IRISH CATTLE BREEDING FEDERATION

Genetic Gain & Breeding Programmes



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

Genetic Improvement

- Trying to breed better animals which leave more profit
- Identify and select the animals with the best ‘genes’ for traits of economic importance
- Next generation should be better than the previous generation and so on….

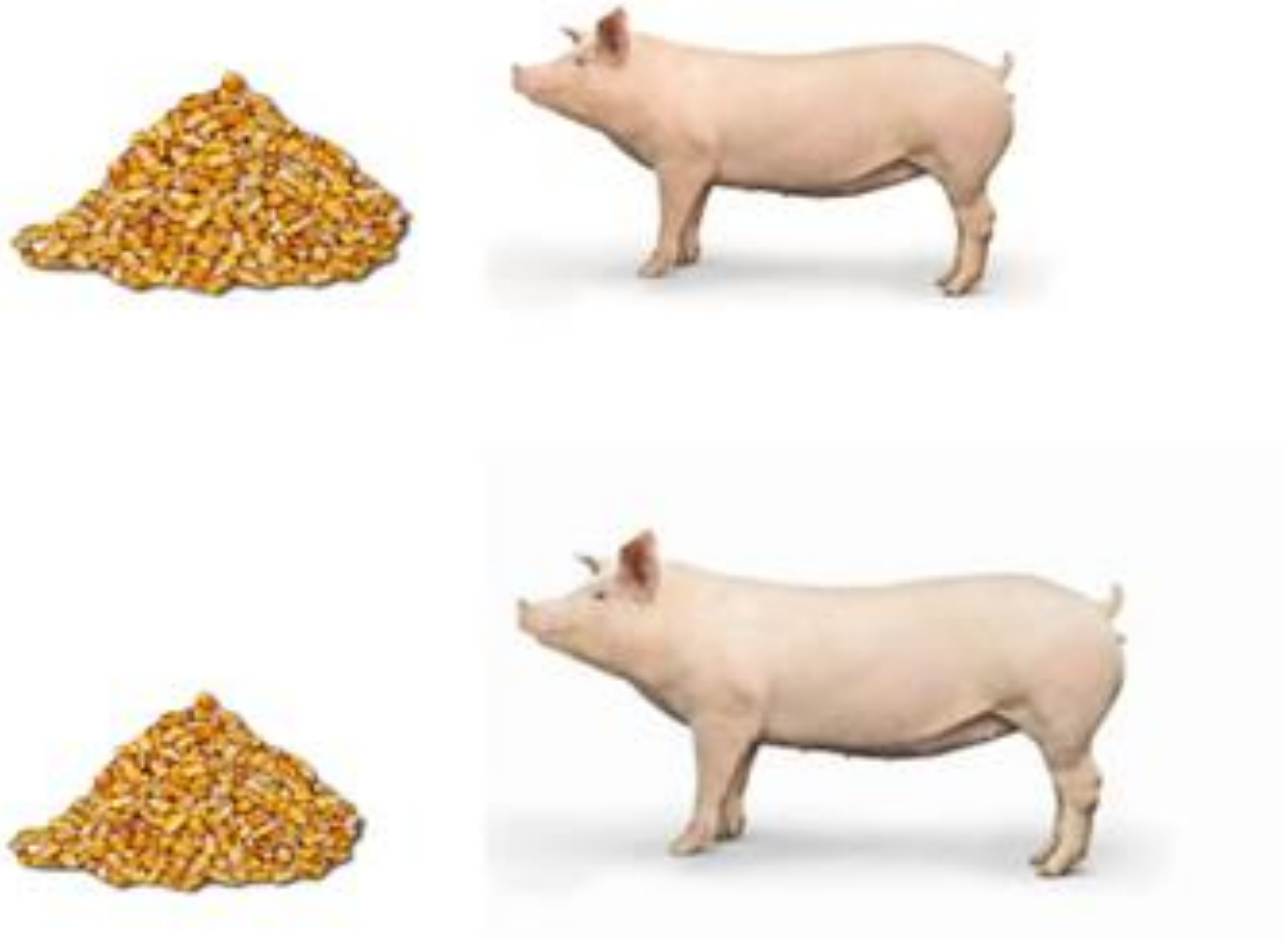
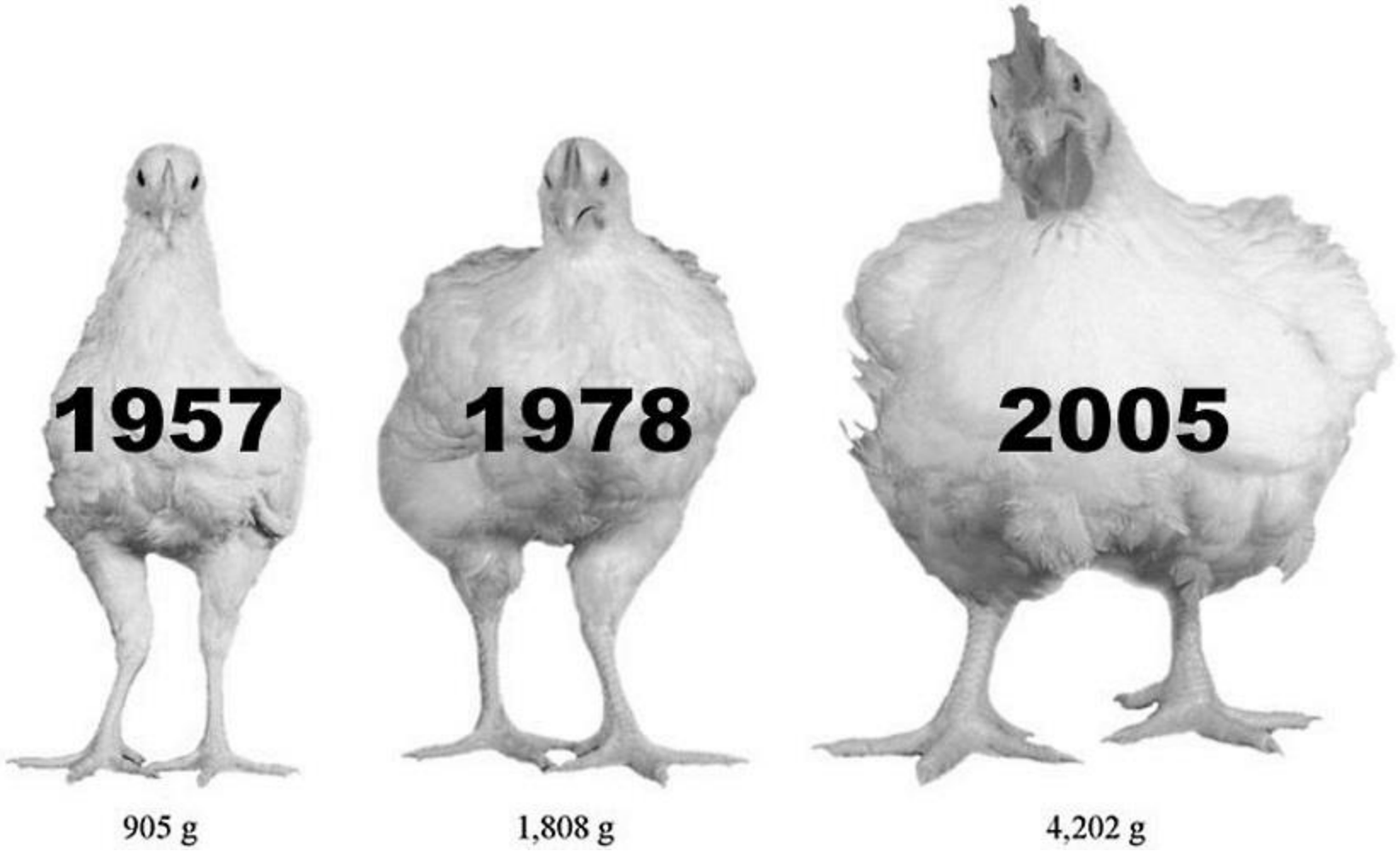
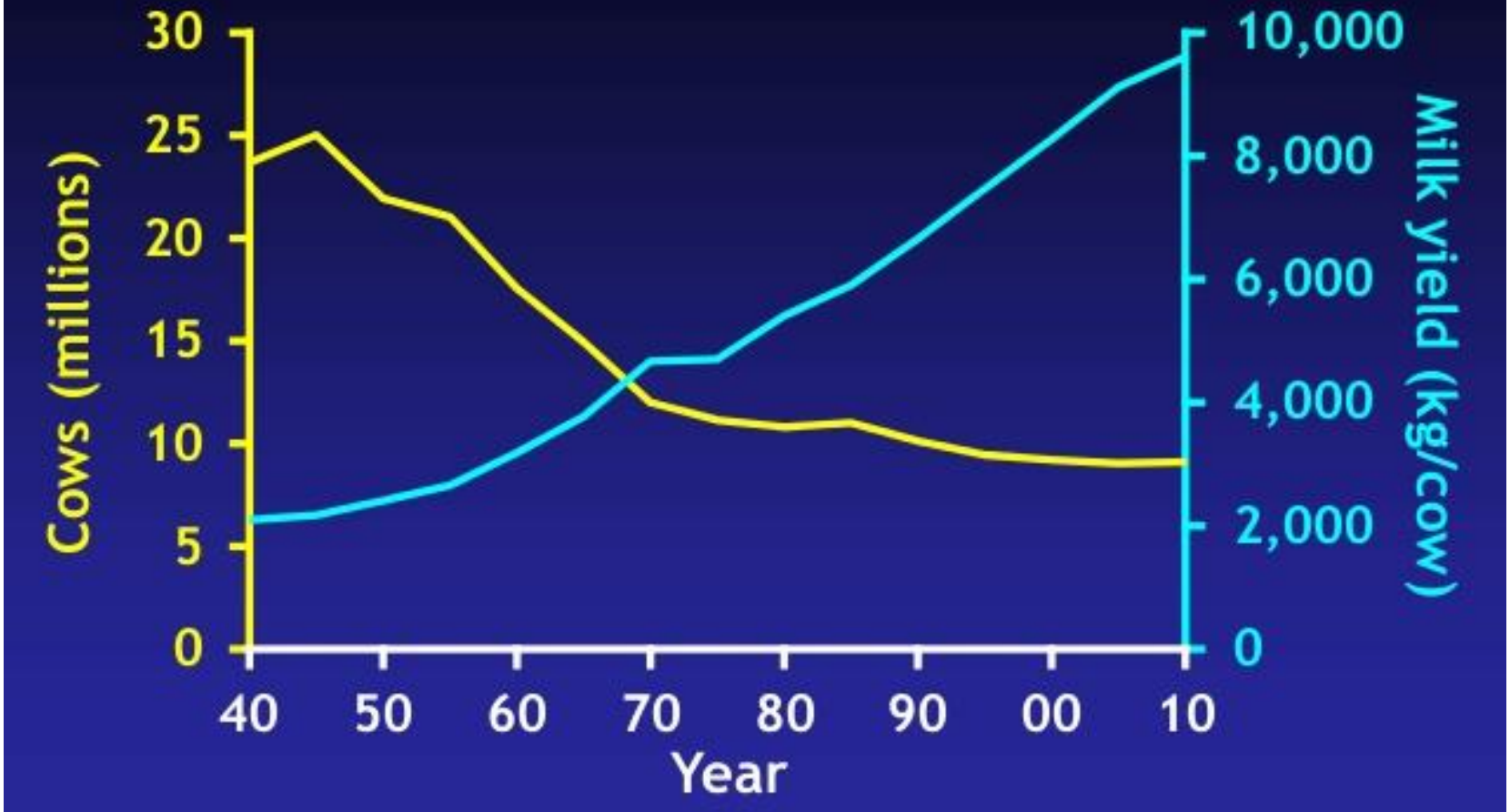


