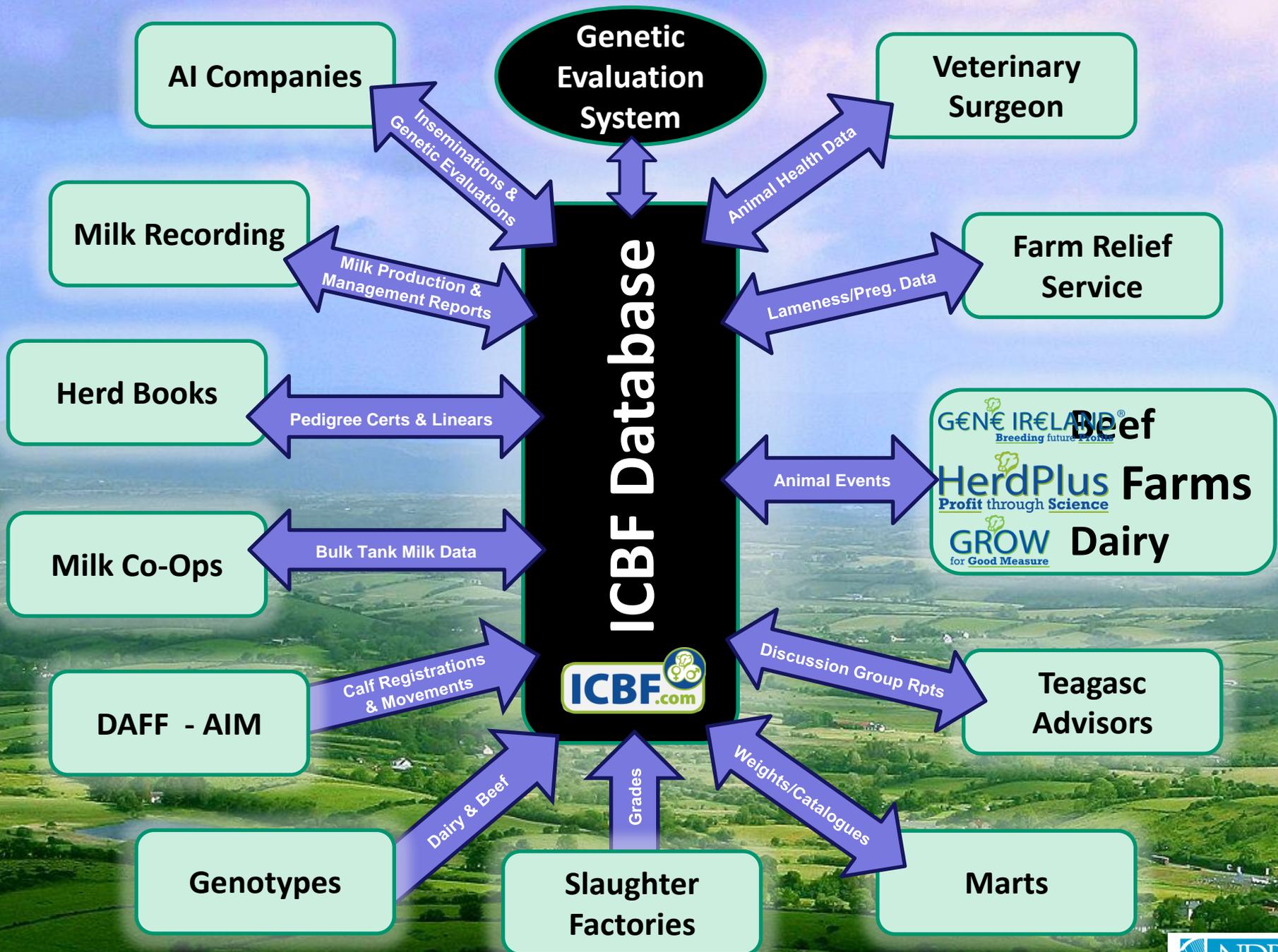# Application of Genomic Selection in Dairy Cattle
## Francis Kearney ICBF, Donagh Berry Teagasc

Background

- ~1.2 million dairy cows (and growing)

  - 95% Hol/Fr with small levels of crossbreeding

- Seasonal calving (90% calve in spring)

- Maximise use of grazed grass

- Calving dates optimised with turnout to grass

- A+B-C system of milk payments

- Fertility is essential

- EBI – based on Bio-economic farm model developed by Teagasc - breeding index to deliver more profitable animals on farm

