IRISH CATTLE BREEDING FEDERATION

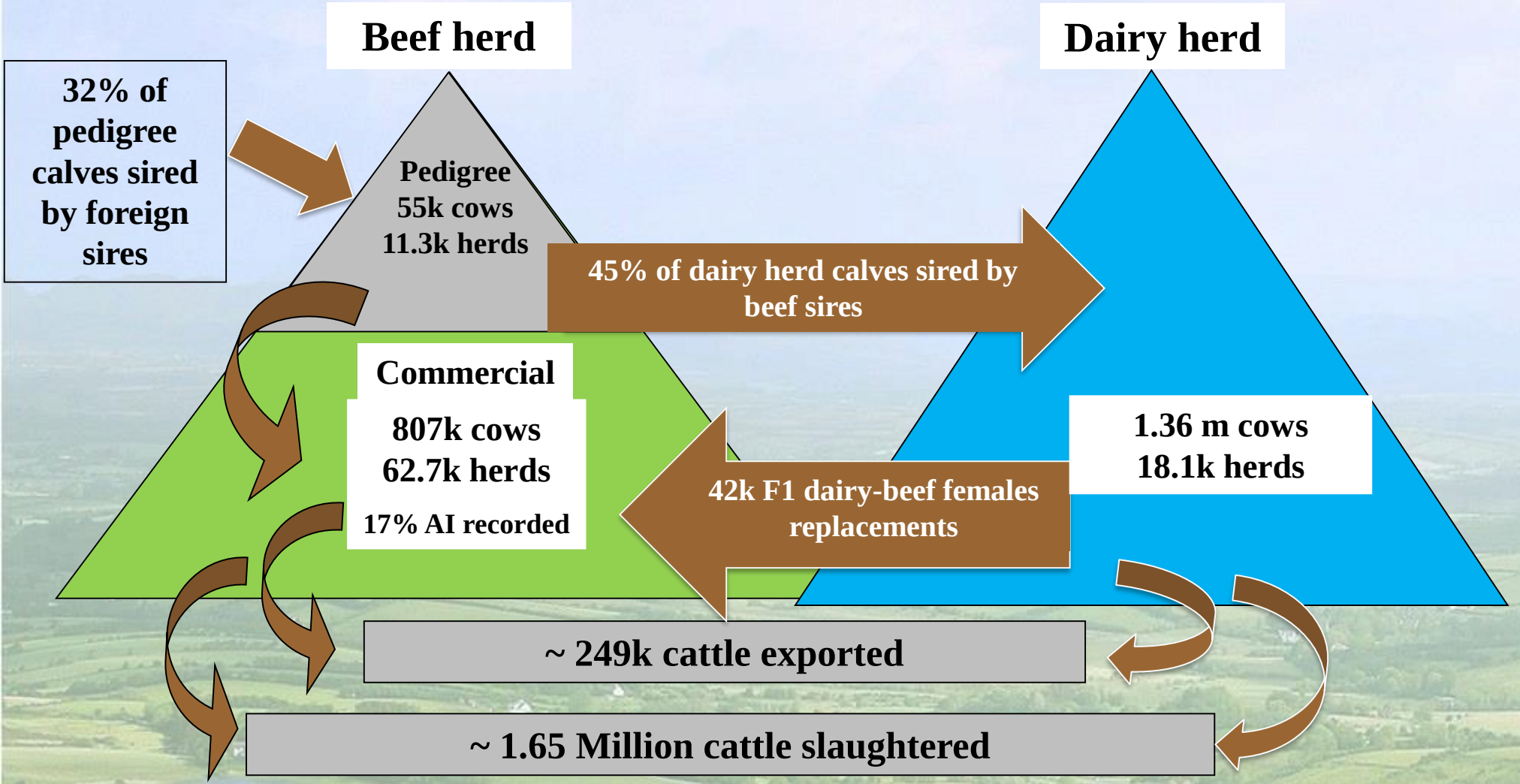
Genomic selection in Irish beef cattle

Ross Evans ICBF

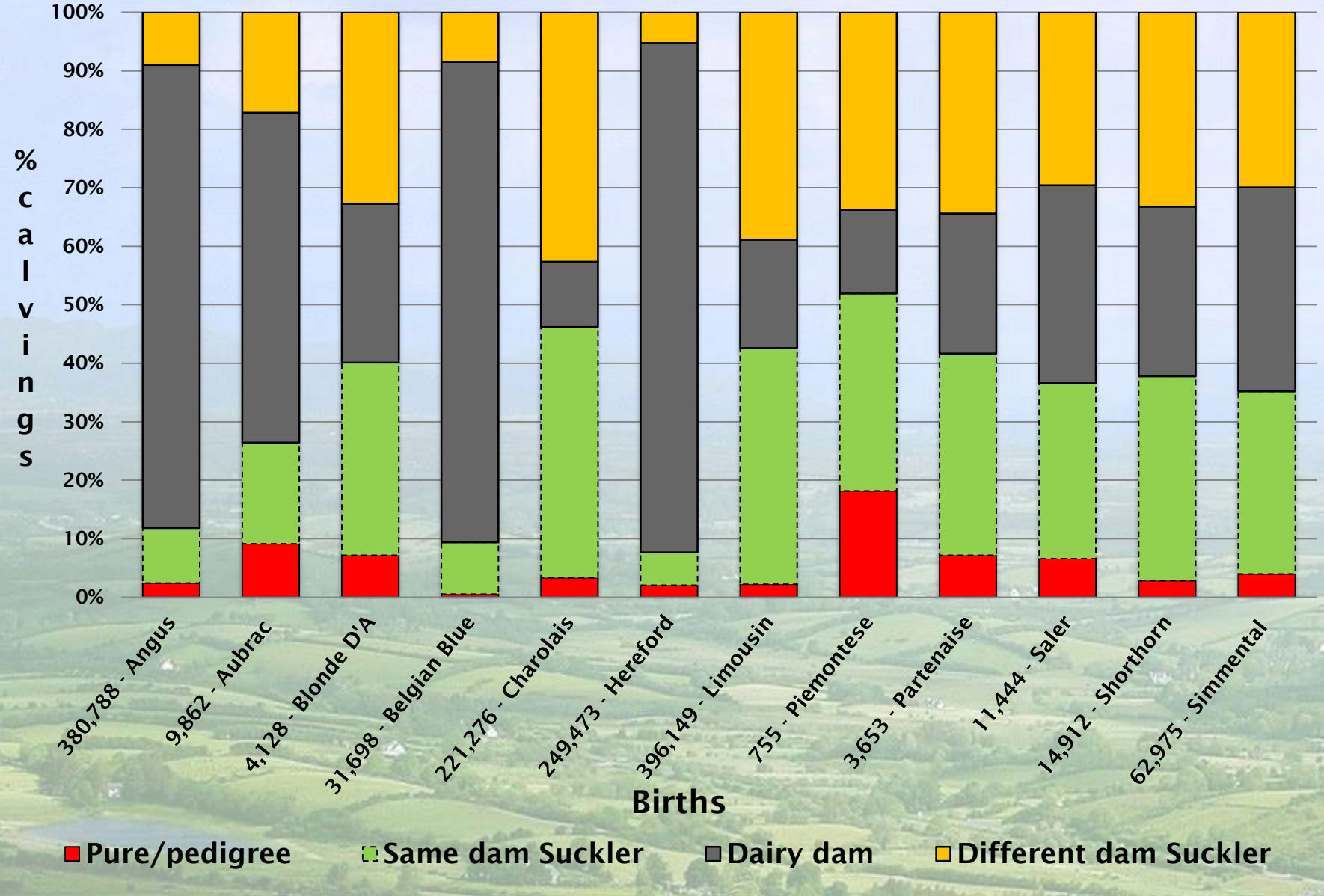
World Charolais Conference - Kilkenny – 08/08/2019

