IRISH CATTLE BREEDING FEDERATION

Genomic Selection in Beef – Ireland

Francis Kearney ICBF

NDP
National Development Plan
Transforming Ireland

Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

Department of Agriculture database

Calf registration, animal movements; 2.1 m calves per year (1.2m dairy & 900k beef)


60k commercial Beef & 18k Dairy Farms

Sire ancestry, calving scores, live-weights, calf quality scores, docility, fertility; 1.5m/yr

Pedigree beef herds 14 herd societies

Ancestry, live-weights, linear scores, fertility; 30k calves/yr

ICBF Beef Database

Genotypes; 150k/yr

Genotyping companies

Inseminations; 700k/year

6 AI Companies

Carcass data; 1.6 m/year

40 Abattoirs

Live-weights and sale prices /year; 1,8m/year

50 Cattle Auctions

Feed intake, live-weights, linear classification, carcass, meat eating quality; 500 animals/year

Progeny test

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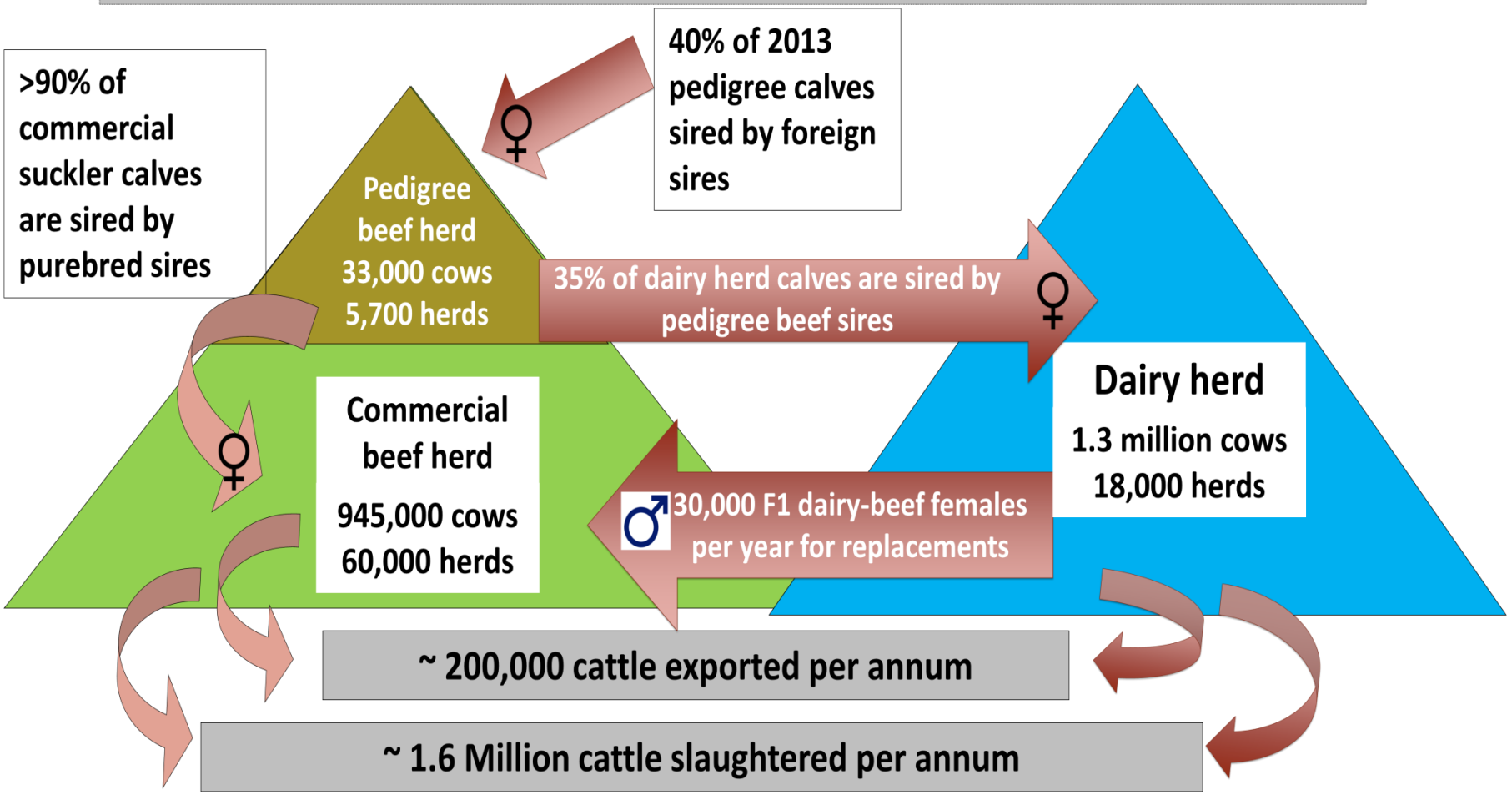
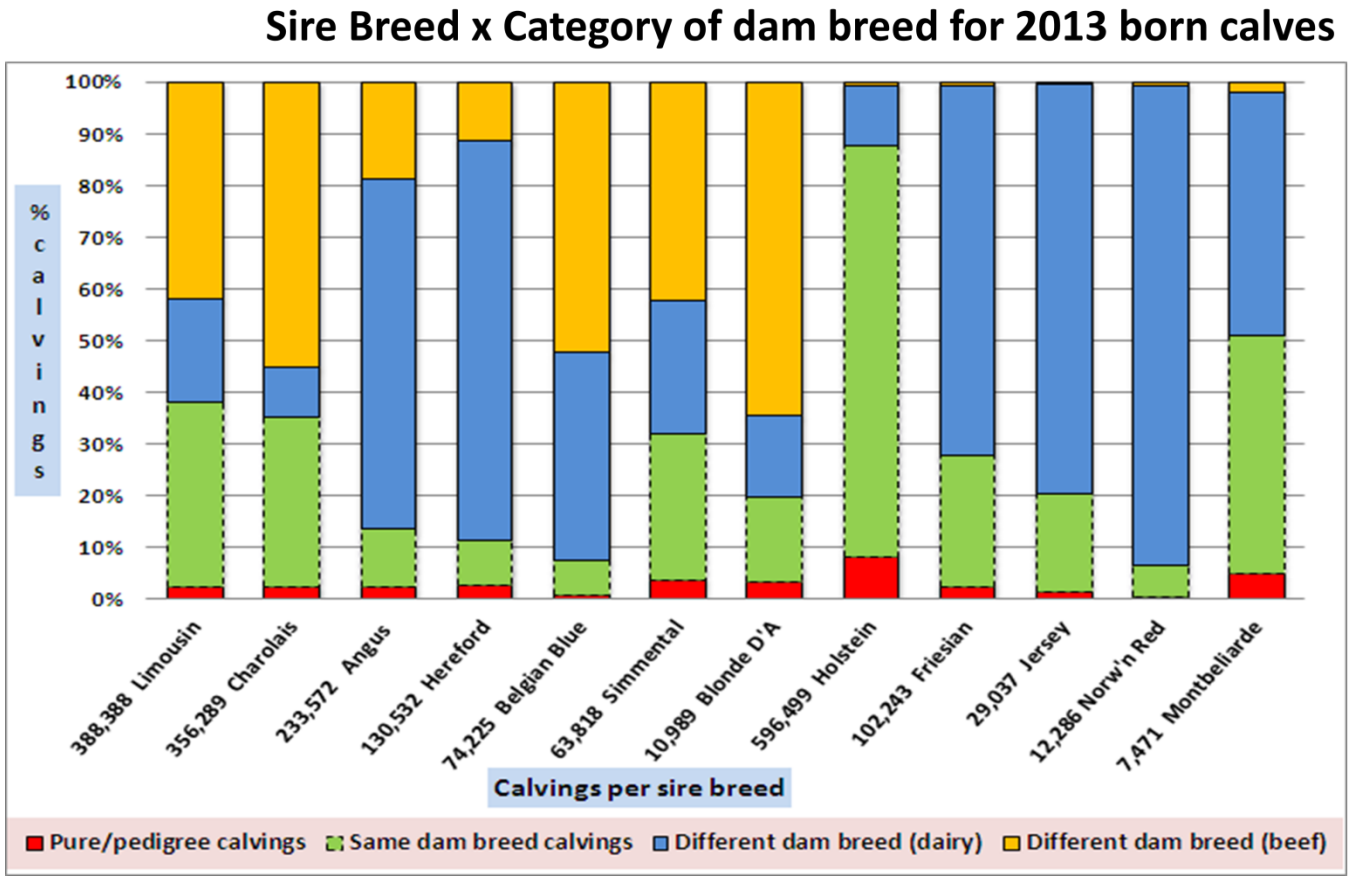
Overview of the different layers in the Irish beef production system



