



Instituto Nacional de Investigación Agropecuaria
U R U G U A Y



IMPLEMENTATION OF ANIMAL GENOMIC SELECTION IN URUGUAY

Elly Ana Navajas, Ignacio Aguilar, Olga Ravagnolo

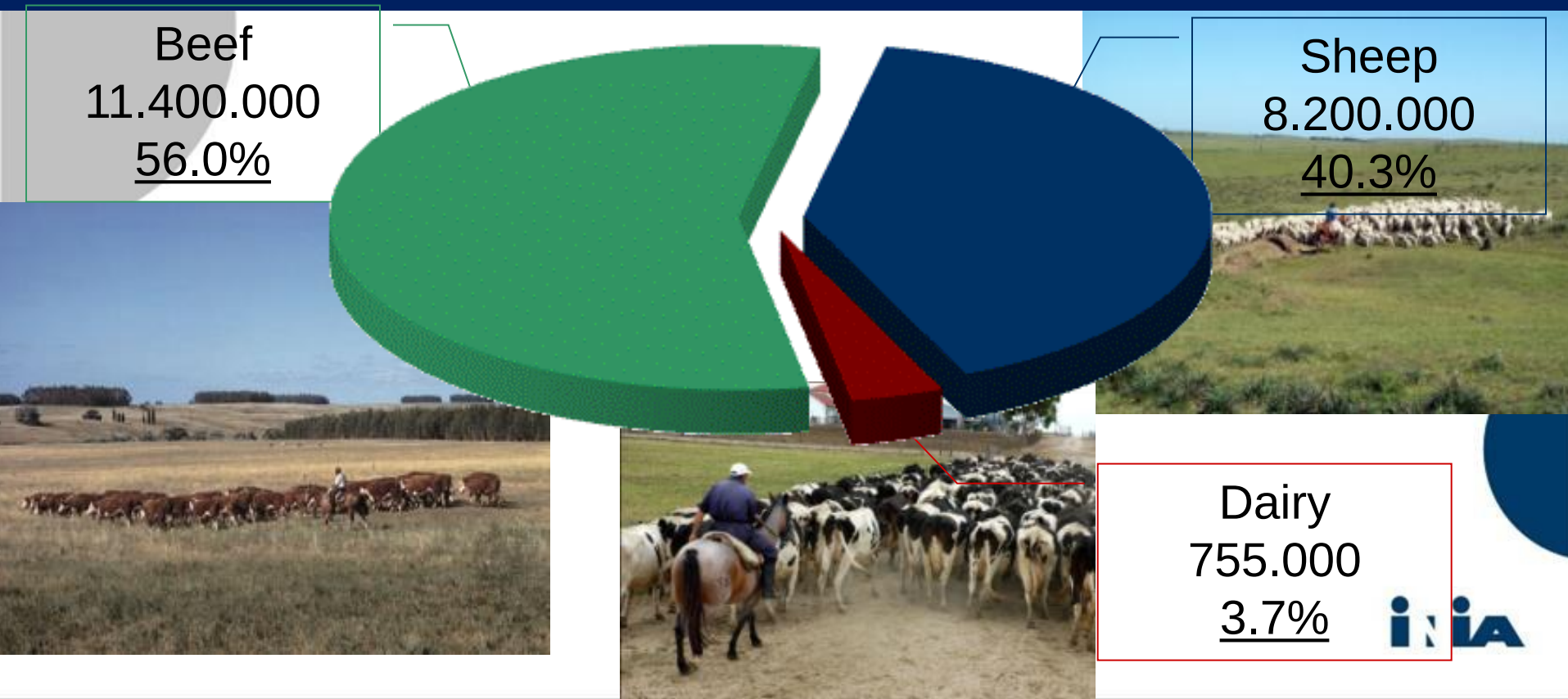
**Biotechnology Unit
Dairy Research Program
Meat and Wool Research Program**

