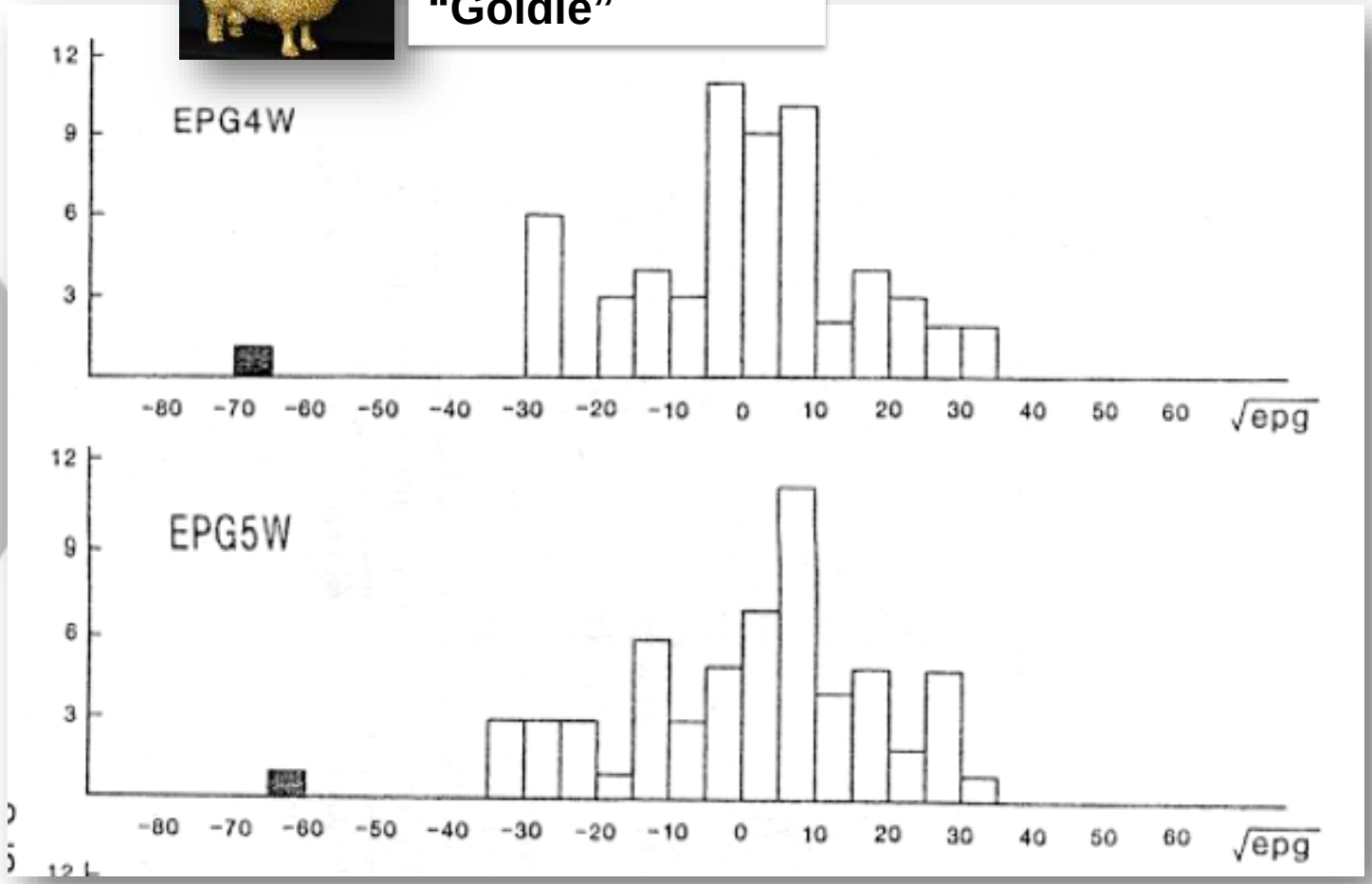
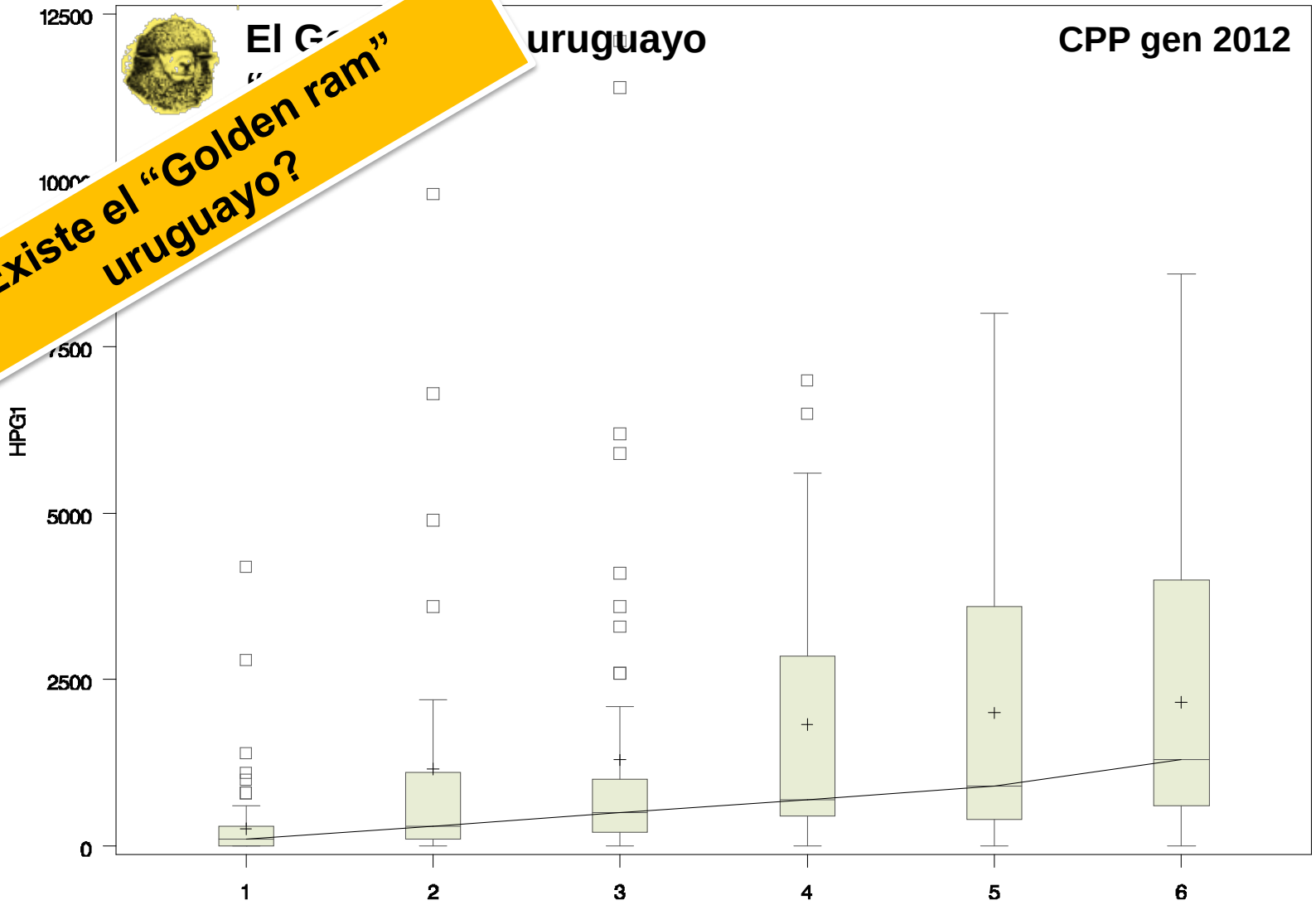
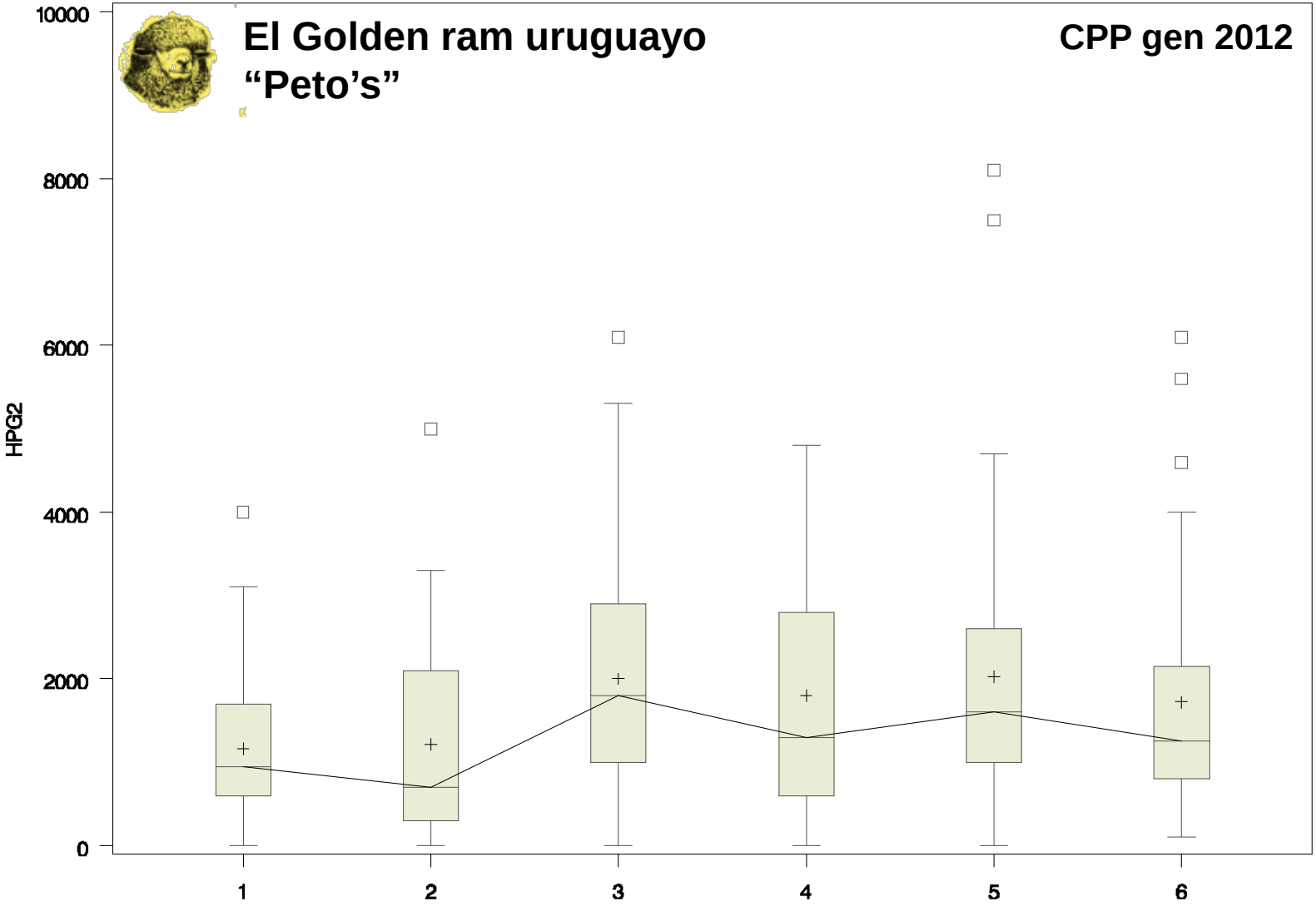


