# *Genetic Improvement in the Irish Dairy and Suckler Beef Herds: Latest developments*

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***RDS 2nd December 2008***

# What's new in breeding?

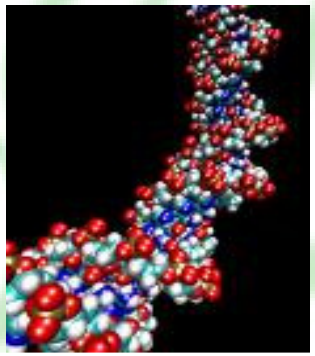
- **Dairy: Genomic Selection (+ beef)**
- **Beef: Advent of Suckler Beef Eurostar indexes**
  - **AWRBS: increased levels of data for existing traits, new traits e.g. Docility**
  - **Possibility of new carcass traits using digital images**

# Current Approach to genetic improvement

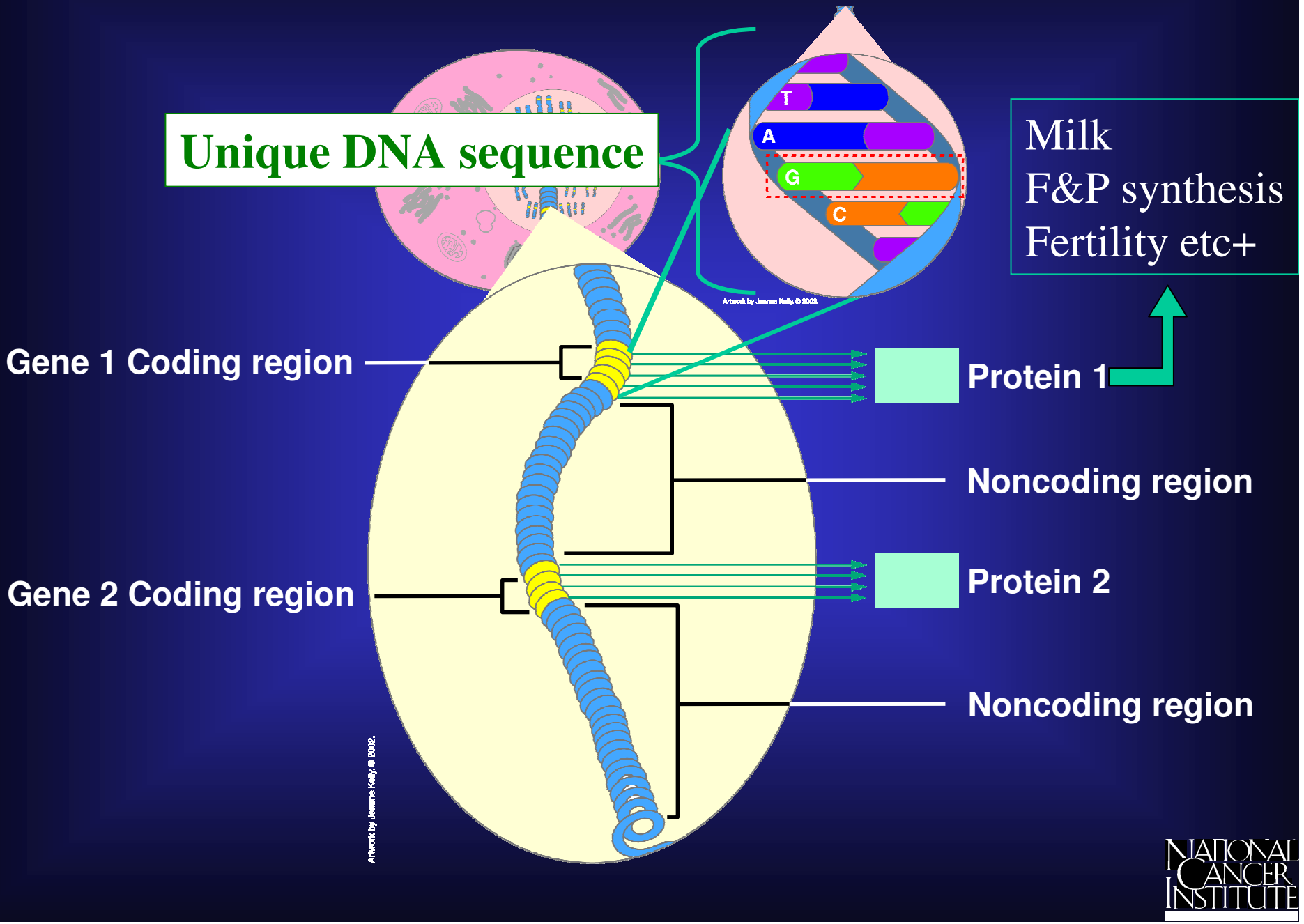
- **Increase profitability of farming by making genetic progress in traits of economic importance**
- **Based on recording information (phenotypes) of animals on farm, marts, factories etc…**
  - **e.g., fat & protein, fertility, carcass yield and quality, calving ease**
- **Quantitative approach (statistical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

# What is genomics?

- All living organisms store genetic instructions in their cells which help determine how they grow and function : DNA
- Compilation of DNA is called the genome



# The Genome Contains Genes

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# Why the interest in Genomics?

- **Example Bulls – 2 full brothers.**

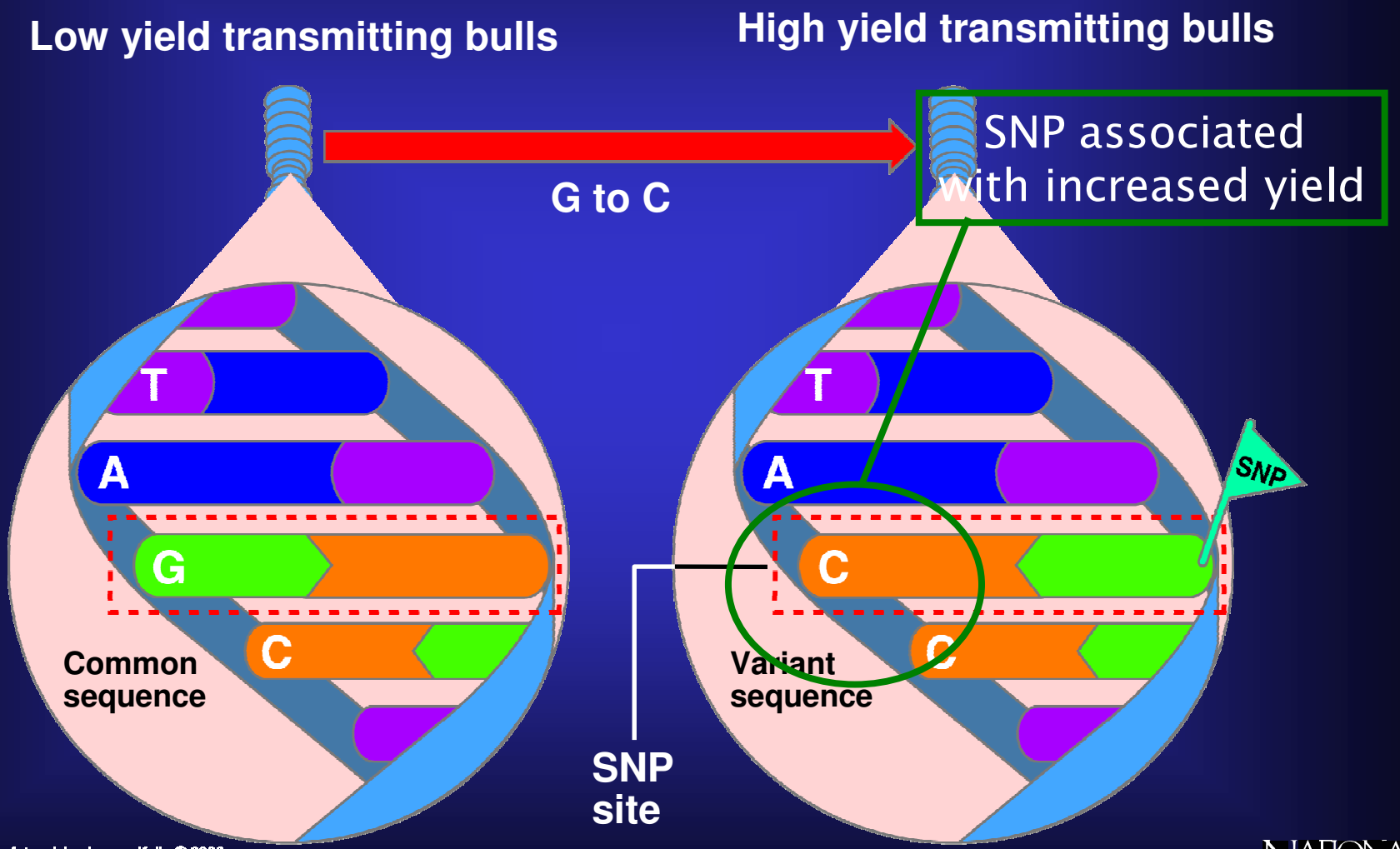
| Bull | Addison | Slogan | Difference |
|---|---|---|---|
| EBI | €26 (97%) | €75 (98%) | **-€49** |
| Milk | €74 (99%) | €32 (99%) | **+€42** |
| Fertility | €-77(95%) | €43 (97%) | **-€120** |
| Milk kg | 748 (99%) | 57 (99%) | **+691** |
| F+P | 27.5(99%) | 10 (99%) | **+17.5** |
| CI | 4.7 (95%) | -2.1(97%) | **+6.8** |