NATIONAL AGRICULTURAL RESEARCH INSTITUTE



URUGUAY

- Population: 3,2 millions
- An agricultural country
 - Economy relies on agriculture (70% of all exports)
- Livestock industry is strategic



URUGUAYAN BEEF INDUSTRY

- **Traditionally grass fed, outdoors**
 - **but 13% of steers came from feedlots (recent trend, export markets)**
- **Purebred production system**
 - **Hereford, Angus**
 - **Others: Limousin, Braford, Charolais**
- **Slaughter : 2,16 mill heads per year**
 - **53% steers, 45% cow&heifers**
- **Significant influence of export markets**
 - **Keeping/improving position internationally**

URUGUAYAN BEEF INDUSTRY

- **Carcass classification and grading system**
 - **INACUR**
 - **More objective: VIA, 2 abattoirs**
 - **Validated by National Meat Institute (INAC)**
 - **Compulsory, all abattoirs in future?**
- **Individual traceability system in place**
 - **All cattle, with electronic ID**
- **Interactions with other databases**
 - **Electronic Information System for the Beef Industry**
 - **From farm for the final product**

Trazabilidad Integral

FASE ANIMAL



FASE INDUSTRIAL



URUGUAY
URUGUAYAN MEAT. FROM NATURE TO CONSUMER.



Trazabilidad Integral

FASE ANIMAL



FASE INDUSTRIAL



URUGUAY
URUGUAYAN MEAT. FROM NATURE TO CONSUMER.