Figure 1: Frequency of progeny group mean deviations for faecal eggs per gram (square root transformation). The mean of The Golden ram progeny are sha*ded at the right (Albers et al., 1987)*

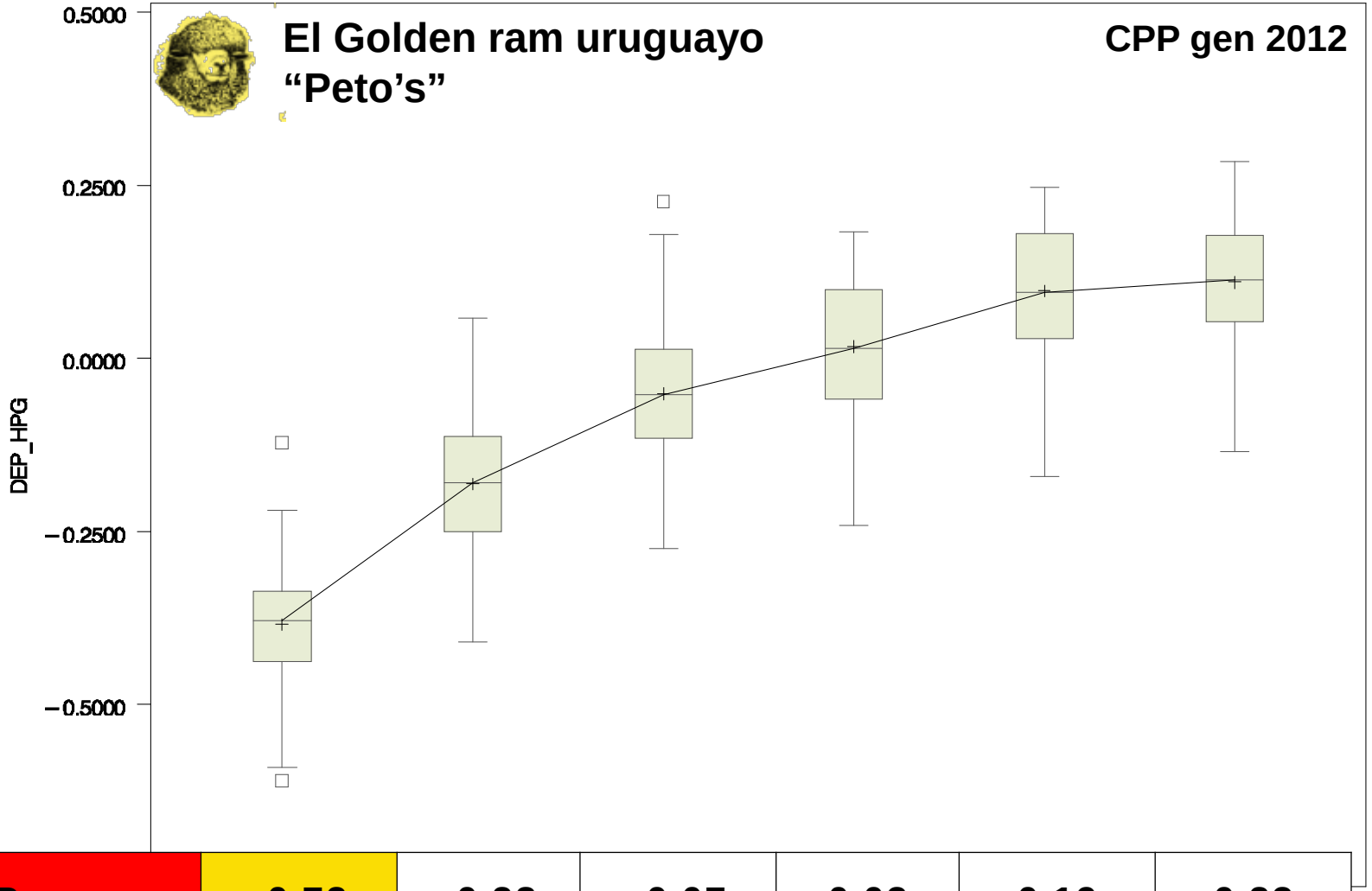
¿Existe el "Golden ram" uruguayo?



	1	2	3	4	5	6
HPG1	257	1162	1293	1825	2003	2165
HPG2	1164	1217	2004	1800	2025	1722
DEP_HPG	-0.38	-0.18	-0.05	0.02	0.10	0.11



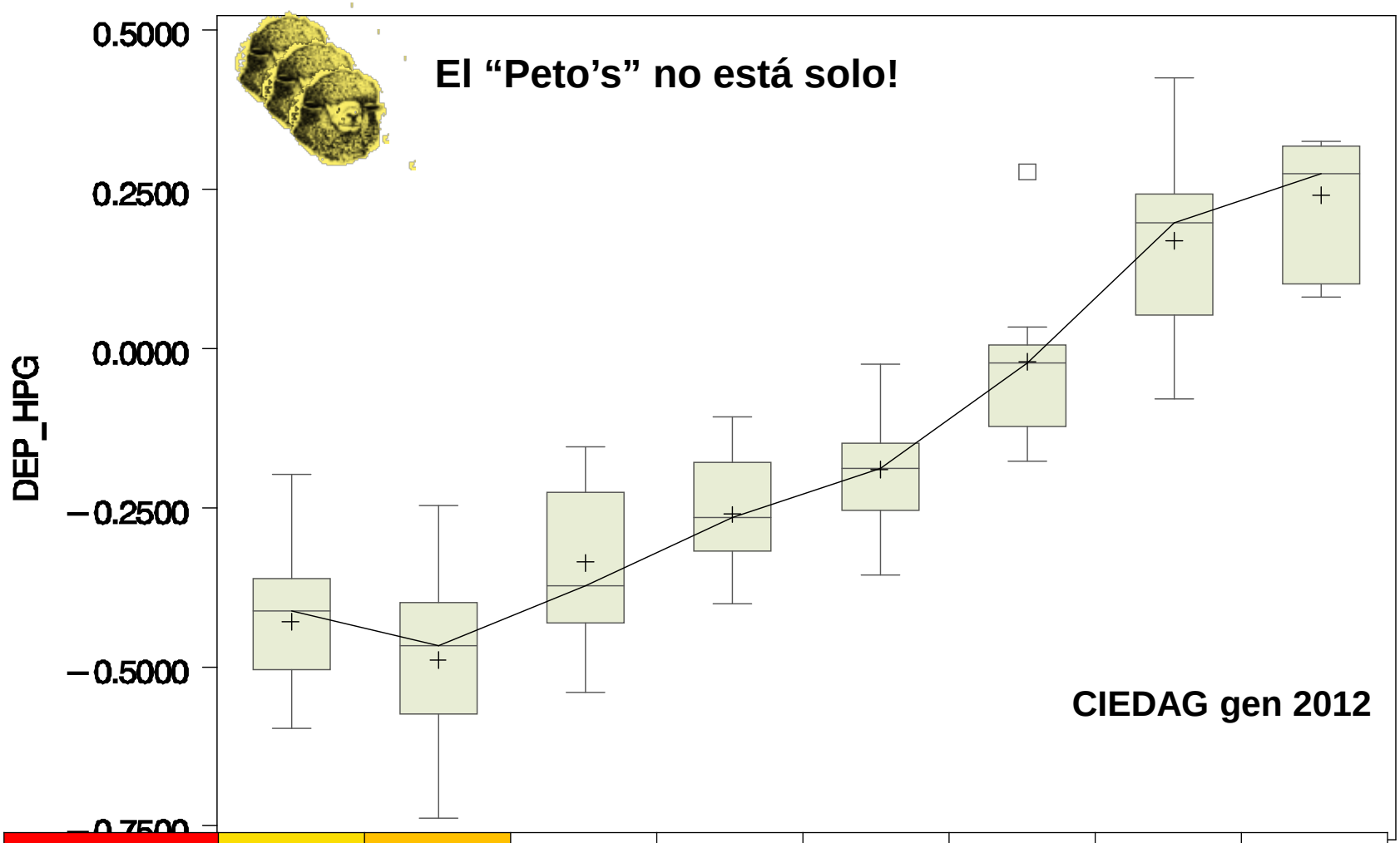
	1	2	3	4	5	6
HPG1	257	1162	1293	1825	2003	2165
HPG2	**1164**	**1217**	**2004**	**1800**	**2025**	**1722**
DEP_HPG	-0.38	-0.18	-0.05	0.02	0.10	0.11



DEP carnero	-0.72	-0.28	-0.07	0.03	0.19	0.23

	1	2	3	4	5	6
HPG1	257	1162	1293	1825	2003	2165
HPG2	1164	1217	2004	1800	2025	1722
DEP_HPG	-0.38	-0.18	-0.05	0.02	0.10	0.11

El “Peto’s” no está solo!



DEP carnero	-0.72	-0.73	-0.36	-0.29	-0.19	0.03	0.26	0.42

	1	2	3	4	5	6	7	8
HPG1	2944	2093	2905	4685	4957	3113	4587	5600
HPG2	1408	1574	2324	2143	8350	4878	6800	8850
DEP_HPG	-0.43	-0.49	-0.34	-0.26	-0.19	-0.02	0.17	0.24