Figure 2. **Improvements in feed conversion ratio.** Feed requirements moved from 836 lbs to produce a 220 market hog in 1972 to 715 lbs of feed in 2007 to produce a 275 lb market hog. (Adapted from Graham Plastow, 2012)



The three chickens you see above were raised on the exact same diet, for the same length of time, and under the same conditions. The left-hand chicken is a breed from 1957. The middle chicken is a breed from 1978. The right-hand one is a breed from 2005.

U.S. dairy population and milk yield



Breeding Objectives

What about the future???

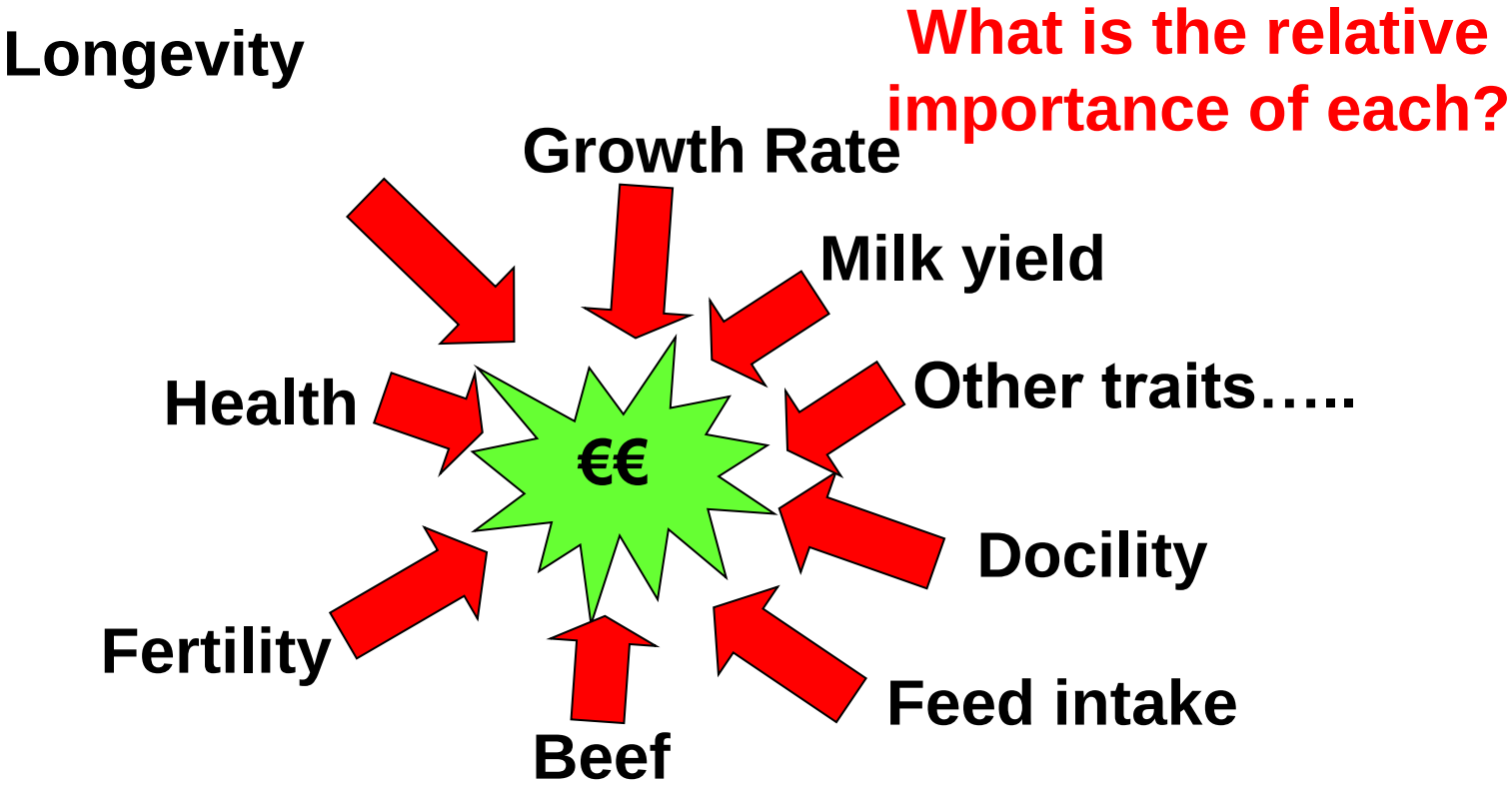
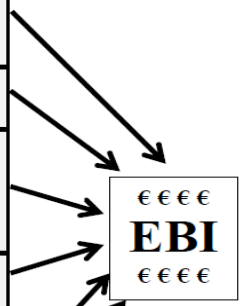


Table 1. *Economic values and % emphasis of the various traits in the EBI formula.*

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%	



Animal Details

« Search Again

AI Code:	OHT	Breed:	LM (100%)	Pedigree Status:	PED
Animal Name:	ROUNDHILL HUNTER	Owner:	GENEIRELAND MATERNAL PROGR	Sire:	VIVALDI / VVI
National ID:	IE241280291413	Date of Birth:	22-OCT-2012	Dam:	ROUNDHILL AJOYEUSE 922 (ET) / IE241280240922
International ID:	LIMIRLM241280291413	Date of Evaluation:	Aug 2015	MGS:	OTAN / OTX

€uro-star Index | Replacement Graphics | Terminal Graphics | Linear Type | Pedigree | Prev Eval

Help

Star Rating (within Limousin breed)	Economic Indexes	€uro value	Index reliability	Star Rating (across all beef breeds)
★★★★★	Replacement (per daughter lactation) Maternal Cow Traits Maternal Progeny Traits	€111 €30 €81	36% (Low) 31% 48%	★★★★★
★★★★★	Terminal (per progeny)	€129	45% (Average)	★★★★★
☆☆☆☆☆	Dairy Beef	€	% (N/A)	☆☆☆☆☆

Star Rating (within Limousin breed)	Key profit traits	Index value	Trait reliability	Star Rating (across all beef breeds)
	Expected progeny performance			
	Calving difficulty (% 3 & 4) Breed ave: 4.95%, All breeds ave: 4.49%	6.30%	70% (High)	
★★★★☆	Docility (1-5 scale) Breed ave: -0.06, All breeds ave: 0.00	-0.05 scale	48% (Average)	★★☆☆☆
★★★★★	Carcass weight (kg) Breed ave: 21.88kg, All breeds ave: 13.98kg	28kg	41% (Average)	★★★★★
★★★★★	Carcass conformation (1-15 scale) Breed ave: 1.99, All breeds ave: 1.23	2.33 scale	35% (Low)	★★★★★