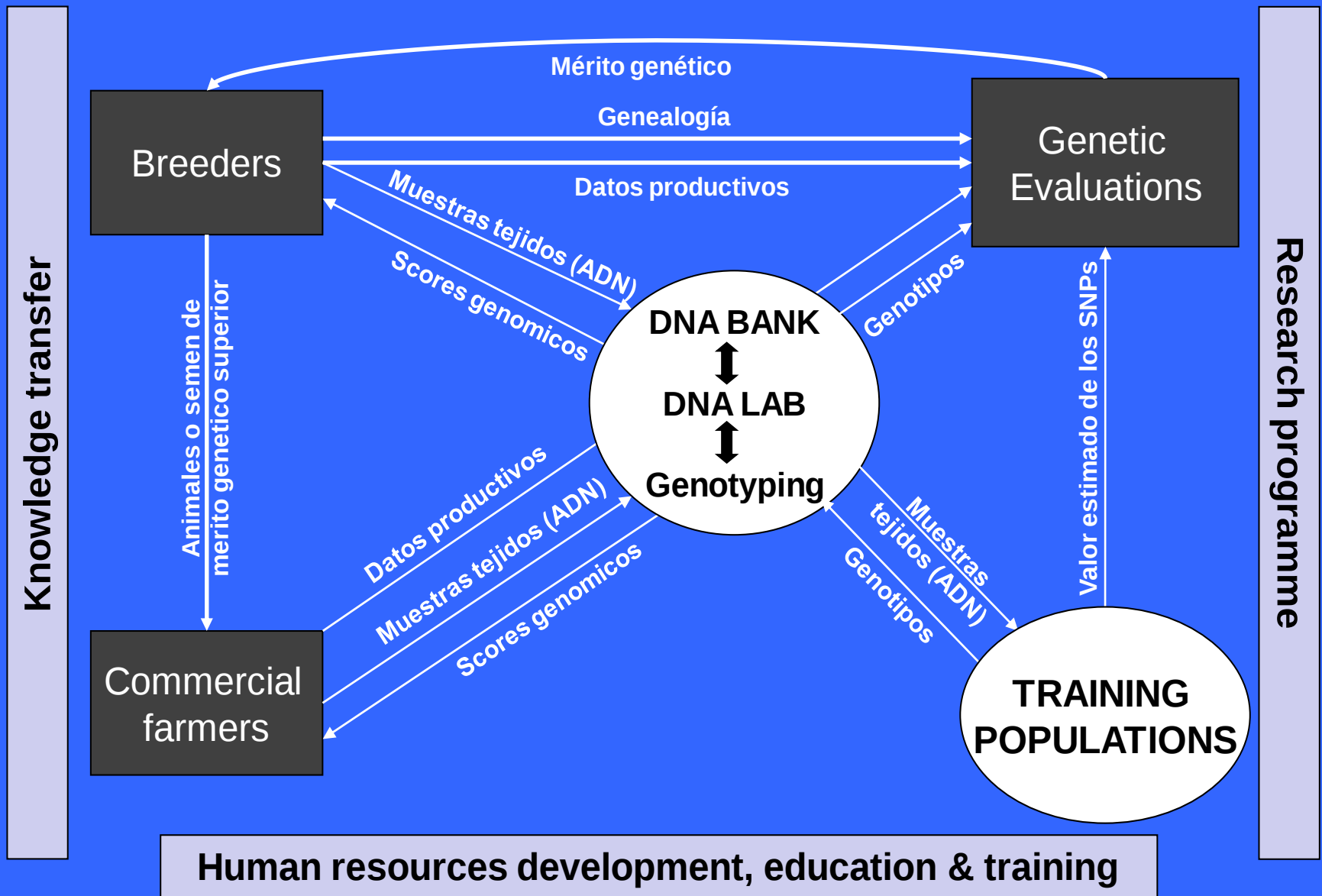




Genomic Selection Platform

Beef cattle
Dairy cattle
Sheep

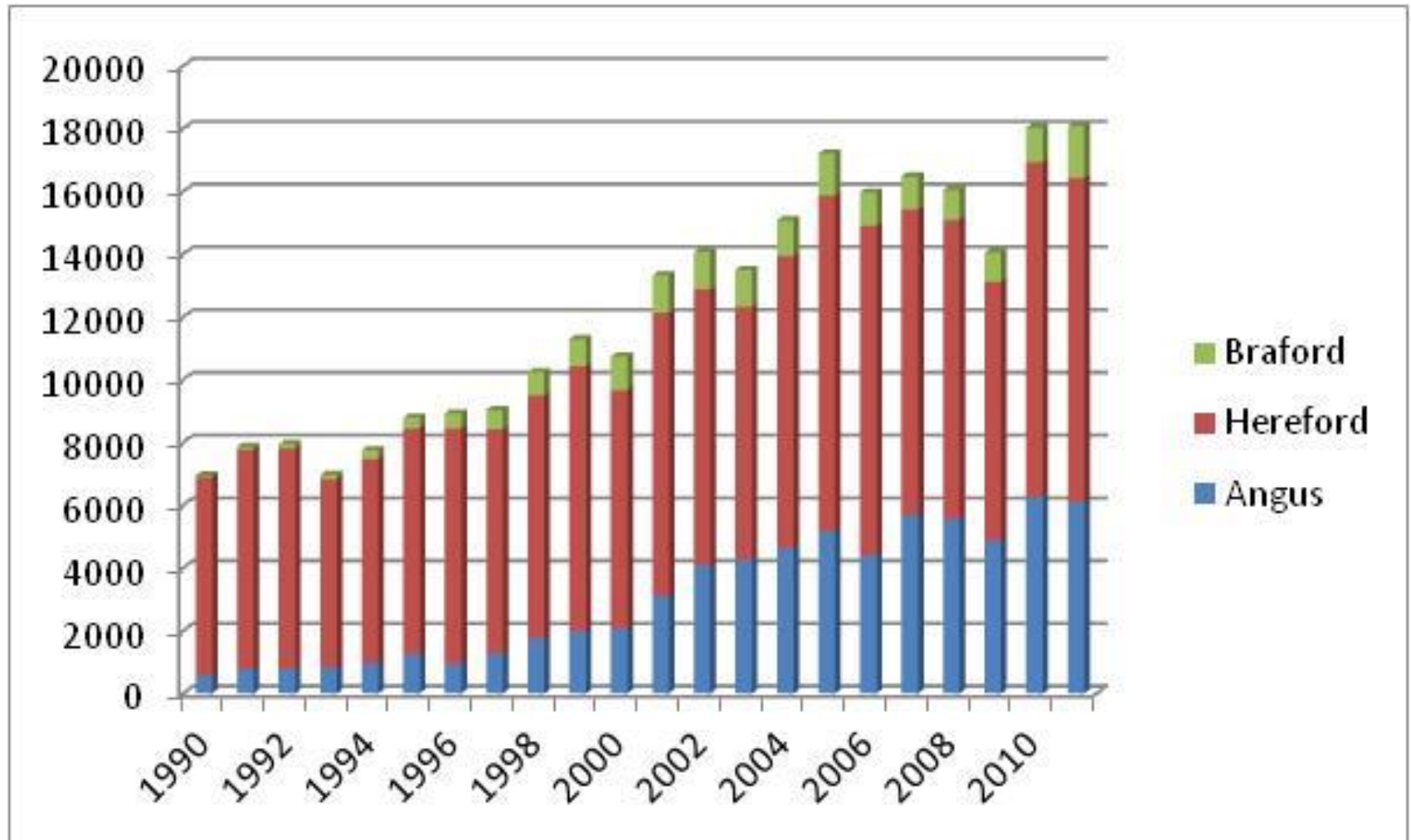
Strategic associations with public and private sector