Evans et al., WCGALP 2014

Population Structure



Example

Limousin sired calves

- ***388,388 calves born***
- ***2% from pedigree Limousin cows (red)***
- ***36% from non pedigree same dam breed cows (Limousin) (green)***
- ***20% from different dam breed dairy cows (blue)***
- ***42% from different dam breed beef cows (yellow)***

Evans et al., WCGALP 2014

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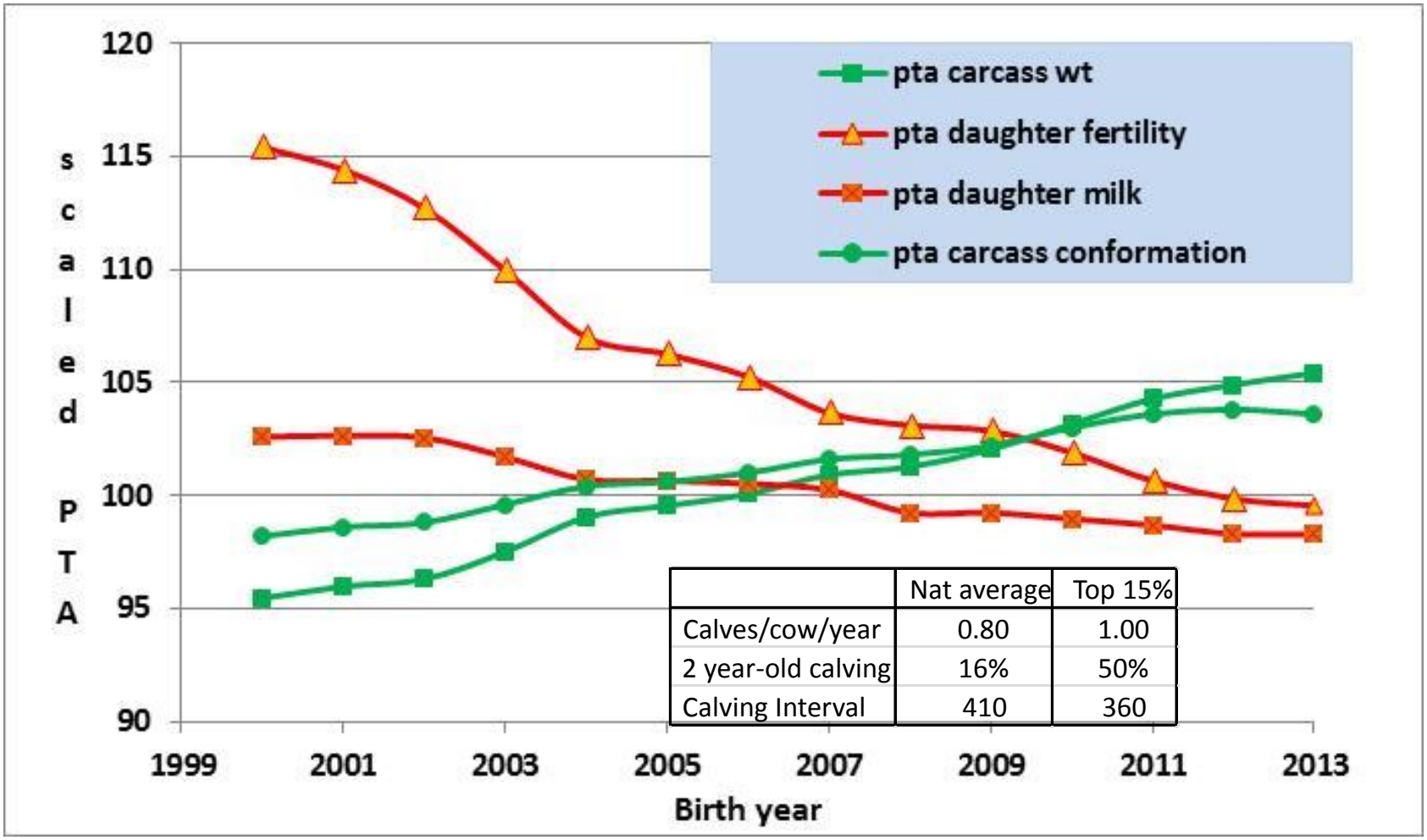
Genetic Trends



	Nat average	Top 15%
Calves/cow/year	0.80	1.00
2 year-old calving	16%	50%
Calving Interval	410	360

Why the decline

- 20% of animals required for replacements
- 80% of animals produced for sale as weanlings or finished
- Mating decisions (AI and natural matings sires) were focus on animals for sale/slaughter
- Females destined for slaughter are kept as breeding females
- Analysis of replacement index clearly demonstrates this

The Challenge

- Identify animals that are excellent for maternal traits while also maintaining good beef characteristics (growth, carcass, feed intake)
- Create a breeding structure to ensure widespread use of genetics