Expected daughter breeding performance

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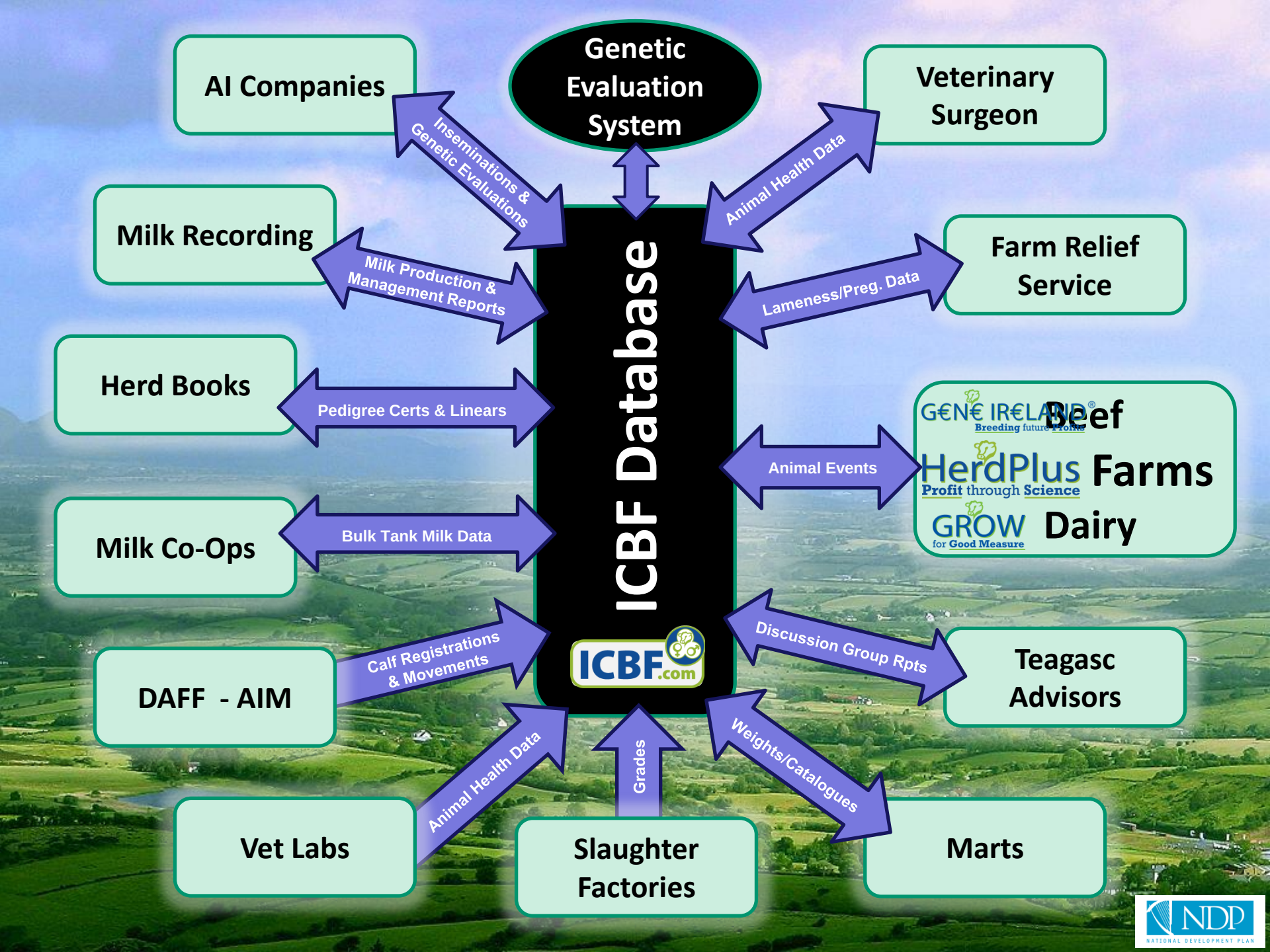
Achieving Genetic Gain

- Genetic improvement is dependant upon;
  - ***Accurate data*** (the key element)
    - ID & ancestry (Sire, Dam, DOB…..)
    - Performance for profitable traits (milk, beef, calving, health etc)
  - Genetic indices focused on profitable traits e.g., Economic Breeding Index, Euro-Stars;
  - Effective breeding program so that farmers have access to the best genetics to increase profitability (Gene Ireland)


Genetic Evaluation System
AI Companies
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Veterinary Surgeon
Animal Health Data
Milk Recording
Milk Production & Management Reports
Farm Relief Service
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Bulk Tank Milk Data
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Teagasc Advisors
DAFF - AIM
Calf Registrations & Movements
Vet Labs
Animal Health Data
Grades
Slaughter Factories
Weights/Catalogues
Marts
NDP
NATIONAL DEVELOPMENT PLAN

Recording Life Cycle of Dairy Cow

	Event	Information for genetic evaluations
1	Birth of animal	Sire, Dam, Calving ease, gestation, mortality

Data Capture

	Event	Data Capture
1	Birth of animal	Dept Ag E-reg or white card, Farm Software, Animal Events
2	Sold at Mart?	Information direct from marts
3	Calving @2yr	Same as 1
4	Milk Recording	EDIY, Milk recording technician
5	Insemination(s)	Farmer recorded, AI technician
6	Other Events	Farmer, Vet, Herdbook, Farm Relief
7	Liveweight	Farmer, weight recording provider
8	Calving @3yr	Same as 1
9	Culled	Information direct from factory

Real-Time Fertility Data

- AI handhelds;
  - Linked directly to database (GPRS)
  - All cows on hand-held
  - Inbreeding check.
  - Docket printed on-farm
  - Copy of data sent to database
  - “fertility management” reports
  - Bull Fertility

Breeding Indexes

- Use data to conduct a genetic evaluation for each animal
- Gives an idea to how superior their genes are
- Need to combine the genetic evaluation with the economic value of each trait
- Combined into an overall index and Sub-indexes

Genetic Improvement

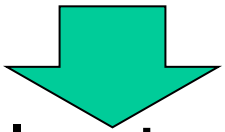
Is the trait economically important?

Is there data/can it be collected easily?

Is Heritability > 0

Calculate a breeding value (PTA) & reliability

Combine into overall & sub index



Make Selection Decisions

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Response to selection

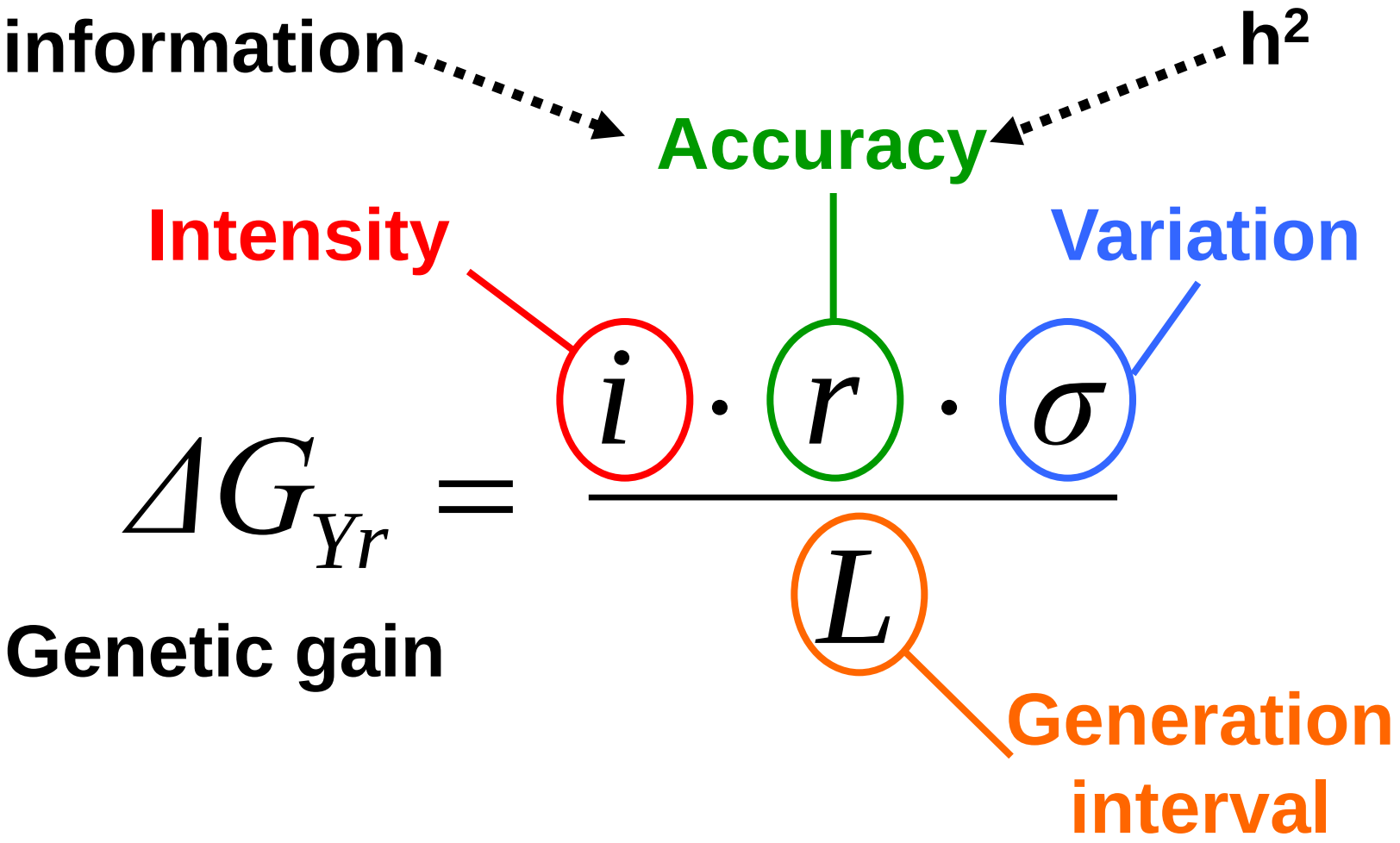
Response to selection is determined by 4 factors:

1. **Genetic variation**
2. **Accuracy of selection (i.e. reliability)**
3. **Selection intensity**
4. **Generation Interval**

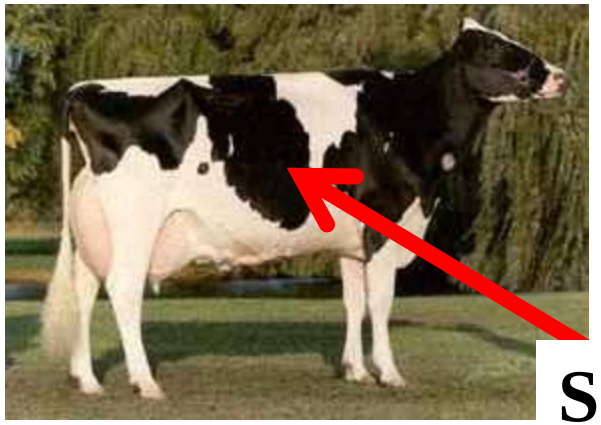
How to determine a response to selection

1. **How large are the heritable differences between individuals??**
2. **How precise do we know their true breeding value??**
3. **Selection of the very best individuals??**
4. **How often can we select per unit of time??**

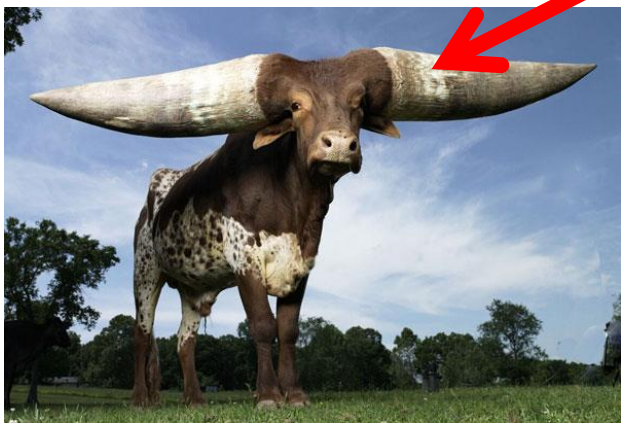
Genetic Improvement



Several trade-offs at play

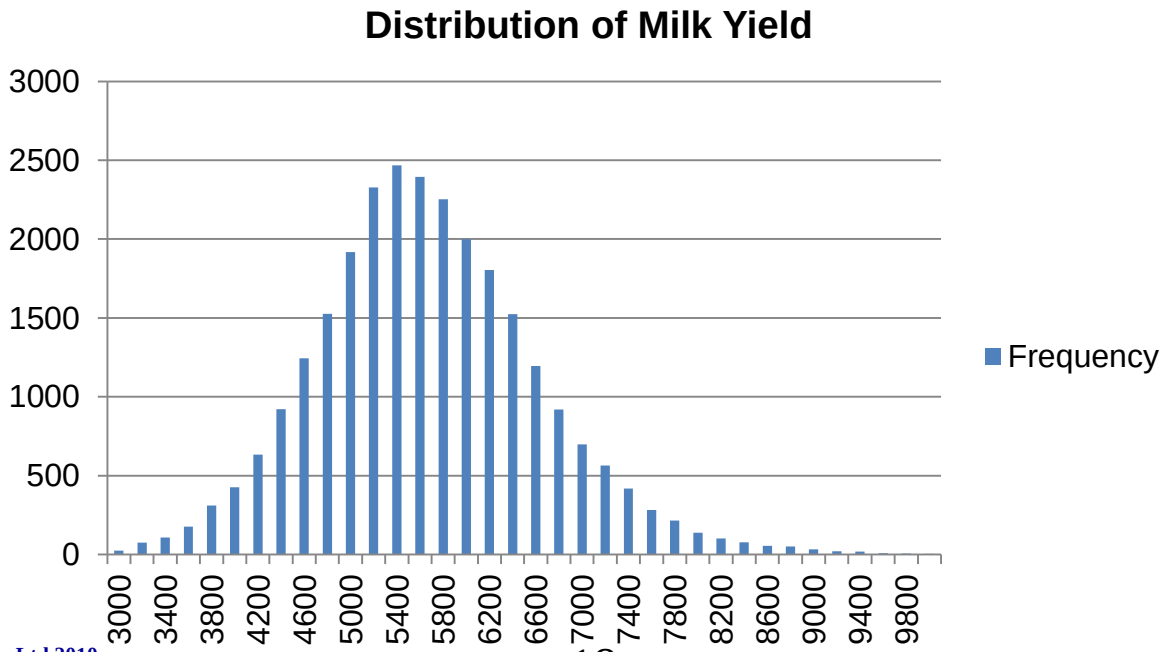


Single/Few Genes



Genetic Variation (σ)

- Most economically important traits controlled by genes at many loci
- Few genes with large effects, many with small effect
- Performance follows a smooth bell shaped distribution – normal distribution



Accuracy (r)

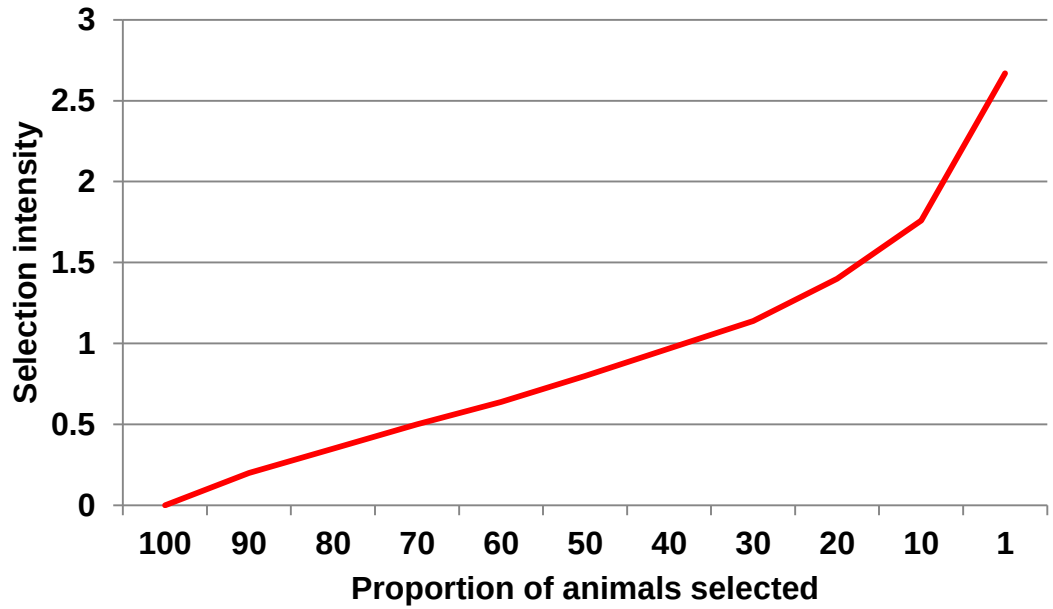
- **Depends on 3 main factors**
  1. **Heritability**
  2. **The source of information on which selection is based (e.g., own performance, progeny, relative)**
  3. **The amount of information available from relatives**

- **Information from relatives depends on the proportion of genes in common between selection candidate and relative**

Relationship	Genes in common
Identical twins; clones	100%
Parent-offspring	50%
Full siblings	50%
Grandparent-grandchild	25%
Half siblings	25%
aunt/uncle-nephew/niece	25%
Great grandparent-great grandchild	12.5%
First cousins	12.5%

Selection Intensity (i)

- **Number of animals selected for breeding in relation to all animals available for selection**
- **The lower the number of animals selected the higher the selection intensity**



Selection Intensity (i)

Generation Interval (L)