- **How could 2 full brothers be so different?**
- **Need to progeny test bulls to determine value**
- **Could genomics have told us earlier?**

# Genomic Selection – How?

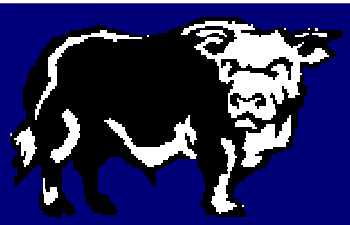
- The bovine genome.
  - 30 chromosomes & 3 billion pieces of DNA
  - 30,000 genes controlling all functions
  - We do not know many of these genes
- ***S***ingle ***N***ucleotide ***P***olymorphism's are a type of variation
  - These are known markers (sign-post). Many genes associated with this sign-post.
  - We do know the location of all SNP but not function
- 54,000 pieces of DNA information available on a chip (SNP chip)

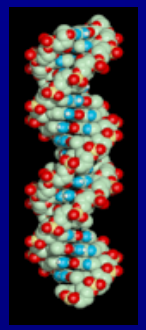
# How Does it Work?



# How does it work?

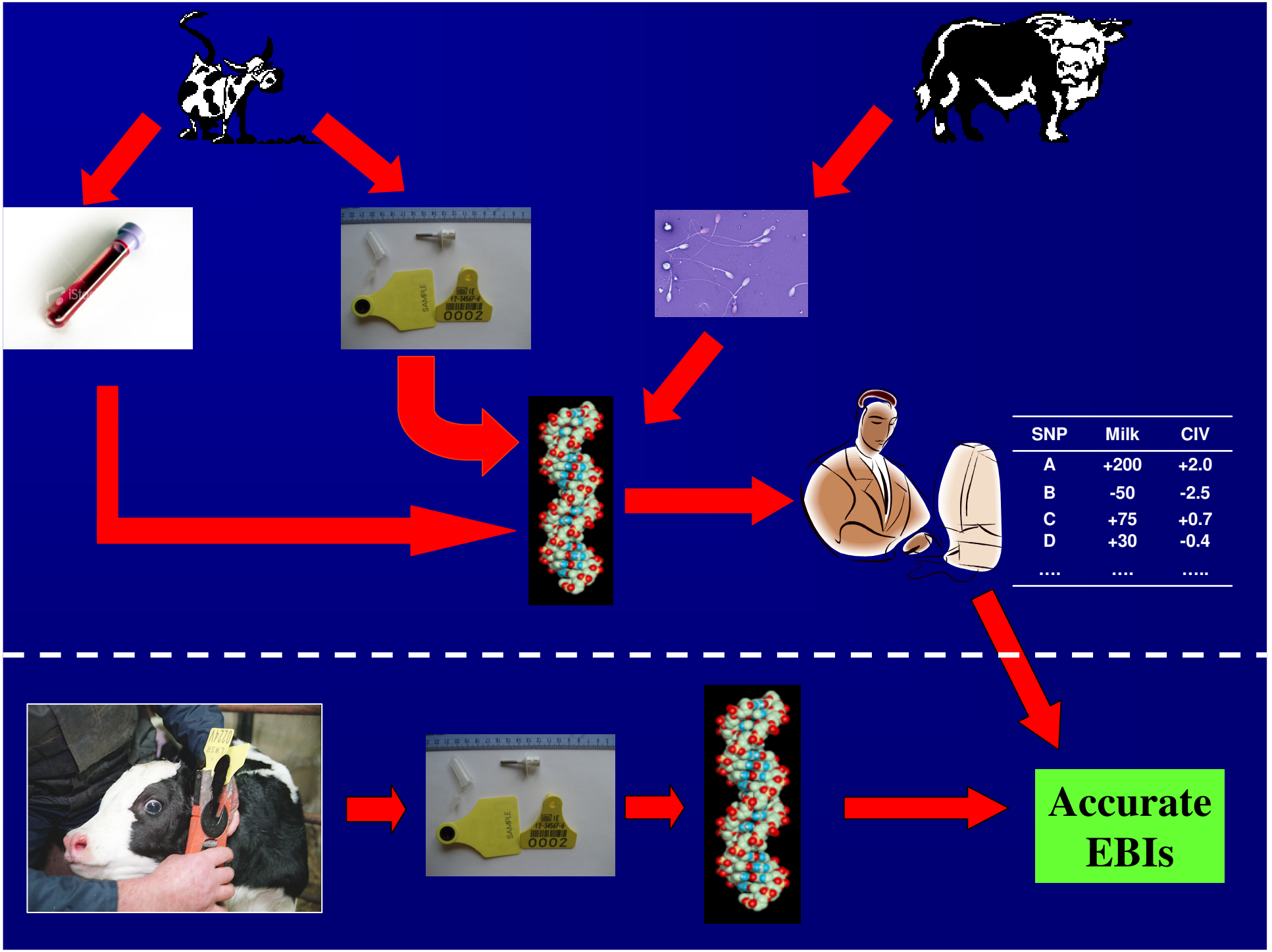
- Estimate what effect each SNP has on each of the traits in the EBI (Genomic Key)
- To do this we need a 'training population'
- A training population is a group of proven bulls
  - With reliably proven traits and EBI
  - Genotypes (54k SNP chips)
- Potential to use cows also