National Development Plan
Transforming Ireland

Overview of the different layers in the Irish beef Industry 2018



Breed Profile of Calves Born 2018

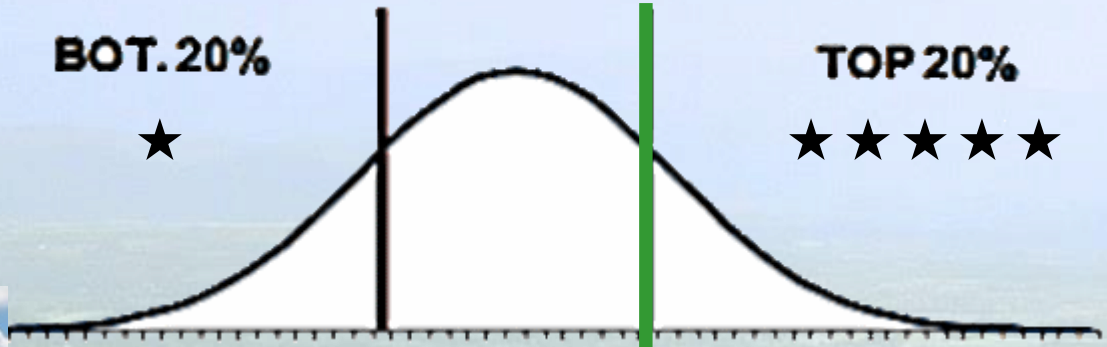


The Beef Genomics Journey

- 2006 +: Genotyping of AI straws (AI, Herdbooks, breeders)
- 2008–2012: Animal Welfare Recording and Breeding Scheme (Govt funded)
  - Sire recording, calving & weanling trait recording & weanling welfare
- 2013-2014: Beef Data Programme (BDP) (Govt funded)
  - Extension of BDP to cow traits
- 2014: Beef Genomics Scheme (BGS) Govt funded
  - 15% of herd genotype requirement
- 2015 - 2020: Beef Data and Genomics Program
  - Co-Funded by Irish Government and EU Rural Development program
  - Breeding Profitable, Sustainable, Carbon efficient cows
  - Farmers paid ~€80/cow/year to complete actions (Reference yr 2014)
- 2017 - 2020: Beef Data and Genomics Program II

Breeding More Efficient Cows

- REPLACEMENT INDEX



- Cows live longer +11%
- More weight at weaning +27kg
- More milk score (1-5) +0.72
- Younger at 1st calving -1.9m
- Reduced calving Int. -20d
- No extra gain in carcass weight

Estimated reduction -0.009kg CO_2/kg meat per breeding cow per year for a €1 increase in replacement index

Main Requirements

1. Commitment to stay for duration of scheme
2. Calf surveys: calving difficulty, calf size
3. Cow surveys: docility, milk
4. Genotyping 60% of animals / year
5. Replacement strategy: 50% females indexed 4 or 5 stars + (if any) 1bull 4 or 5 stars
6. Carbon navigator
7. Training

Participation

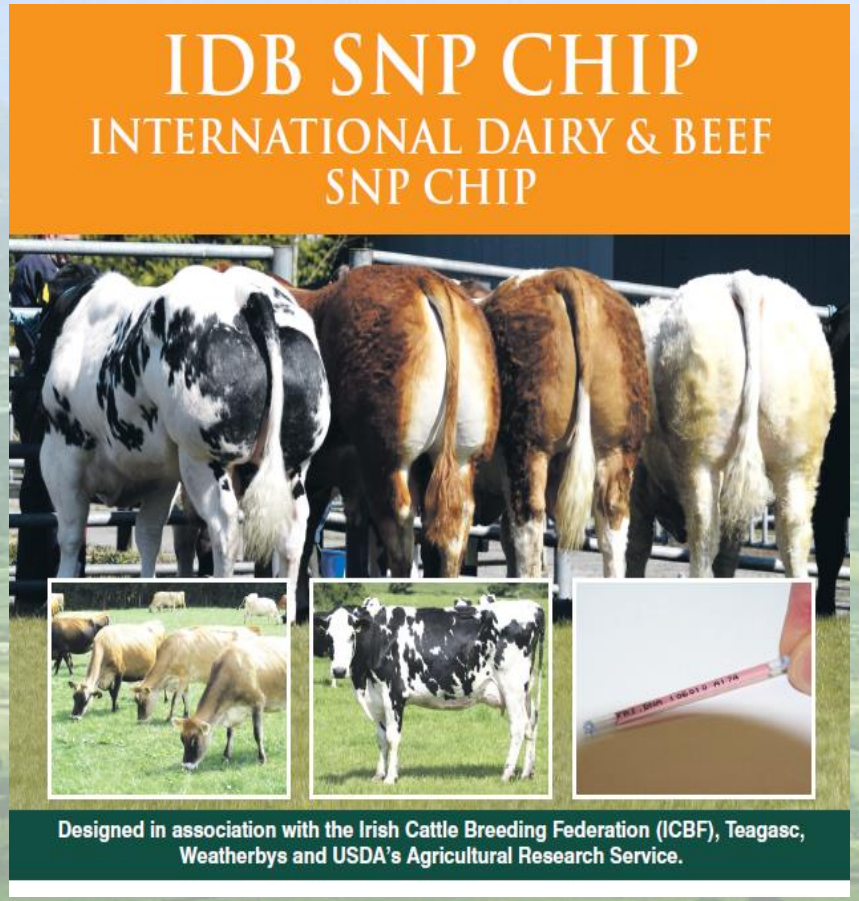
- Total signups BDGP 1: 29,889 herds
- Currently Active BDGP 1: 22,944 herds (77%)