2014 Economic values and % emphasis for traits in the EBI

| Sub-Index	Trait	Economic Weight	Trait Emphasis	Overall Emphasis
Production	Milk	-€0.09	10.6%	33%
	Fat	€1.04	3.4%	
	Protein	€6.64	18.9%	
Fertility	Calving Interval	-€12.43	24.0%	35%
	Survival	€12.01	10.9%	
Calving	Direct Calving Difficulty	-€3.52	2.8%	9%
	Maternal Calving Difficulty	-€1.73	1.3%	
	Gestation Length	-€7.49	4.1%	
	Calf Mortality	-€2.58	1.0%	
Beef	Cull Cow Weight	€0.15	0.7%	9%
	Carcass Weight	€1.38	5.1%	
	Carcass Conformation	€10.32	1.7%	
	Carcase Fat	-€11.71	1.1%	
Maintenance	Cull Cow Weight	-€1.65	7.2%	7%
Management	Milking Time	-€0.25	2.1%	4%
	Milking Temperament	€33.69	1.9%	
Health	Lameness	-€54.26	0.6%	3%
	SCC	-€43.49	1.8%	
	Mastitis	-€77.10	0.8%	

€ € € €
EBI
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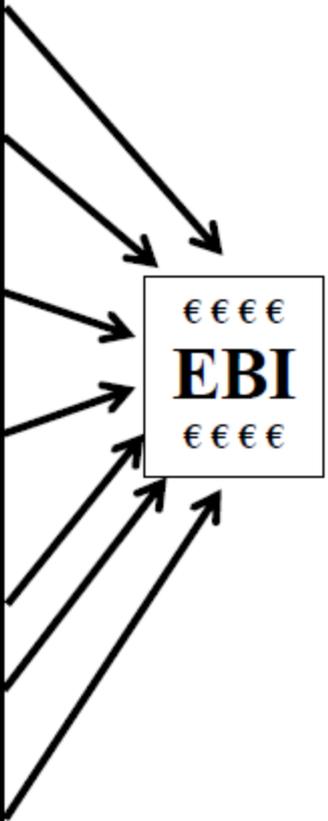
Genetic Trends in EBI
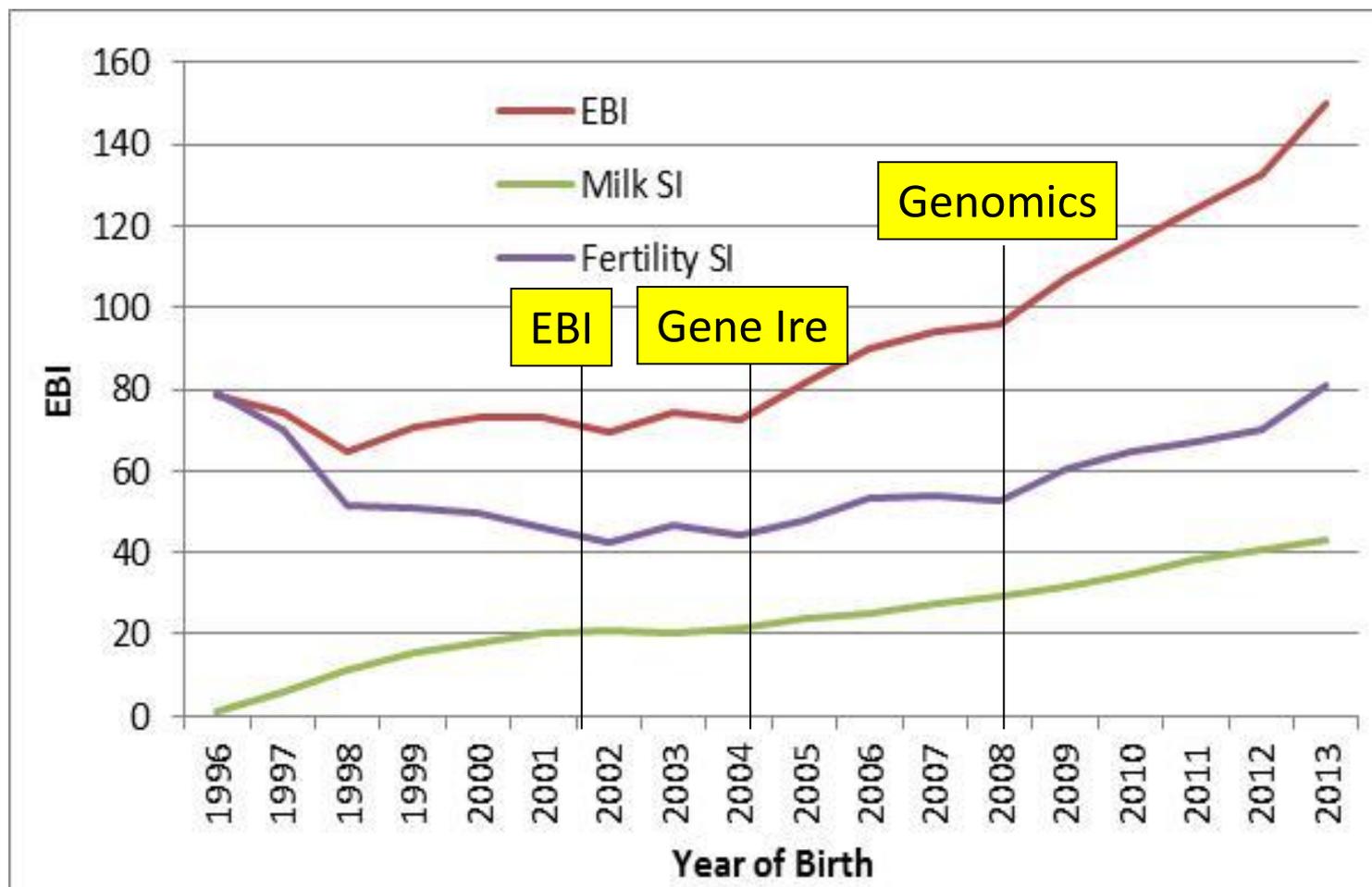
Genomic Selection