Maternal Breeding Programme

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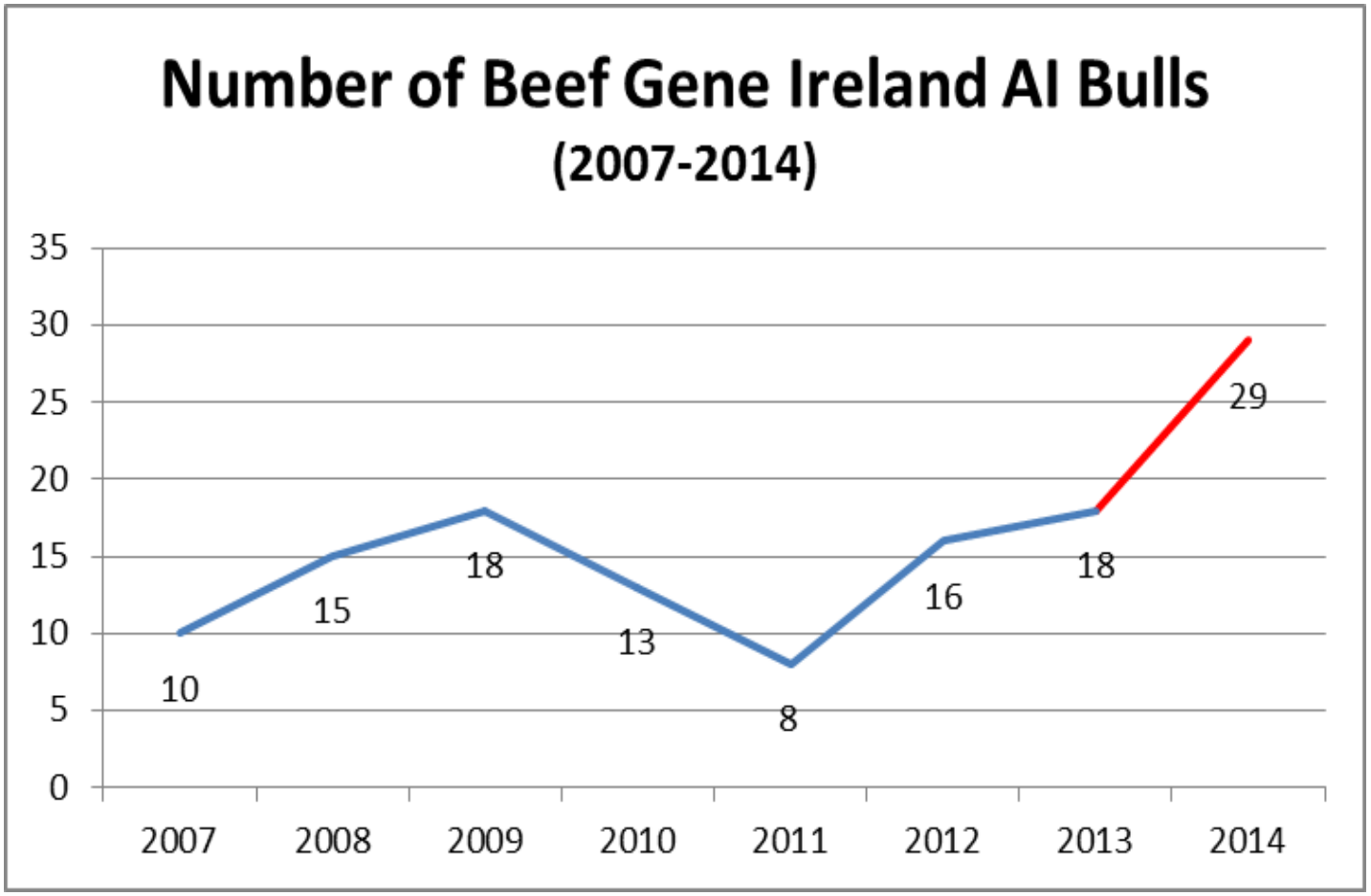
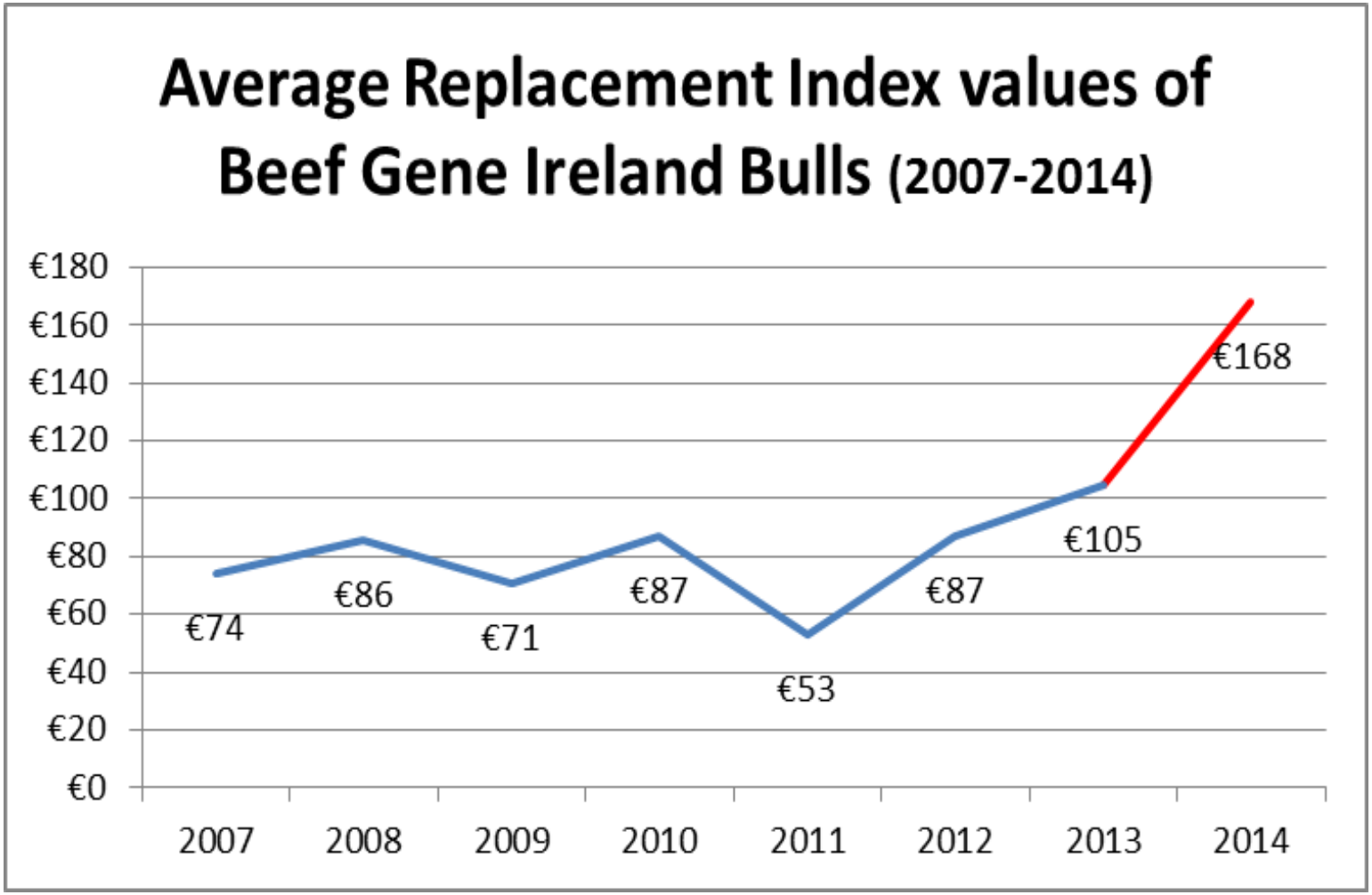
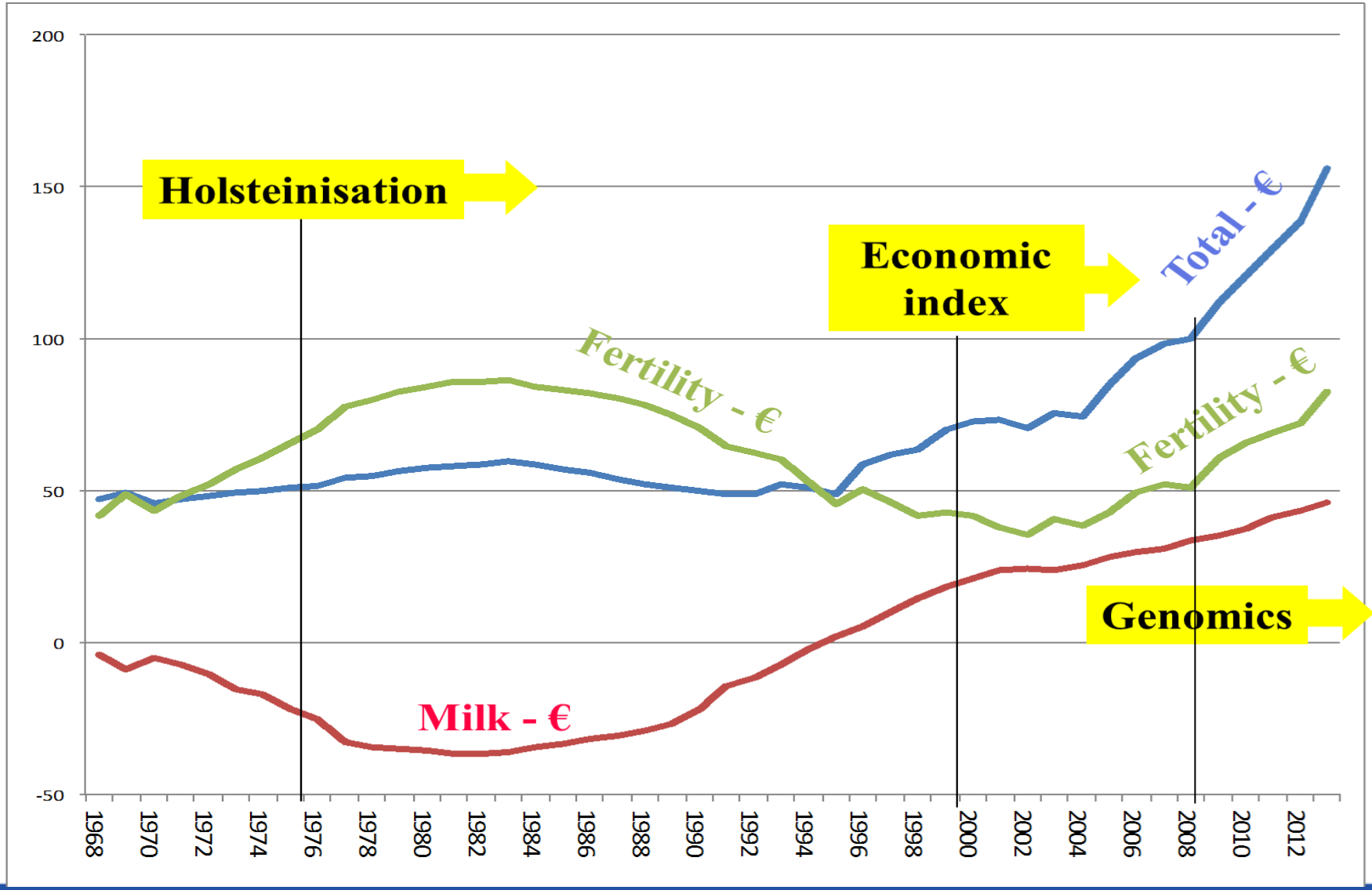