BEEF CATTLE

- **Genetic evaluations**
 - Hereford
 - Angus
 - Braford
 - (Limousin and Shorthorn)
- **Molecular tools in process, but not implemented**
 - Genomic EPDs
 - Paternity tests

Number of animals with phenotypic records



Trait	Hereford	Aberdeen Angus	Braford
Calving difficulties	✓		
Birth weigh	✓	✓	✓
Weaning weight	✓	✓	✓
Milk	✓	✓	✓
15 m weight	✓		✓
18 m	✓	✓	✓
Mature weight	✓	✓	
Calving difficulties mat.	✓		
Scrotal circumference	✓	✓	
Eye Muscle Area	✓	✓	
Fat depth	✓	✓	
Intramuscular fat		✓	
Selection index	Maternal Index		

TRAINING POPULATION & GENOMIC SELECTION

- Hereford breed
- Pan-American Genetic Evaluation (PACE)
- Training populations
 - Genetic evaluation
 - Genomic EPDs August 2015

Genotypes Uruguayan Hereford associated with genetic evaluation

	# samples
50kV2	629
GGP-HD	447
Total	1083
Genotyped with phenotypes	1013
Genotyped sires	496
Genotyped dams	189

Accuracy GEPD

- ssGLBUP Multiple-trait model
- Cross-validation
- Training
 - All phenotypes records up 2009
 - 747 genotypes
- Validation
 - Young sires (YOB $\geq$ 2010) with no phenotypes
 - 329 genotypes

Imputation

- Evaluate performance of different chips based on Uruguayan population
- Illumina 50K
- GenSeek GGP-HD
- Illumina LD

TRAINING POPULATION & GENOMIC SELECTION

- Hereford breed
- Pan-American Genetic Evaluation (PACE)
- Training populations
 - Genetic evaluation
 - Genomic EPDs August 2015
 - New traits
 - FEED INTAKE
 - CARCASS QUALITY
 - MEAT QUALITY
 - (REPRODUCTION, DISEASES)

Enhancing competitiveness of the Uruguayan beef industry by implementing genomic tools to genetically improve feed efficiency and carcass quality of Hereford breed

Some numbers

Starting date: 15 January 2014

Duration: 36 months

Total investment: US\$ 2 millions

Hereford contribution: US\$ 400K

Other institutions: US\$ 700K

ANII : US\$ 900K



Feed efficiency & carcass quality project

- **Building training populations for genomic selection**
 - 1000 purebred Hereford (bulls and steers)
 - Individual feed intake
 - Growsafe equipment; post weaning evaluation
 - 2 pens for 80 steers/64 bull each
 - Timetable:
 - 2014-2016: 3 tests/year, ~ 350 animals/year
 - After 2016:
 - Adding more information to training population
 - Other aims & traits: i.e. efficiency at finishing, proxy measurements of methane emissions
 - Growth records:
 - Weights beginning and end of test, and every 2 weeks
 - Ultrasound scanning 3 times during test