- Total signups BDGP 2: 1,811 herds
- Currently Active BDGP 2: 1,489 herds (82%)

- Circa 400 herds merged into farm partnerships

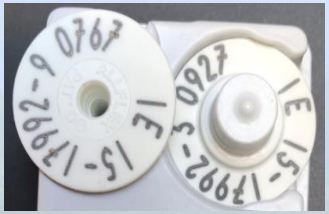
Genotyping Chip

- BDGP scheme: public EU tenders for
  - ✓ SNP chip provision
  - ✓ Lab services: DNA extraction, genotype reporting



- Developed in Ireland
- 54,000 SNPs
- 160 Major genes/defects
- Imputation SNPs
- Microsatellite imputation SNPs
- 800 Parentage SNPs
- V1 to V3 - Illumina platform
- V4 - Thermofisher platform
- Lab services
  - ➢ Weatherbys Ireland
  - ➢ Eurofins Denmark

Choice of DNA sampling method Biological sample failure rates



Sample type	Count	% Fail (Call rate <90%)
Ear punch	92,868	2.46%
Tail Hair	15,518	4.18%
Semen	309	16.80%
BVD diluent	341	20.50%

* The overall call rate of a sample is equal to the number of SNPs receiving an AA, AB, or BB genotype call divided by the total number of SNPs on the chip.

Selection of animals in BGS

- Farmers were required to genotype 15% of cows (100k)
- Algorithm developed to identify most informative animals to develop genomic selection
- Based on quantity of data and divergence

$$\text{Data Quantity} = WT_{CIV} \cdot \sum_{i=1}^{3} \text{Info\_CIV}_i + WT_{MILK} \cdot \sum_{i=1}^{3} \text{Info\_MILK}_i + WT_{CALVING} \cdot \sum_{i=1}^{3} \text{Info\_CALVING}_i + WT_{CARCASS} \cdot \sum_{i=1}^{3} \text{Info\_CARCASS}_i$$

$$\text{Divergence} = WT_{CIV} \cdot |\widetilde{\text{Diverge}_{CIV}}| + WT_{MILK} \cdot |\widetilde{\text{Diverge}_{MILK}}| + WT_{CALVING} \cdot |\widetilde{\text{Diverge}_{CALVING}}| + WT_{CARCASS} \cdot |\widetilde{\text{Diverge}_{CARCASS}}|$$

$$\text{INDEX} = 0.66 \cdot \widetilde{\text{Quantity}} + 0.33 \cdot |\widetilde{\text{Divergence}}|$$

$$Sire_{LIMIT} = 10 + \left(\frac{(1 - reliability)}{2} * 100\right)$$

BDGP Genotyping process

Farmer option to change online

Genotypes

ICBF.com

Selection algorithm: identify and prioritise animals for genotyping within herd

Empty sample: hair card

Lists sent to TAG providers

Priority based on urgency of sample e.g. AI, pedigree

SMS TEXT

Barcode tracks sample

Mullinahone Co-op Est. 1893

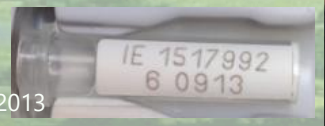
DATAMARS

CormacTagging

3-4 week turnaround

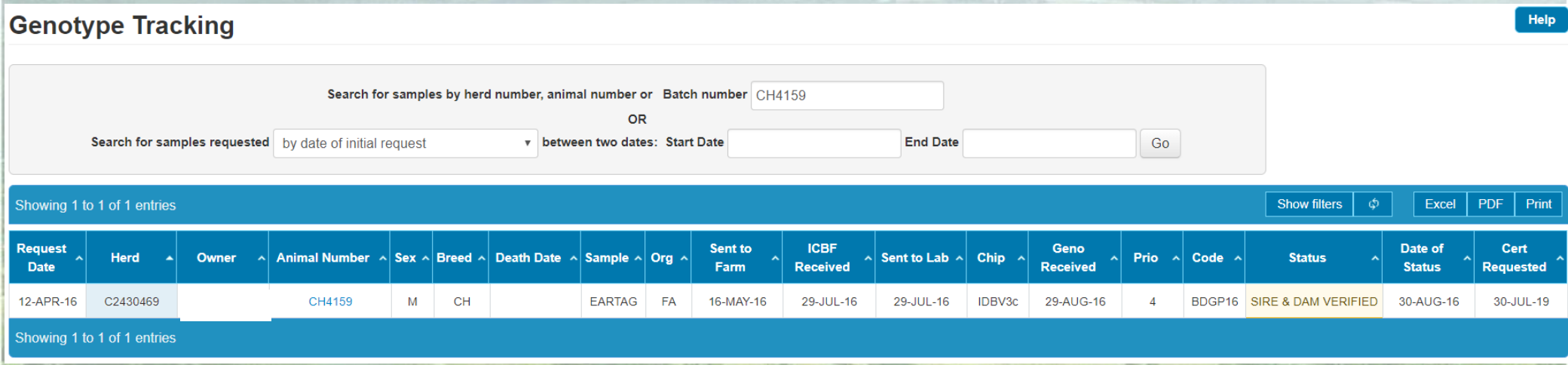
WEATHERBYS

eurofins



ICBF genotype QC process

- Genotype call rate check (>90%)
- Sex check
- Breed composition check
- Duplicate check
- Parentage check (ISAG 200 parentage SNPs + 600 ICBF)
- Checks complete: Genotype is validated for further use



Genotype Tracking

Help

Search for samples by herd number, animal number or Batch number CH4159

OR

Search for samples requested by date of initial request between two dates: Start Date End Date Go

Showing 1 to 1 of 1 entries

Show filters Excel PDF Print

Request Date	Herd	Owner	Animal Number	Sex	Breed	Death Date	Sample	Org	Sent to Farm	ICBF Received	Sent to Lab	Chip	Geno Received	Prio	Code	Status	Date of Status	Cert Requested
12-APR-16	C2430469		CH4159	M	CH		EARTAG	FA	16-MAY-16	29-JUL-16	29-JUL-16	IDBV3c	29-AUG-16	4	BDGP16	SIRE & DAM VERIFIED	30-AUG-16	30-JUL-19