	CIEDAG	CPP
HPG1	2944	257
HPG2	1408	1164
DEP_HPG	-0.43	-0.38

Merino

Nombre	Lana	Doble Proposito	Afinador	LM cm	CVD %	HPG	PVL %	PVS %	Diámetro micras	PC %	LC grd	SP grd	Número Hijos	Lugares Año	Propietario
TALITAS 11-0353	138.3 S/D	134.4 S/D	135.9 S/D	0.4 0.86	-0.6 0.85	-0.56 0.76	4.0 0.83	2.7 0.83	-0.8 0.91	4.4 0.82	-0.53 0.92	-0.1 0.83	19	1	...
TALITAS 09-9153	113.6 S/D	104.2 S/D	123.5 S/D	0.3 0.91	-1.9 0.90	-0.53 0.85	-1.2 0.89	-6.0 0.89	-0.8 0.94	-1.0 0.88	-0.17 0.95	-0.3 0.90	38	1	TALITAS...
TALITAS 7079	125.6 S/D	124.0 S/D	119.3 S/D	0.2 0.91	0.0 0.90	-0.44 0.86	6.0 0.89	2.4 0.89	-0.3 0.94	0.9 0.88	-0.40 0.95	-0.3 0.89	32	1	TALITAS...
TALITAS 3296	116.5 S/D	118.5 S/D	110.8 S/D	0.0 0.94	0.0 0.94	-0.43 0.89	2.7 0.93	4.9 0.93	-0.1 0.96	2.9 0.92	0.12 0.97	0.4 0.93	62	2	TALITAS...
GRINDON 0118	113.3 S/D	100.5 S/D	127.0 S/D	0.0 0.97	-1.4 0.97	-0.42 0.95	-1.7 0.96	-4.0 0.96	-1.0 0.98	-2.5 0.96	0.11 0.98	-0.3 0.97	151	6	Semen impo...
TALITAS - 6331	96.8 S/D	88.9 S/D	106.7 S/D	0.0 0.89	-0.2 0.88	-0.41 0.77	-1.9 0.86	-1.5 0.86	-0.4 0.92	-3.9 0.85	-0.15 0.94	-0.1 0.87	23	1	TALITAS...
TALITAS 80698	112.9 S/D	105.8 S/D	121.4 S/D	-0.2 0.96	-1.0 0.96	-0.40 0.91	-2.1 0.95	-3.2 0.95	-0.8 0.97	0.7 0.92	-0.38 0.97	0.1 0.94	88	2	TALITAS...
PURO CERNO 101	47.2 S/D	66.7 S/D	34.5 S/D	0.0 0.51	-0.5 0.37	-0.38 0.84	-3.8 0.88	1.9 0.88	1.8 0.93	-0.6 0.87	0.0 0.95	0.2 0.89	44	1	Enrique Fl...
ARRAYAN A LORELMO 218-359	112.0 S/D	122.4 S/D	105.7 S/D	0.0 0.93	0.0 0.92	-0.38 0.87	-4.0 0.91	-4.7 0.91	-0.2 0.95	11.1 0.90	-0.24 0.96	0.0 0.92	46	1	LOS ARRAYA...
CORONA 990	69.9 S/D	63.1 S/D	84.6 S/D	-0.5 0.98	-0.7 0.97	-0.36 0.87	-6.2 0.97	-5.7 0.97	0.0 0.98	-7.0 0.97	0.42 0.99	-0.4 0.97	268	11	LA CORONA...
PASO DEL SAUCE 2322	86.6 S/D	97.0 S/D	80.9 S/D	-0.1 0.33	0.2 0.81	-0.34 0.77	-3.6 0.78	-0.4 0.78	0.5 0.87	4.4 0.78	-0.10 0.91	-0.1 0.83	28	1	PASO DEL S...
CRILU 11426	156.9 S/D	149.8 S/D	151.7 S/D	0.3 0.89	0.1 0.88	-0.34 0.82	8.8 0.87	7.5 0.87	-1.1 0.93	3.9 0.86	0.06 0.94	0.1 0.88	20	1	...
ARRAYAN - 052	141.5 S/D	137.1 S/D	136.9 S/D	0.3 0.82	-0.4 0.81	-0.33 0.66	6.4 0.79	4.4 0.79	-0.7 0.88	3.2 0.78	0.03 0.91	-0.5 0.82	3	1	LOS ARRAYA...
TALITAS - 5543	123.8 S/D	126.2 S/D	112.6 S/D	0.2 0.88	-0.1 0.87	-0.32 0.79	7.0 0.85	1.3 0.85	0.0 0.91	1.9 0.84	-0.15 0.90	0.0 0.80	35	1	TALITAS...
ARRAYAN GRINDON 419	134.3 S/D	124.6 S/D	138.4 S/D	0.3 0.96	-0.6 0.96	-0.31 0.88	3.4 0.95	0.8 0.95	-1.0 0.98	0.7 0.95	0.14 0.98	-0.3 0.96	105	5	LOS ARRAYA...
THE GRANGE	115.6 S/D	104.5 S/D	128.0 S/D	-0.2 0.95	0.7 0.95	-0.30 0.84	-2.2 0.94	-4.5 0.94	-1.0 0.97	-0.6 0.94	0.18 0.97				
	140.3	135.6	135.3	0.6	-0.3	-0.30	6.9	8.6	-0.7	2.4	-0.09				

Evaluaciones Genéticas Ovinas

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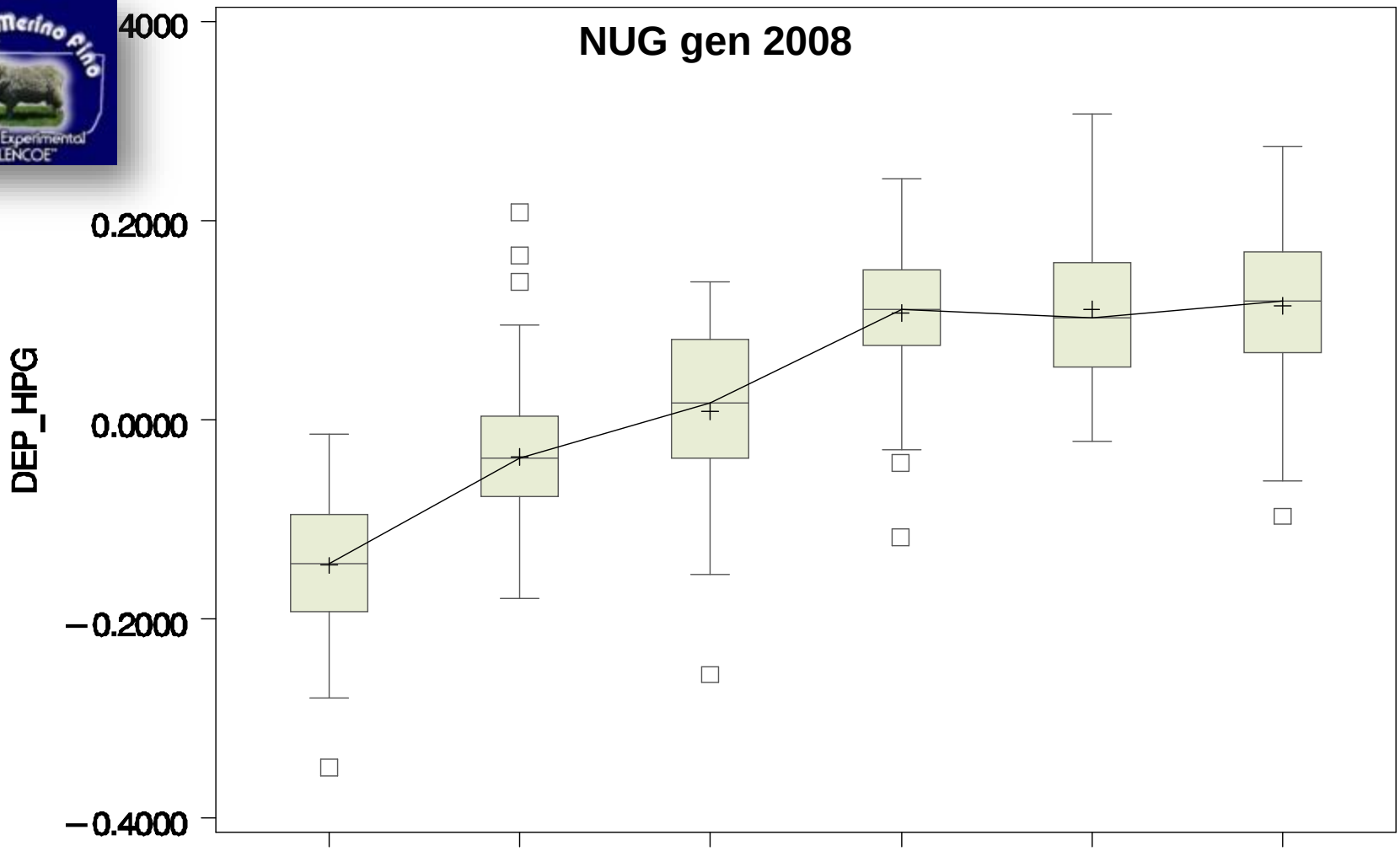
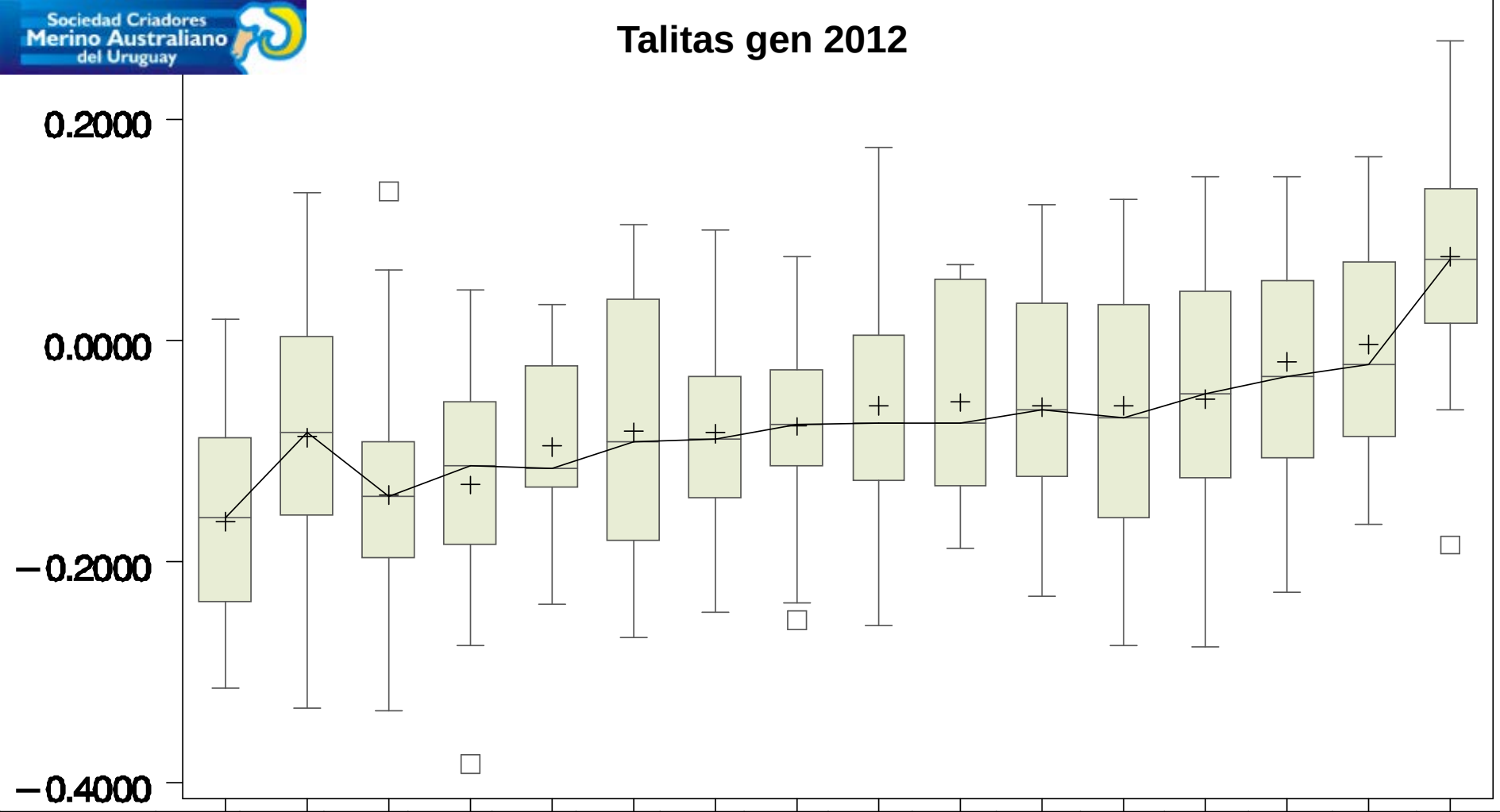


