

Uses of genomics in Charolais breeding programs

Donagh Berry

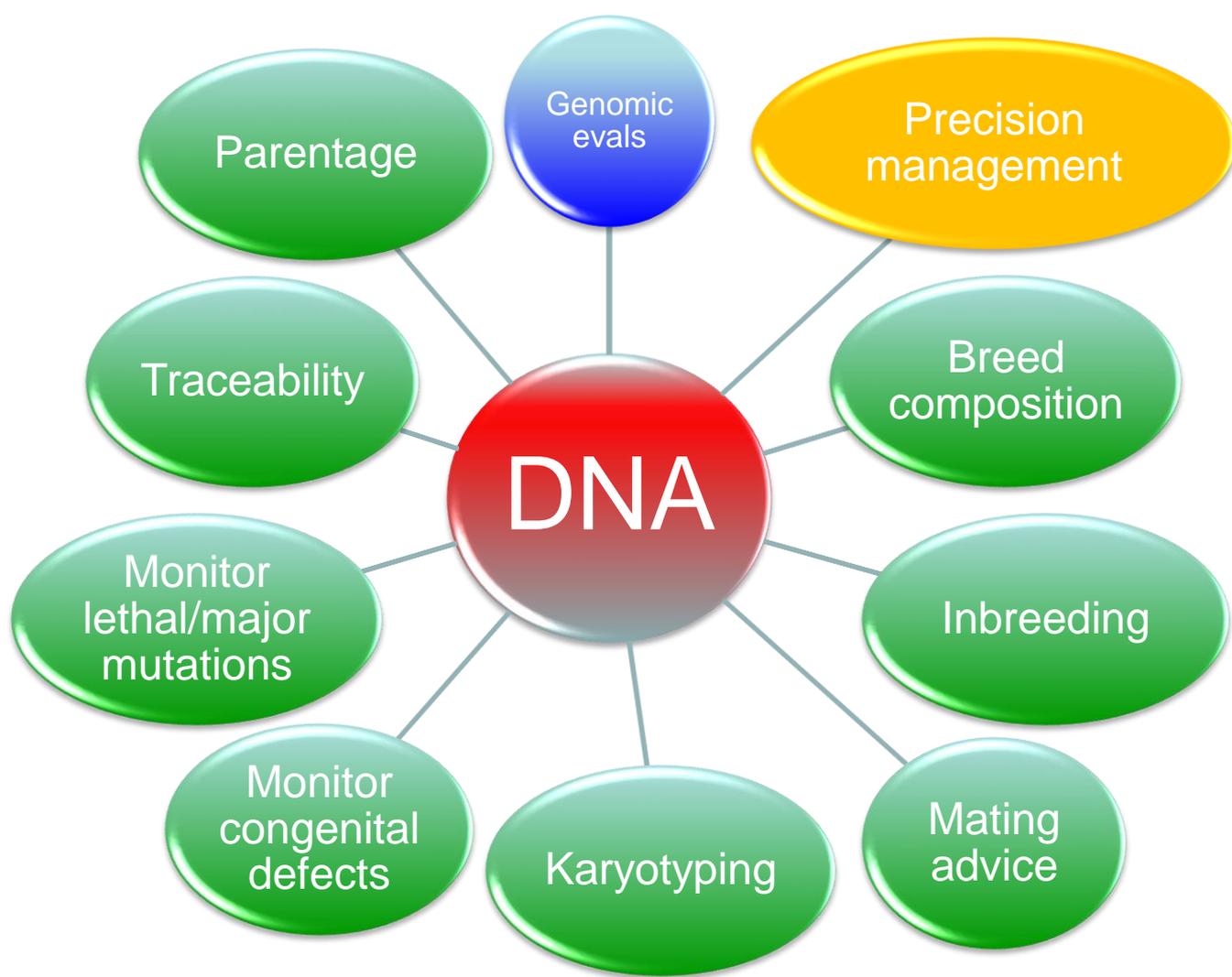
Teagasc, Moorepark, Ireland

donagh.berry@teagasc.ie

World Charolais Technical Conference, August 2019

Interesting facts

- We all share 99% of our DNA
- We share 98% of our DNA with a chimpanzee
- The same DNA profile exists in all the cells of your body (almost!)
- The DNA you're born with is the DNA you die with
- Each cell contains 3 billion pieces of DNA information
- **DNA has many many uses**



