

IRISH CATTLE BREEDING FEDERATION

Genomic Selection - The revolution has begun!

What is it?
How will it impact ICBF?

Current Scenario

- Increase profitability of farming by making genetic progress in traits of economic importance
- Based on recording information (phenotypes) of animals on farm, marts, factories etc...
 - e.g., fat & protein, fertility, carcass yield and quality, calving ease (
- Quantitative approach (black box) – do not use DNA to estimate genetic merit/ don't know what genes contribute to superior animals

Genetic Gain

Current scenario

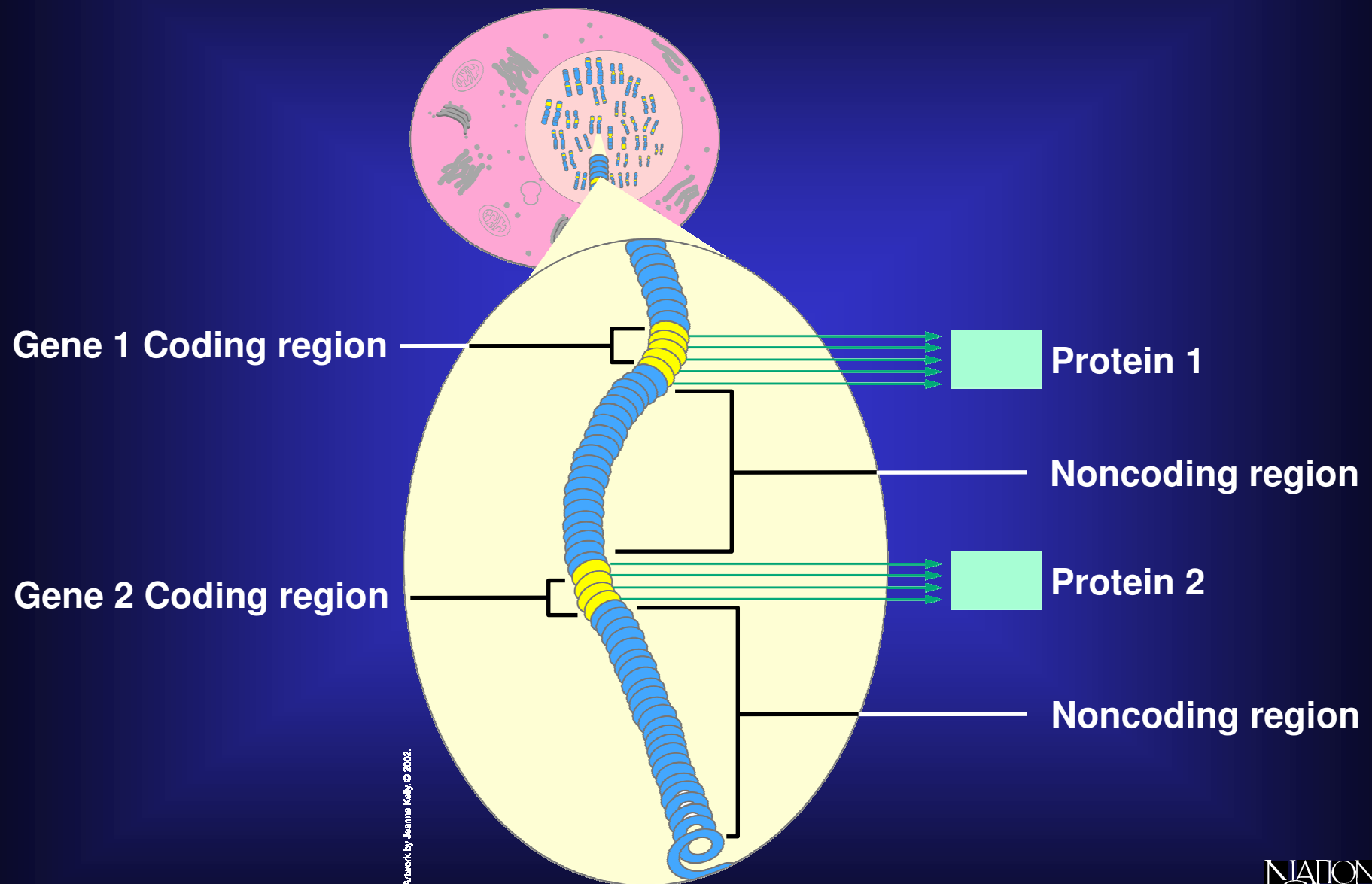
Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Cows Contract Mated	Bull Calves Bought	Bulls enter GENE IRELAND	Daughters born	Daughters mated	Daughter calves/mil k	Bulls for widesprea d AI use