DEP carnero	-0.39	-0.14	0.06	0.13	0.16	0.18

	1	2	3	4	5	6
HPG1	1075	992	1097	1536	1209	1487
HPG2	1292	1911	2465	2530	2900	2917
DEP_HPG	-0.15	-0.04	0.01	0.11	0.11	0.12

Sociedad Criadores Merino Australiano del Uruguay

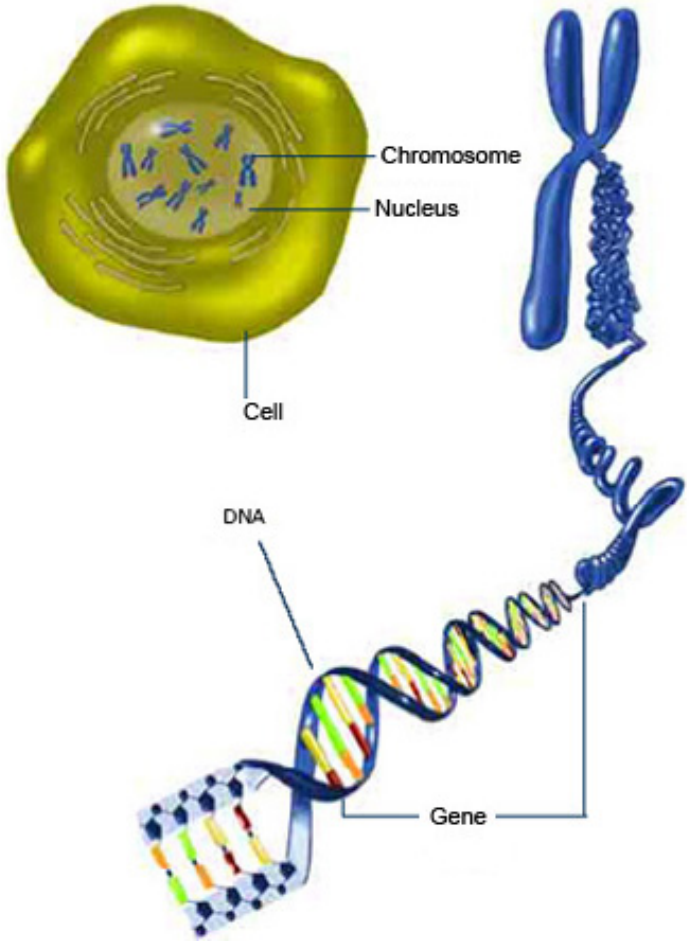
Talitas gen 2012



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
HPG1	**679**	818	541	672	450	968	968	658	1422	414	521	1320	798	1650	1467	1439
HPG2	**966**	1704	764	836	1792	1983	1063	910	1540	900	1757	1371	1352	1555	1510	1545
DEP_HPG	**-0.16**	-0.09	-0.14	-0.13	-0.1	-0.08	-0.08	-0.08	-0.06	-0.06	-0.06	-0.06	-0.05	-0.02	0.00	0.08
DEP carnero	**-0.28**	-0.25	-0.24	-0.23	-0.15	-0.14	-0.12	-0.09	-0.09	-0.08	-0.06	-0.06	-0.05	-0.02	0.03	0.12

Herramientas Moleculares

QTL y MAS



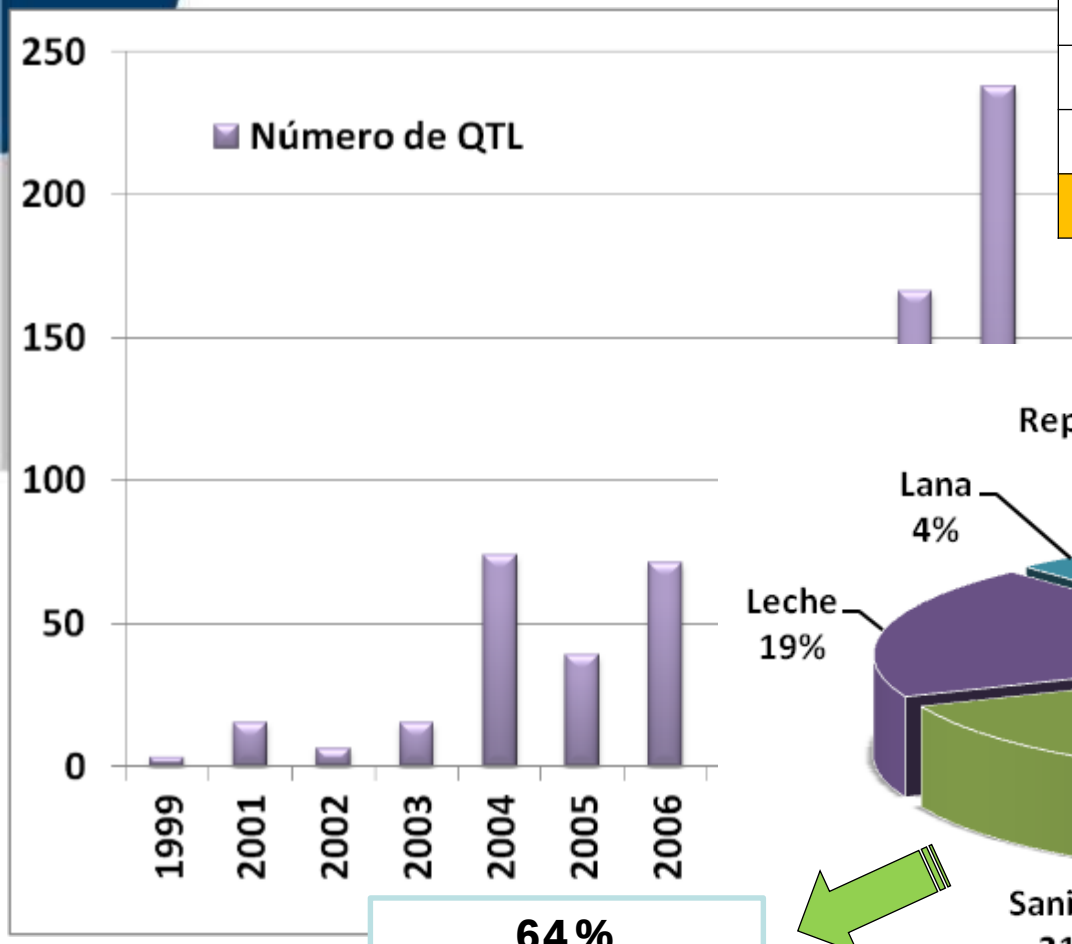
- **Muchas investigaciones**
- **Muchos *tipos* de marcadores**
- **Mucha**
- **Pocos resultados**

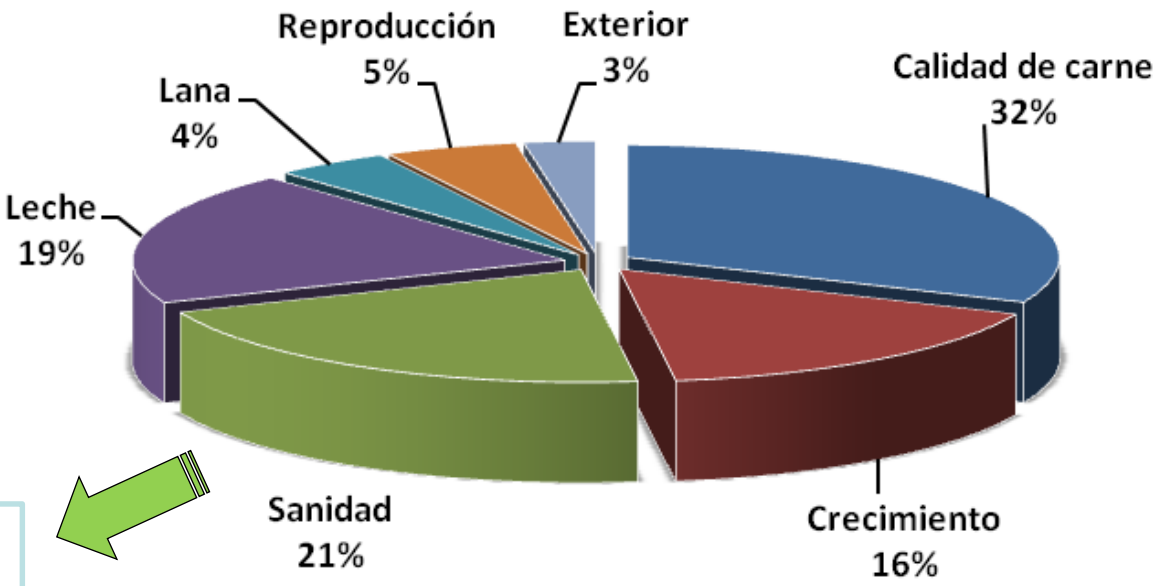
QTL y MAS

Herramientas Moleculares

SheepQTLdb

Versión	Fecha	QTL	Publ.	Caract.
14	20-abr	454	59	152
15	22-sep	**639**	74	184
18	5-sep	**753**	86	212
20	20-abr	**789**	90	219





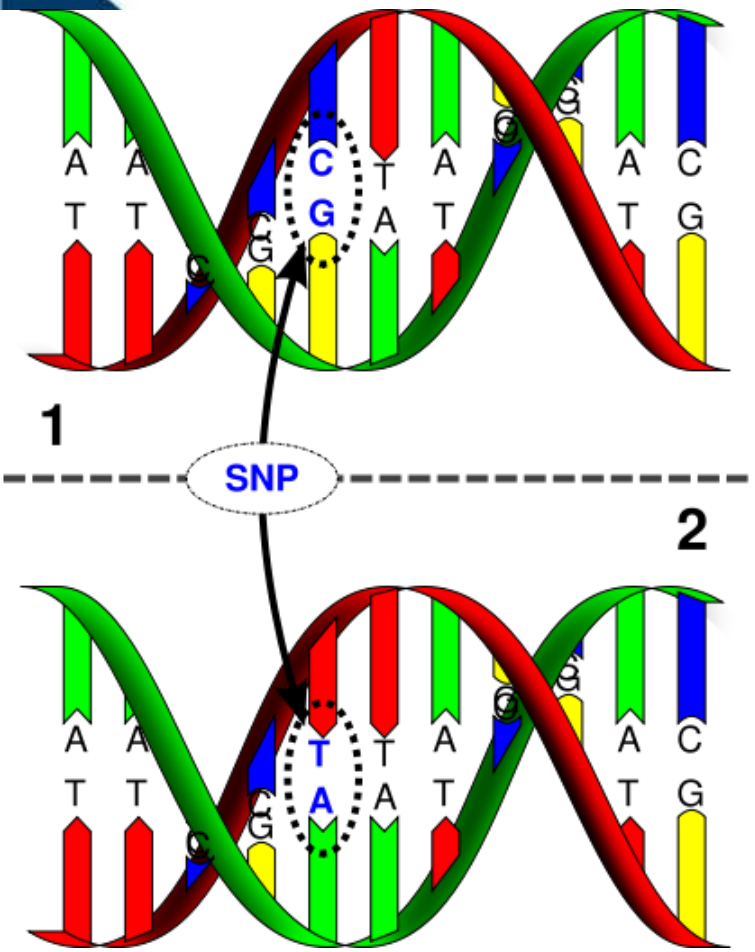
64%
Parásitos GI

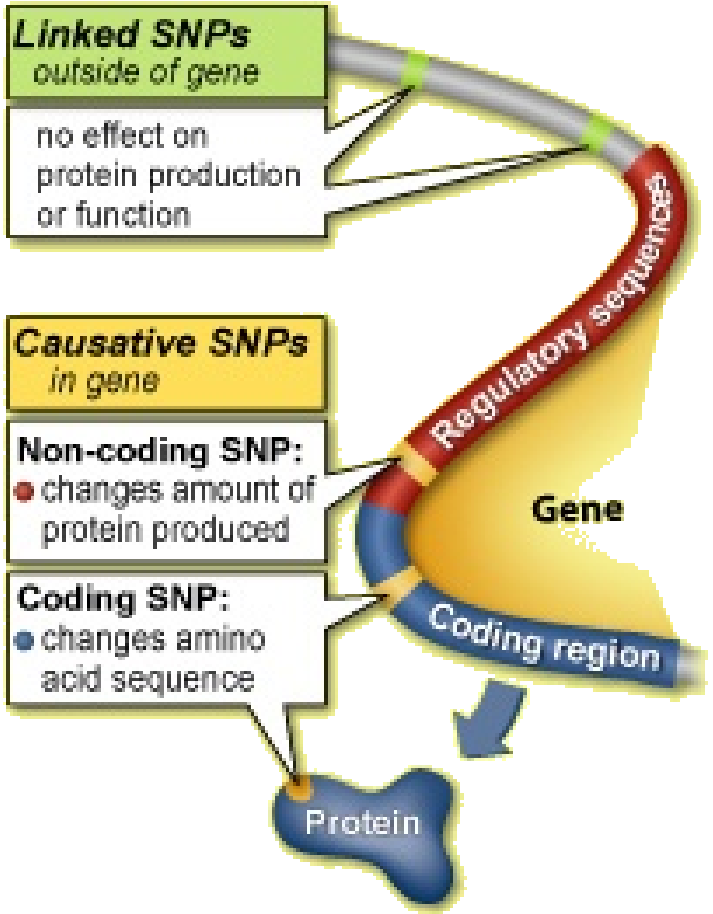
¿Por qué?