- National Genomic Evaluations introduced in Feb 2009 (2nd country in world after US)

- Revolutionised dairy cattle breeding globally

- Initially 1000 bulls in the reference population

- Reliability closely linked to the size of reference population

- Grown to 5000 through swapping with other countries primarily NZ, Aus, Poland, Switzerland, Belgium

Genomic Selection
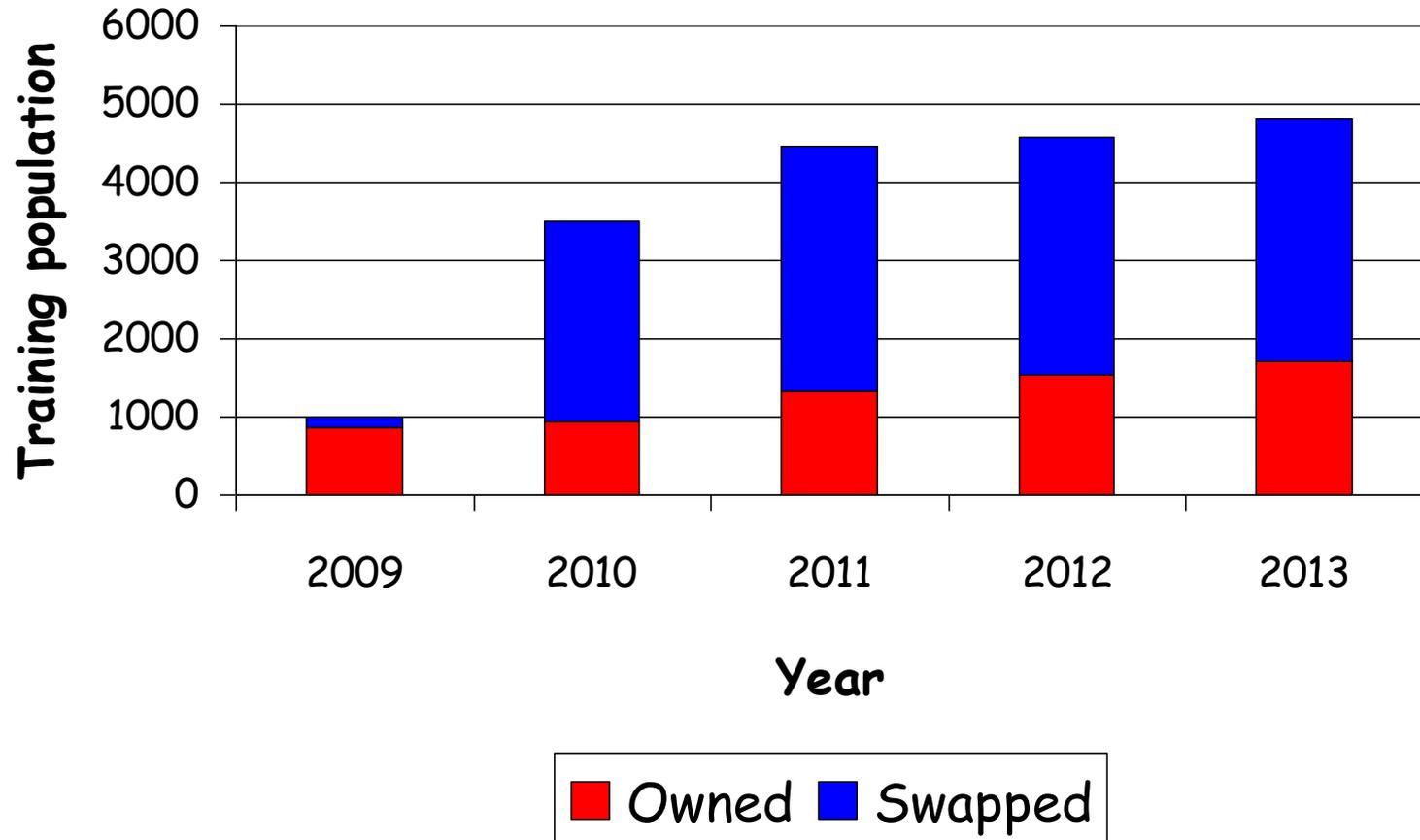
Genomic Selection

Thousands of young bulls genotyped

⬇

30-50 Enter AI

⬇

Calves Born

Progeny test Widespred @5yrs @80% Rel.

Genomic Selection Widespread @2yr @60% Rel.

Returned to Service

⬇

Large progeny groups each year thereafter

Potential to increase rate of genetic gain by **50-100%**

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Inseminations 2013