- **Generation Interval (L) is the average age of the parents when their offspring are born**
- **Can be different for males and female**
- **Range of animals at different ages**

Species	Generation Interval
Dairy Cattle*	4 to 6 years
Beef Cattle*	4 to 6 years
Horses	8 to 12 years
Pigs	1.5 to 2 years
Chickens	1 to 1.5 years
Sheep	3 to 5 years

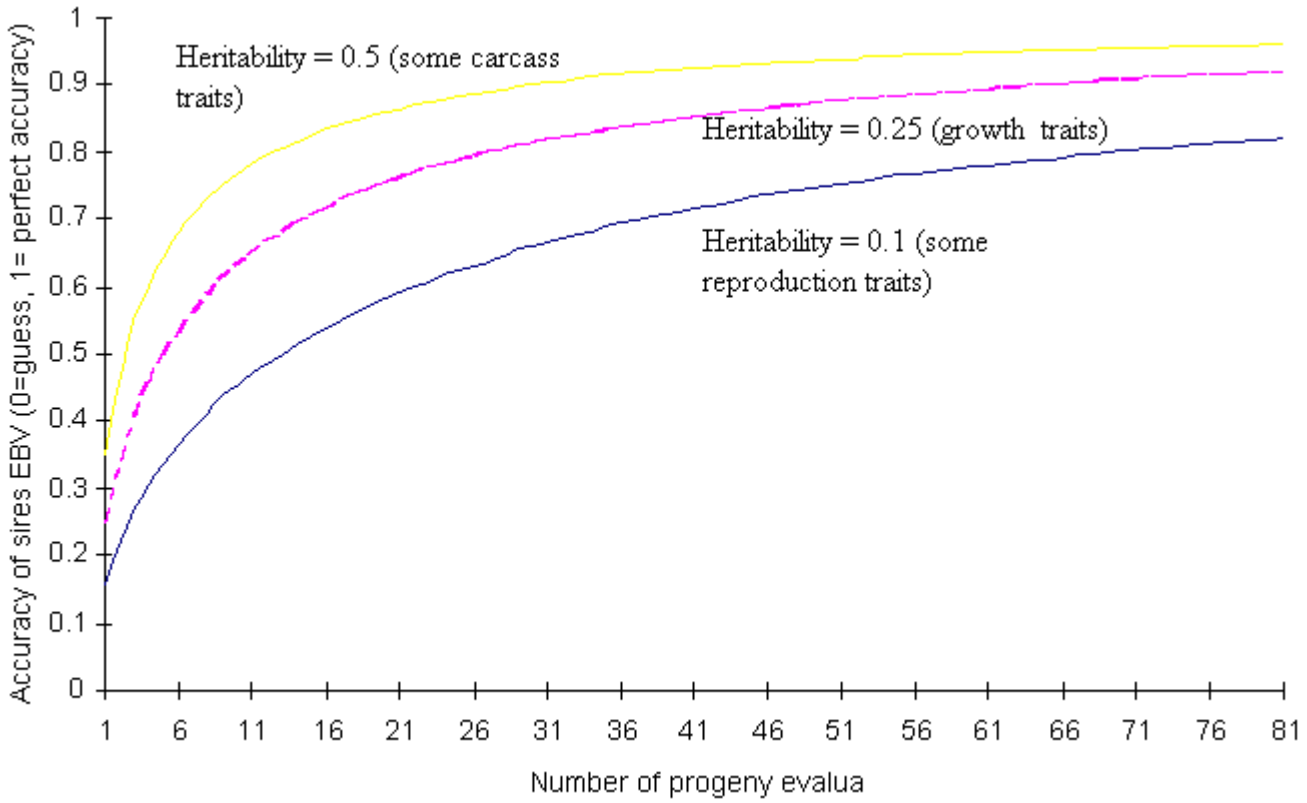
Heritability

- Heritability is the proportion of observed differences in a trait among individuals of a population that is due to genetic differences
- Or the amount on offspring resembles its parent for a particular trait
- Central concept in animal breeding – no heritability -> no genetic selection possible

Heritability

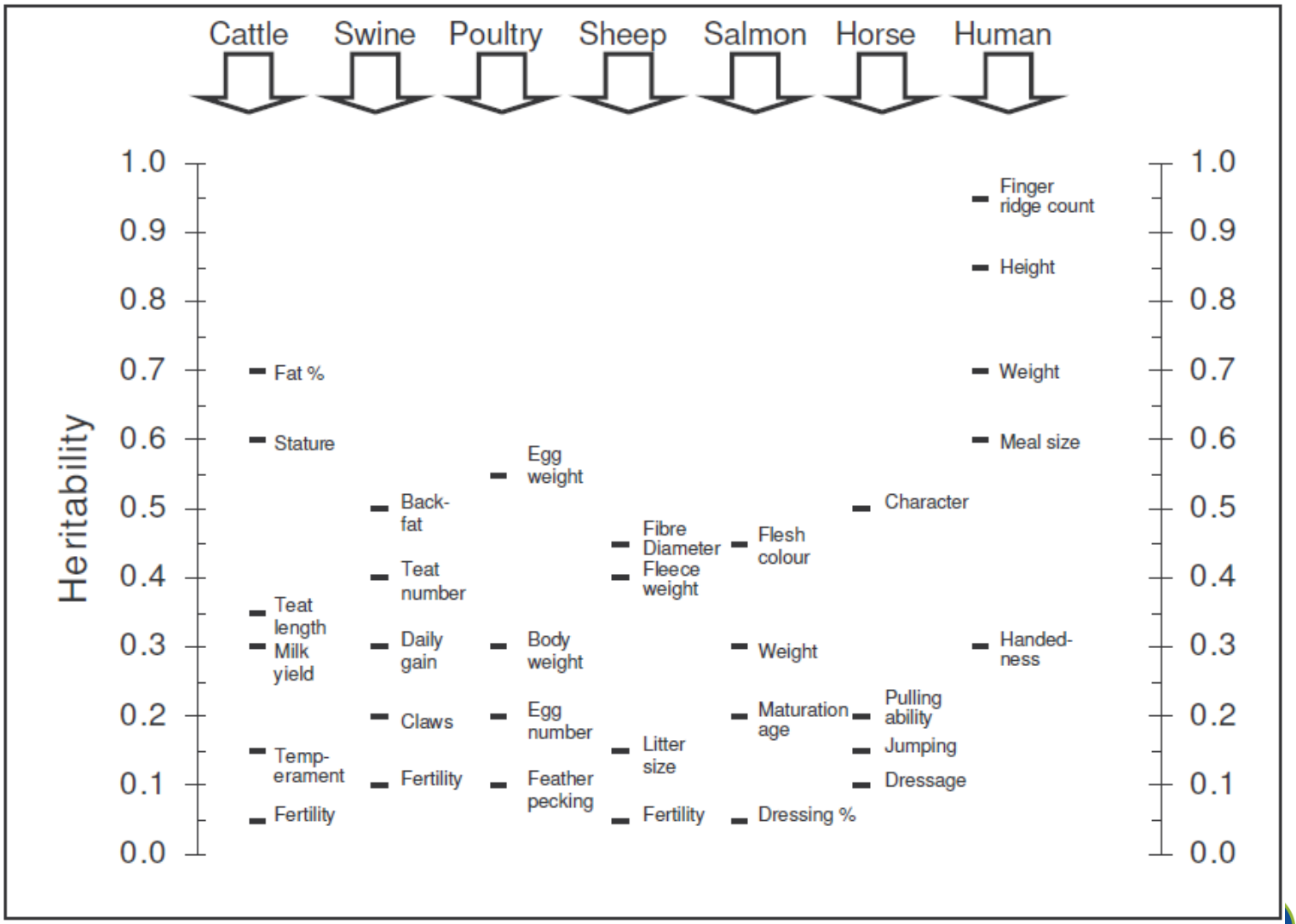
- If h^2 is high then genetics play a large role in the phenotype observed
- If h^2 is low non-genetic factors play a much larger role in the phenotype
- If h^2 is high need fewer records to get high **accuracy/reliability**
- If h^2 is low need many more records to get to high accuracy
- Expressed 0 to 100% or 0 to 1