Genomic Selection can help!



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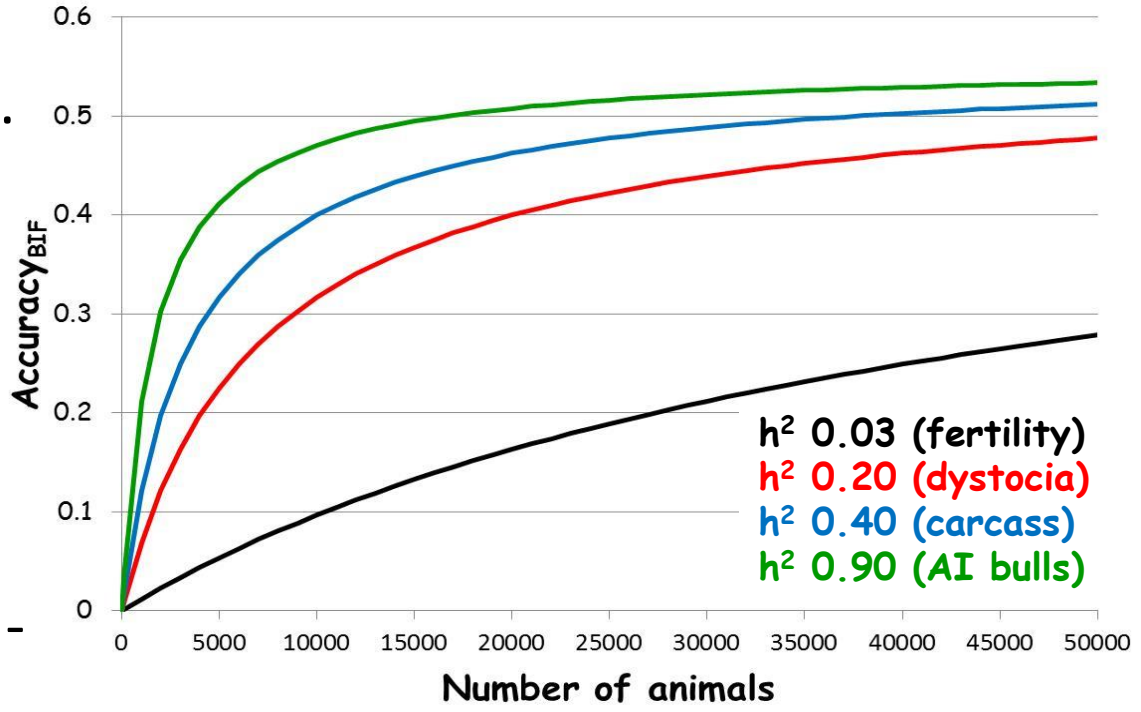
Genomic Selection can help!

- Large training pop – especially for low h^2 traits.
- Problem compounded by low level beef AI.

  In Ireland, 2640 AI sires (>1985) of which 749 are "well proven".
- Benefits of collaboration -> Interbeef



Building the training population…I

- Since 2010 AI bulls and natural mating bulls with high accuracy were genotyped on HD
- 5000 bulls genotyped on HD to date
- Swapped HD genotypes with other countries (no phenotypes…Interbeef)
- Initial results were poor especially for maternal traits => more genotypes required

Building the training population…II

- 2013 encouraged herdbooks to start to genotype young animals, especially males
- Needed a chip that was compatible with MS, high imputation accuracy, major genes/defectives
- Developed a customised Illumina IDB chip (17k)
- Longer terms strategy as animals not immediately available

IDB SNP CHIP
INTERNATIONAL DAIRY & BEEF SNP CHIP

Designed in association with the Irish Cattle Breeding Federation (ICBF), Teagasc, Weatherbys and USDA's Agricultural Research Service.

This custom chip is the very latest design catering for both Beef and Dairy.

The chip consists of the Illumina LD (7K) base content plus a further 10,000 (10K) SNPs carefully selected to ensure very high imputation accuracy to HD & to convert to Microsatellite data for parentage verification. This extra panel of SNPs provides the very latest dual product for both Beef & Dairy breeds.

Both the core and additional ISAG recommended SNP parentage panels are present on the chip.

The IDB also contains a comprehensive selection of genetic markers to screen for genetic disorders & major genes.