recorded

Genomic Technology

- Explosion in DNA technology has allowed us to 'look into' genetic make-up to see what genes control what
- Mapping of the human genome (2003) and continued with other species including livestock

The Genome Contains Genes

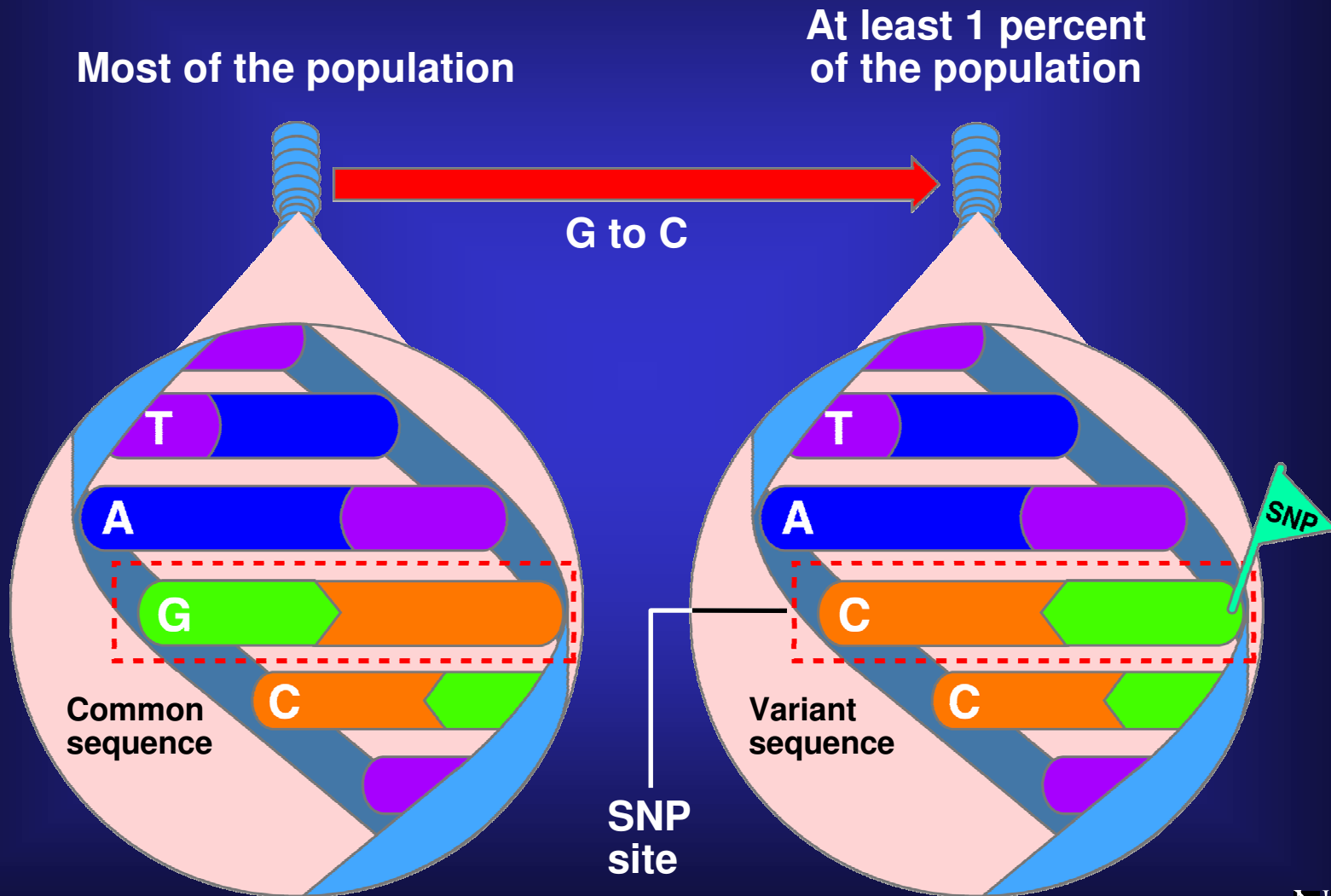


Artwork by Jeanne Kelly, © 2002.

Genomic Technology

- 99.9% of DNA is same; 0.1% different
- 0.1% variation determines why 2 people look different and may develop different diseases
- Variation in genes can cause no change, harmless (eye, hair colour), harmful (cancer, heart disease, haemophilia etc)

SNPs Are the Most Common Type of Variation



Artwork by Jeanne Kelly. © 2002.

Genomic Technology

- Through association studies we can determine which SNPs have an effect on an array of harmful and harmless traits e.g.,
 - Susceptibility to various diseases
 - Type of ear wax
 - Restless leg syndrome
 - Avoidance of errors
- Can pay to have your genome tested!!
 - ~1 million SNP
 - ~€1500

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1866: Gregor Mendel discovers the laws of inheritance.

200,000 years ago: *Homo sapiens* walks the Earth.

2003: The Human Genome Project maps a single person's genome.

2007: 23andMe introduces the first Personal Genome Service.

Unlock the secrets of your own DNA. Today.

175,000 years ago: The mother of all present-day humans is born in Africa.

1953: Watson and Crick uncover the double-helix structure of DNA.

Welcome to 23andMe, a web-based service that helps you read and