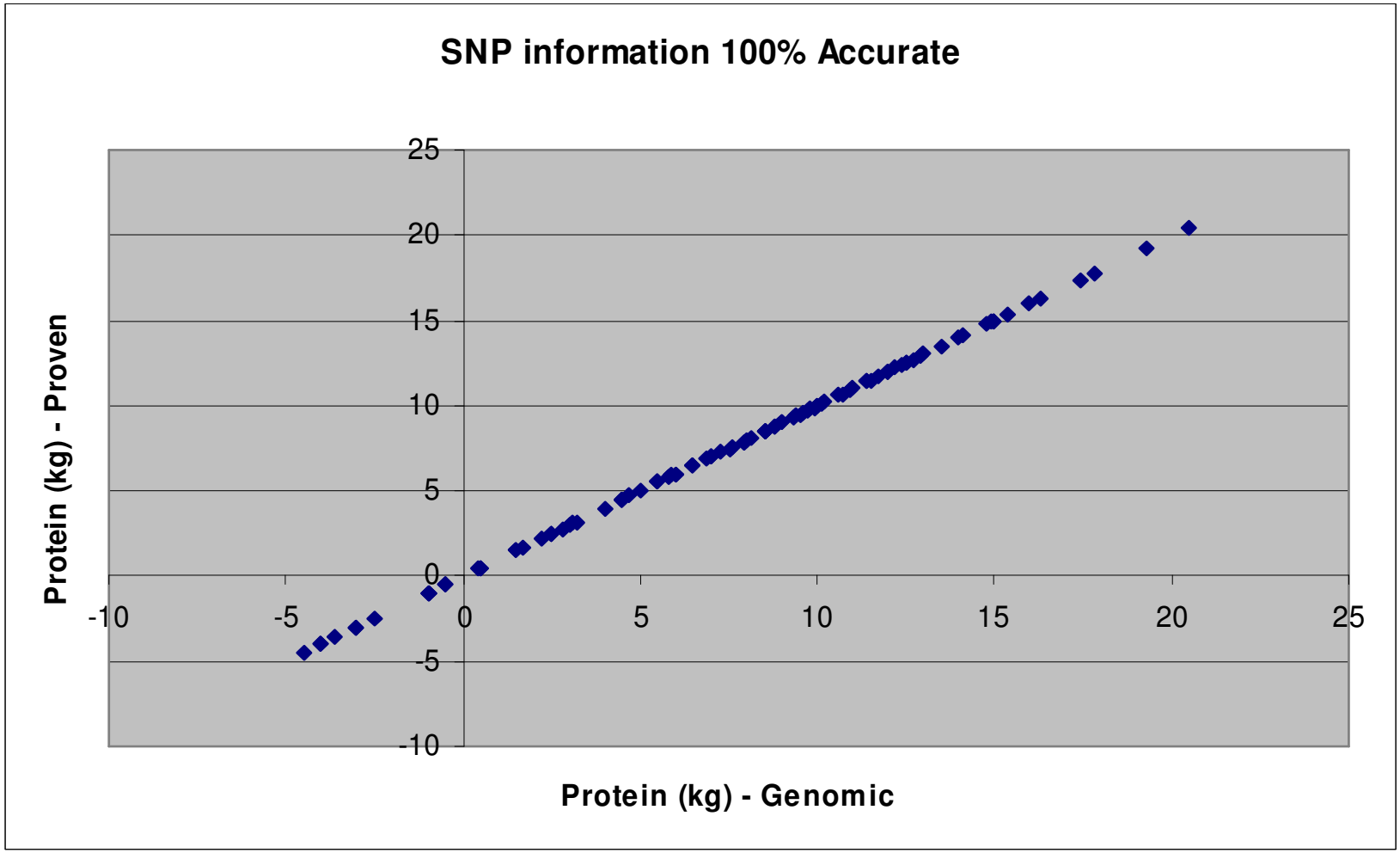



| SNP | Milk | CIV |
|---|---|---|
| A | +200 | +2.0 |
| B | -50 | -2.5 |
| C | +75 | +0.7 |
| D | +30 | -0.4 |
| .... | .... | ..... |

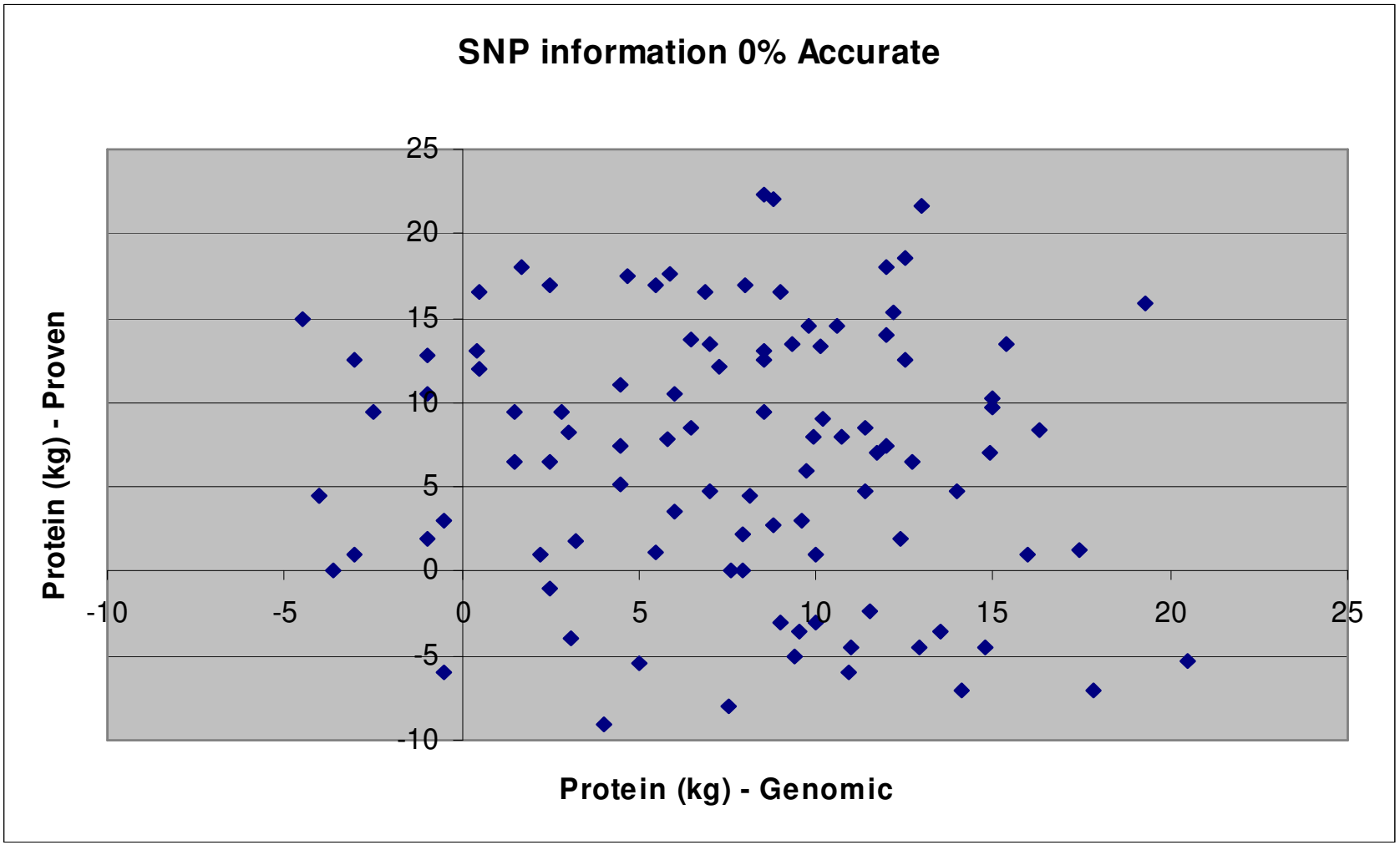
# IRISH GENOMIC KEY


SNP Milk CIV
A +200 +2.0
B -50 -2.5
C +75 +0.7
D +30 -0.4
.... .... .....
Accurate EBIs