Parentage

Genomic
evals

Precision
management

Traceability

Breed
composition

Monitor
lethal/major
mutations

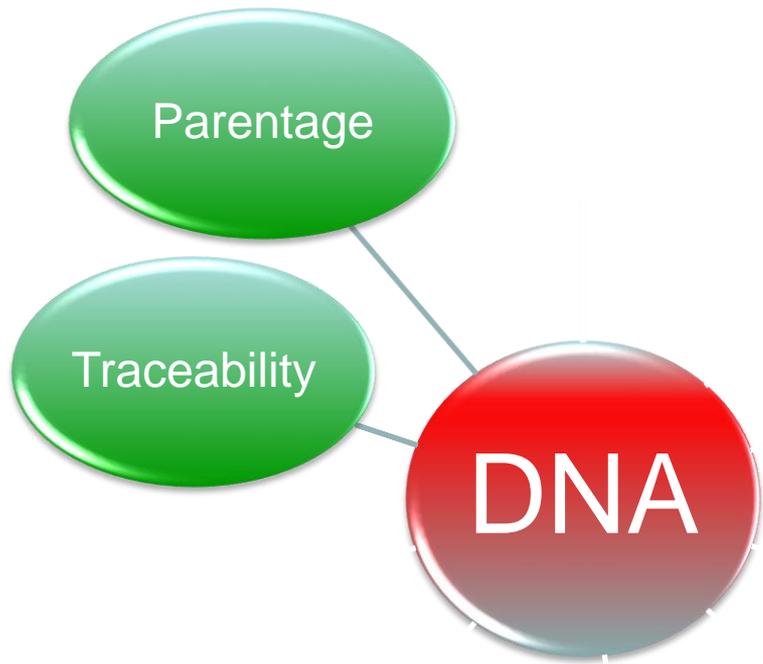
Inbreeding

Monitor
congenital
defects

Karyotyping

Mating
advice

DNA



Parentage

Sire

....TCACCGCT GAG....
....CAGATAGGATT....



....CAGATAGGATT....
....AATGCTACGCT....
Offspring

Parentage

Database

Sire 1TCGGGCTGTG....
Sire 2CAGATAGGATT....
Sire 3TCACCGCTGAG....
Sire 4AATGCTACGCT....

Sire

....TCACCGCTGAG
....CAGATAG

**Sire-offspring errors
~7.5%**

....TCAGCATATCC...
....AATGCTACGCT....

Offspring

Traceability

Animal

....TCACCGCTGAG....
....CAGATAGGATT....



....TCACCGCTGAG....
....CAGATAGGATT....

Meat sample

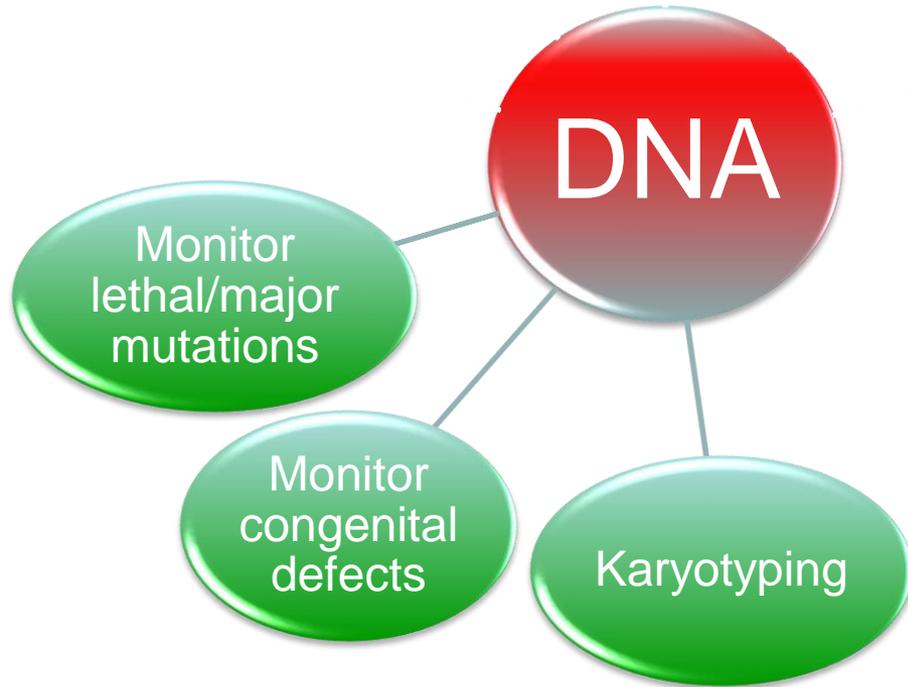
Animal

....TCACCGCTGAG....
....CAGATAGGATT....