understand your DNA. After prov

at-home kit, you can use our int

your distant ancestors, your clo

[Sign up for c](#)

Gene Journal



Family Inheritance



news

What's new at 23andMe

Browse and Search Topics

View: All Topics	Search:	Go	Show All Topics
☐ Show Established Research first			
Name	Study Size	Date Modified	
✓ Age-related Macular Degeneration	✓	Feb 8, 2008	
✓ Alcohol Flush Reaction	✓	Dec 18, 2007	
Amyotrophic Lateral Sclerosis	111	Feb 21, 2008	
Ankylosing Spondylitis	111	Feb 21, 2008	
Atrial Fibrillation	111	Feb 21, 2008	
Attention-Deficit/Hyperactivity Disorder	11	Feb 21, 2008	
Avoidance of Errors	1	Feb 21, 2008	
Back Pain	11	Feb 21, 2008	
Born Weight	111	Feb 21, 2008	
✓ Bitter Taste Perception	✓	Nov 19, 2007	
✓ Breast Cancer	✓	Dec 17, 2007	

Select topic by body part:

Show All

Head

Abdomen

Torso

Northern Region

Limbs

Behavioral

Nervous System

Circulatory System

Established Research

These topics meet our criteria for findings that are very likely to reflect real effects.

At least five studies that examined more than 1,000 people with the trait/condition, or smaller studies where there is a consensus that the effect is real.

Gene Journal

23andMe can help you discover how your genes may affect your chances of developing various diseases and conditions, as well as traits such as athletic ability. And because genes are not the only things that influence your health, you also get abundant background information to put their significance in context when you consult 23andMe's Gene Journal.