CHIP CONTENTS FOR DISEASES & TRAITS

Lethal recessives

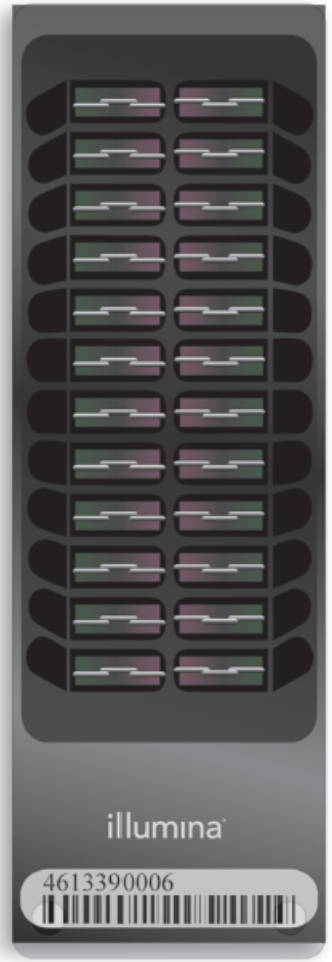
1 CVM*-Complex Vertebral malformation
2 DUMPS
3 Brachyspina*
4 BLAD

Congenital disorders

1 Arthrogryposis (Curly Calf)*
2 Fawn Calf Syndrome or Contractural Arachnodactyly*
3 Hypotrichosis_PMel17
4 Hypotrichosis in Belted Galloway, HEPHL1 SNP
5 Hypotrichosis_KRT71*
6 Spiderleg- MOCS1 gene- Simmental
7 Spiderleg- SOUX gene- Brown Swiss
8 Polledness
9 Mule Foot
10 Tibial Hemimelia (TH)*
11 Black/Red Coat Color/Red Factor
12 Red Recessive coat colour (Different to red factor)
13 Silver Color Dilutor
14 Dun Color
15 RNF11 (affects growth and stature)
16 Osteopetrosis (Marble Bone Disease)
17 Pink Eye (Infectious Bovine Keratoconjunctivitis)
18 Protoporphyria (Photosensitization)
19 SMA- Spinal muscular atrophy
20 Beta Lactoglobulin
21 Beta Mannosidosis
22 Alpha Mannosidosis
23 Citrullinemia
24 CMDI: Congenital muscular dystonia I
25 CMDII: Congenital muscular dystonia II
26 Crooked Tail Syndrome*
27 Factor XI
28 Ferrochelatase Gene
29 Heterochromia Irides (White Eye)
30 SDM- Spinal dysmyelination-SPAST Gene
31 Idiopathic Epilepsy*
32 Pulmonary Hypoplasia*
33 Weaver
34 Neuropathic hydrocephalus* (water head syndrome)

Major genes

1 DGAT1
2 MSTN (GDF8) Double Muscling*
3 A1/A2 beta casein + *
4-7 Fertility Haplotypes (HH1, HH2, HH3, JH1)
5 Kappa Casein I
6 Kappa Casein II
7 ABCG2
8 GH-2141
9 GHR-F279Y*
10 IGF1-AF017143
11 STAT1*
12 STAT3*
13 STAT5*
14 Calpain (Tenderness) loci



Building the training population…III

- Beef Genomics Scheme introduced by DAFM in 2014
- *"Using latest technology to underpin an important indigenous resource".*
- Farmer paid €60/cow to collect key data for beef cattle breeding.
  - Genotype ~15% of herd (1 NS sire & 3 cows).
  - Record data on; dystocia, calf quality, calf docility, cow docility, cow milk score & stock bull functionality.
  - 20 cow herd; €1200 - €120 (4*€30) = €1080/herd

Building the training population…III

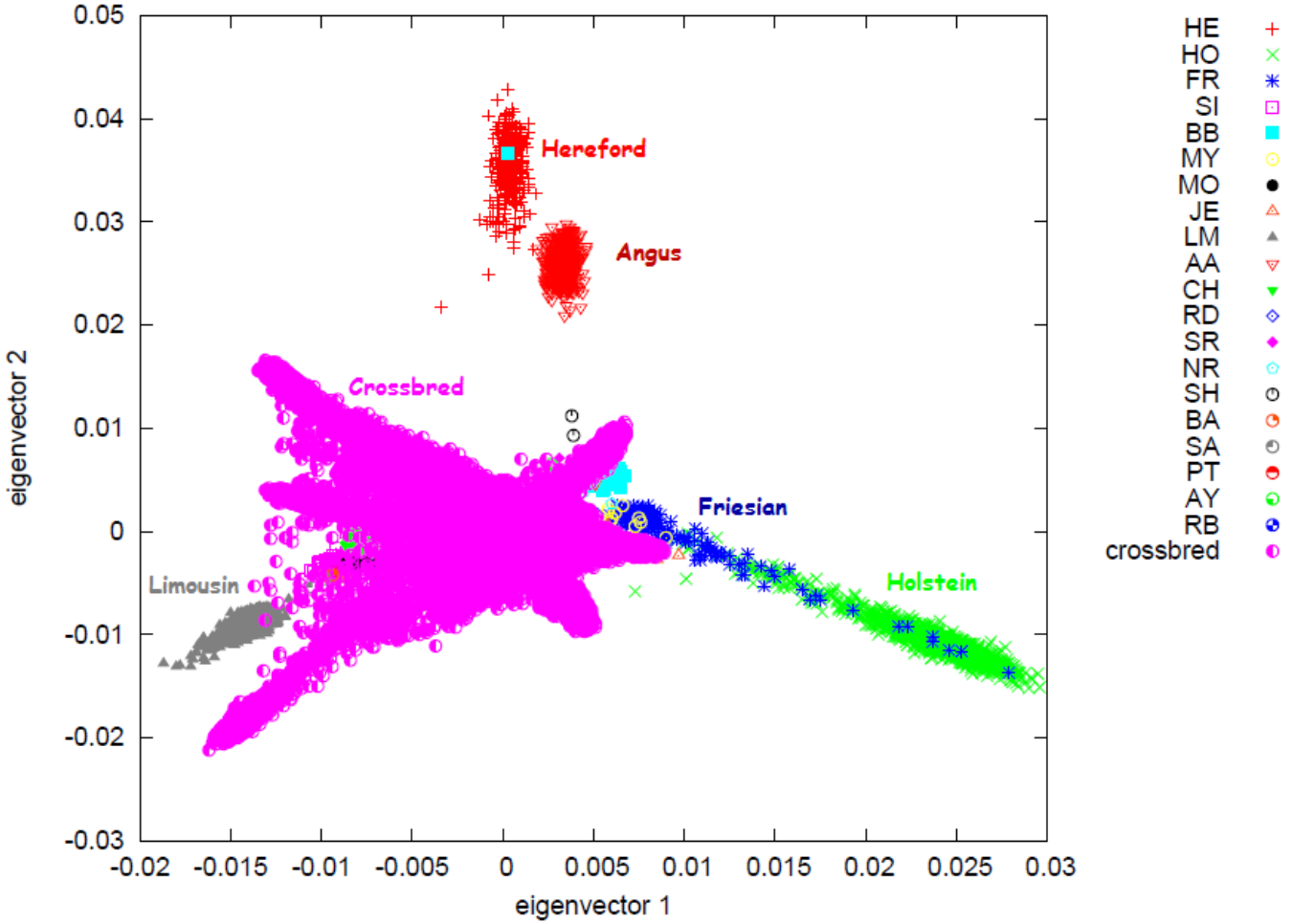
- 120,000 DNA kits sent out (35,000 farmers)
- 111,000 returned
- 90,000 genotyped
  - 21k males (all NS bulls), 69k female (selected for information on milk and fertility)
- Mainly ear tags but some hair cards
- Excellent quality DNA & genotypes (<1% below 90% call rate)