Heritability and Accuracy



Heritability

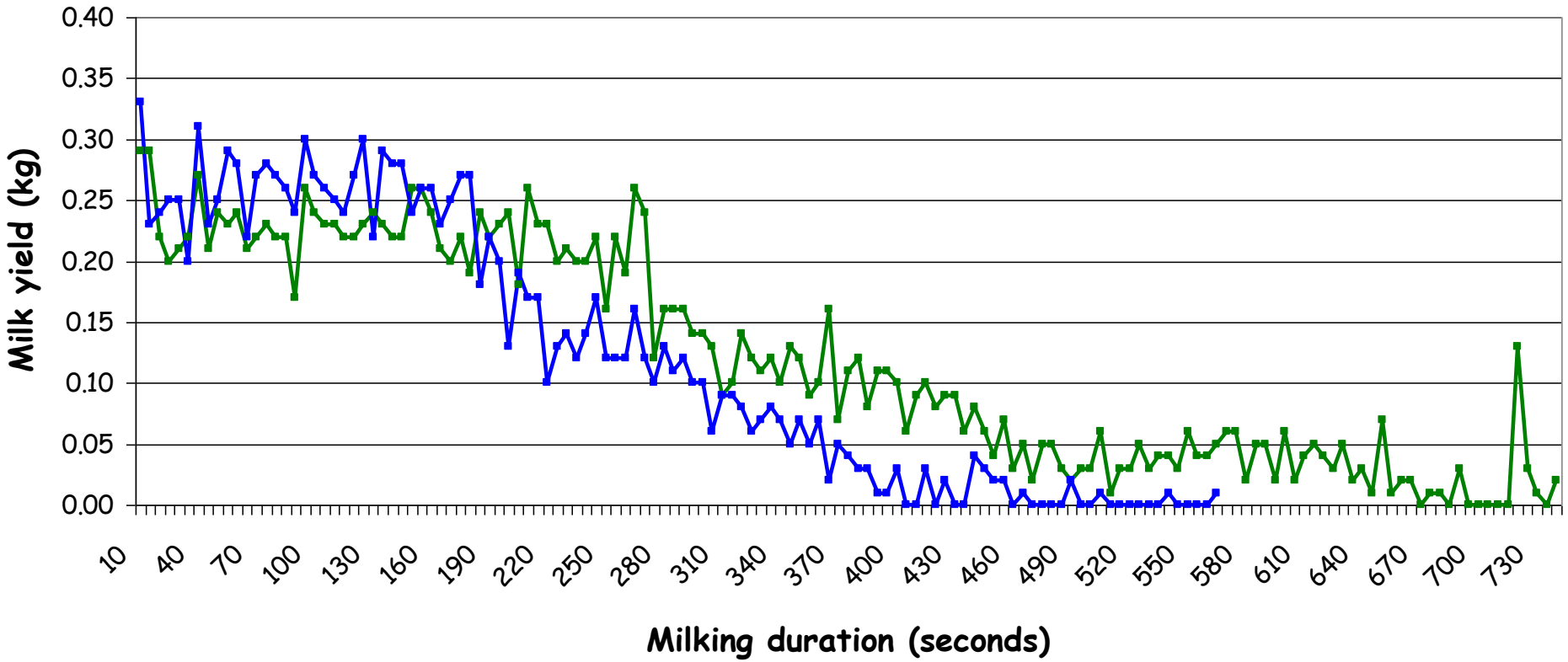
- h^2 will not be constant across populations
- Specific for a population and for a range of environments



Estimating h^2 - Objective

- DIY milk meters
- Average milk yield recorded every 5 seconds
  - Milking duration
  - Flow rates (max., average)
- 370,597 records from 121,335 lactations on 1,365 farms during the year 2012
- h^2=0.18

Milk flow characteristics



Estimating h^2 - Subjective

BAS1

Beef Data & Genomics Programme

Requirement 2: Animal Survey

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Herd Id:

Date: 09-Oct-2015

The calves listed below were alive and in your herd at 5 months of age. Calf quality and calf docility must be recorded on **all** animals in this section.

Calf Ear Tag Number	Birth Date	Calf Docility VG = Very Good / Very Quiet G = Good / Quiet A = Average P = Poor / Difficult VP = Very Poor / Very Difficult (Ensure a value is circled)	Calf Quality VG = Very Good G = Good A = Average P = Poor VP = Very Poor (Ensure a value is circled)
'0368	16-Jan-2015	VG G A P VP	VG G A P VP
10379	12-Apr-2015	VG G A P VP	VG G A P VP
30377	12-Apr-2015	VG G A P VP	VG G A P VP
)0378	12-Apr-2015	VG G A P VP	VG G A P VP

Medical Condition / Topic	Heritability Est.	References
Age-related macular degeneration	49 - 71%	[PMID 9869796]
Alcoholism	50 - 60%	[PMID 19785977]
Alzheimer's disease	58 - 79%	[PMID 16461860]
Anorexia nervosa	57 - 79%	[PMID 19828139]
Asthma	30%	[PMID 16117840]
Attention deficit hyperactivity disorder	70%	[PMID 22833045]
Autism	30 - 90%	[PMID 17033636]
Bipolar disorder	70%	[PMID 14601036]
Bladder cancer	7 - 31%	[PMID 21927616]
Blood pressure, diastolic	49%	[PMID 19858476]
Blood pressure, systolic	30%	[PMID 22479213]
Body mass index	23 - 51%	[PMID 25383972, PMID 18271028]
Bone mineral density	44 - 87%	[PMID 15750698, PMID 16025191]
Breast cancer	25 - 56%	[PMID 11979442, PMID 2491011]
Celiac disease	57 - 87%	[1]
Cervical cancer	22%	[PMID 11979442]
Chronic obstructive pulmonary disease	76%	[PMID 20541380]
Colon cancer	13%	[PMID 11979442]
Coronary artery disease	49%	[PMID 15710764]
Crohn's disease	53%	[PMID 3396969]
Depression	50%	[PMID 15877306]
Epilepsy	70 - 88%	[PMID 11325572]
Eye color	98%	[PMID 9152135]
Celiac disease	57 - 87%	[PMID 16354797]
Gallstone disease	25%	[PMID 15747383]
Glaucoma	36 - 57%	[PMID 14691154]
Graves' disease	79%	[PMID 11158069]
Hair curliness	85-95%	[PMID 19803779]
Hangover	24-45%	[PMID 25098862]
Heart disease	34 - 53%	[PMID 10892820]

Breeding Programme

- An effective breeding programme is necessary to ensure an adequate supply of top bulls each year to allow farmers to increase profitability from breeding over time

- Without this genetic gain will stagnate

- G€N€ IR€LAND is name given to both dairy and beef breeding programmes in Ireland

Why G€N€ IR€LAND?

- Farmers need a new top bull each year.
  - How quickly do we want to make progress?
  - More progress = more top bulls.
- Program focused on EBI & Euro-Stars
- Historically tested bulls were not Irish
- Dairy Launched in Spring 2005
- Beef launched in 2008 & changed in 2014