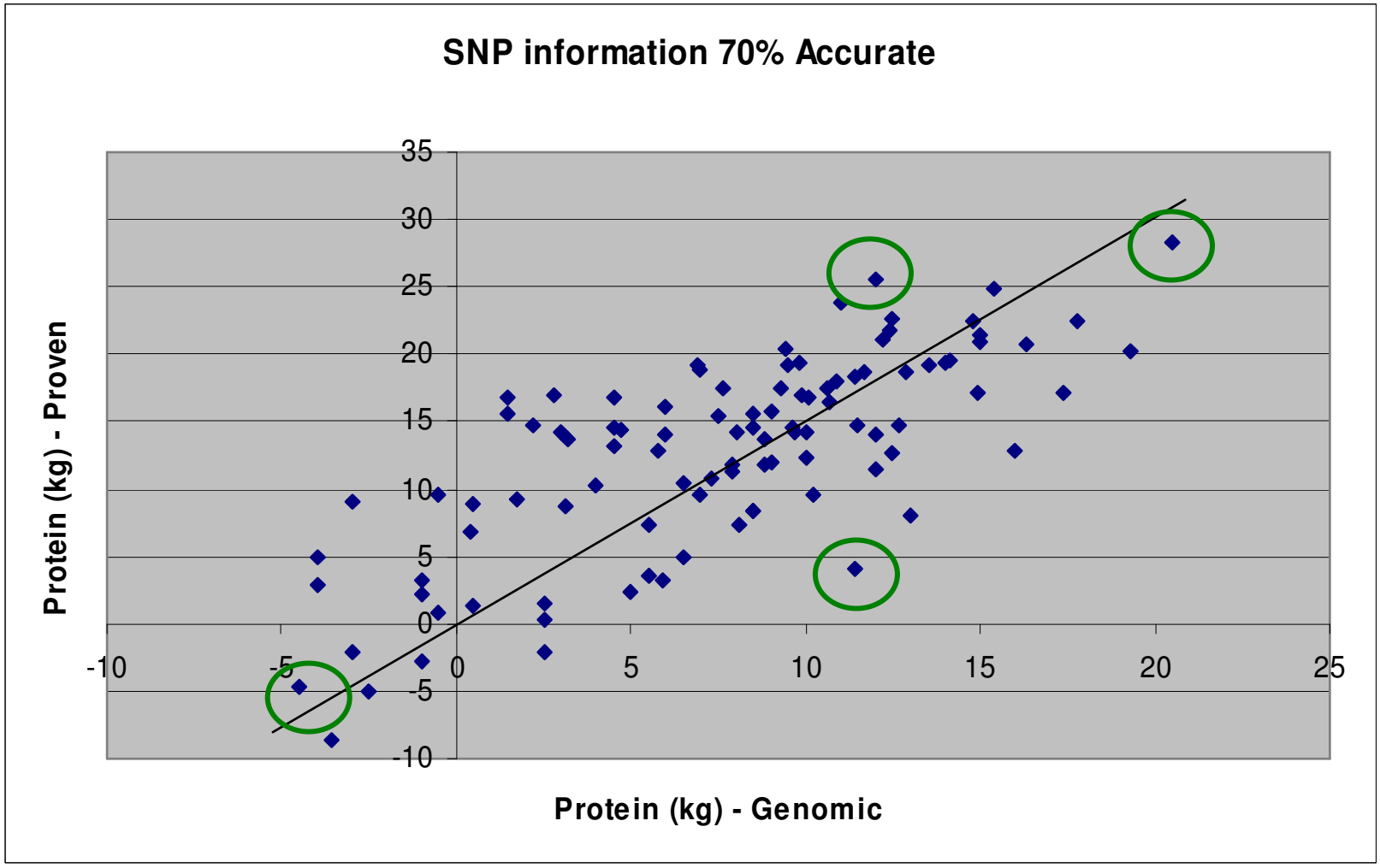
# SNP Info – Perfect Prediction



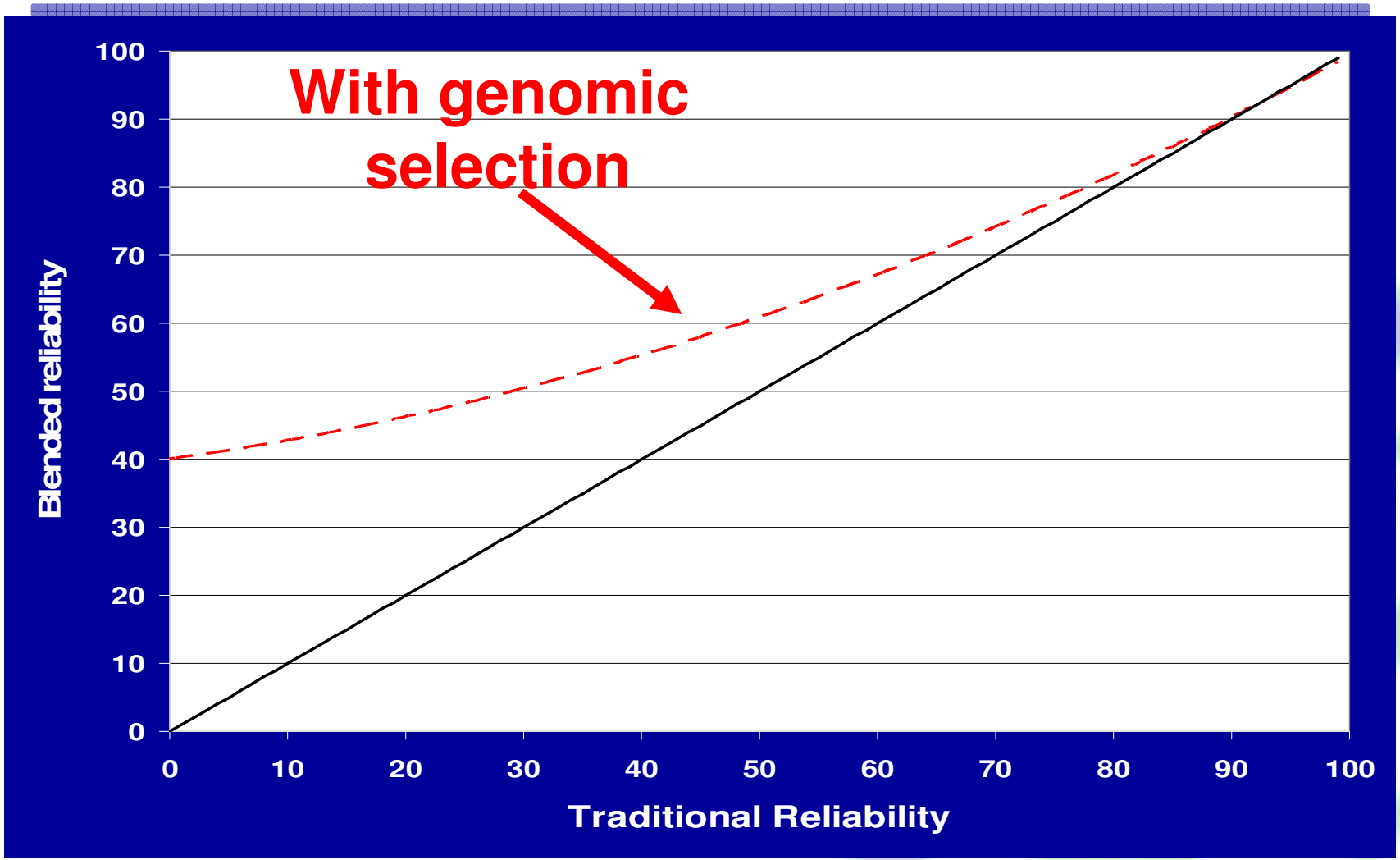
# SNP Info - Useless



# SNP Info - Expected



# Effect on Reliability



# Cost

- Current cost is about €300/animal
- May be able to develop a smaller SNP chip based on most relevant SNP?
- Used to screen cows (bull dams) and young animals – lower cost?

# Where is the Irish research work?

- Goal of having GS data incorporated into National EBI's
  - Parent Average + Genomics + Foreign Data + Performance in Ireland
  - Integrated research: Irish training population (now ~1000 AI sires) + data from other countries (LIC, CRV….?)
  - We want to be able to give Irish Farmers EBIs for all imported bulls

# Impact at level of breeder

- Some breeders: will be conservative, continue to use traditionally proven bulls
- Higher risk (but less than before) for those using teams of genomic tested young bulls but faster genetic gain
- Ability to more rapidly breed cows to meet changing requirements within the industry
- Increased reliability on heifers and cows, more accurate identification of elite females
- More careful analysis of inbreeding