Data

Parity	Proportion
1	16.03
2	6.43
3	8.60
4	10.37
5	12.43
6	12.75
7	10.45
≥8	22.93

	Male		Female	
	Purebred	Pure-equiv.	Purebred	Pure-equiv.
AA	1167	1230	562	4766
AU	124	126	120	385
BA	215	223	34	381
BB	368	443	19	2175
CH	8628	8865	1290	10306
HE	603	636	217	4314
HO	19	76	51	4642
FR	8	19	2	436
LM	7069	7223	1592	13735
PI	42	42	25	160
PT	132	136	43	340
SA	196	204	139	656
SH	134	153	466	2209
SI	968	1026	702	6515

Breed Composition



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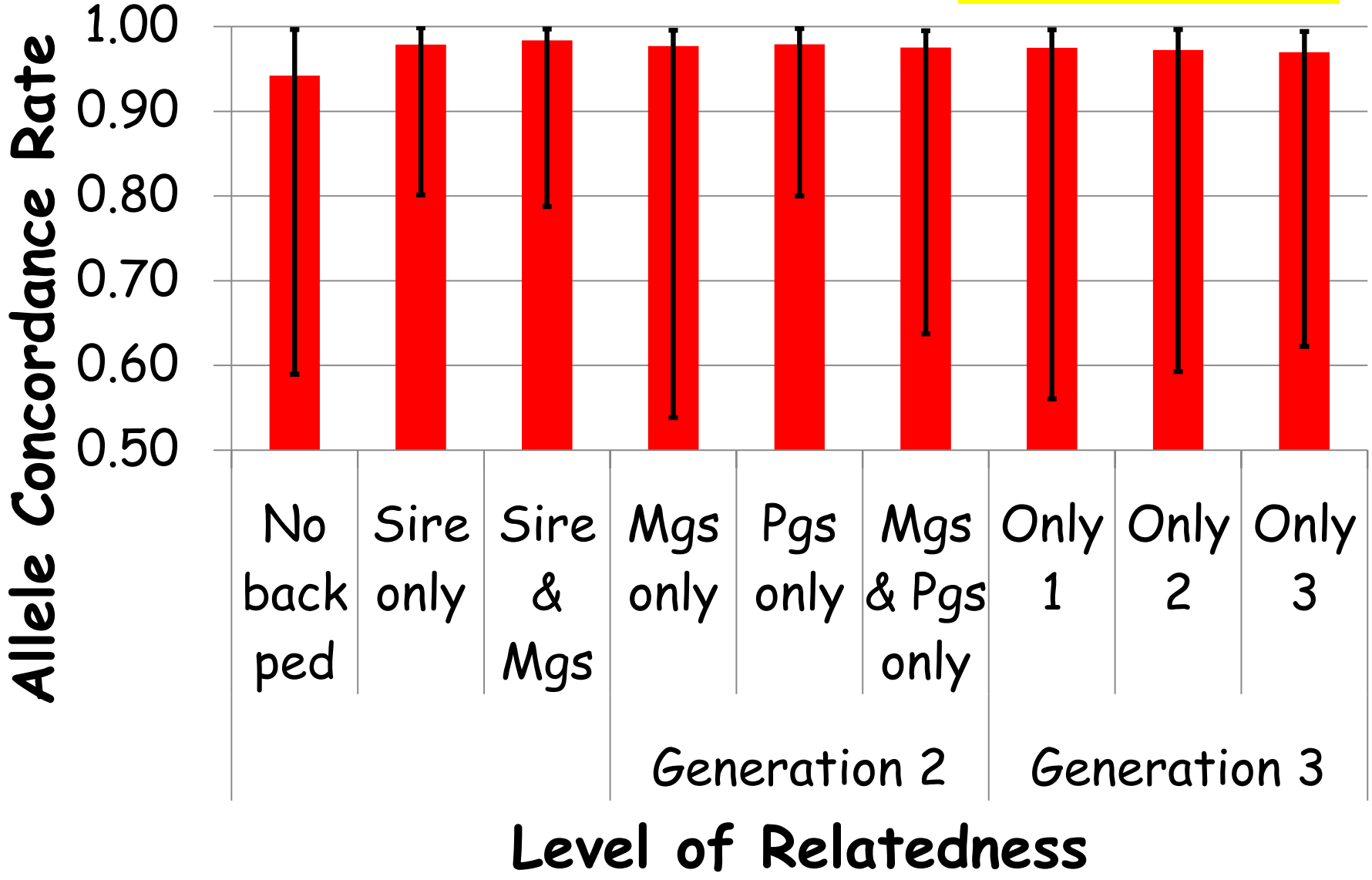
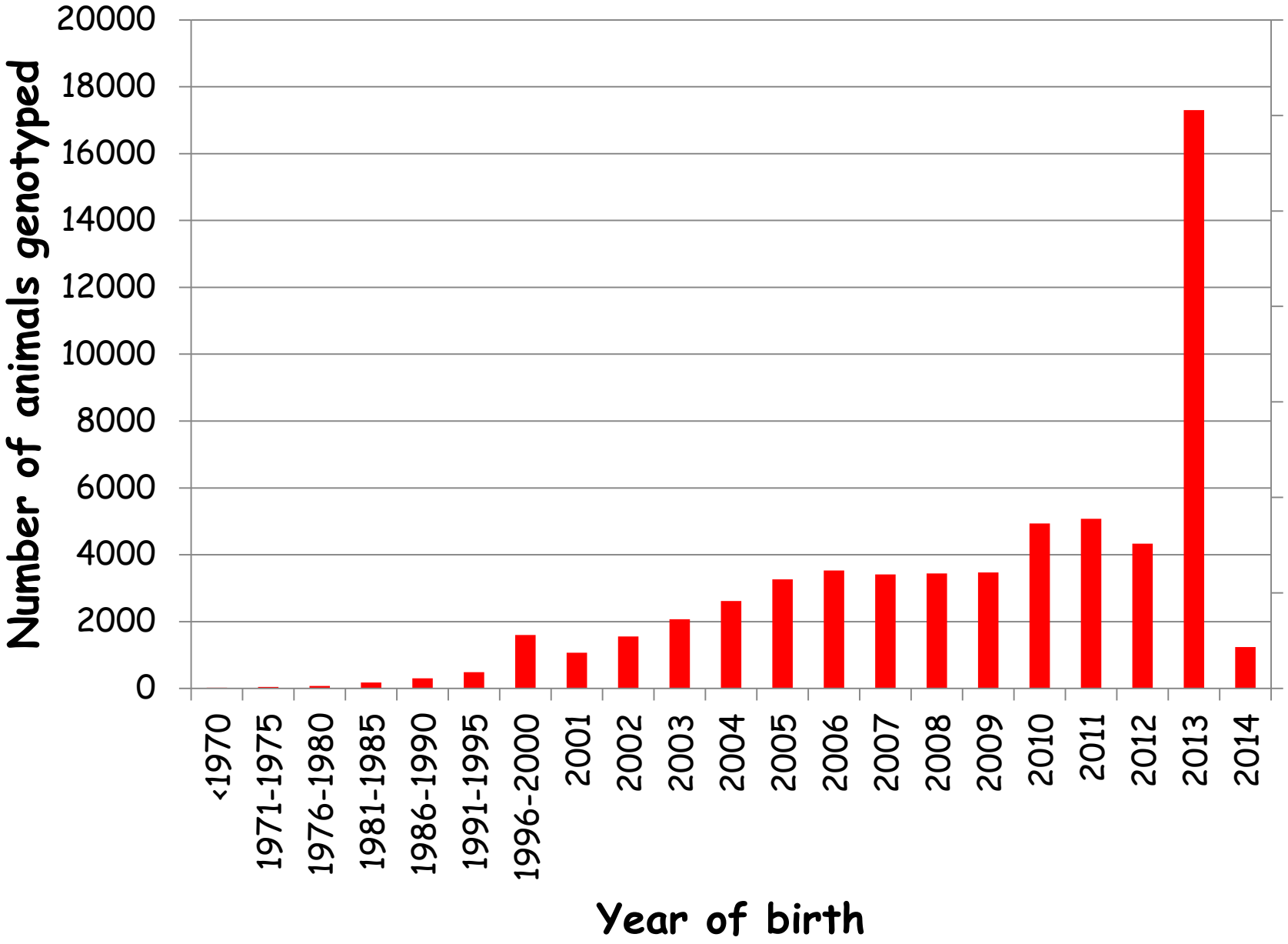
Imputation