Showing 1 to 1 of 1 entries

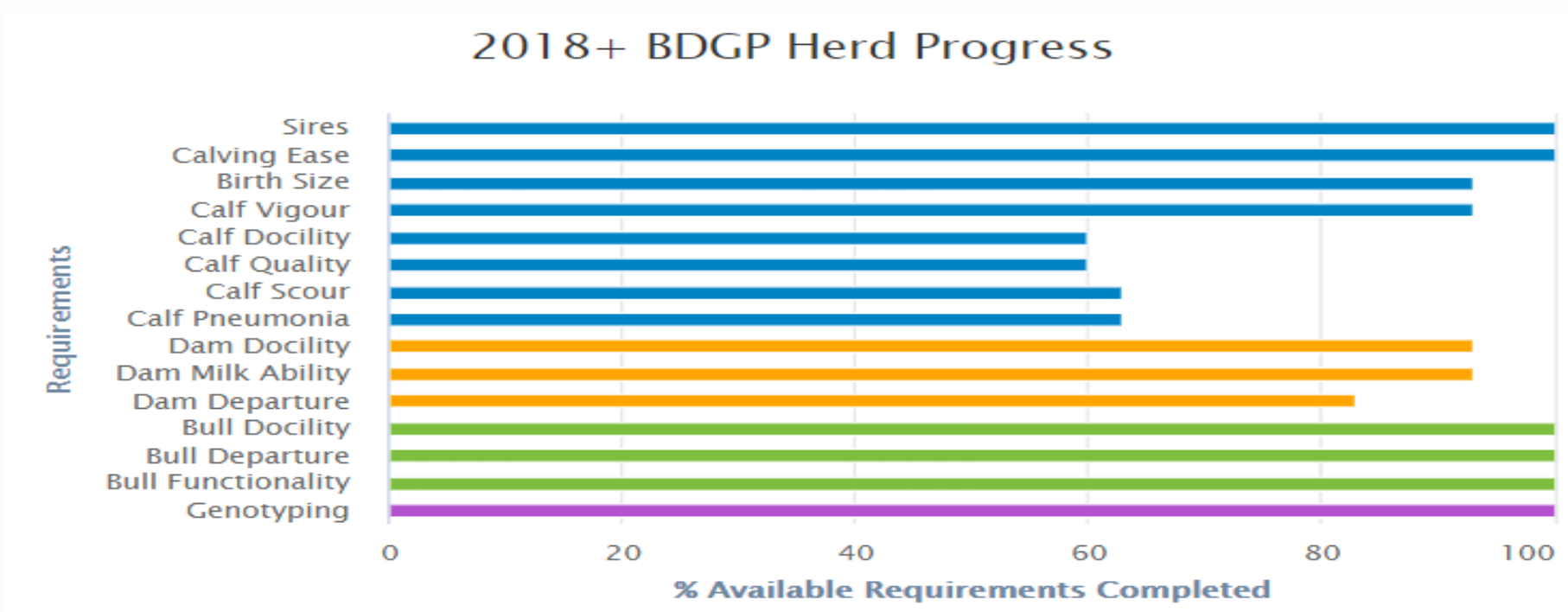
Parentage verification/prediction

Categories	Commercial	Pedigree	Ped Charolais
Number	1,499,259	277,328	48,186
Genotyped sire	68%	84%	87%
Sire to offspring conflict	14%	5%	5%
Sire changed	15%	6%	6%
Predicted sire where unknown	6%	1%	1%
Genotyped dam	51%	42%	42%
Dam to offspring conflict	6%	2%	2%

*Stats July 2019

BDGP Herd progress

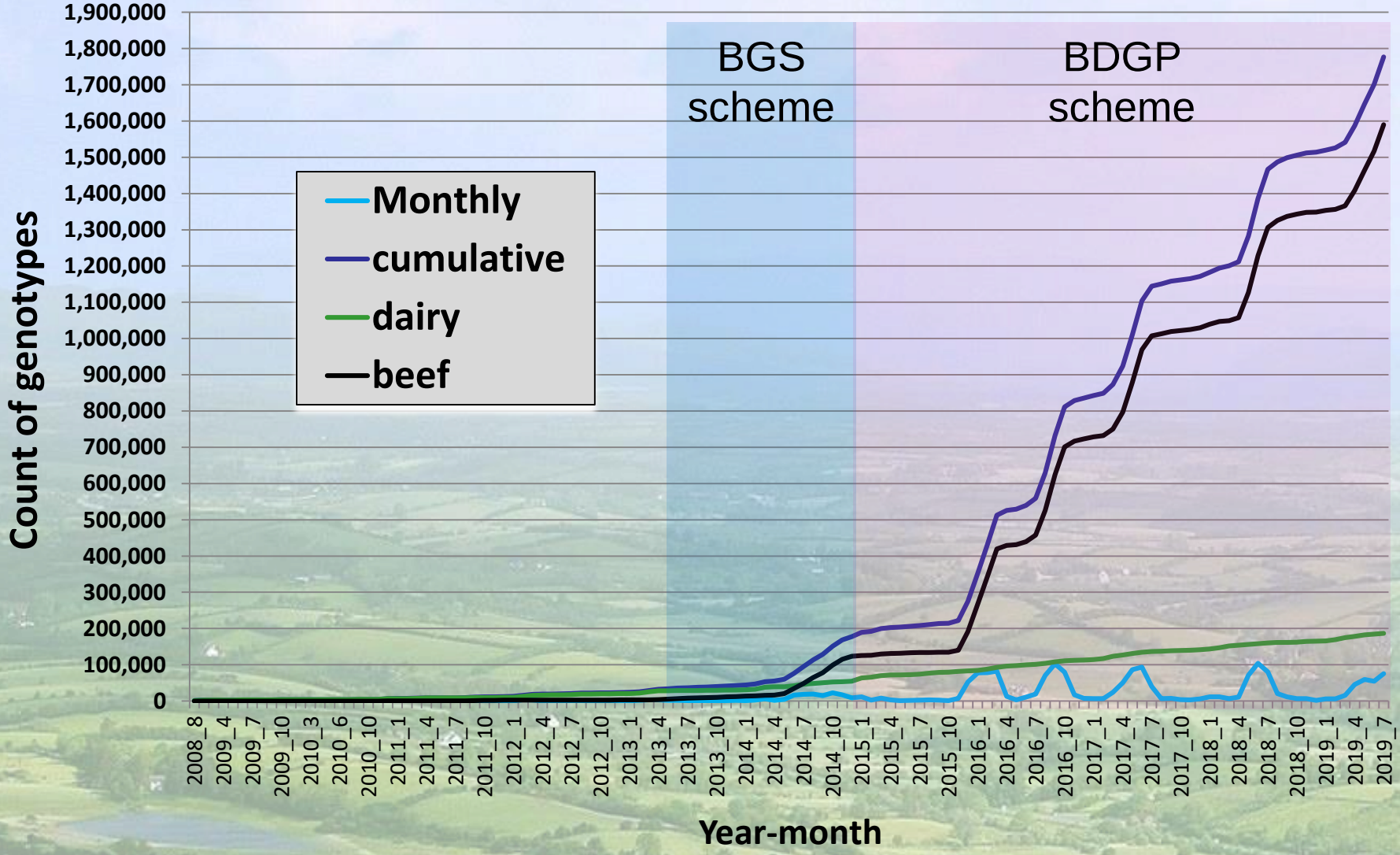
BDGP | Young Stock Recording | Dairy EBI | Beef €uro-Star | Health | Fertility