- **Pequeña % Va explicada**
- Relación **Costo/beneficio**
- **Más difícil que las EG** (en algunos casos)
- Características que no están en el **objetivo de selección**

SNP: Polimorfismo de nucleótido simple

FCI





OvineSNP50 Genotyping Bead Chip de Illumina®

Pasos:

1- Estudio de asociación

2- Secuenciado del genoma completo

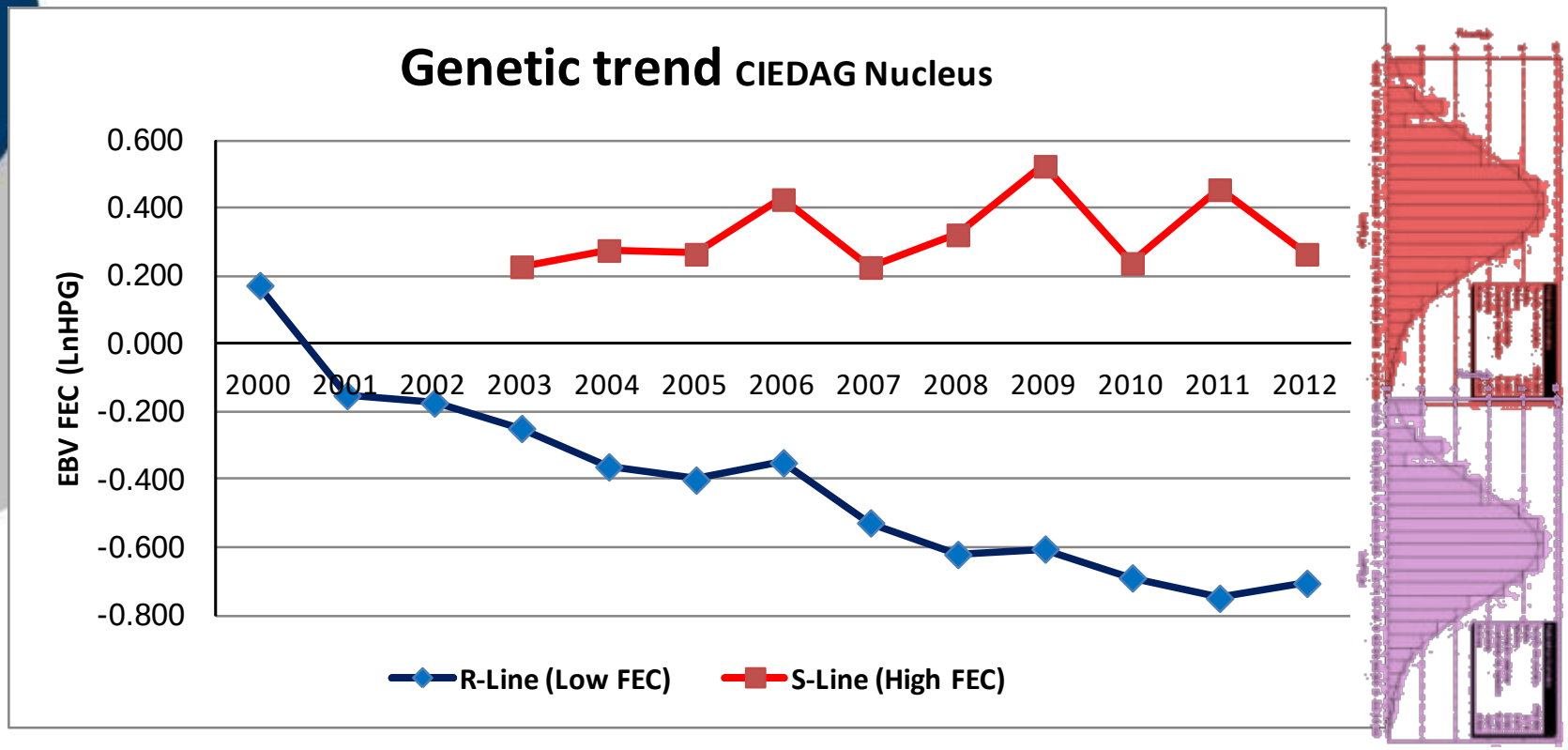
3- RNA-sequencing

4- Combinación de técnicas: “integrative approach”

174 SNP = 16 “50K” + 158 “genómicos”

+ ID parentesco y otros = **507 SNP**

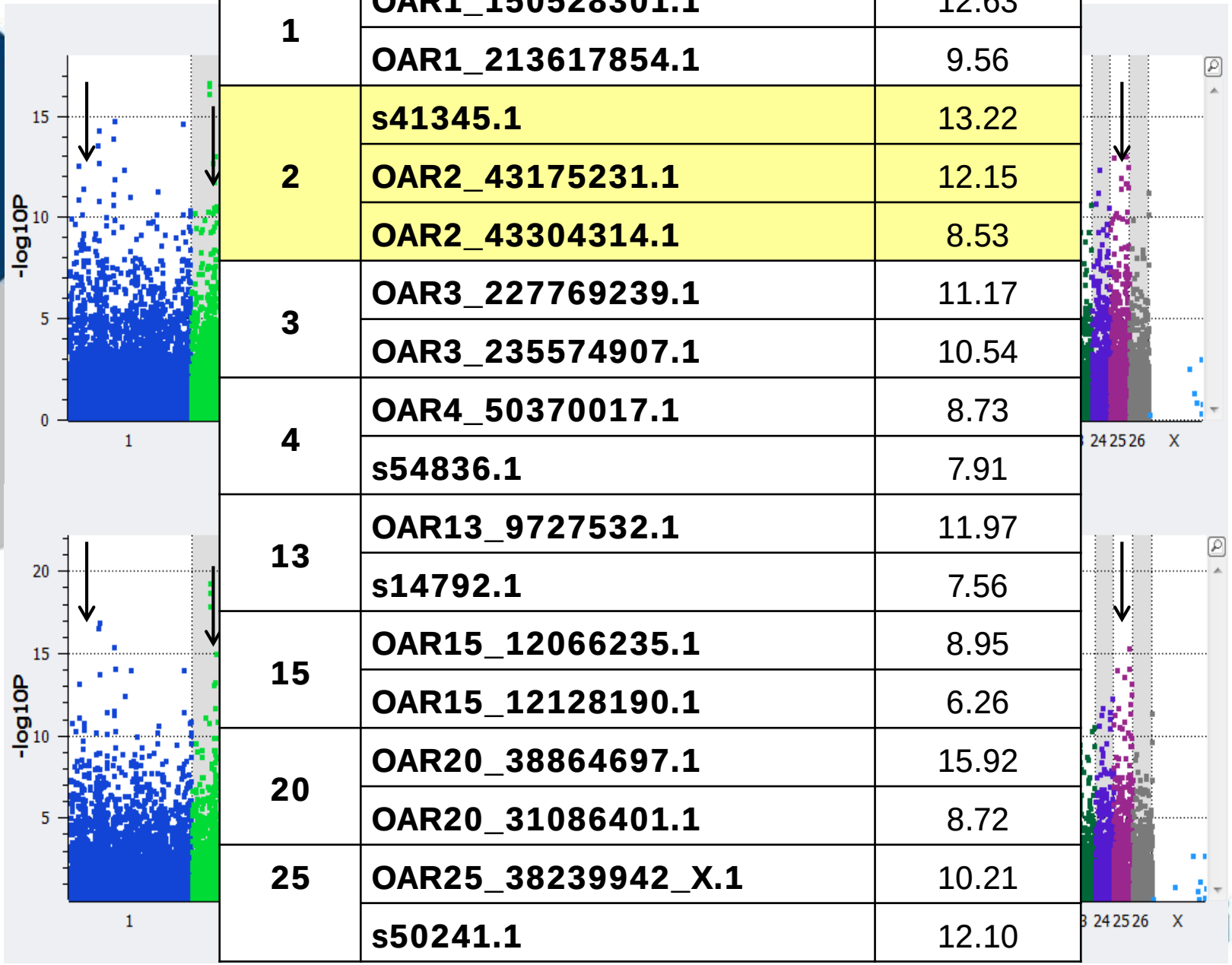
Selección de SNP selection: Líneas divergentes DEP HPG



- **Divergent selection lines** (Corriedale, CIEDAG-SUL, n=100)
- **Selection Nucleus Glencoe** (Merino, INIA-Glencoe n=100)

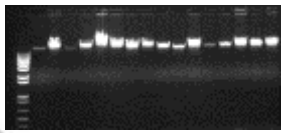
1er Paso: Es

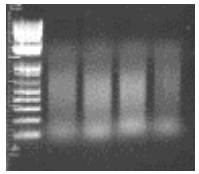
OAR	SNP	-log10P
1	OAR1_150528301.1	12.63
	OAR1_213617854.1	9.56
2	s41345.1	13.22
	OAR2_43175231.1	12.15
	OAR2_43304314.1	8.53
3	OAR3_227769239.1	11.17
	OAR3_235574907.1	10.54
4	OAR4_50370017.1	8.73
	s54836.1	7.91
13	OAR13_9727532.1	11.97
	s14792.1	7.56
15	OAR15_12066235.1	8.95
	OAR15_12128190.1	6.26
20	OAR20_38864697.1	15.92
	OAR20_31086401.1	8.72
25	OAR25_38239942_X.1	10.21
	s50241.1	12.10

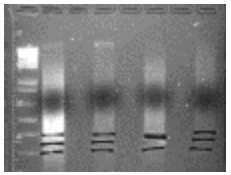


2do Secuenciado del genoma completo

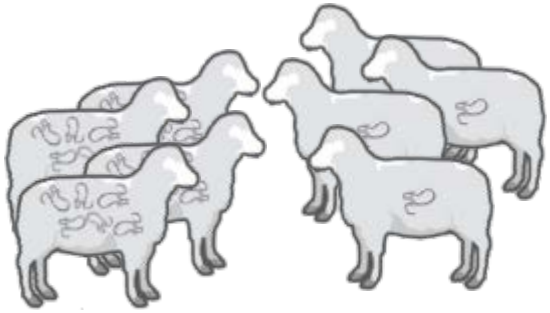
Nicolás Grasso MSc. Tesis







4 S



4 R

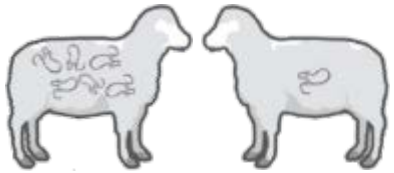
3er RNA-sequencing

Pablo Peraza MSc. Tesis

Tejidos

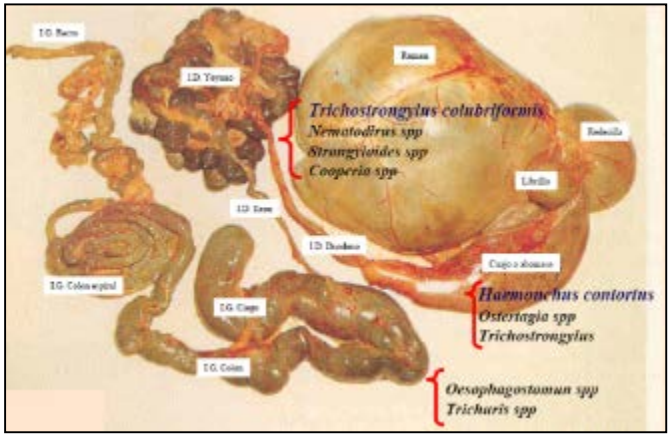
- Yeyuno
- Duodeno
- Íleon
- Mucosa del abomaso
- Nodo linfáticos abomasales