New facilities at Kiyú Experimental Station



Proposed timetable

TYPE OF ANIMAL	PHASES	2014	2015	2016
Autumn-born Young Bulls	Arrival			
	Warm-up			
	TEST	60	60	60
Spring-born Young Bulls	Arrival			
	Warm-up	128	128	128
	TEST			
Young Steers	Arrival			
	Warm-up	160	160	160
	TEST			

**564
young
bulls**

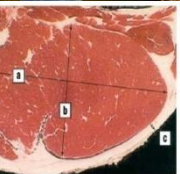
**460
steers**

- 10 days on pasture
- 10 days - warming up in a pen with traditional bunk
- 15 days – warming up with GROWSAFE system
- 70 days – Feed intake trial

• CARCASS QUALITY TRAITS

– Steers after efficiency test will be finished

- “Traditional research method” by INIA & INAC teams
- Carcass traits: hot and cold carcass weight, conformation and fatness grades, quarters, primal and cuts weights.
- Meat quality: meat and fat colour, intramuscular fat percentage, pH, tenderness (Warner Braztler), and intramuscular fat.



- **More data will be recorded by exploiting the advantages of:**
 - ✓ National traceability system
 - ✓ Electronic Information System for the Beef Industry (black boxes)
 - Access to individual information from origin to weights of primal cuts (and final cut)
 - Recording information to be used in breeding programs with minimum additional cost (i.e. retail yield)

- **LIVESTOCK PRECISION FARMING**
- **Experiment recording carcass meat quality traits**
 - Hereford sires: high vs average EMA EPD
 - Growing diets
 - DNA samples in DNA Bank

+ GENOMICS

- 500 steers with carcass and meat quality data genotyped
- Sired by bulls in the training population

TRAINING POPULATION & GENOMIC SELECTION

- Aberdeen Angus
- National Genetic Evaluation
- Training populations
 - Genetic evaluation
 - So far 700 samples to be genotyped (\$\$)
 - New traits
 - FEED INTAKE
 - Private initiative by breeder and farmers
 - Expanded to the Angus Society
 - Equipment on its way, starting in autumn

FINAL COMMENTS

- **Significant progress in a short period of time**
- **Next step:**
 - Implementation of genomic selection
- **Many challenges**
 - Implementation (profitable!)
 - LD chip to reduce costs
 - Larger (better) training populations
 - Joint data? Are phenotypes similar in complex traits?
 - KT & development of human resources



Many thanks

enavajas@inia.org.uy

Cross validation accuracy

		Non-Genotyped			Genotyped		
Trait	H ²	N	Acc BLUP	Acc ssGBLUP	N	Acc BLUP	Acc ssGBLUP
BW	0.43	27,029	0.32	0.32	385	0.32	0.39
WW	0.20	25,108	0.35	0.38	381	0.32	0.50
15MW	0.36	10,951	0.29	0.31	315	0.27	0.41
18MW	0.33	12,540	0.32	0.34	358	0.25	0.42
IMF	0.26	7,643	0.24	0.24	321	0.08	0.08
REA	0.26	11,439	0.38	0.40	358	0.46	0.60
FAT	0.30	11,439	0.32	0.31	358	0.21	0.23
SC	0.30	4,920	0.38	0.41	282	0.39	0.46

Imputation 50k to 80K

Data set

- 697 genotypes 80K
 - 458 Herford PACE
 - 239 Hereford research trial (steers + sires)

4 fold cross validation

	R2	Concordance rate	Allelic Error (%)
All SNP	0.979	0.987	0.633
Only Imputed	0.979	0.987	0.642

2 fold cross validation

	R2	Concordance rate	Allelic Error (%)
All SNP	0.975	0.985	0.771
Only Imputed	0.974	0.985	0.782