Carbon Navigator: **2018 Completed**

BDGP Replacement Strategy Requirements						
1. Females		2. Stock Bulls		3. AI Requirement		
2018	2020	2019	2020	2017/2018	2018/2019	2019/2020
✓	✓	✓	✓	✓	✓	

Genotype levels



Characteristics of Genotyped animals

Main Breed	Angus	Belgian Blue	*Charolais*	Hereford	Holstein	Limousin	Simmental	Other
Total	169,617	57,070	***367,998***	95,132	158,624	543,700	124,326	135,203
AI sires	306	313	***506***	223	2,904	509	378	1,465
Natural service sires	10,029	1,294	***20,797***	5,646	11,852	21,024	3,713	7,206
Cows	83,180	34,542	***146,905***	53,494	66,982	277,302	83,289	78,530
Non parent Males	13,577	2,083	***24,236***	8,026	60,370	29,535	6,320	14,938
Non Parent Females	62,556	18,862	***175,572***	27,765	16,703	215,352	30,694	33,200
Pedigree registered	34,010	2,608	***51,624***	20,389	24,702	63,328	16,769	23,451
Single Breed Non ped	4,914	1,474	***27,328***	3,707	5,415	37,238	11,897	8,245
Multi-breed	130,693	52,988	***289,046***	71,036	128,507	443,134	95,660	103,507
Sired by AI	53,470	36,967	***82,962***	23,115	114,324	151,985	35,788	45,778
Known sire	143,162	50,226	***324,791***	73,010	136,052	477,897	104,832	115,904
Sire is also genotyped	105,033	45,468	***270,393***	50,676	121,996	391,426	78,886	84,600
Dam is also genotyped	68,374	18,516	***200,372***	23,417	34,672	285,794	53,742	59,119

Development of genomic evaluations

- Scientific Advisory Committee established

Esa Maantasari
Ismo Stranden

Roel Veerkamp
Jeremie Vandeplas
Jan te Napel

Theo Meuwissen

Peter Amer

Dorian Garrick

Donagh Berry

- Tasked with guidance in the rollout of genomic selection
  - Computation Methods: GBLUP, SNPBLUP, Single step
  - Validation

Genomic Evaluations

Chip	SNPs	%
3K	3k	0.19%
LD	7k	1.28%
HD	49K	0.38%
50K	50k	2.18%
HD	780k	0.38%
IDBv1	10k	2.28%
IDBv2	18k	14%
IDBv3	53k	79%

Univariate evaluations
n = 16 goal traits

EBV

Reliability

Genotypes

Impute to 50k in FIMPUTE

De-regression of EBVs Weighted by ERC

ERC calculation Identify Training population

SNP BLUP
DBV weighted by ERC
Random regression coeff matrix
Common marker σ^2 Σ2pq

7 multi-trait evaluations
63 traits
Calving, Beef, Milk, Fertility, Docility

DGV

PA from genotyped ancestors using traditional relationships

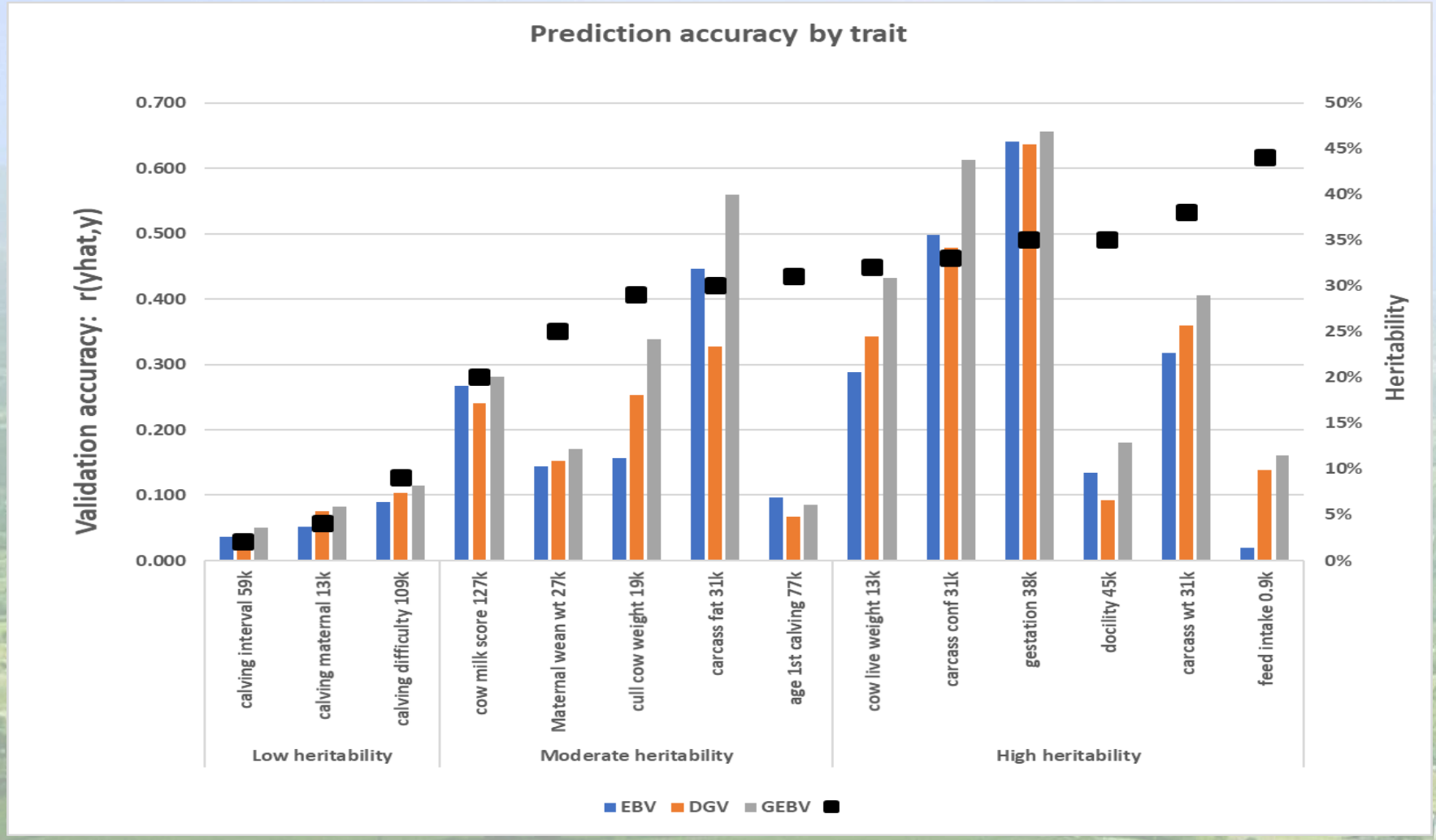
Published GEBV: Blending using selection index methodology
(Van Raden et al. 2009)