1 S

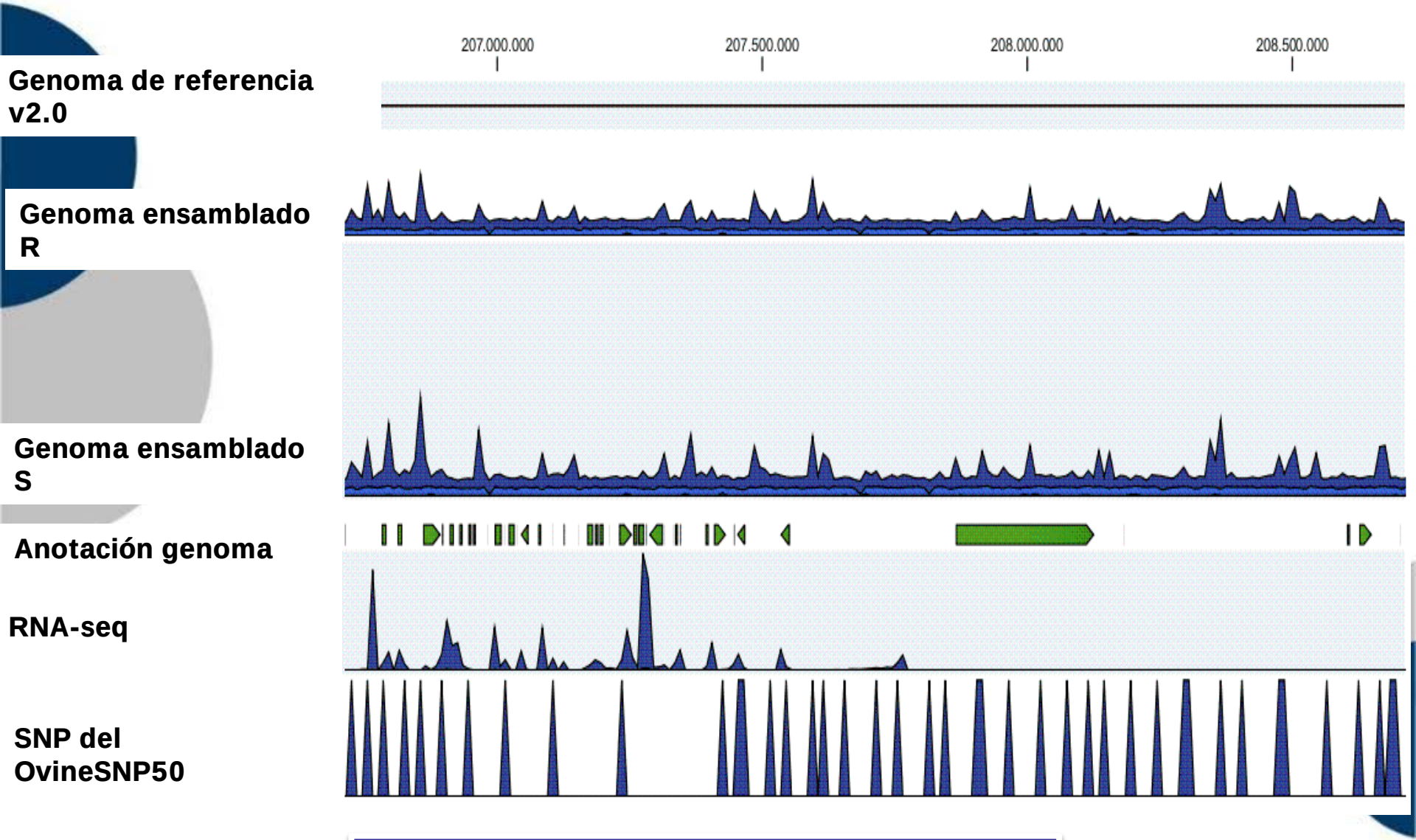


1R

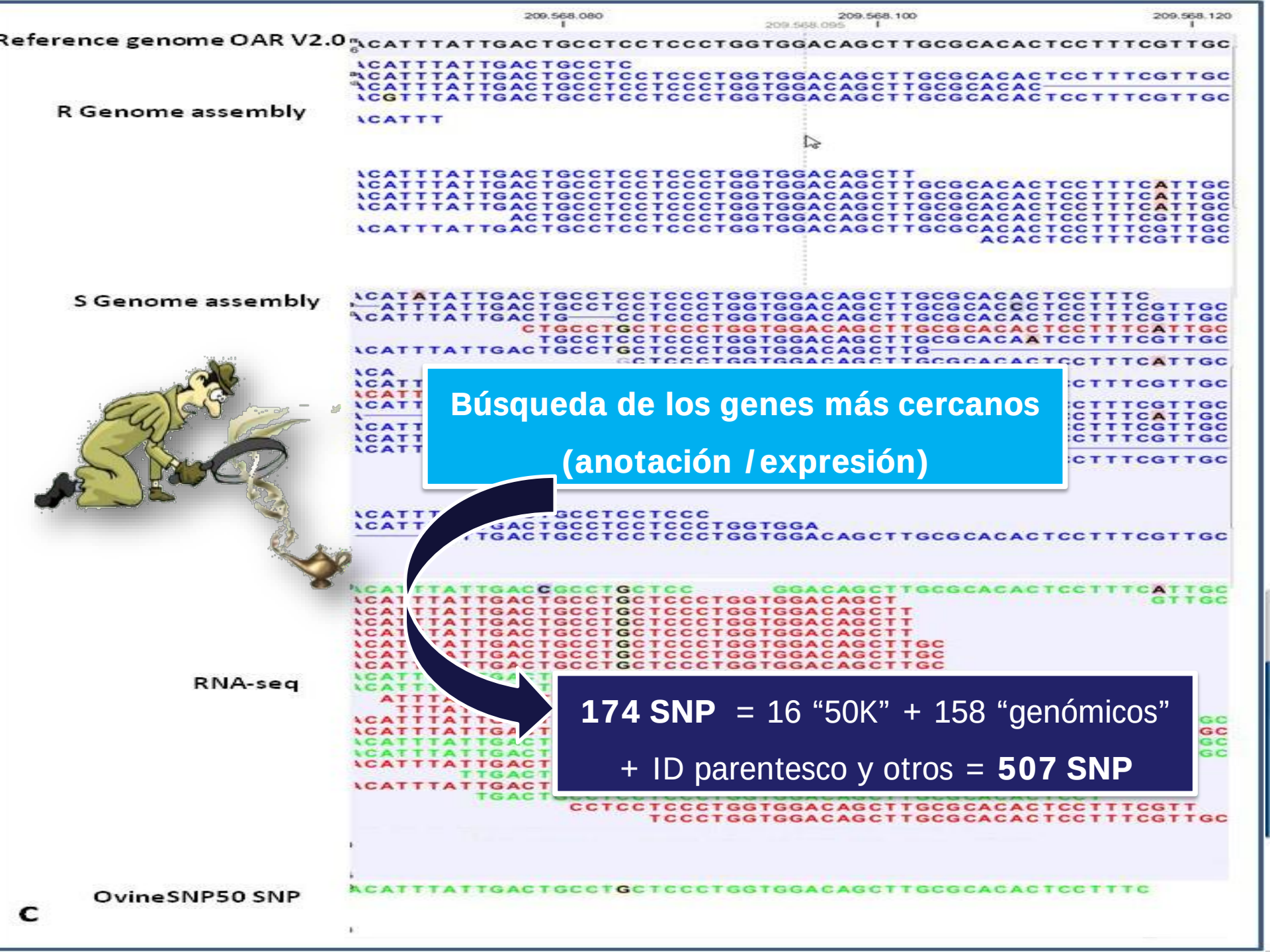
Reads	RNA-seq Pool
Total	140.820.015
Mapped	92.360.108
Unmapped	48.459.907



4to Combinación de técnicas: "integrative approach"



Búsqueda de los genes más cercanos (anotación / expresión)


209.568.080
209.568.100
209.568.120
Reference genome OAR V2.0
R Genome assembly
S Genome assembly
RNA-seq
OvineSNP50 SNP
C
Búsqueda de los genes más cercanos
(anotación / expresión)
174 SNP = 16 “50K” + 158 “genómicos”
+ ID parentesco y otros = 507 SNP

Very Low Density SNP panel: Development

EUREKAGENOMICS.

affymetrix

VLD SNP panel: development

SNPs	Purpose	reference
250	INIA Parentage preselected (50k)	INIA Project (+ ANII)
69	ISGC Parentage	Kijas et al., 2012
2	Horn/Poll	Dominik et al. 2011; Johnston et al. 2011
174	FEC associated (16 from 50k)	INIA Project
7	Merino Breed specific	INIA Project (QC, population genetics, crossbreeding, prolific, etc.)
5	Corriedale Breed specific	

Agreement between

EUREKAGENOMICS

INIA

Parentage SNPs: Uruguayan panel

Panel	n	Criteria
1	83	Min Nº PE of 0.9999 for Corriedale, Merino and Texel
2	96	P1+7 rare SNP (>0-0.1) and 10 SNP MAF 0.1-0.4
3	141	P2+ Kijas et al., 2012 (pass QC citeria)
4	154	P3+ FEC (pass QC criteria)
0 Total	**258**	P4 + others parentage SNP

Panel	Corriedale	Merino	Texel
1	0.9999033	0.9999099	0.9999045
2	0.9999871	0.9999961	0.9999497
3	0.9999999...	0.9999999...	0.9999992
4	0.9999999...	0.9999999...	0.9999997
0 – Total	**0.9999999...**	**0.9999999...**	**0.9999999...**