	% Use	No. bulls	Ave no. bulls used	Average EBI	EBI Rel
DP-INT	16	407	2.6	€204	58%
DP-IRL	24	754	1.9	€197	83%
GS	60	129	4.5	€259	55%

DP-INT – Daughter Proof with foreign daughters
DP-IRL – Daughter Proof with Irish daughters
GS – Genomically selected with no daughter

Similar trends seen in GS bull usage internationally

Results

- Average PTA (reliabilities in brackets)

	Genomic	Daughter	PA
Milk	108 (61)	116 (90)	168 (41)
Fat	10.2	10.4	11.9
Prot	7.7	7.8	9.6
CI	-3.7 (46)	-4.5 (71)	-3.1 (30)
SU	1.7	2.01	1.52
CD	1.9 (50)	2.7 (90)	3.05 (37)
Gest	-2.05	-2.7	-1.5
Carcase Weight	-3	-1.55	-1.39
Carcase Conf	-0.67	-0.64	-0.56

Results

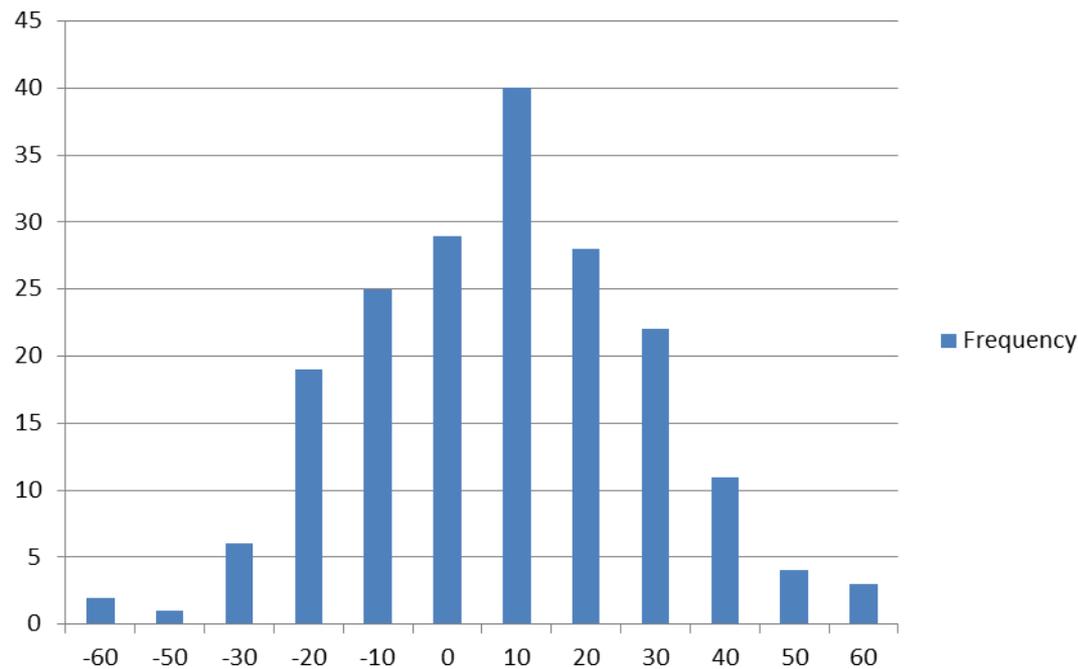- Expected difference among bulls – average MSI -€3