# Impact at level of ICBF

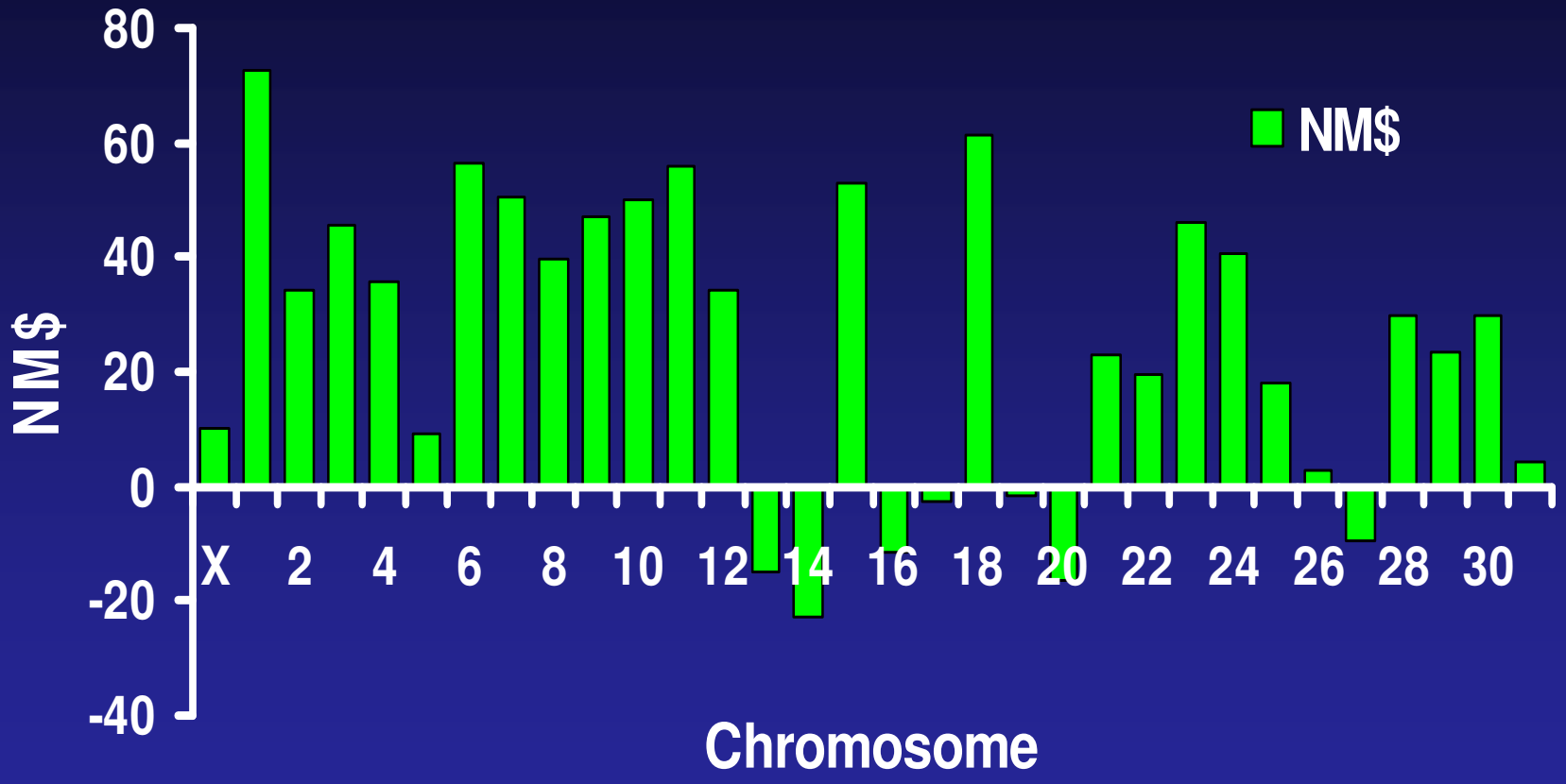
- Creates uncertainty for role of INTERBULL unless co-operation and sharing of genomic information
- Consortiums at present: USA & Canada, Dutch, New Zealand
- Ireland unlikely to be large enough to operate alone, co-operation needed
- Ideally ICBF in a position to provide genomically enhanced breeding values for bulls from all countries on one scale: uncertainty how this will materialize

# Summary

- Genomics has much to offer Irish farmers and dairy industry.
- Progress in traits traditionally hard to measure e.g. fertility, mastitis resistance
- New technology….but there will be some teething problems.
- Important to note that recording of phenotypic information is still vital: training population re-est
- Not the “silver bullet”….an extra tool on which to make better breeding decisions.
- Working towards having GS for young bulls in Spring 2009.
- Wider application Spring 2009+

# Net Merit by Chromosome for O Man

## Top bull for Net Merit

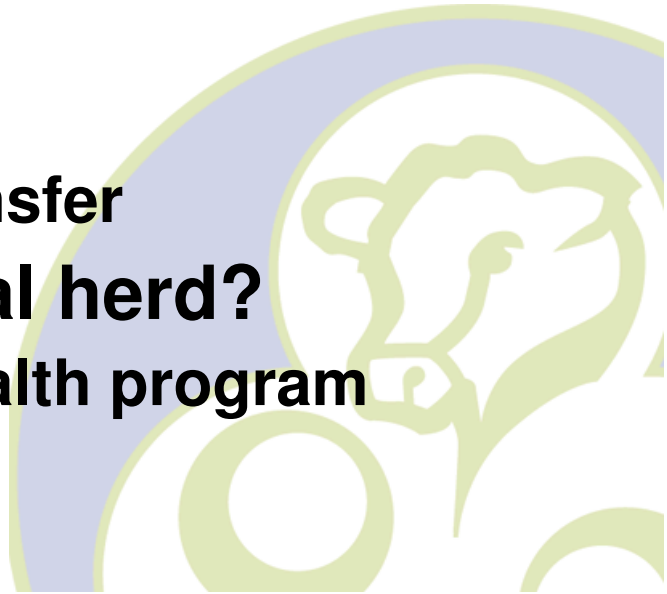



**Genomic Prediction very close to actual Net Merit**

# *Developments in Suckler Beef Breeding*

# *Challenges: Beef viewpoint*

- **Severe lack of sire ancestry recording to compliment quality phenotypic data**
- **Very low level of AI usage:**
  - **Affects genetic connections across herds**
- **Low farm incomes**
  - **Lack of interest in breeding**
- **Ageing farmer profile**
  - **Challenges for technology transfer**
- **Disease status of the national herd?**
  - **Lack of a concerted animal health program**