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Top Cows

Top Bulls

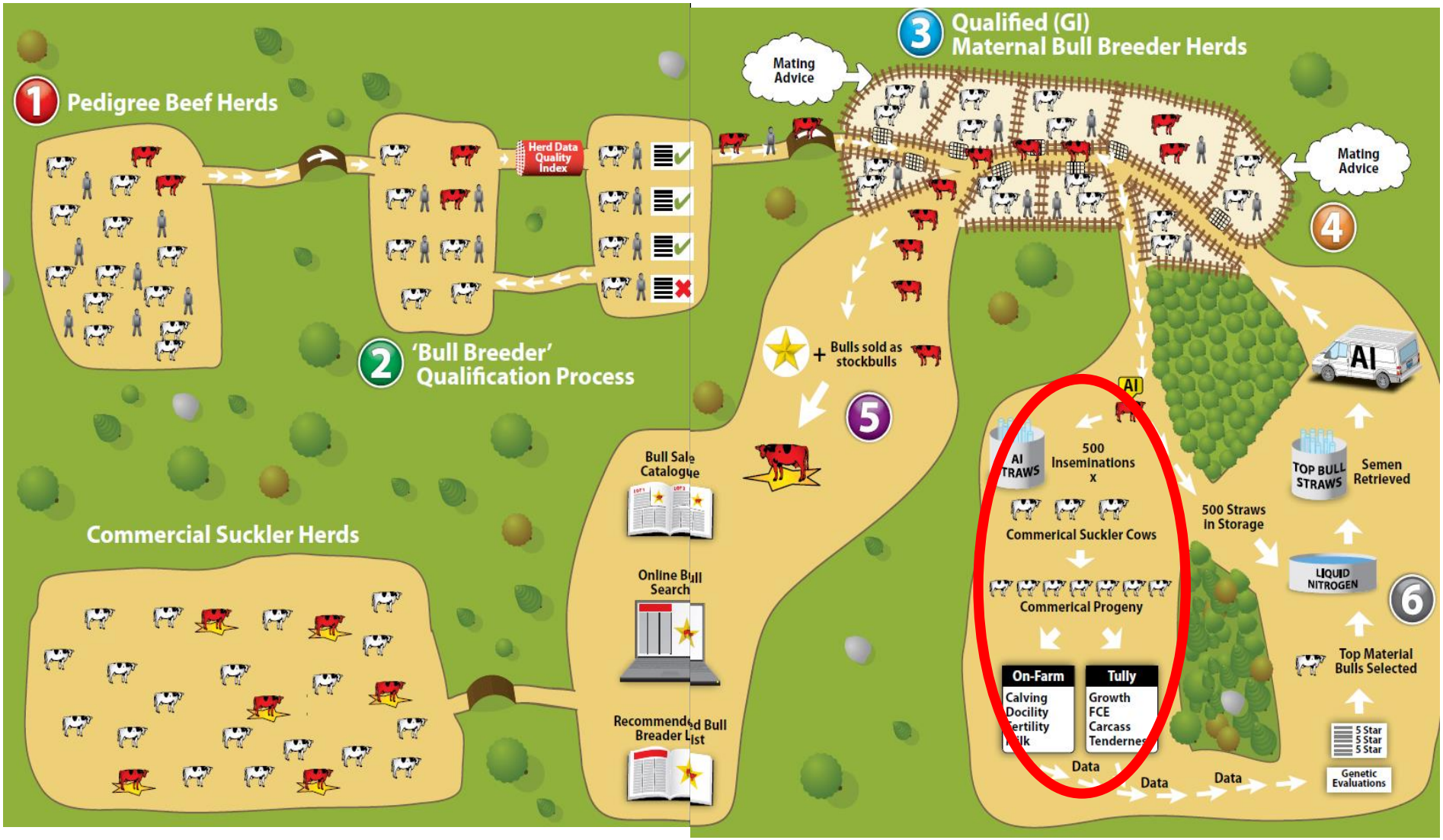
Mixture of progeny
Good on average

Elite Cows

Fall through system

Young Test Sires Mated to General cow pop

GENE IRELAND



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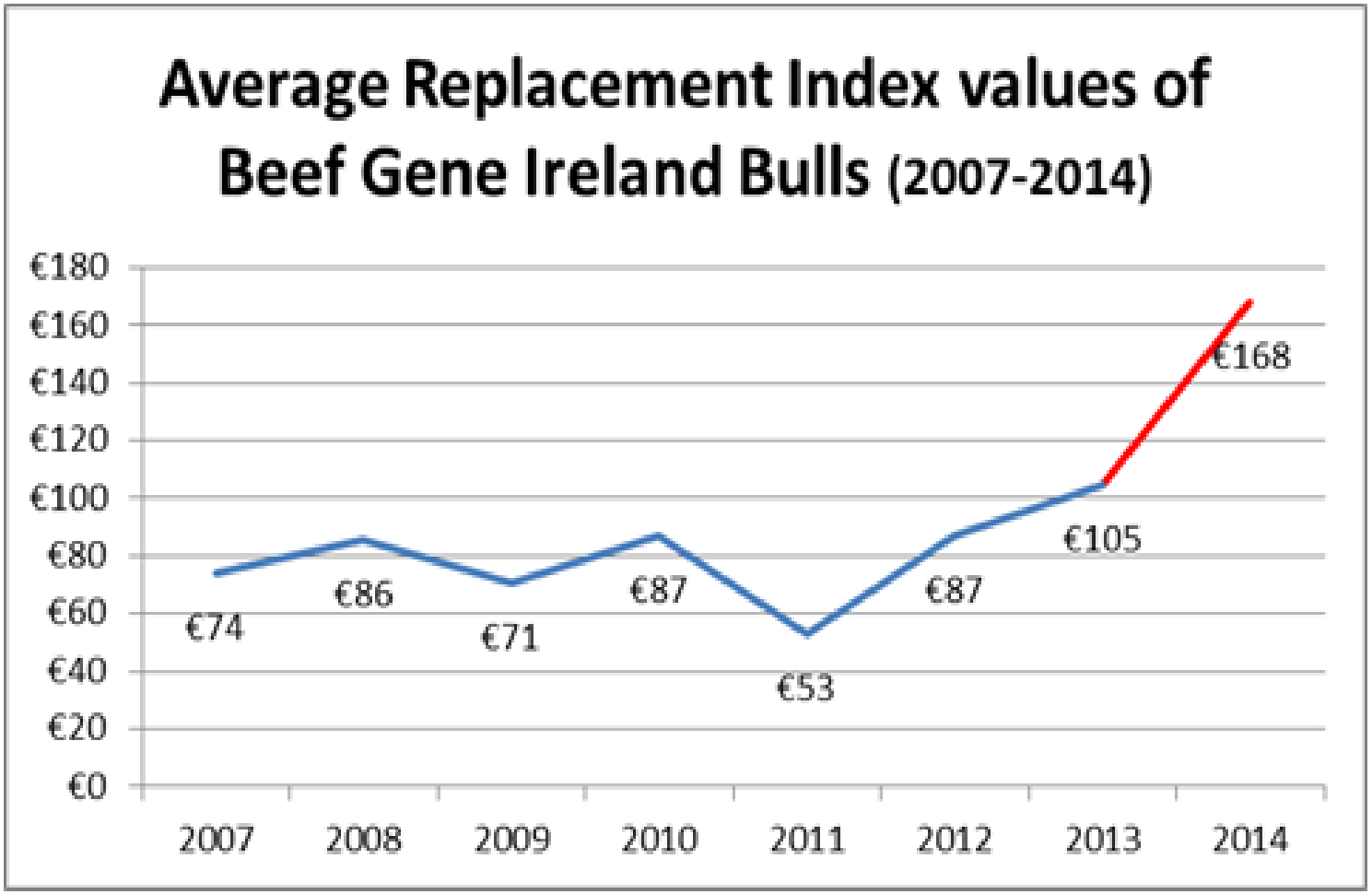
Gene Ireland



Breeding profitable Suckler Cows for the National Herd.

NDP

ICBF

GENE IRELAND®

Breeding future Profits

Autumn 2015 Dairy Bull's

Dam of Rhincrue Sherlock

To Order Straws Call 023 8820458

Munster Genetics · Progressive Genetics · National Cattle Breeding Centre · Dovea Genetics · Norgenus · LIC

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Beef Gene Ireland Maternal Progeny Test Program
Youngbull Panel – Autumn 2015

GENE IRELAND Beef — Breeding Profitable Suckler Cows

Gene Ireland Maternal Bull Breeder Program

1850-600-900

Gene Ireland Pedigree Herd — Herd Data Accredited

Genomics

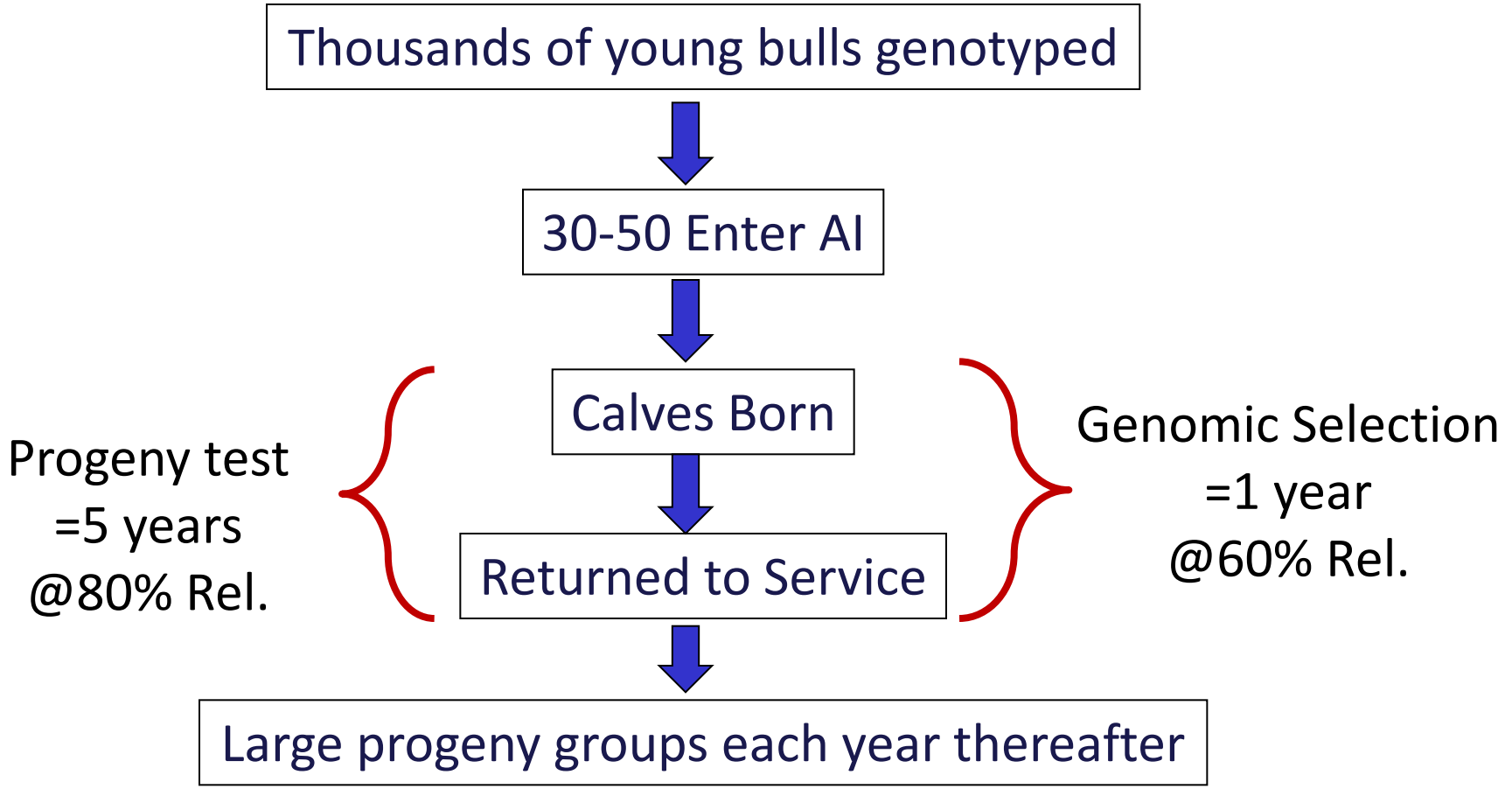
- Traditional sources of information
  - Ancestry
  - Own performance
  - Progeny performance