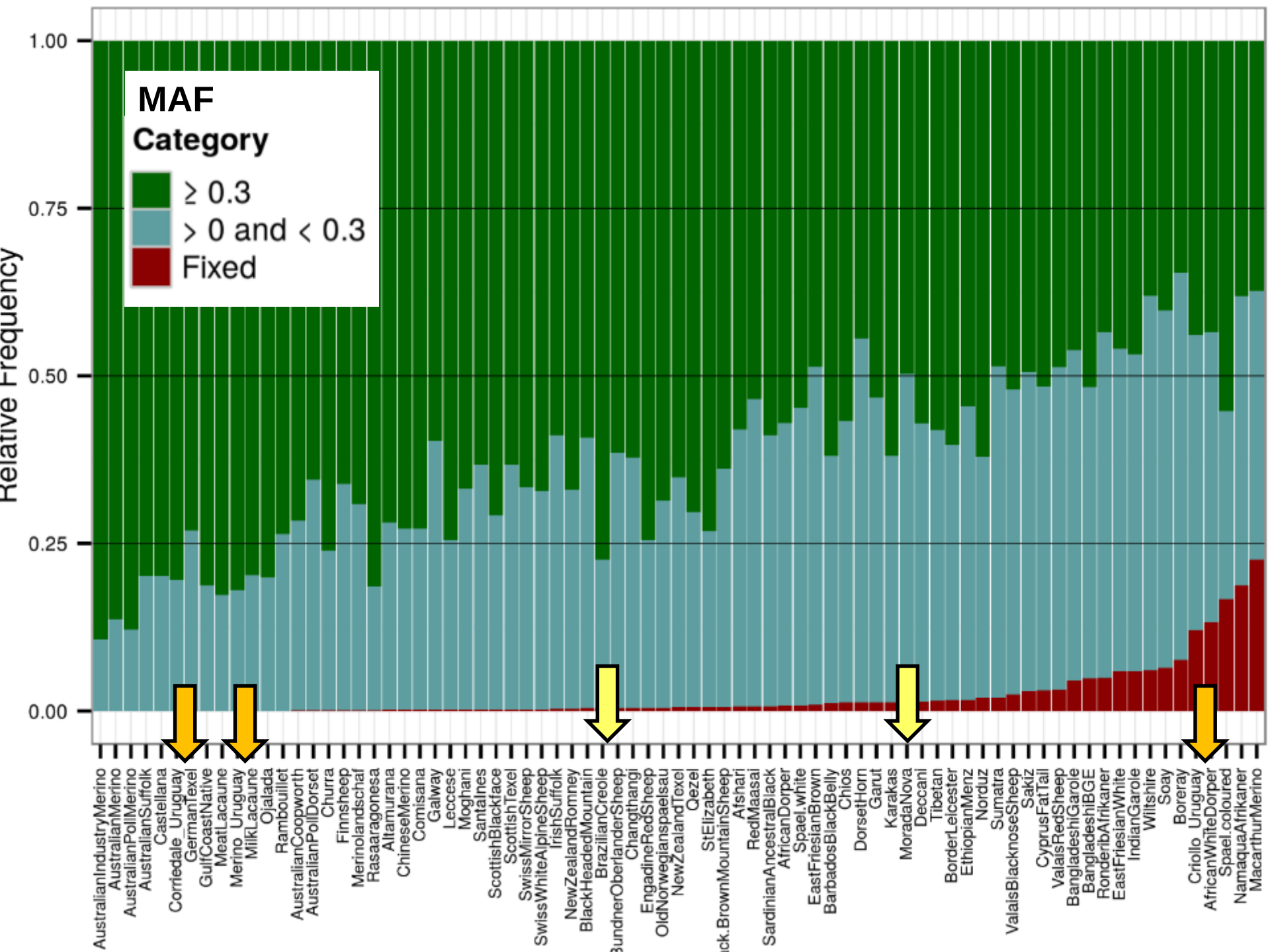
$$P = 1 - 4\sum_{i=1}^{n} p_i^2 + 2\left(\sum_{i=1}^{n} p_i^2\right)^2 + 4\sum_{i=1}^{n} p_i^3 - 3\sum_{i=1}^{n} p_i^4$$

PE: combined exclusion probability according to Jamieson & Taylor, 1997

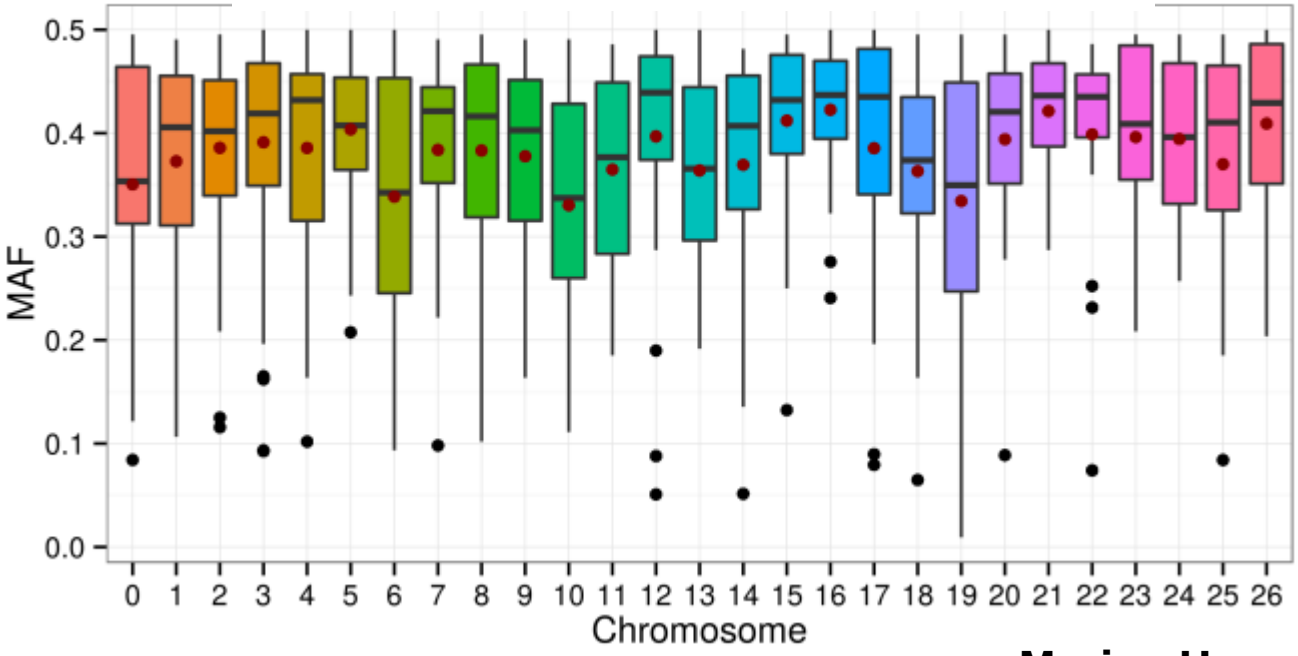
Parentage SNPs: ISGC Subgroup on parentage

Panel	Breeds	N° SNPs	Reference
ISGC	various	**88**	Kijas et al., 2012
CSIRO	Australian Merino, Dohne Merino	64 – **383**	Bell et al., 2013
AgR	Texel, Romney, Perendale, Booroola, MerinoxRomney	**84**	Clarke et al., 2014
USDA	74 breed groups	109 – **163**	Heaton et al., 2014.
INIA	Australian Merino, Corriedale, Texel	83 – **258**	Macedo & Ciappesoni 2013
INRA	30 French breeds	**192**	Carole & Flavie pers. comm.
		856	