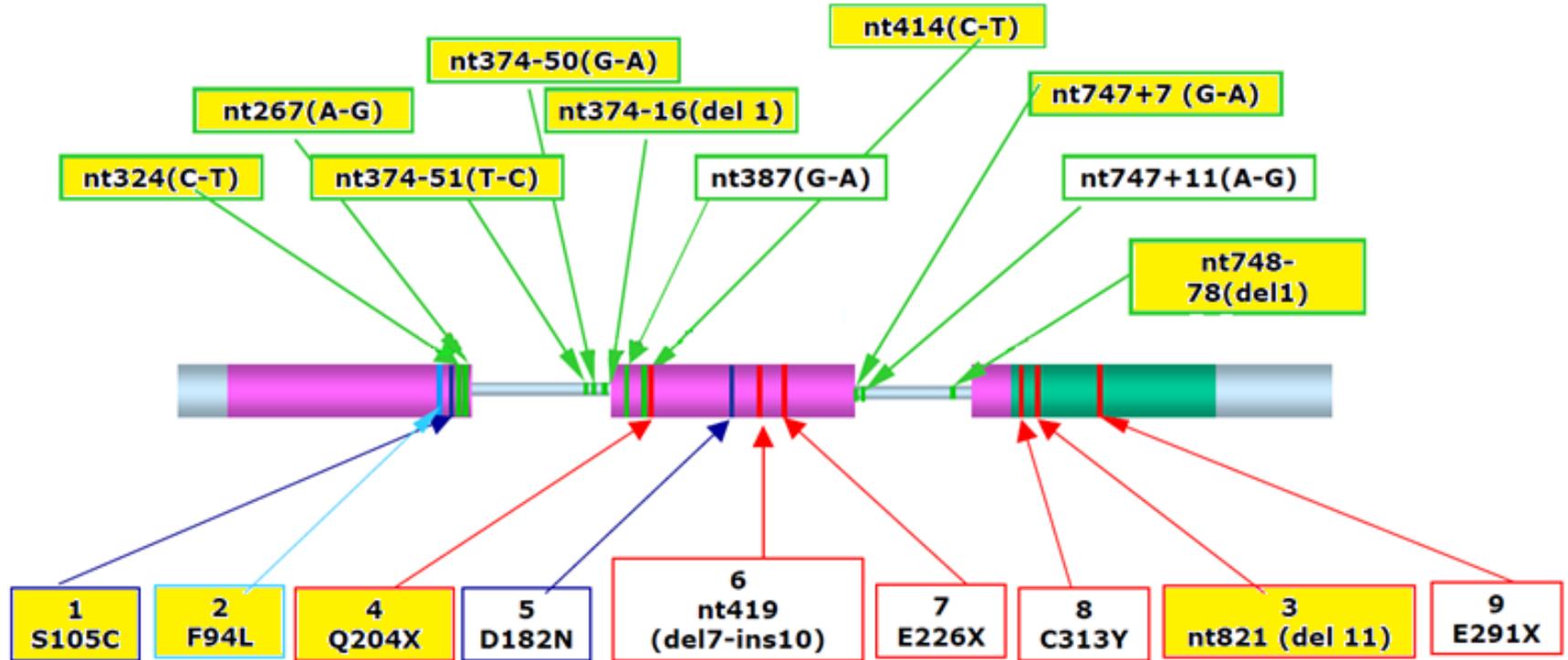


....TGTATTAGAAG....
....CAGATAGGATT....