97.3% (54%-100%)

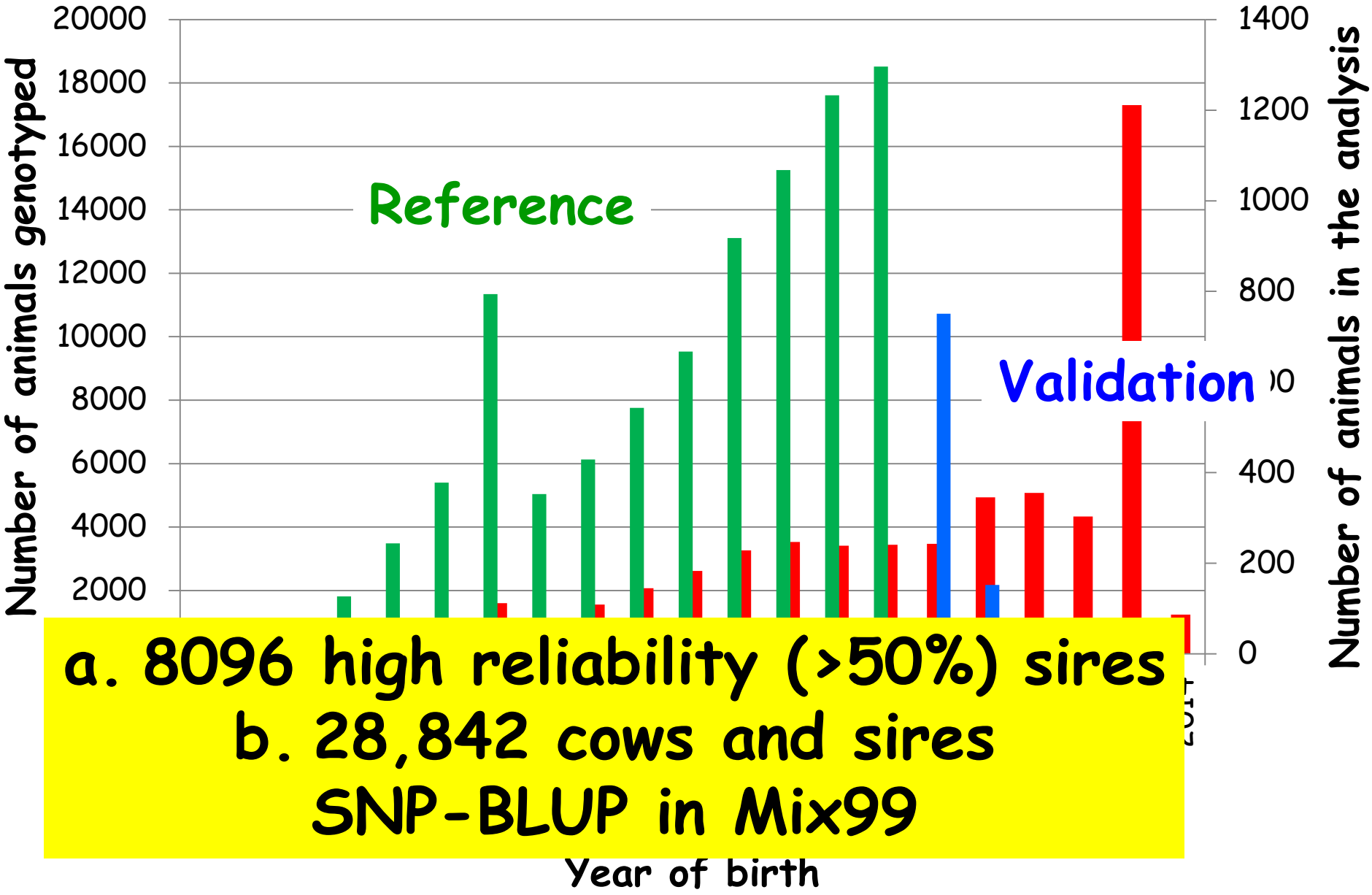


Genotyped animals



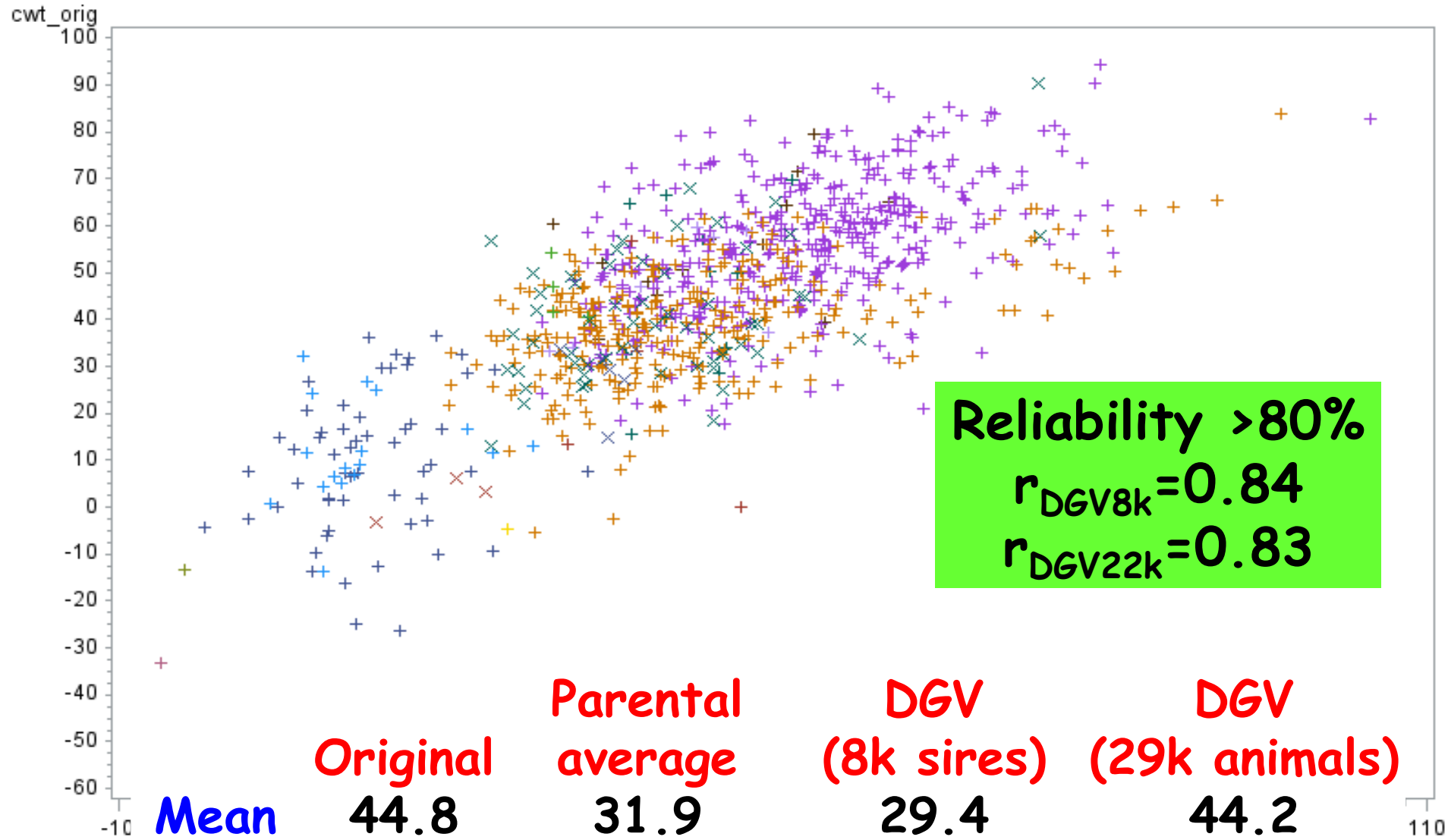
Very Preliminary Results!

Genotyped animals



a. 8096 high reliability (>50%) sires
b. 28,842 cows and sires
SNP-BLUP in Mix99

Carcass weight (n=898; >50% rel.)



	Original	Parental average	DGV (8k sires)	DGV (29k animals)
Mean	44.8	31.9	29.4	44.2
SD	19.5	15.7	14.2	15.9

breed AA AU BA BB CH FR HE HO LM PI PT RM SA SH SI

Within breed carcass weight

Breed		Original	PA	DGV (8000 sires)	DGV (29,000 animals)
CH (n=430)	MEAN	55.85	42.67	41.17	52.36
	STD	13.90	9.89	5.02	11.14
	CORR		0.52	0.45	0.52
LM (n=286)	MEAN	39.29	27.52	24.46	42.42
	STD	11.90	7.25	3.28	13.21
	CORR		0.43	0.27	0.52

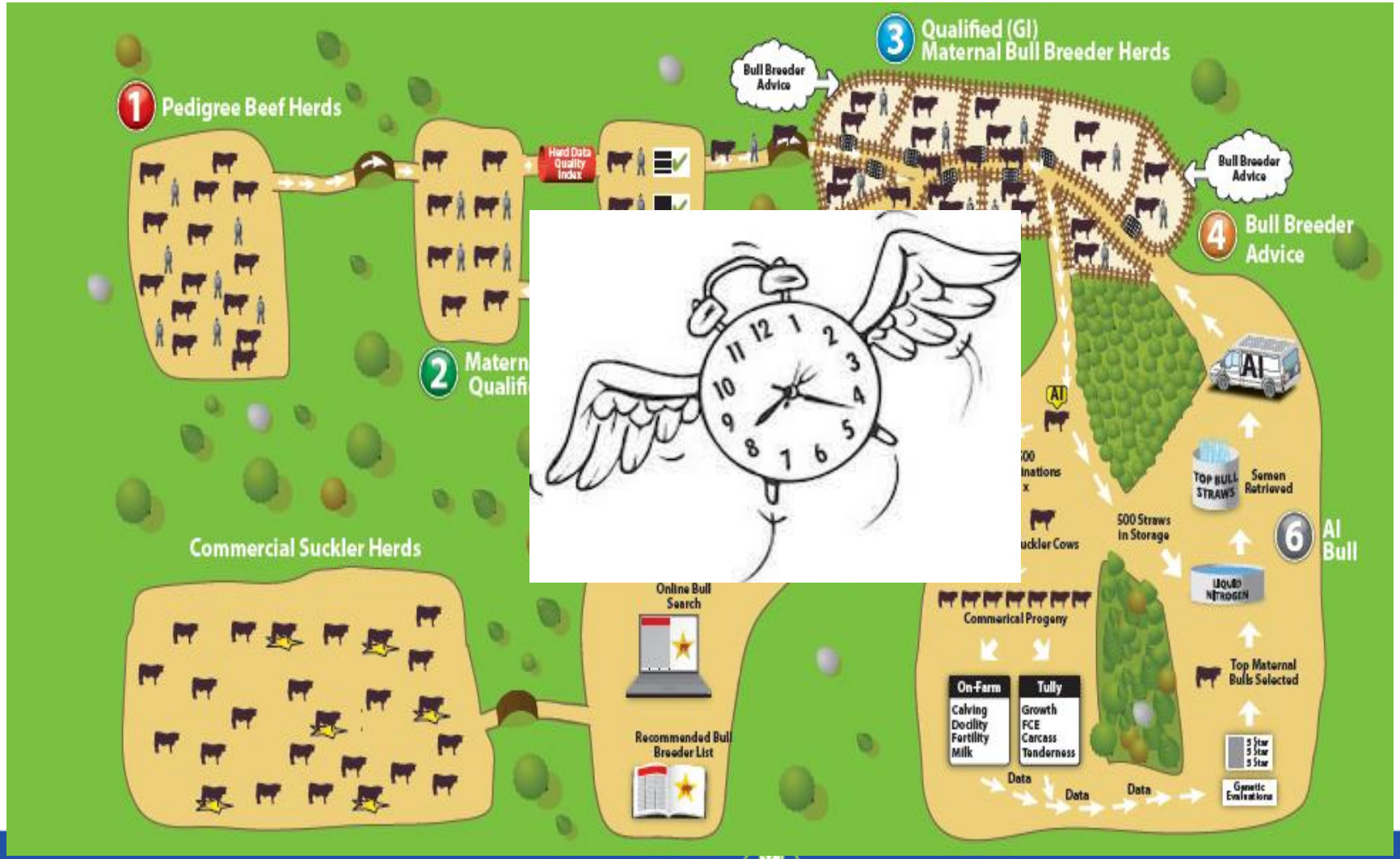
Lots to do!

- Lots of challenges around handling/analysis of data
- Multi breed, small numbers of animals per herd, low heritability traits
- What is best methodology/approach ??
- Scientific advisory committee set up to guide on these issue
- Goal to have GEBVs in mid 2015

Future Plans

- Currently a 6 year Beef Data and Genomics Program being proposed
- Worth ~€50m/year – majority paid to the farmer
- Farmer will be paid €100/calf
  - have to continue to collect relevant breeding data and genotype a proportion of his herd
- Provides a fantastic opportunity to increase genetic gain through the use genomic information

Maternal Breeding Programme



Acknowledgements

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