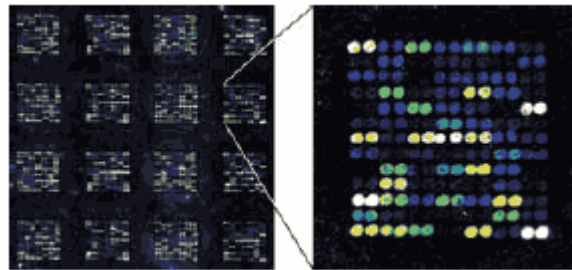
8 new Gene Journal topics to its introduces a 23andMe survey on [our service](#) today!

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Genomic Technology

- Bovine approach is similar to human approach
- Sequencing has led to SNP chips being made available to investigate effect of SNPs on economically important traits
- Currently



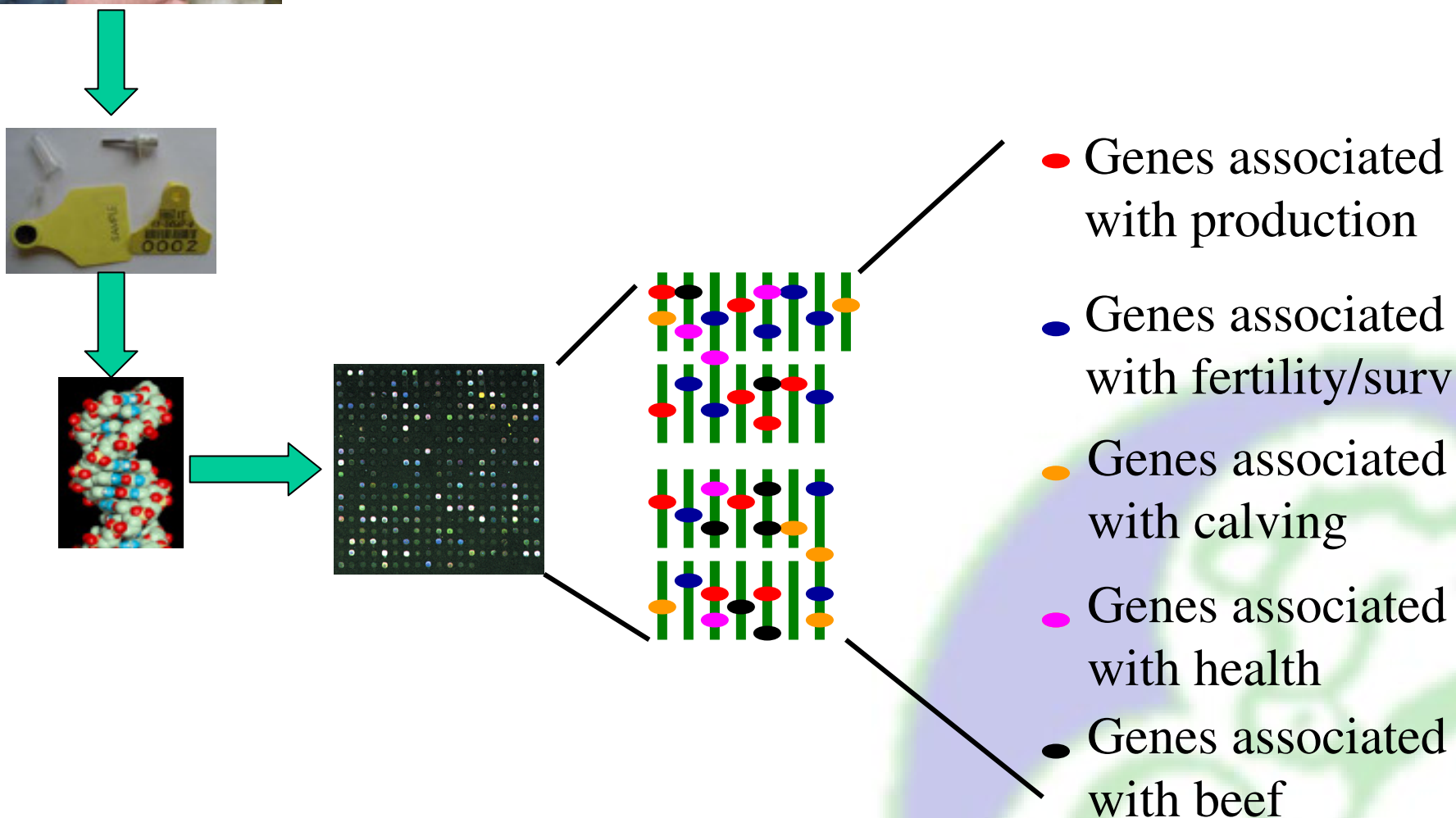
h ~54k SNP

Genomic Selection Steps

- Genotype proven bulls using SNP chips (€200/bull)
- Statistical analysis to determine the effect of each SNP on the traits in the EBI (training population)
- Use estimates of SNP effects of proven bulls to calculate an EBI on young animals