Meat sample



Major genes - myostatin



Disease/congenital defects

RESEARCH ARTICLE

Progressive ataxia of Charolais cattle highlights a role of KIF1C in sustainable myelination

Amandine Duchesne^{1*}, Anne Vaiman¹, Magali Frah^{2,3,4,5}, Sandrine Floriot¹, Sabrina Legoueix-Rodriguez^{1,6}, Anne Desmazières^{2,3,4,5}, Sébastien Fritz^{1,7}, Christian Beauvallet¹, Olivier Albaric⁸, Eric Venot¹, Maud Bertaud¹, Romain Saintilan^{1,7}, Raphaël Guatteo⁹, Diane Esquerre¹⁰, Julien Branchu^{2,3,4,5}, Anaïs Fleming¹, Alexis Brice^{2,3,4,5,11}, Frédéric Darios^{2,3,4,5}, Jean-Luc Vilotte¹, Giovanni Stevanin^{2,3,4,5,11,12}, Didier Boichard¹, Khalid Hamid El Hachimi^{2,3,4,5,12*}

Cleft Palate

Myophosphorylase deficiency

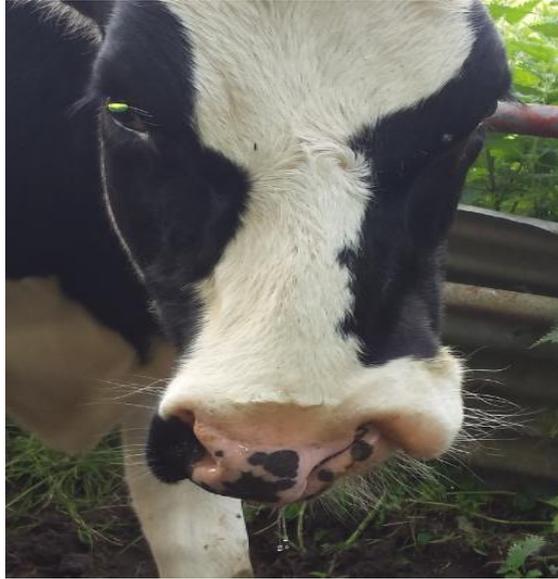
Ehlers–Danlos syndrome

Arthrogryposis With Palatoschisis

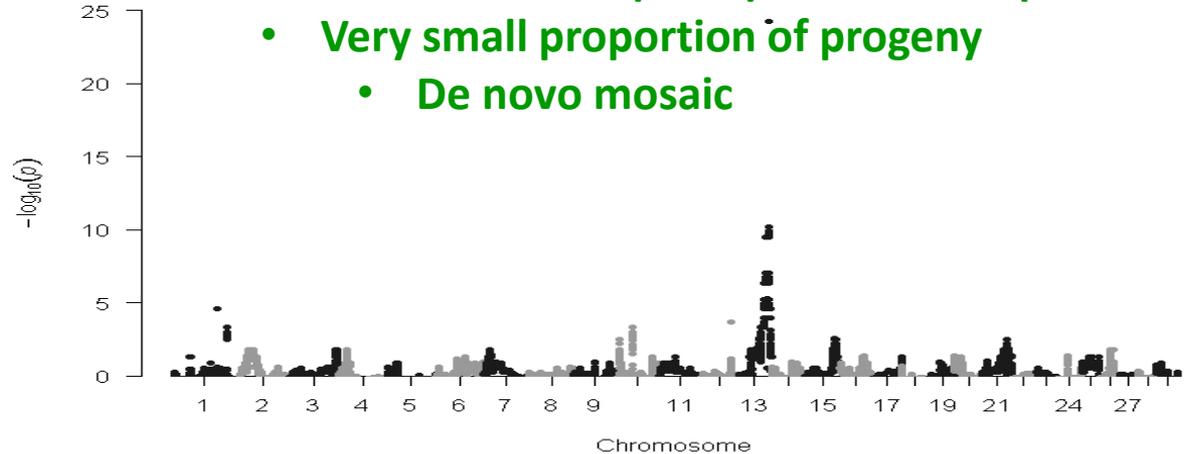
Colobomas

Leukodystrophy

Case study – Cleft palate



- Recessive
 - Inbreeding
- Dominant
 - Sire did not express trait
 - De novo, incomplete penetrance, epistasis
 - Very small proportion of progeny
 - De novo mosaic