Influence in SNP training: CH

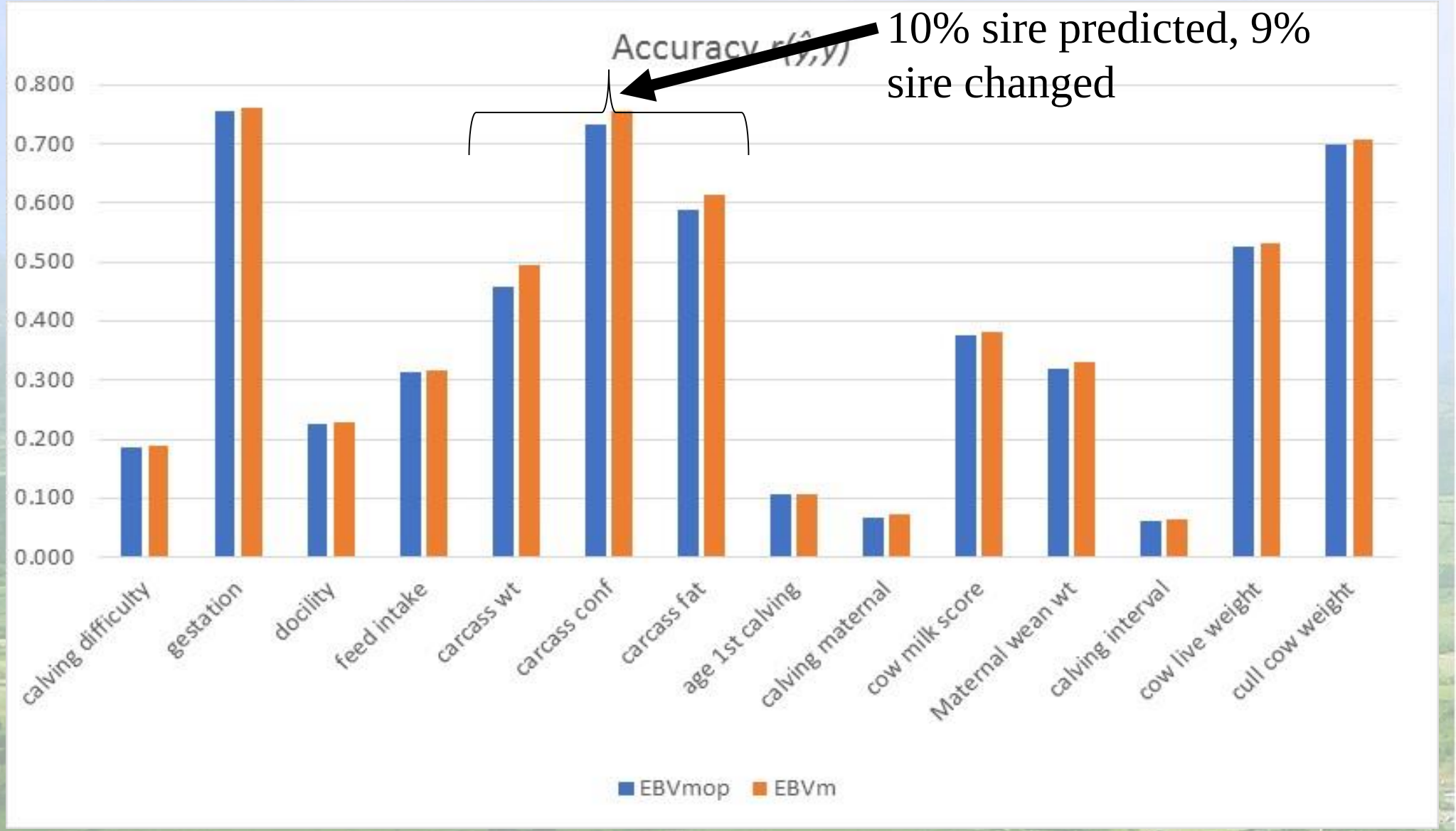
Trait	Category	count	avg_ERC	max_ERC	Total ERC
calving difficulty	AI sires	421	322	9,420	135,543
calving difficulty	Natural service sires	16,372	16	134	261,461
calving difficulty	Cows	17,979	3.5	11	64,234
carcass weight	AI sires	405	164	4,668	66,232
carcass weight	Natural service sires	14,942	8	74	118,229
carcass weight	Cows	32,338	1.1	6.6	33,925
maternal weaning wt	AI sires	250	34	877	8,497
maternal weaning wt	Natural service sires	378	2.0	11.5	754
maternal weaning wt	Cows	43,126	4.0	10	173,374
calving interval	AI sires	282	193	5,036	54,402
calving interval	Natural service sires	950	6.7	95	6,341
calving interval	Cows	69,383	5.9	18	411,081

Does genomics work?