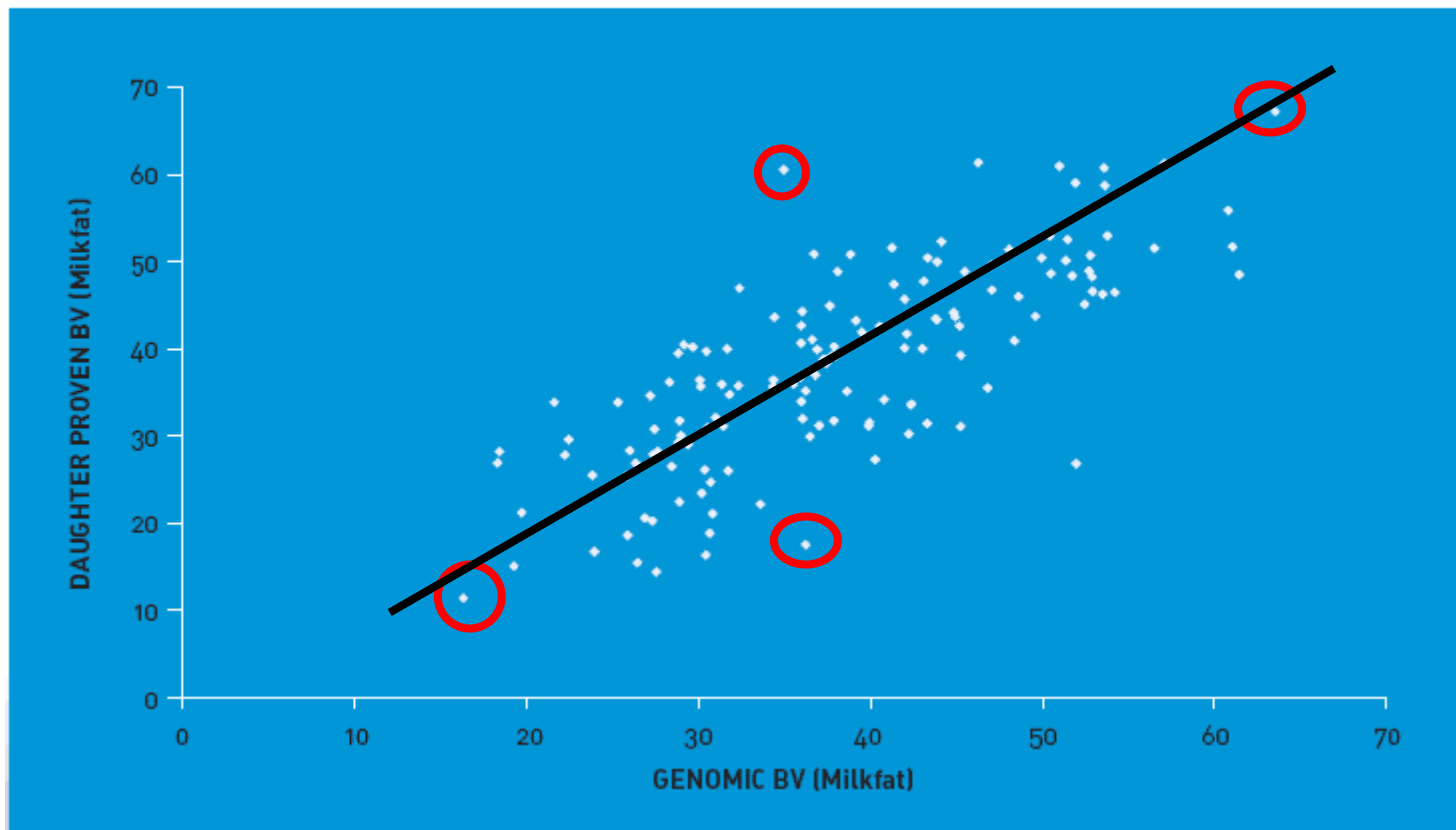
Genomic Selection



$$\text{GS EBI } \text{€} = \text{Sum}(\text{all genes associated with traits in EBI}) * \text{EV}$$

Does it work?

Scatter graph showing the correlation between Genomic Breeding Values and Daughter Proven Breeding Values for Milkfat of 143 Holstein-Friesian Bulls



http://www.lic.co.nz/lic_The_Science.cfm, 2008

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Reliability

- At selection young bull has parent average reliability of ~35%