Distribution of Differences - MSI
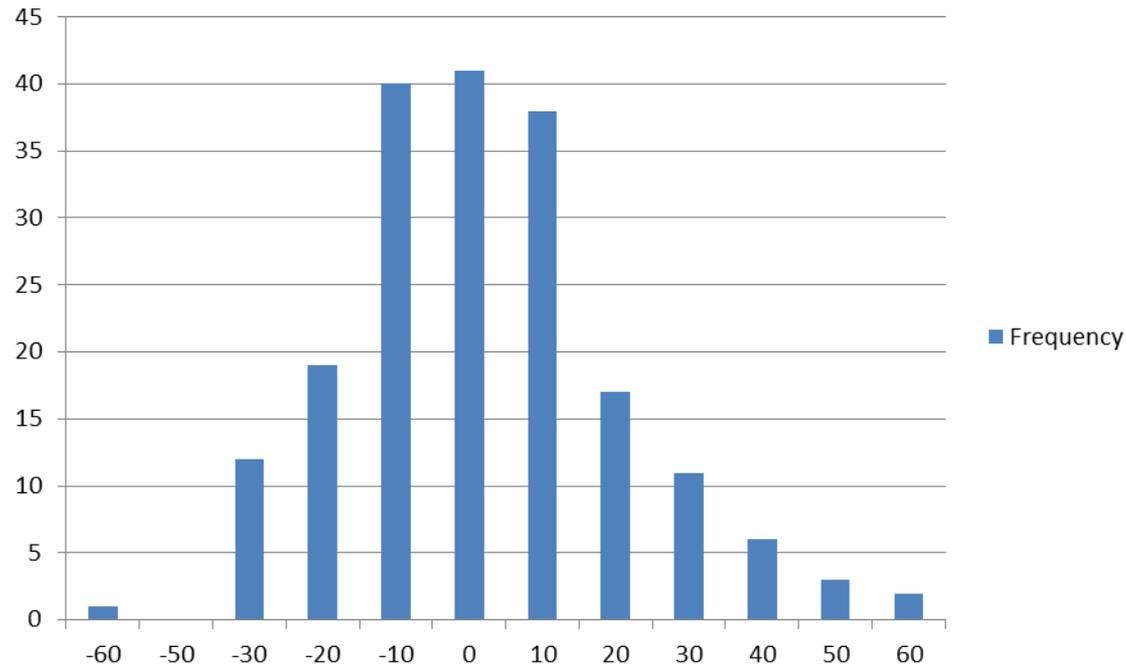
Results

- Expected difference among bulls – average diff FSI of €12 (daughter proof is greater than genomic proof)

Distribution of Differences - FSI

Next Generation Herd - Objective

Genetically elite and diverse research herd

1. Breeding cows compatible to Irish grass based production system

2. To facilitate the monitoring of difficult to measure traits
   - Cow health, greenhouse gas emissions, intake
   - Deleterious consequences of genetic selection?

3. To enhance the development of the EBI
   - Identify new traits

Genetic Potential

	Elite (n=90)	Average (n=45)
EBI	244	133
Milk SI	67	48
Fertility SI	169	63
Calving SI	35	28
Beef SI	-12	-9
Maintenance SI	13	4
Health SI	0	0
Management SI	2	0

Mature equivalents . . .

21/09/2014	National Avg			Elite		
	CON	LGA	HC	CON	LGA	HC
Milk yield	4611	4247	5502	4671	4434	5315
Fat (%)	4.20	4.17	4.10	4.55	4.57	4.36
Protein (%)	3.46	3.43	3.52	3.61	3.61	3.72
Milk solids	353	323	419	381	363	429
Cumulative MS yield	365 (kg/cow)			391 (kg/cow)		

Fertility to date . . .