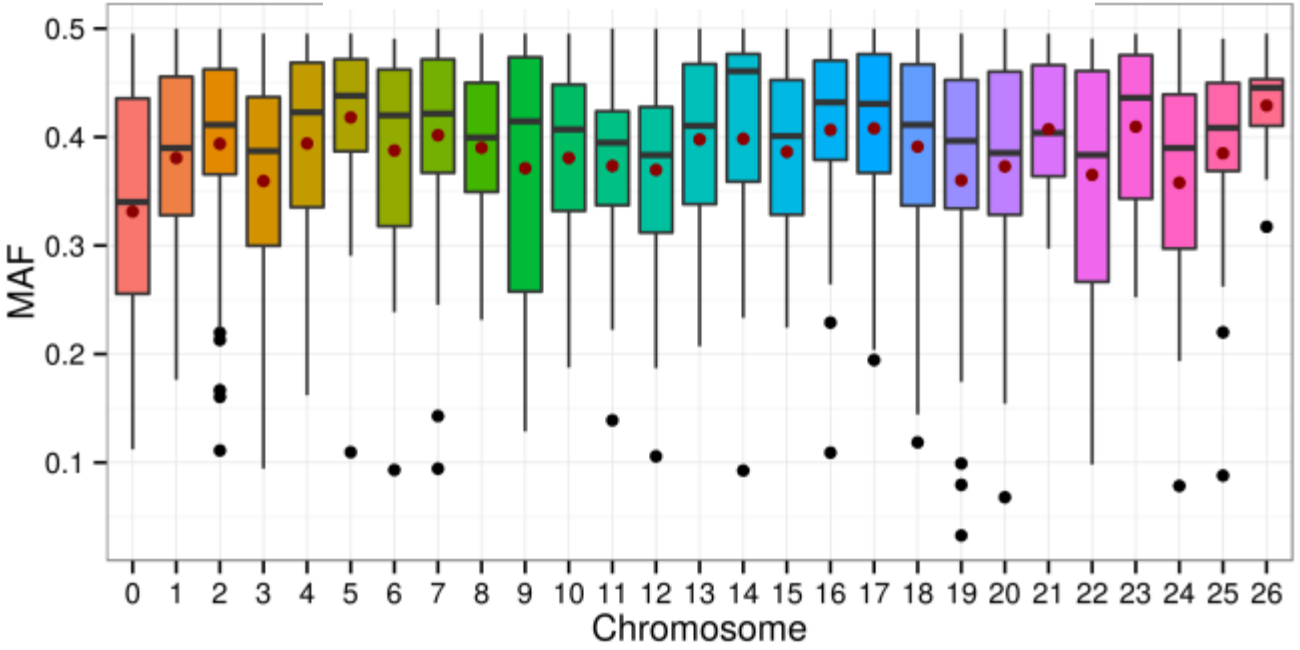
856 SNPs to the LD 15K chip

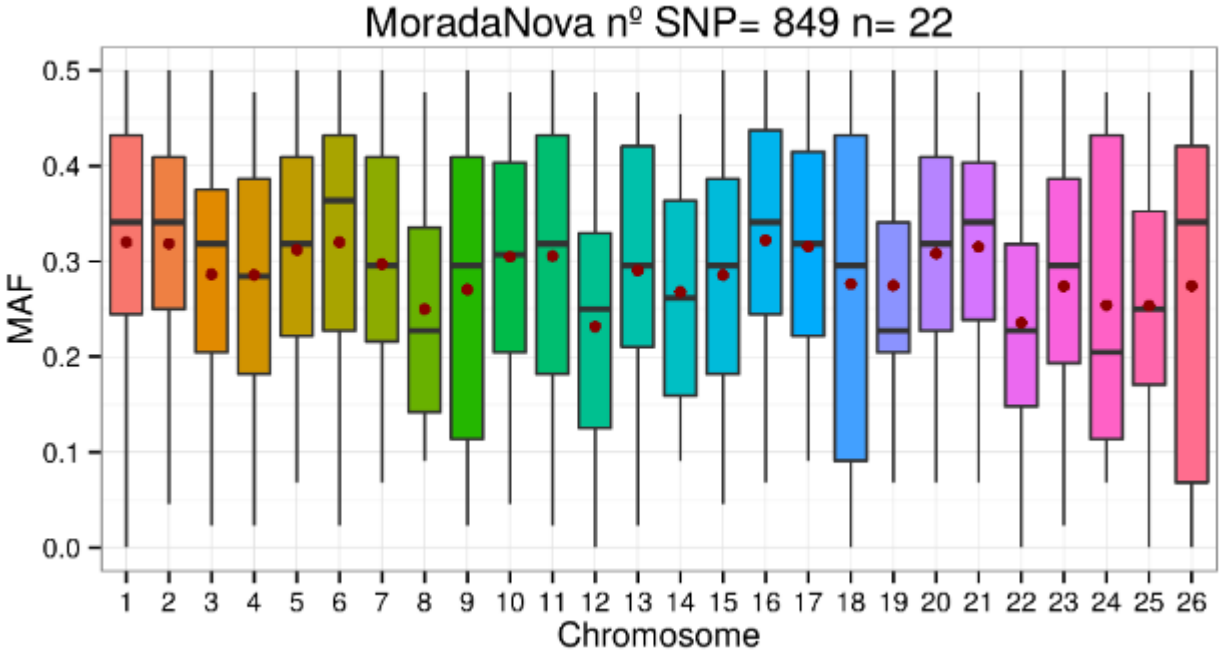

MAF
Category
≥ 0.3
> 0 and < 0.3
Fixed
Relative Frequency
1.00
0.75
0.50
0.25
0.00
AustralianIndustryMerino
AustralianMerino
AustralianPolledMerino
AustralianSuffolk
Castellana
Corriedale_Uruguay
GermanTexel
GulfCoastNative
MeatLacaune
Merino_Uruguay
MilkLacaune
Ojalada
Rambouillet
AustralianCoopworth
AustralianPolledDorset
Churra
Finnsheep
MerinolandschaF
Rasaaragonesa
Altamurana
ChineseMerino
Comisana
Galway
Leccese
Moghani
Santalnes
ScottishBlackface
ScottishTexel
SwissMirrorSheep
SwissWhiteAlpineSheep
IrishSuffolk
NewZealandRomney
BlackHeadedMountain
BrazilianCreole
BundnerOberlanderSheep
Changthangi
EngadineRedSheep
OldNorwegianspaelsau
NewZealandTexel
Qezel
StElizabeth
ck.BrownMountainSheep
Afshari
RedMaasai
SardinianAncestralBlack
AfricanDorper
Spael.white
EastFriesianBrown
BarbadosBlackBelly
Chios
DorsetHorn
Garut
Karakas
MoradaNova
Deccani
Tibetan
BorderLeicester
EthiopianMenz
Norduz
Sumatra
ValaisBlacknoseSheep
Sakiz
CyprusFatTail
ValaisRedSheep
BangladeshiGarole
BangladeshiBGE
RonderibAfrikaner
EastFriesianWhite
IndianGarole
Wiltshire
Soay
Boreray
Criollo_Uruguay
AfricanWhiteDorper
Spael.coloured
NamaquaAfrikaner
MacarthurMerino

Corriedale Uruguay n=108



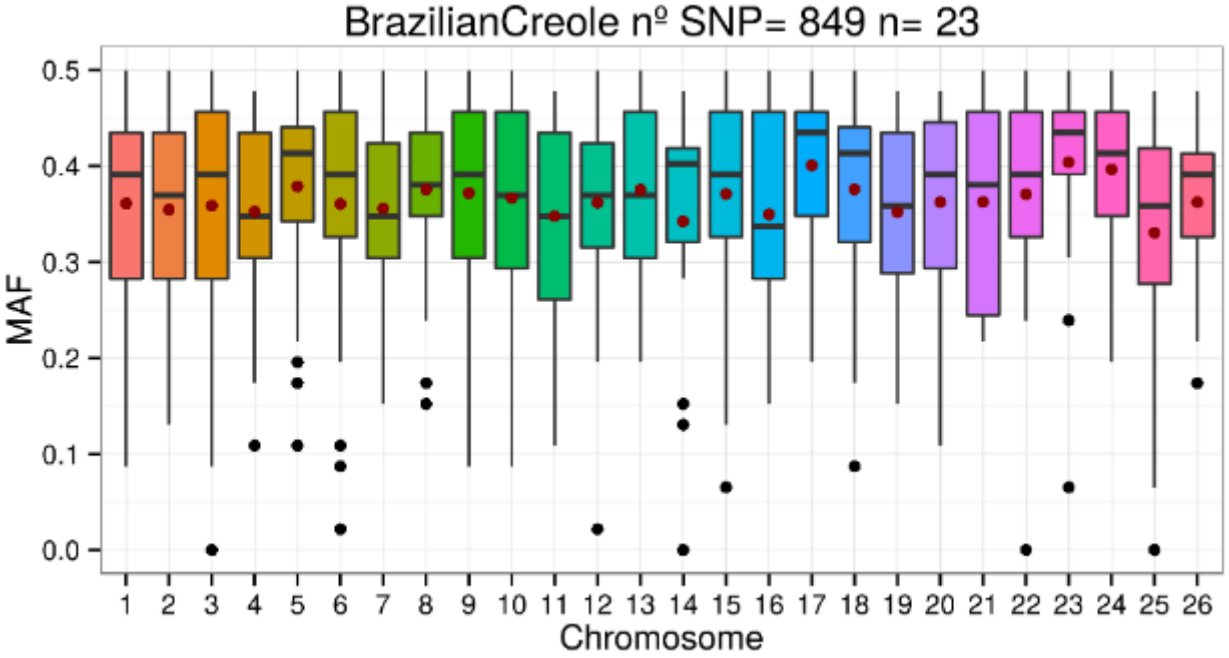
Merino Uruguay n=110



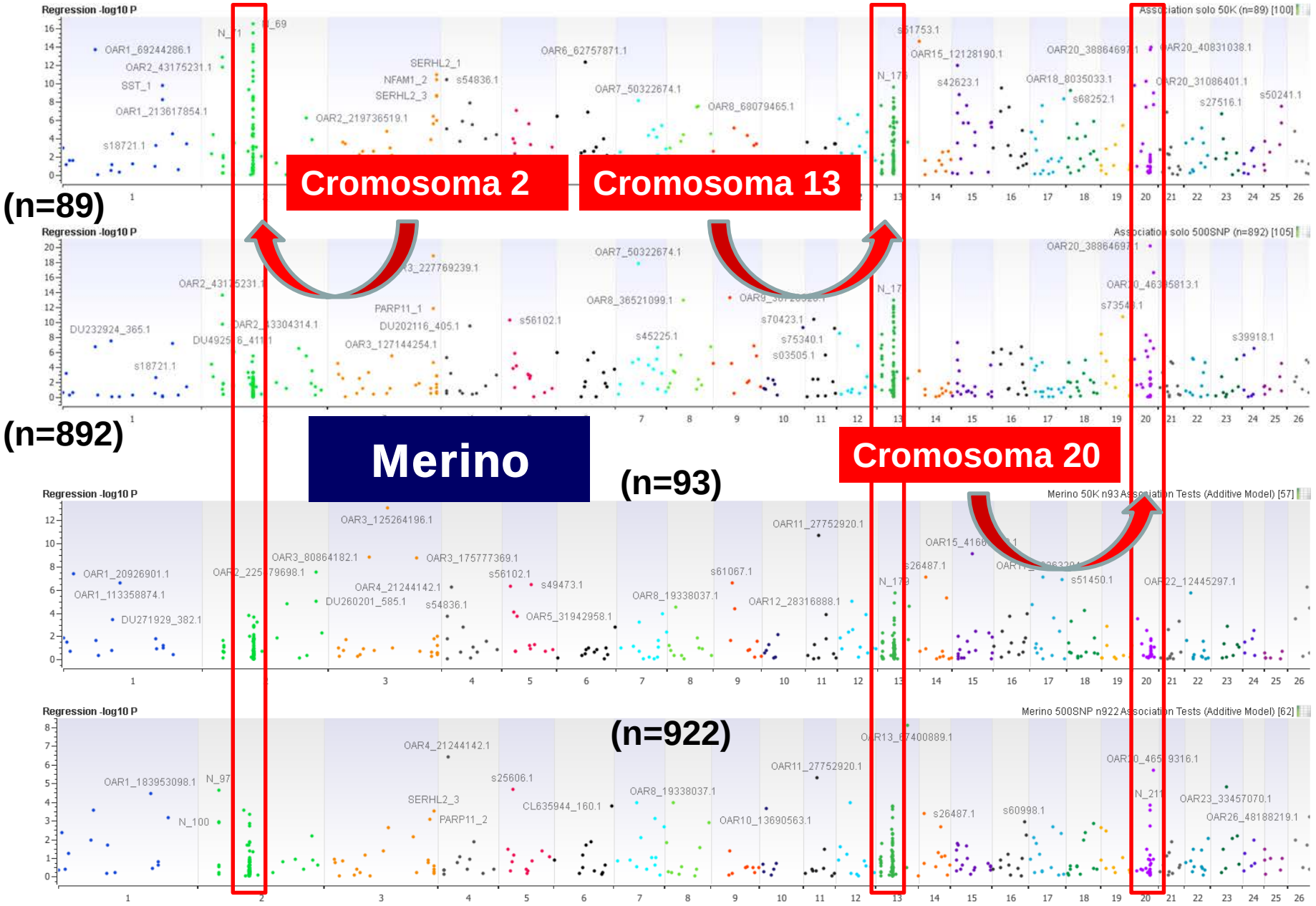


http://www.cabraeovelha.com.br/

http://www.arcoovinos.com.br/



5to Validación: Corriedale



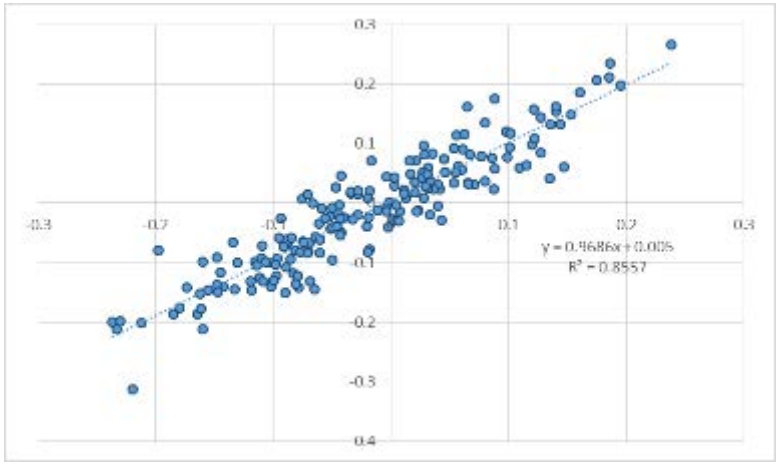
Genomic and accuracies

How are EPD accuracies increased with the genomic test?

	Australian Merino		Corriedale
	AUS	UY	UY
F Diameter	5.0%	8.7%	11.7%
CFW	11.9%	17.0%	16.4%
FEC	6.4%	18.5%	20.6%

2015

Nucleus	4-5%



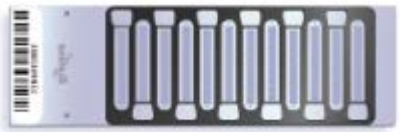
Sheep CRC Practical Wisdom Know it. Do it.

By Stephen Lee, University of Adelaide and Julius van der Werf, University of New England

INIA

Comentarios finales

Consideraciones finales

1. Existen herramientas disponibles HOY (**DEP HPG carneros**)
2. **Corriedale**: Nuevos objetivos en CIEDAG, más cabañas
3. **Merino**: núcleo de selección (INNOVAGRO: Fagro-INIA-SUL-SCMAU)
4. **Chipito SNP:** uso estratégico 
5. **Selección Genómica** (Merino, Corriedale) combinar 50K+15K
6. Otras herramientas: **FAMACHA**?

Implementación de herramientas genómicas?

Objetivos de Selección?

Sí

Flock testing o similar?

No

Sí

Evaluaciones dentro del rebaño?

No

Sí

Evaluaciones entre-rebaños?

No

Sí

Bienvenido a la "era genómica"!!

Buen sistema de registros?

No

Sí

Índices de selección?

No

Sí

Buena ganancia genética?

No

Sí

Equipo inter disciplinario + $$$$?

No

Sí

www.geneticaovina.com.uy

Evaluaciones Genéticas ovinas