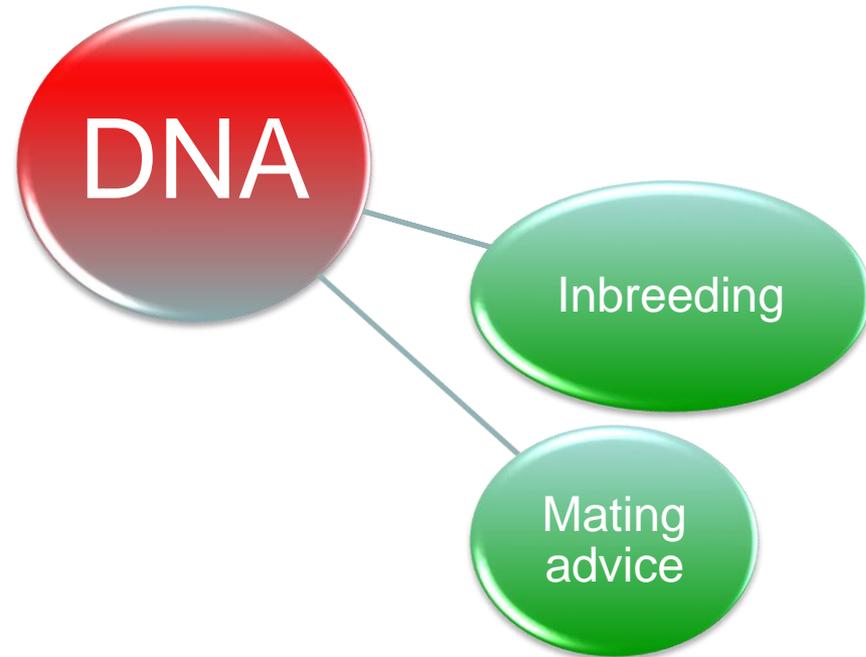


Strategy

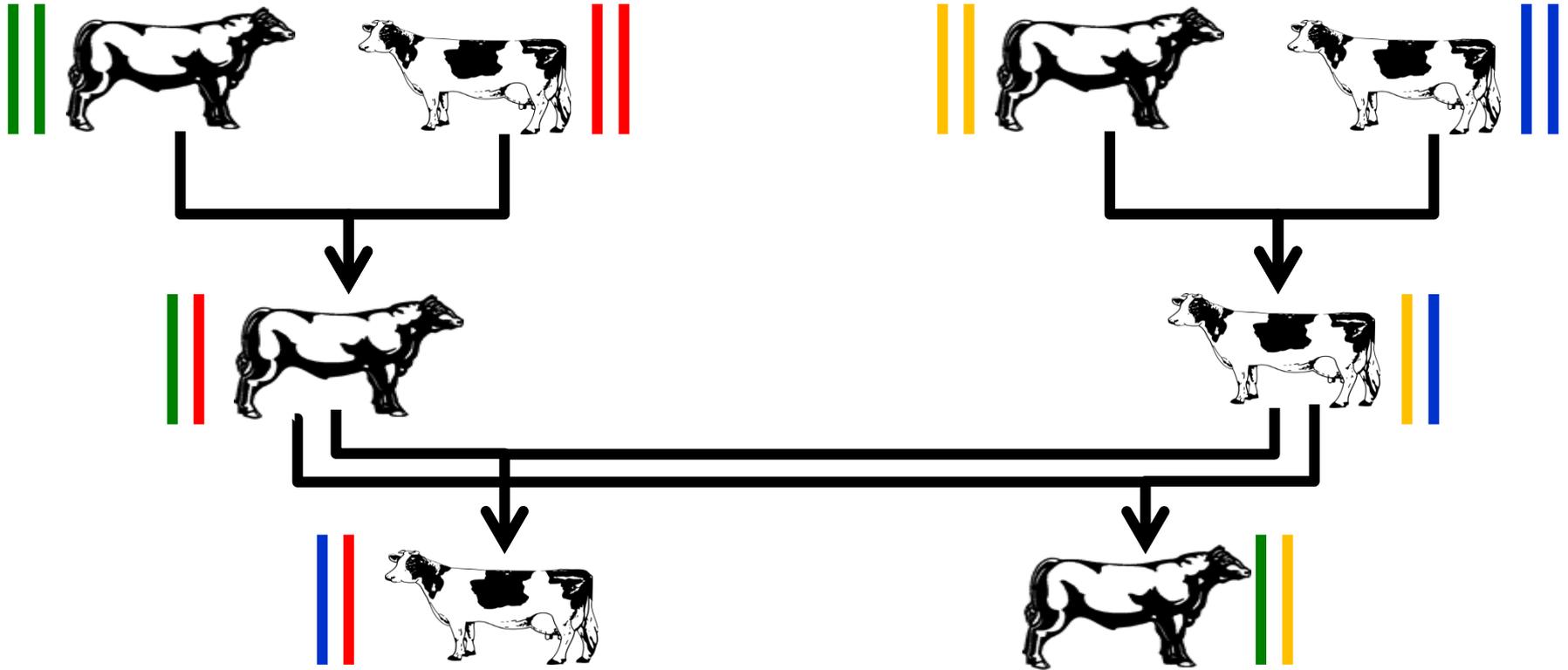


- **Collect sample (ideally blood/ear punch) from**
 - **Animal, sire, dam, ≥ 2 half-sibs**
- **Probably need around 20 cases and >20 controls**
- **Inbreeding**
- **Paternal/Maternal line**