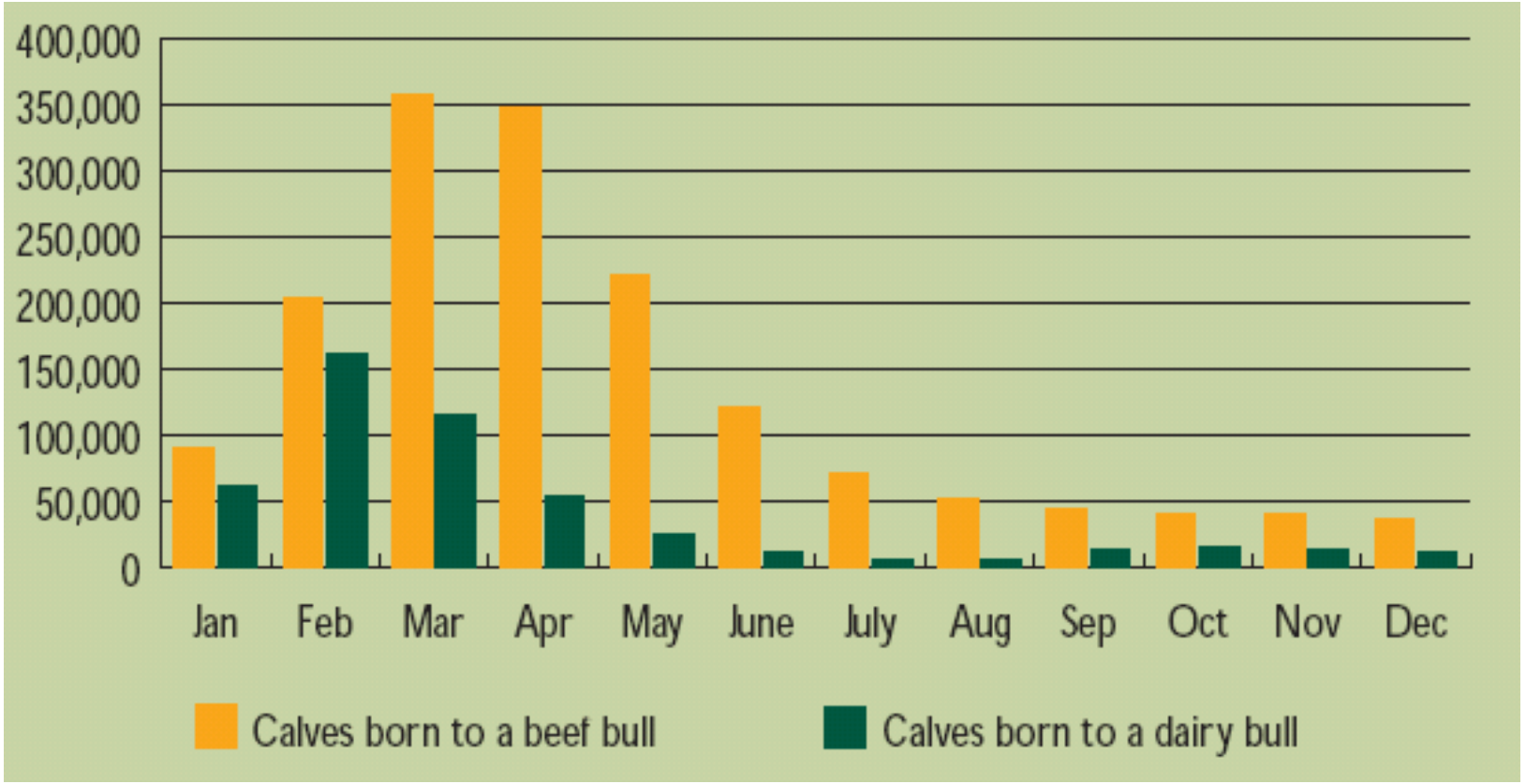


# Profile of Breed Combinations

| Dam Breed | Breed of Sire | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Charolais | Hol/Fries | Limousin | Angus | Hereford | Simment | BBlue | Montbel | Sht_horn | Blonde | Saler | Rotbunt | Jersey | MRI | Other | Total |
| Charolais | 168,419 | 556 | 52,559 | 9,711 | 4,651 | 11,170 | 7,807 | 117 | 1,245 | 1,156 | 1,123 | 6 | 3 | 22 | 561 | 259,106 |
| Hol/Fries | 39,698 | 487,285 | 92,520 | 148,908 | 131,275 | 38,874 | 41,959 | 12,656 | 2,851 | 1,744 | 1,577 | 4,455 | 4,135 | 1,157 | 4,211 | 1,013,305 |
| Limousine | 90,048 | 1,052 | 120,731 | 12,487 | 5,357 | 11,618 | 12,827 | 126 | 1,610 | 1,701 | 1,304 | 30 | 7 | 35 | 663 | 259,596 |
| Angus | 52,017 | 1,371 | 31,193 | 28,814 | 5,129 | 6,742 | 5,914 | 105 | 1,473 | 685 | 834 | 27 | 12 | 27 | 573 | 134,916 |
| Hereford | 62,654 | 1,534 | 40,474 | 10,428 | 27,400 | 12,246 | 5,949 | 133 | 1,464 | 965 | 656 | 22 | 9 | 19 | 446 | 164,399 |
| Simmental | 67,216 | 1,522 | 40,954 | 7,923 | 5,309 | 32,844 | 7,326 | 306 | 856 | 1,114 | 818 | 33 | 5 | 36 | 459 | 166,721 |
| BBlue | 20,460 | 848 | 17,111 | 4,314 | 1,890 | 2,958 | 7,349 | 76 | 478 | 621 | 317 | 23 | 11 | 10 | 235 | 56,701 |
| Montbel | 1,736 | 3,805 | 2,615 | 3,576 | 2,002 | 1,061 | 1,181 | 6,110 | 124 | 97 | 76 | 197 | 85 | 32 | 283 | 22,980 |
| Shorthorn | 13,597 | 538 | 8,754 | 2,844 | 1,675 | 1,992 | 1,373 | 59 | 7,207 | 219 | 386 | 20 | 17 | 10 | 189 | 38,880 |
| Blonde | 1,472 | 28 | 1,550 | 311 | 128 | 238 | 494 | 3 | 17 | 1,793 | 69 | 1 | 0 | 2 | 47 | 6,153 |
| Saler | 2,385 | 10 | 1,122 | 275 | 111 | 194 | 193 | 2 | 57 | 24 | 1,952 | 0 | 0 | 1 | 45 | 6,371 |
| Rotbunte | 115 | 1,212 | 248 | 939 | 451 | 78 | 117 | 108 | 47 | 36 | 14 | 1,488 | 110 | 14 | 58 | 5,035 |
| Jersey | 116 | 1,177 | 135 | 351 | 167 | 26 | 101 | 41 | 26 | 8 | 3 | 18 | 1,328 | 7 | 54 | 3,558 |
| MRI | 353 | 917 | 560 | 415 | 521 | 186 | 212 | 252 | 93 | 21 | 22 | 145 | 15 | 1,095 | 101 | 4,908 |
| Other | 802 | 811 | 839 | 1,229 | 324 | 253 | 249 | 119 | 77 | 34 | 58 | 66 | 94 | 9 | 2,472 | 7,436 |
| Total | 521,088 | 502,666 | 411,365 | 232,525 | 186,390 | 120,480 | 93,051 | 20,213 | 17,625 | 10,218 | 9,209 | 6,531 | 5,831 | 2,476 | 10,397 | 2,150,065 |
| percent | 24.2 | 23.4 | 19.1 | 10.8 | 8.7 | 5.6 | 4.3 | 0.9 | 0.8 | 0.5 | 0.4 | 0.3 | 0.3 | 0.1 | 0.5 | 100.0 |

- Suckler Beef Herd combinations in Grey
- Dairy herd combinations in white, Purebred births in yellow
- **Large use of Beef Sires on the dairy herd**
- **Large level of crossbreeding in the Suckler herd**

# *Calving Patterns*




- **Seasonal aspect to calving**
- **High usage of natural service beef sires in dairy herds at end of breeding season**

# Profile of Beef Calving herds

| Type of Calving herd on ICBF database | Count of herds | Count of cows calved | Averages no. of cows per type of herd | | Count of calving herds in various categories of herd size (total beef cows only) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | pedigree | crossbred | <5 | 5 to 9 | 10 to 24 | 25 to 49 | 50 to 99 | >100 |
| Crossbred beef cows only | 40,482 | 503,270 | 0 | 12 | 10,786 | 10,328 | 14,439 | 4,238 | 651 | 40 |
| Pedigree beef & crossbred beef cows | 5,905 | 126,512 | 4 | 17 | 385 | 1,036 | 2,704 | 1,375 | 382 | 23 |
| Pedigree beef, crossbred beef & dairy cows | 967 | 17,712 | 4 | 14 | 135 | 227 | 377 | 168 | 52 | 8 |
| Pedigree beef cows only | 702 | 5,028 | 7 | 0 | 366 | 171 | 135 | 29 | 1 | 0 |
| Pedigree beef & dairy cows | 214 | 1,061 | 5 | 0 | 146 | 38 | 24 | 5 | 1 | 0 |

- Pedigree herd size is small but substantial linkage with commercial herds
- ~30% of herd replacements in commercial herds sourced from dairy herds

# Profile of Fattening beef herds

| Type of fattener herd on ICBF database | Count of herds | Count of animals | Averages no. of animals per type of herd | | | Count of fattening herds in various categories of herd size | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dairy | Beef | Dairy x Beef | <25 | 25 to 49 | 50 to 99 | 100 to 499 | >500 |
| beef animals only | 11,598 | 57,919 | 0 | 5 | 0 | 11,303 | 241 | 46 | 8 | 0 |
| beef, dairy & 1st cross dairy-beef animals | 7,257 | 273,193 | 13 | 12 | 13 | 3,574 | 2,100 | 1,169 | 402 | 12 |
| dairy & 1st cross dairy-beef | 6,384 | 120,927 | 12 | 0 | 7 | 4,792 | 1,236 | 331 | 25 | 0 |
| beef & 1st cross dairy-beef | 5,250 | 89,065 | 0 | 14 | 3 | 4,207 | 706 | 264 | 73 | 0 |
| dairy animals only | 2,937 | 26,562 | 9 | 0 | 0 | 2,700 | 192 | 40 | 5 | 0 |
| 1st cross dairy-beef | 1,216 | 2,855 | 0 | 0 | 2 | 1,215 | 1 | 0 | 0 | 0 |
| beef & dairy animals | 959 | 10,223 | 6 | 4 | 0 | 874 | 74 | 10 | 1 | 0 |

# Suckler Beef Index: SBV

**Comparable Across breeds**

**(C)**
**23%**
**kept for**
**replacements**

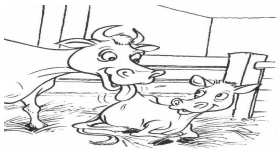
**33 months +**

**Calf Value**
- *Calving Traits*
- *Wean Weight*
- *Feed Intake*
- *Carcass Traits*

**Milk & Fertility**
- *Cow Survival*
- *Calving Interval*
- *Age at Calving*
- *Calving Difficulty*
- *Milkability*
- *Cull-Cow Carcass*

**Breeding decision today**

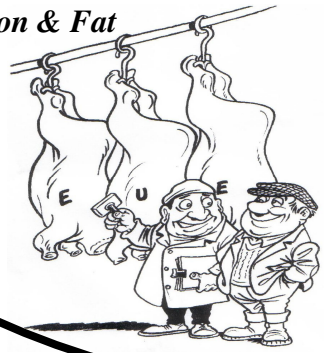
**Calving Traits**
- *Calving Difficulty*
- *Gestation*
- *Mortality*