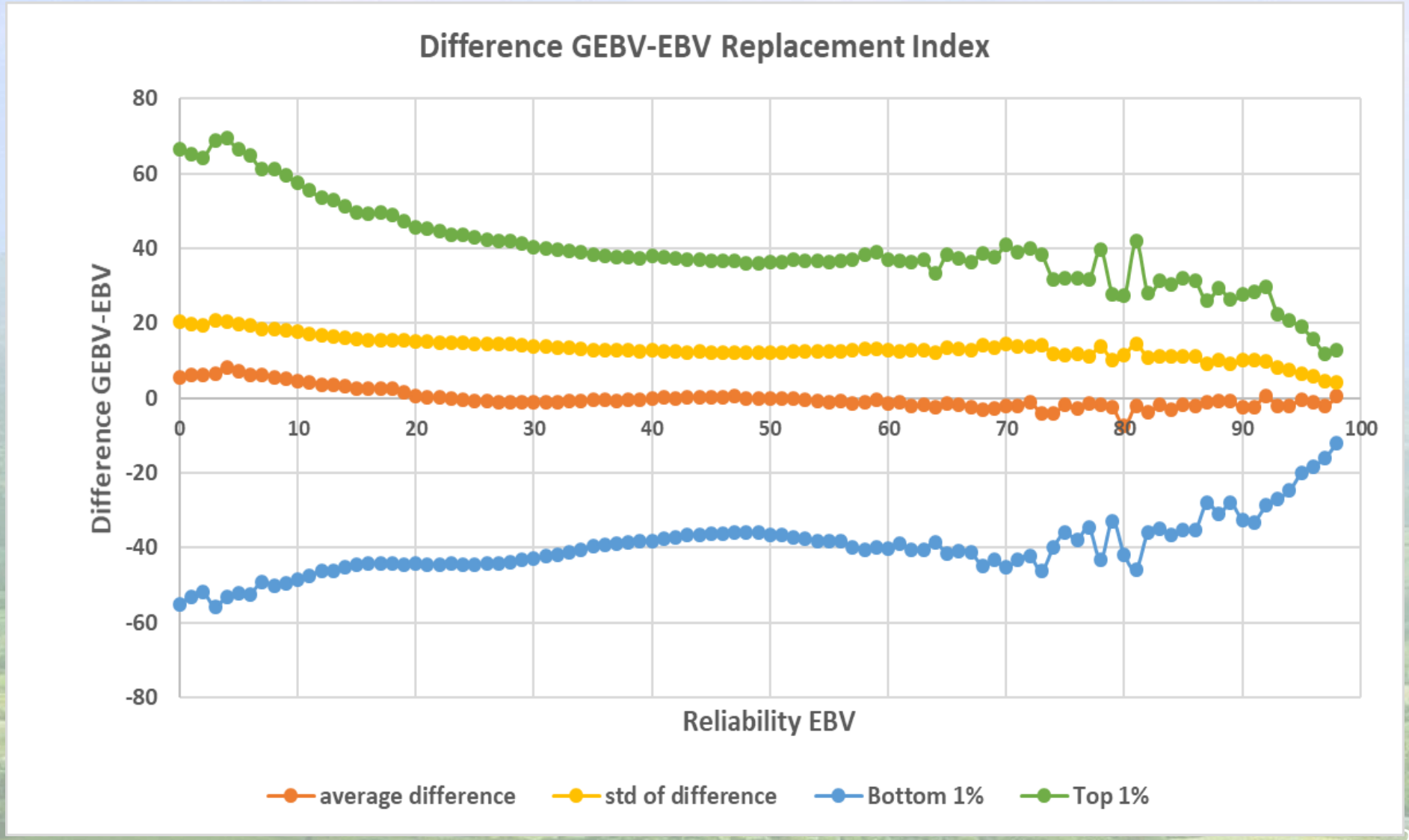
- Forward prediction: 33% of phenotypes from animals with genotypes omitted
- Phenotype corrected for breed and evaluation fixed effects
- Then correlated with validation EBV, DGV and GEBV (without breed)



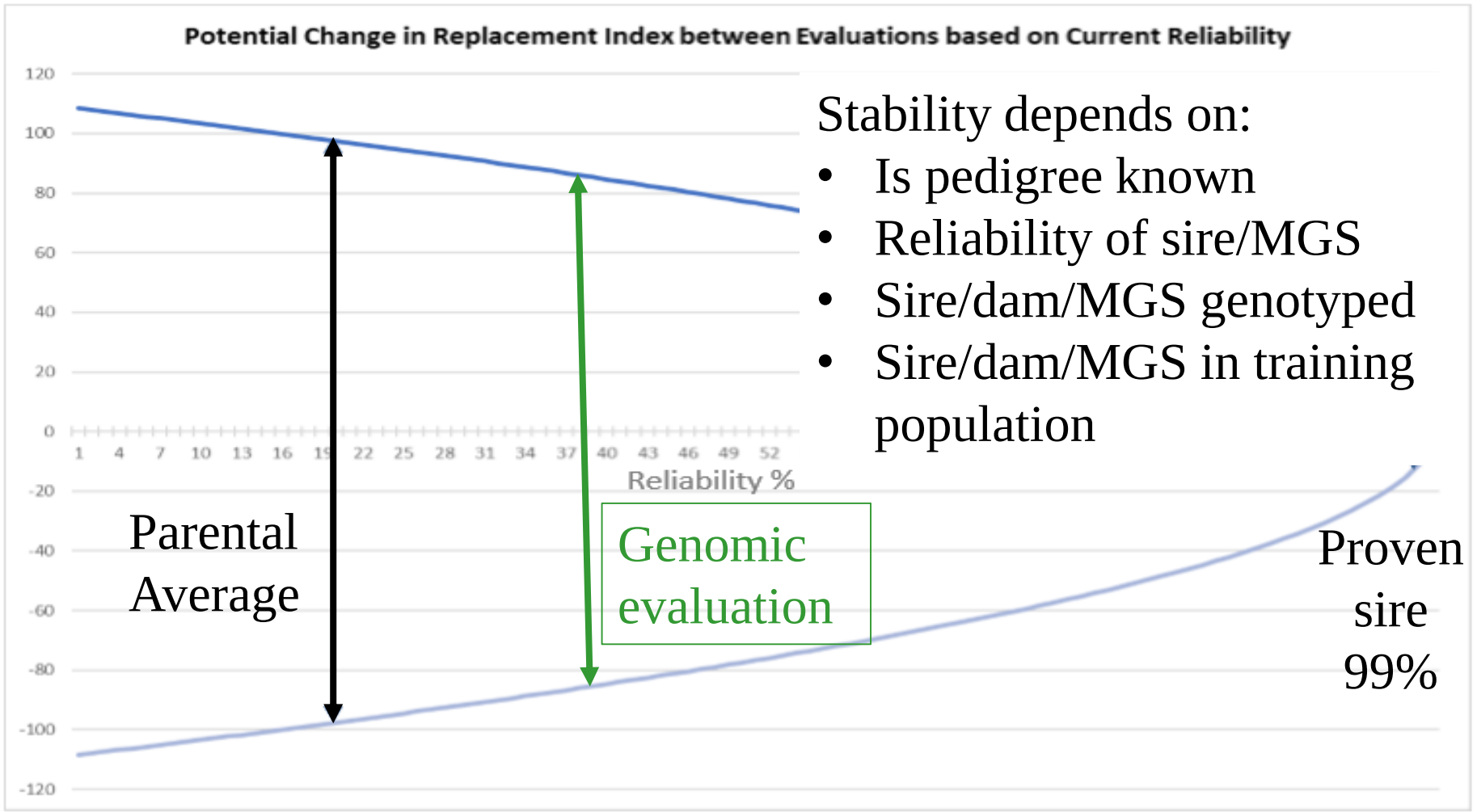
Benefit of correcting pedigree
160k ancestry changes