- At 5 years with 80 daughters bull would have reliability of ~85%
- At birth a GS young bull will have a reliability of 55-65% - or equivalent of having 10-15 daughters
- Using packs of GS bulls to boost reliability further

Genetic Gain

Current scenario

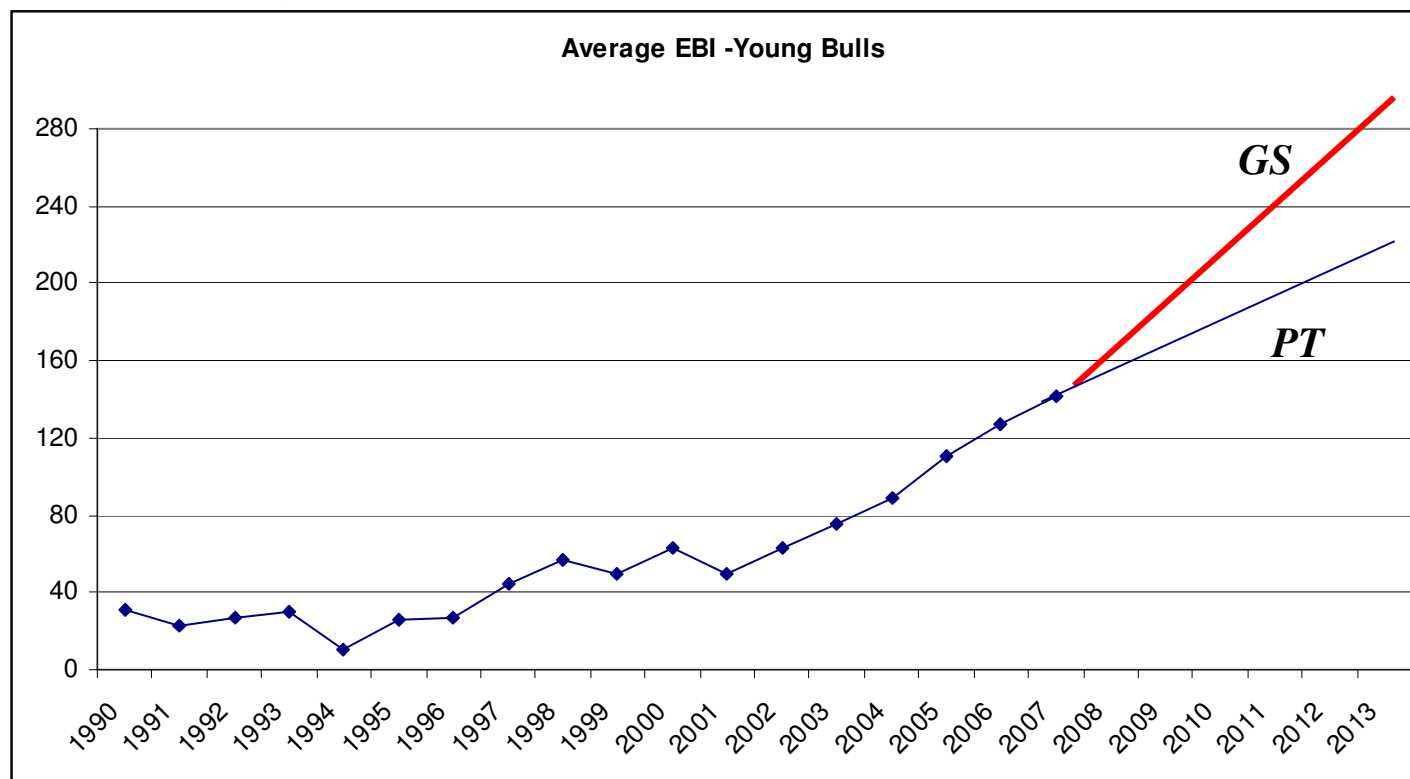
Year -	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Cows Contract Mated	Bull Calves Bought	100 Bulls enter GENE IRELAND	Daughters born	Daughters mated	Daughter calves/milk recorded	Bulls chosen for AI (10-20)