Coancestry/Inbreeding

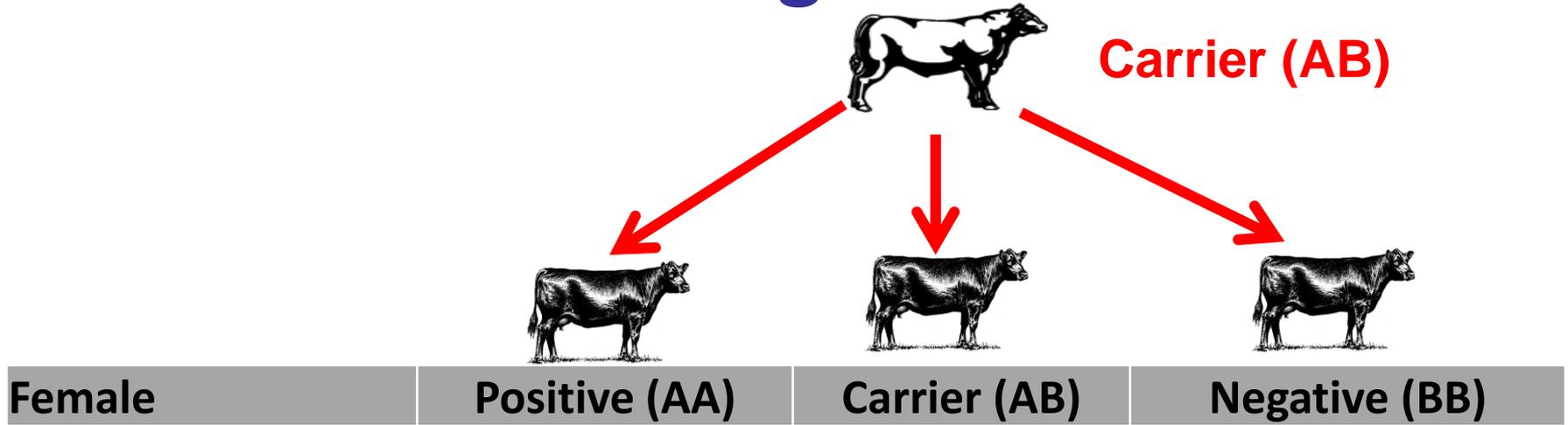


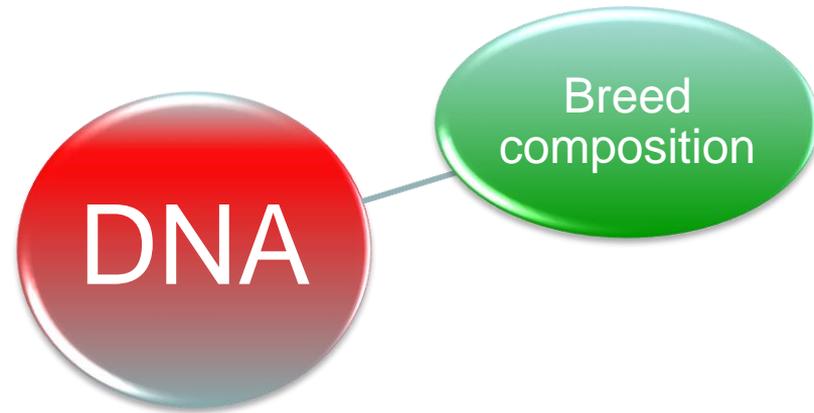
(More granular) coancestry/Inbreeding



1-2% of the genome codes for proteins