Impact of genomics by reliability



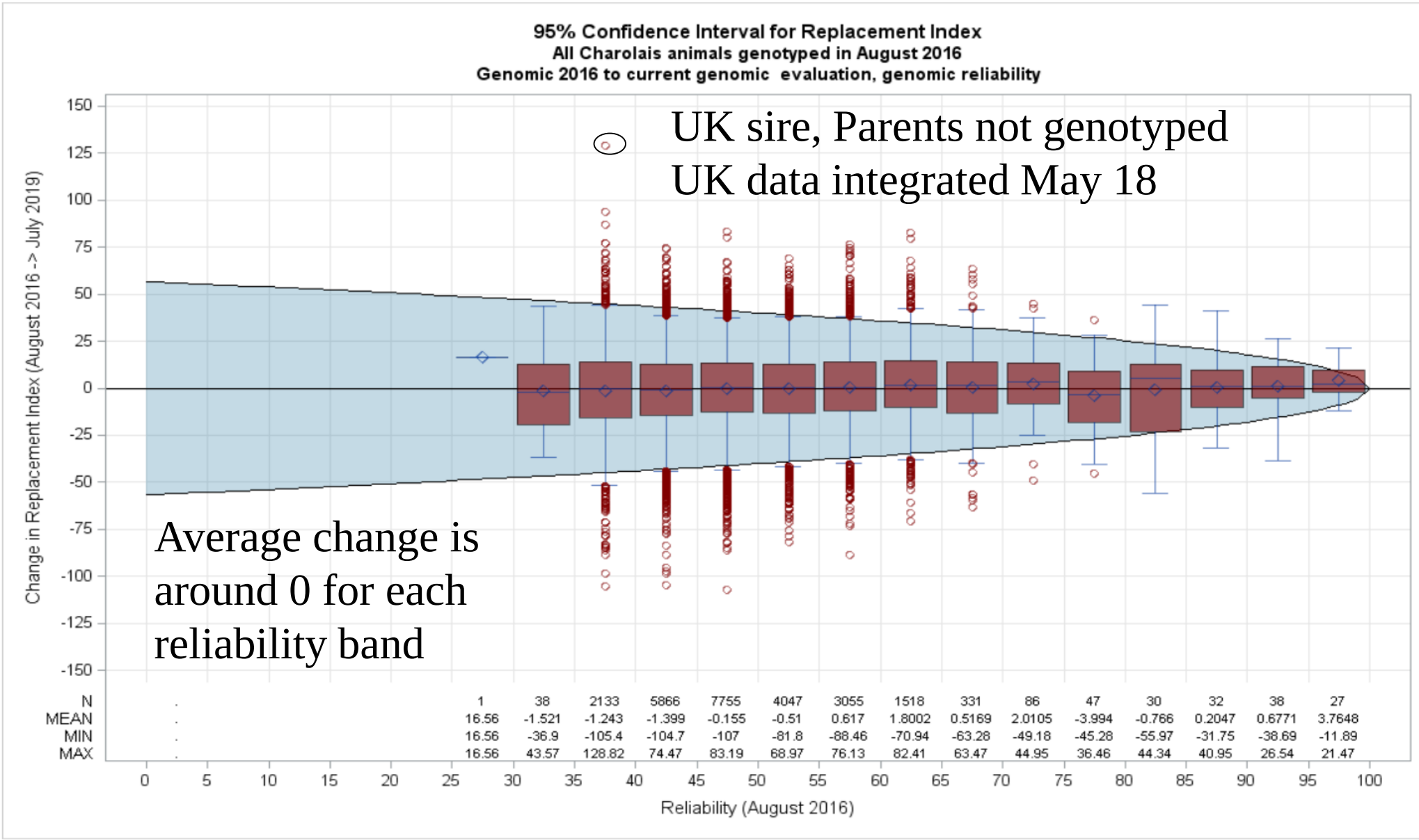
Stability of first GEBV



Stability depends on:

- Is pedigree known
- Reliability of sire/MGS
- Sire/dam/MGS genotyped
- Sire/dam/MGS in training population

In Reality


95% Confidence Interval for Replacement Index
All Charolais animals genotyped in August 2016
Genomic 2016 to current genomic evaluation, genomic reliability
UK sire, Parents not genotyped
UK data integrated May 18
Average change is around 0 for each reliability band
Change in Replacement Index (August 2016 -> July 2019)
Reliability (August 2016)
N 1 38 2133 5866 7755 4047 3055 1518 331 86 47 30 32 38 27
MEAN 16.56 -1.521 -1.243 -1.399 -0.155 -0.51 0.617 1.8002 0.5169 2.0105 -3.994 -0.766 0.2047 0.6771 3.7648
MIN 16.56 -36.9 -105.4 -104.7 -107 -81.8 -88.46 -70.94 -63.28 -49.18 -45.28 -55.97 -31.75 -38.69 -11.89
MAX 16.56 43.57 128.82 74.47 83.19 68.97 76.13 82.41 63.47 44.95 36.46 44.34 40.95 26.54 21.47

Current research

- Single step evaluations
  - Algorithms and knowledge have developed in last 2 years
  - Currently testing on new calving evaluation with SAC partners
- Interbeef
  - 8 countries participating: currently calving, weaning
  - Integration of data into Irish evaluations
- New traits/indexes
  - Dairy Beef index
    - Specific calving traits: Dairy heifer, Dairy Cow, Beef heifer, Beef cow
    - Specific beef traits: Dairy herd carcass, Beef herd carcass
  - Meat Eating Quality
  - Whole Herd Performance cow traits: udder, functionality, skeletal
  - Cow intake: Greenbreed on farm project
  - Carbon emissions: Greenfeed boxes in Tully performance centre
- Sire advice
  - Genomic inbreeding, genetic defects, major genes (myostatin)
  - Beef on the Dairy herd: expanding market


Thanks for listening!

Our Farmer & Government Representation

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

Irish Creamery Milk Suppliers Association

IFA

Our AI & Milk Recording Organisations

Dovea GENETICS

munster cattle breeding group

Progressive Genetics

Tipperary Co-op

Our Herdbooks

Ayrshires Cattle Society of Great Britain and Ireland

The Aberdeen-Angus Cattle Society

IBBCS

EASBB

Irish Aubrac

Blonde d'Aquitaine

Irish Charolais Cattle Society

Irish Hereford

IHFA

Irish Limousin Cattle Society

Parthenais

Irish Piemontese Society

Irish Shorthorn Society Ltd.

Simmental

ISP

Irish Cattle Breeders

Ireland's Native Dairy Breed

Montbeliarde

MRI Cattle Society of Ireland
Meuse Rhine Issel -- Milk & Muscle!

Norwegian Red Cattle Society

Salers Cattle Society of Ireland Ltd.

Acknowledging Our Members