Genomic Selection scenario

Year -	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Cows Contract Mated	'000s Bulls selected on GS	100 (or less) Bulls enter GENE IRELAND	Bulls chosen for AI	3 Years Advanced Gain		

Genetic Gain

- More gain; less expense



Impact on ICBF

- Database
 - Storage of genotypes
 - Currently >50K pieces of info/animal
 - Soon could be > 1m SNP chips
 - Farmers may decide to do analysis of all animals in the herd
 - Dairy and Beef
 - Phenotypes still need to be collected!!

Impact on ICBF

- Genetic Evaluations
 - A whole array of technical questions to be answered regarding inclusion of genomic information
 - On going analysis of genotypes/estimating SNP effects;
 - Computationally very demanding
 - How to publish EBI on international bulls selected on GS in country of origin
 - How will Interbull handle this technology
 - Sharing of SNPs??

Impact on ICBF

- GEN IRELAND

- Need to have GS young bulls entering GI to ensure Irish animals continue to contribute to genetic gain
- Eventual need for a complete progeny test?
 - Use GI model to get calving ease & defect information in year 1 but widespread in year 2 (LIC model)
- Re-appraisal of optimal breeding design for Ireland required

Impact on ICBF

- HerdPlus
 - Most services will be unaffected
 - Likely that animals will still have only a single EBI figure
 - Education of farmers on new technology

Current Situation

- DNA from proven bulls being collected
- Some genotypes already done
- Analysis of training population currently being looked at
- Possibility of selecting GI young bulls based on GS in Spring '09

Summary

- Revolution has begun in many countries
- Costly but benefits should out-weigh costs in the long run
- Technologies improving rapidly
- Many questions still remain
- ICBF needs to be at forefront on GS in Ireland and put in necessary infrastructure to support GS into the future

Genomic Selection

- ICBF Strategy – Board 17th July
 1. Leadership
 2. Research task force
 3. Tissue archive for research
 4. Dairy bull samples
 5. DNA facility
 6. Extend database
 7. Size of training population
 8. Extend genetic evaluation system
 9. Breeding scheme design & GEN€ IRELAND®

GENE IRELAND®

- Impact of Genomic Selection
- NDP Funding for 2009
- Review design & funding