- Takes a long time taking to achieve high reliability for traits such as fertility
- We know that traits are controlled by genes
- Can we use DNA information to help our decisions

Genomics

- Genomics compares an animal's DNA to older proven animals and looks for similarities.
- Genetic Indexes are then produced based on the genes inherited from sire and dam

Genomics



IDB

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

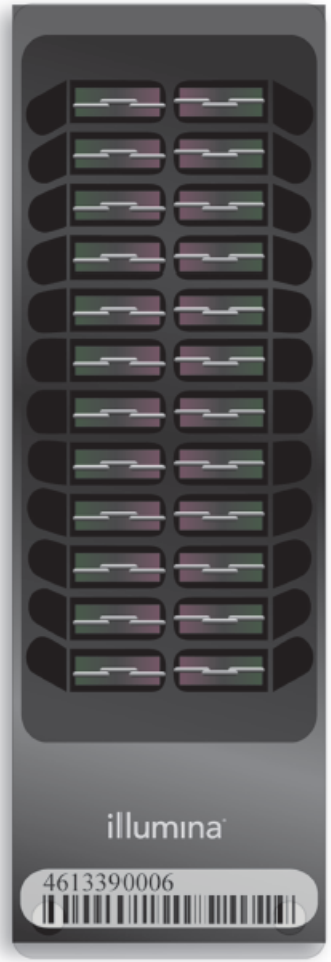
1 CVM*-Complex Vertebral malformation
2 DUMPS
3 Brachyspina*
4 BLAD

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



Genetic Gain

Progeny testing pre genomics

Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Cows Mated (Famer or AI decision)	Bull Calves Bought	Bulls enter G€N€ IR€LAND	Daughters born	Daughters mated	Daughter calves/milk recorded ~100	Bulls for widespread AI use

Genomic Progeny Testing

Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Cows Mated (Famer or AI decision)	'000s Bulls DNA tested	50 (or less) Bulls enter G€N€ IR€LAND	Calves born Bulls chosen for AI	3 Years Advanced Gain		

Genomics - Current

GENERVATIONS LIQUID GOLD +2543 GTPI
250H001049 CANM11397834

08/12

GTPI	Milk	Fat	%F	Prot	%P
+2543	+1597	+102	+0.17	+80	+0.12

Rel	NM$	CE	PL	SCS
73%	865	8	5.1	2.80

PTAT	UD	FL
3.48	2.36	1.96

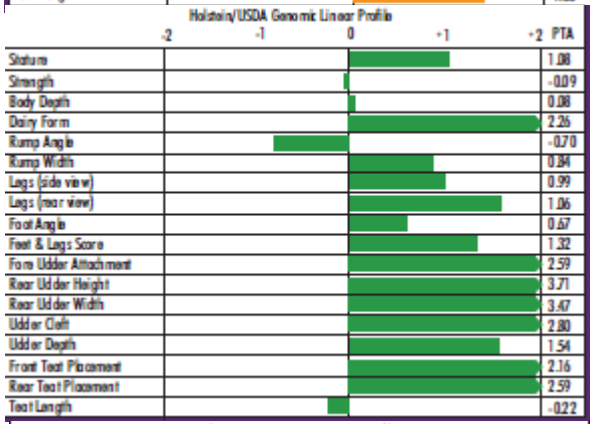
GENERVATIONS FUZION +2460 GTPI
250H001047 CANM11347870

08/12

GTPI	Milk	Fat	%F	Prot	%P
+2460	+1355	+85	+0.14	+72	+0.12

Rel	NM$	CE	PL	SCS
73%	898	7	6.2	2.79

PTAT	UD	FL
2.37	2.21	0.94



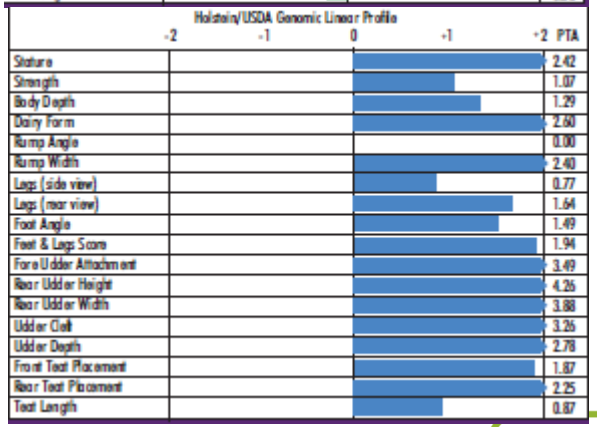
GENERVATIONS GIZMO +2475 GTPI
250H001048 CANM11347872

08/12

GTPI	Milk	Fat	%F	Prot	%P
+2475	+1902	+80	+0.03	+69	+0.05

Rel	NM$	CE	PL	SCS
73%	803	9	5.9	2.81

PTAT	UD	FL
3.37	2.98	1.57



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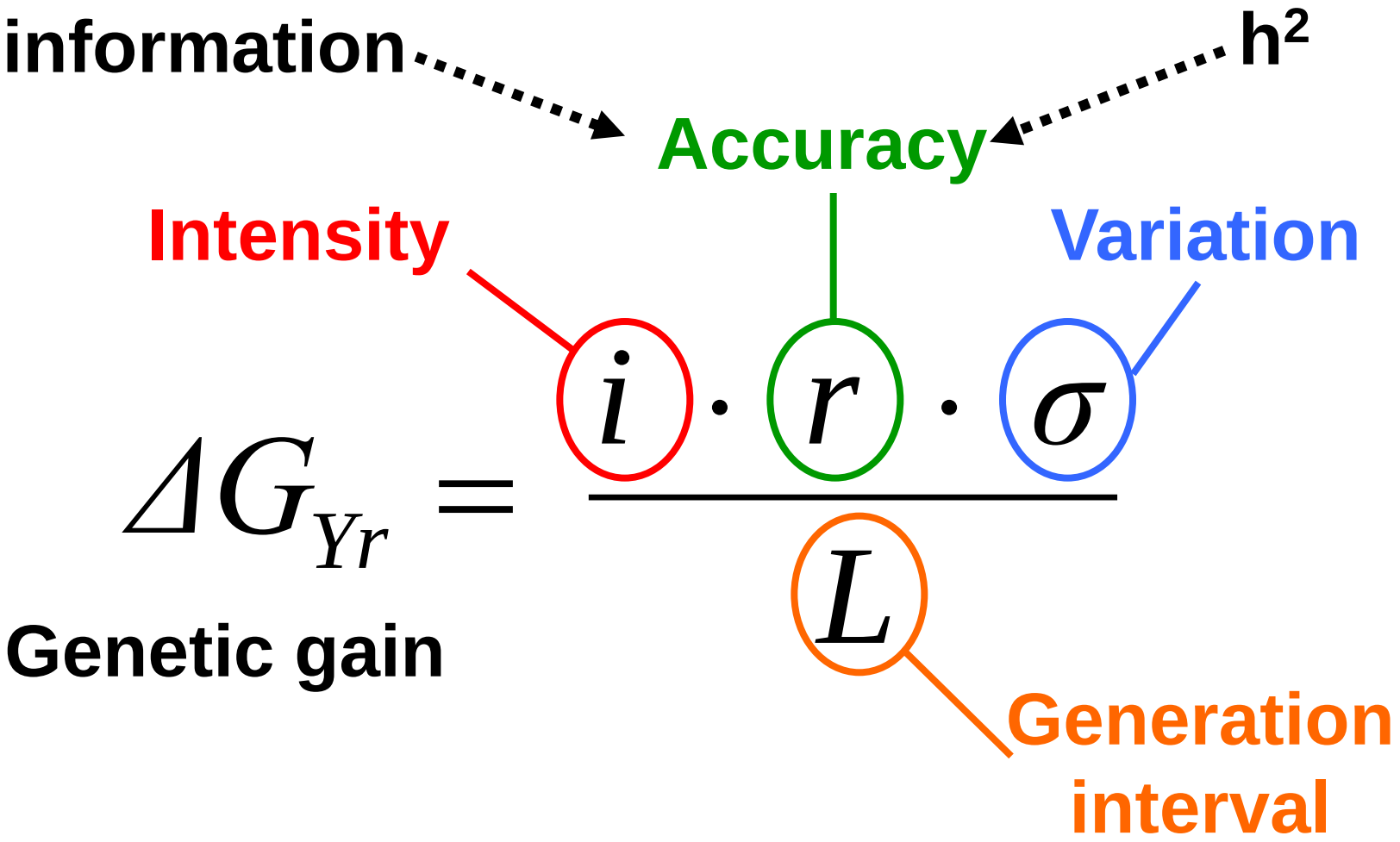
Genetic Improvement



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

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Genetic Gain in EBI.