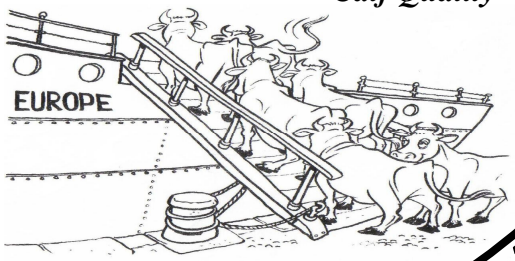
**9 months later**

€205
€113
€128
-€4
€81
€55

**Beef Carcass**
- *Weaning Weight*
- *Feed Intake*
- *Carcass Weight*
- *Carcass Conformation & Fat*




**Weanling Export**
- *Weaning Weight*
- *Calf Quality*




**27 months later**

**15 months later**

**(B)**
**62% slaughtered**
**in Ireland**

**(A)**
**15% exported**
**to Europe**

# Suckler Welfare Scheme

- **Ability to transform the level of information available for genetic improvement of beef industry**

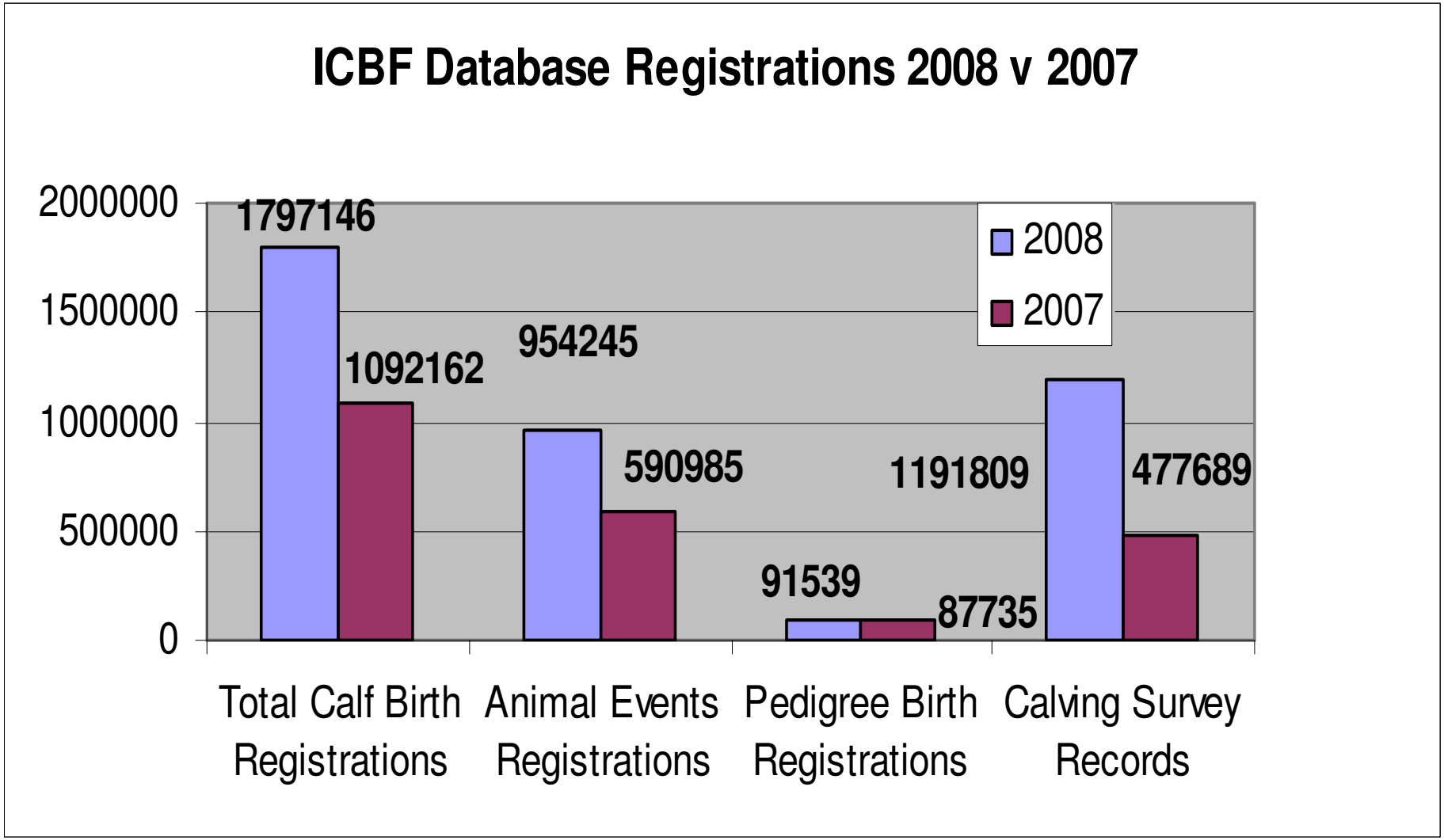
- ***2008 Calving information ~ 600,000 extra calvings***

  - ***2008/2009 ~ weaning weight, calf quality, docility (400,000)***

    - ***2009/2010 ~ Carcass information, fertility information on replacements***

      - ***2011 + ~ Maternal traits***

# Levels of data on ICBF database



| Breed of sire | count |
|---|---|
| CH | 168,493 |
| LM | 126,139 |
| AA | 26,864 |
| SI | 26,143 |
| BB | 19,490 |
| HE | 11,234 |
| SH | 4,544 |
| SA | 4,481 |
| BA | 4,050 |
| AU | 1,449 |
| PT | 713 |
| PI | 586 |
| GA | 123 |
| MA | 75 |
| HI | 67 |
| RM | 47 |
| SP | 26 |
| AN | 13 |
| IM | 11 |
| DX | 7 |
| GS | 5 |
| SD | 2 |
| LH | 1 |
| VO | 1 |

Total : 398,241

# *Docility*

- Very important trait on all farms
- Initial editing for genetic parameter estimation

| Breed of sire | count |
|---|---|
| CH | 92,401 |
| LM | 68,204 |
| SI | 14,301 |
| AA | 12,315 |
| BB | 11,936 |
| HE | 4,696 |
| SA | 2,425 |
| BA | 2,226 |
| SH | 1,845 |
| AU | 908 |
| PT | 429 |
| PI | 350 |
| GA | 45 |
| HI | 32 |
| MA | 23 |
| RM | 20 |
| SP | 17 |
| GS | 3 |
| RW | 2 |
| RB | 1 |

Total : 213,327

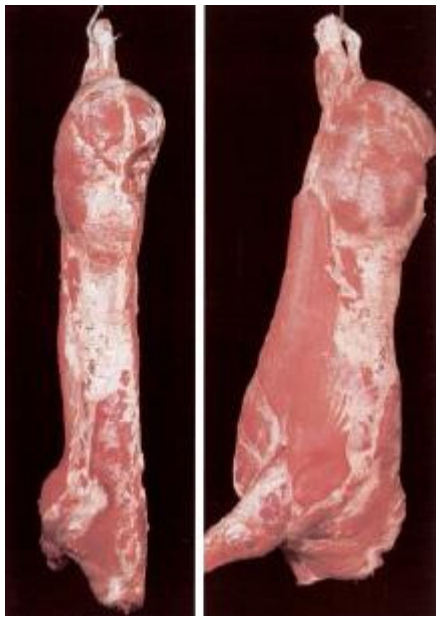
Herds with 5 records per sire, 5 animals per herd year season, at least 2 points used on the scale

# Research on new production traits

- **Can selection help Irish farmers produce carcasses that fit more the retailer's demand?**
  - **... PhD Project of Thierry Pabiou ICBF**
- ***What data?***
  - ***Is selection possible?***
    - ***Integration into current breeding program?***
      - ***Benefit for the Irish beef industry?***