	Average	Elite
3 wk submission rate (%)	82	92
6 wk in-calf rate (%)	60	77
12 wk in-calf rate (%)	78	95

Genomics On Farm

- Use of genomics on farm for management decisions is increasing

- Selecting replacement heifers

- Parentage identification especially in larger herds

- Better management of inbreeding and genetic defects

Genomics on-farm

Parent Avg. EBI V's Genomic EBI
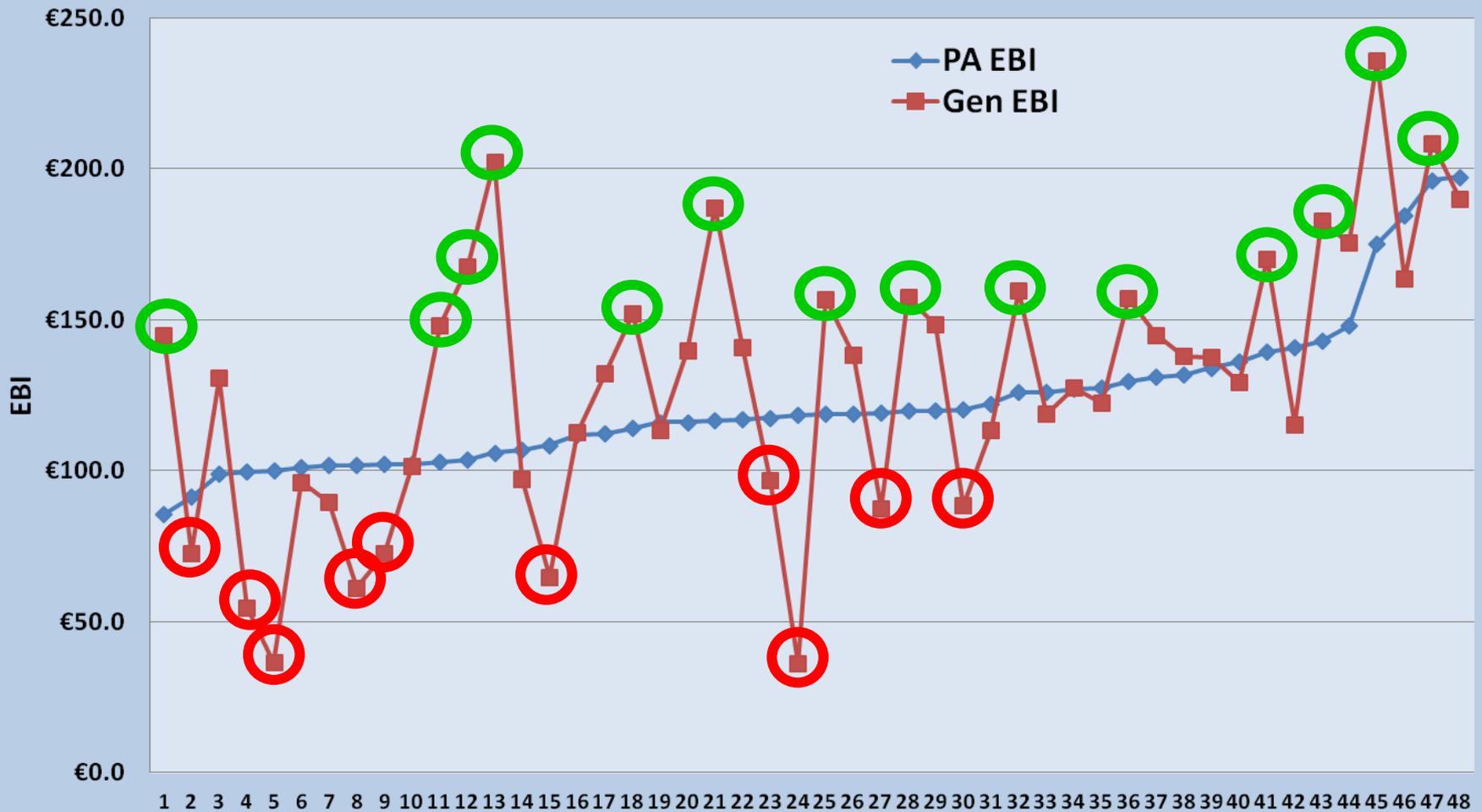
Future Plans

- Continue to increase the size of reference population

- Continue to validate genomic selection

- Work towards multi-breed genomic evaluations

- Genomics will play a crucial role in introduction on new, hard to measure traits such as feed intake, health & disease

- Genomic matings – precision matings based on SNP effects of cow to bulls to create best offspring

- Breeding programme will evolve

- Collection of data is even more crucial with genomics!

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