# Current status of Beef Carcass Index

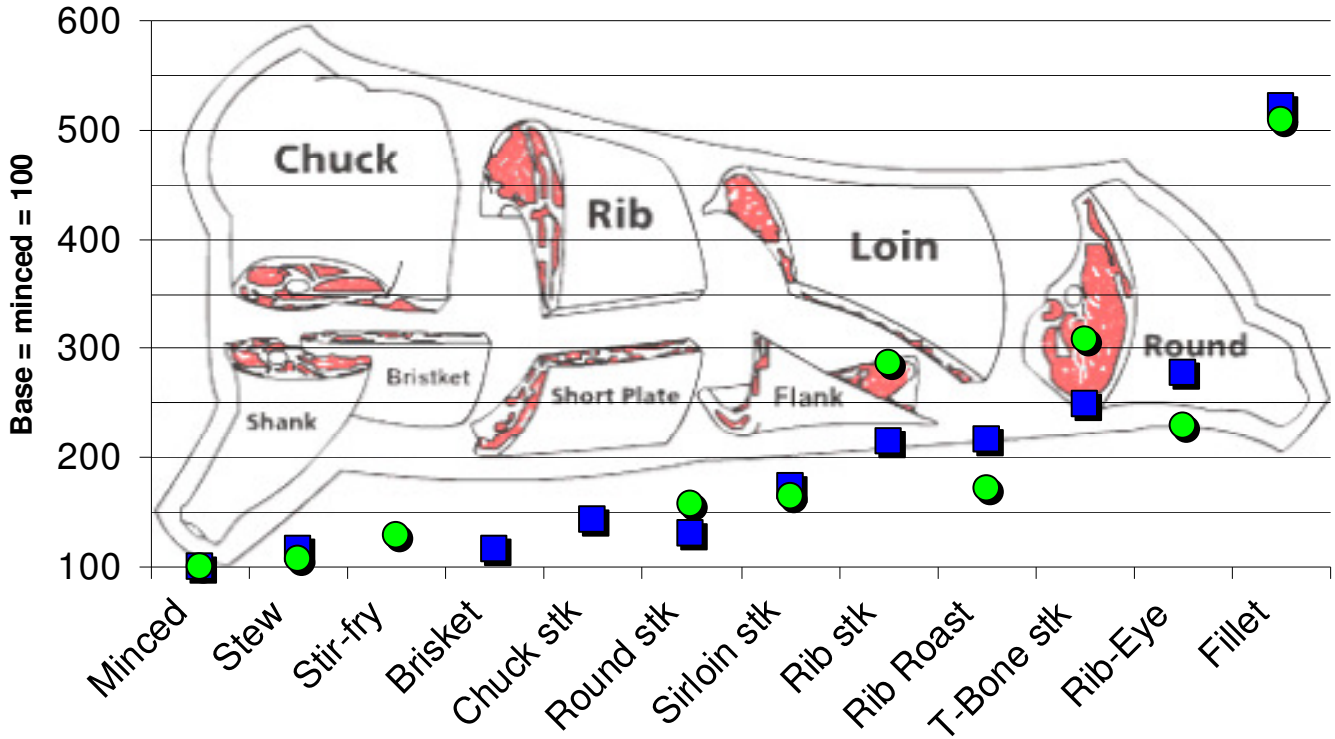
- The EUROP carcass classification
  - Assessment of conformation (6 grades) & fat (5 grades) by Experts / machines



Payment on carcass weight, conformation grading & fat grading.

# Project Background: on the shelves

- The value of a carcass is not uniform
  - ↳Different cuts, different prices




*Data downloaded from 2 commercial websites*
*Price lists September 2008 ($/lb & €/lb)*

# Data Available (1/2)

1. Basic carcass data
   - Fed into Irish genetic database on a routine basis since 2001: weight, sex, EUROP grading
     - ↳ +3 million (July 2008) animals
2. Digital images
   - To derive the EUROP grades
   - Fed into Irish database on a routine basis since 2005
     - ↳ 2 x 2 million (July 2008) images

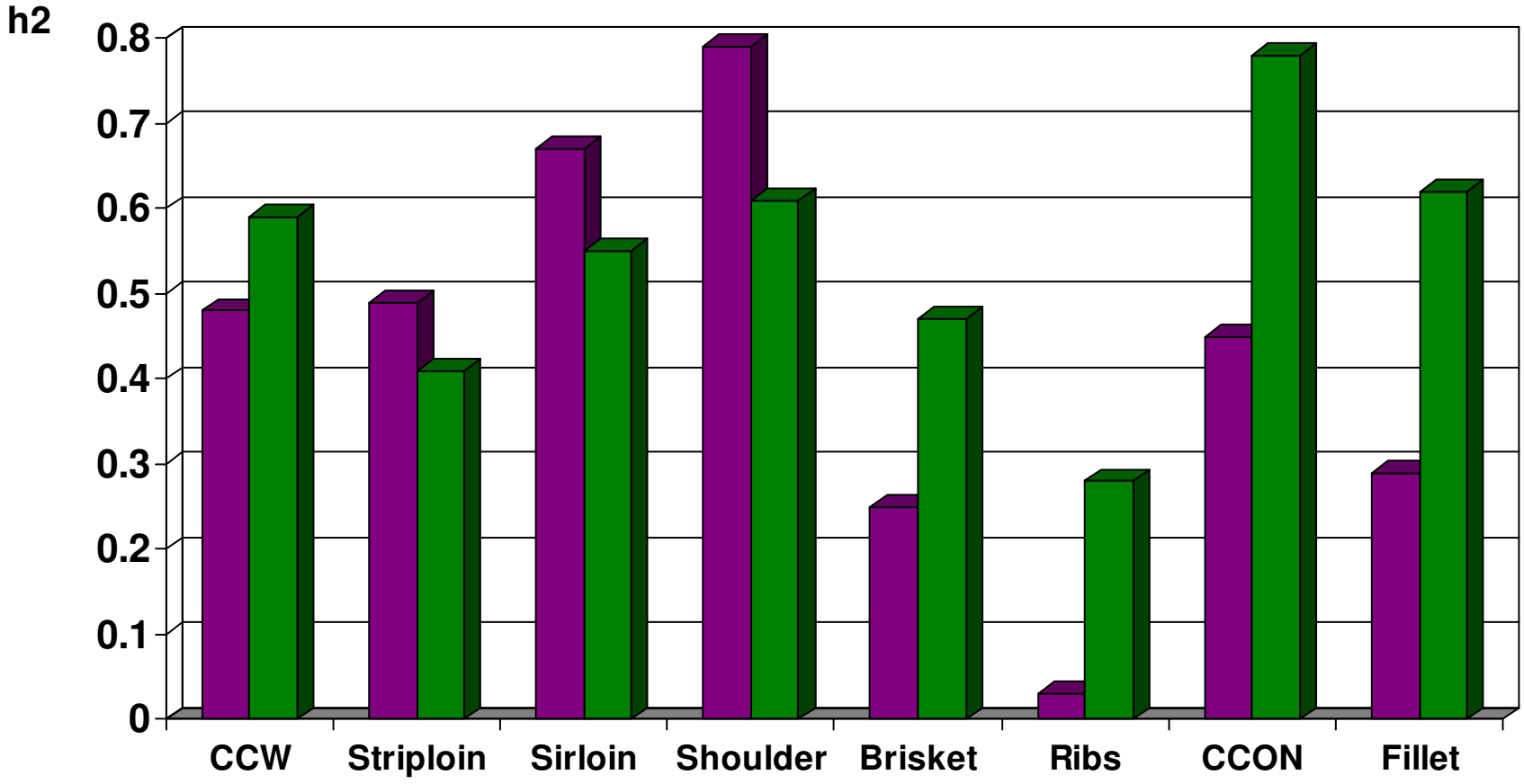
# Example of Images

- Mechanical grading machine VBS2000 (EplusV, Germany)
  - Approved since 2001 for grading beef carcasses
  - 2 images / carcass (2D & 3D)

# Data Available (2/2)

1. Basic carcass data
2. Digital images
3. Carcass dissections: 2 datasets
   - Experimental dataset Teagasc (n=579)
     - Collected 2005 – 2008
     - 1 carcass broken into 23 cuts (kg)
   - Commercial dataset (n=10,845)
     - Collected 1999 – 2005
     - 1 carcass broken into 16 cuts (kg)

# Heritability




*0.19 ≤ s.e. ≤ 0.24*

*0.18 ≤ s.e. ≤ 0.27*

# Impact of research on indexes



E+V grading machine

~ 150 variables

| Conf. | Fat |
|---|---|
| E | 1 |
| U | 2 |
| R | 3 |
| O | 4 |
| P | 5 |

Prediction of meat cuts

**Future: Beef carcass index**

**Move from 3 traits to a multitude of meat yield traits, better prediction of profit for both producer and factory**

# Genomics in Beef

- Larger SNP chips on the way
- 300,000 within 2 years
- Across breed evaluations/database mean Ireland are in great position to become world leaders in beef breeding
- Need to collect as much proven beef semen as possible for testing over the next couple of years

# Genomics in Beef - Implications

- **Ability to screen lots of young bulls at an early age**
- **Progress in traits traditionally hard to measure e.g. feed intake, tenderness**
- **Identify better bulls younger and at a higher reliability > increased genetic gain**
- **AI companies put together teams of bulls e.g., terminal, maternal, overall etc**
- **Breeders/buyers will have more information on which to sell/buy bulls**


Thank You !