Mating advice





Breed composition



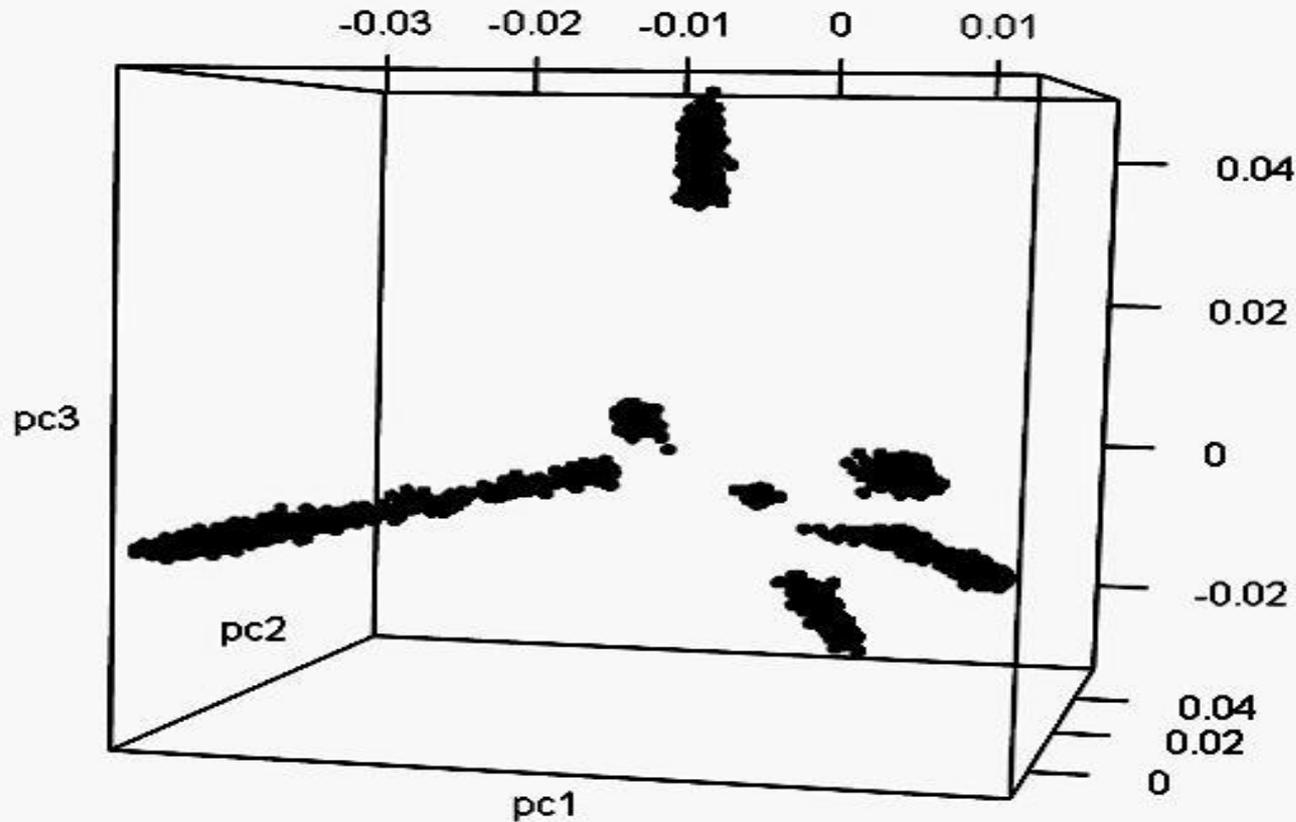
50% LM : 50% HF
(assuming parents are pure)



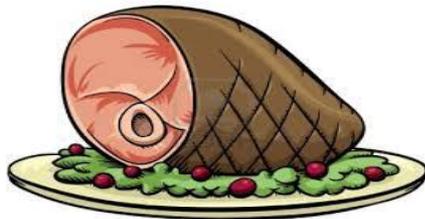
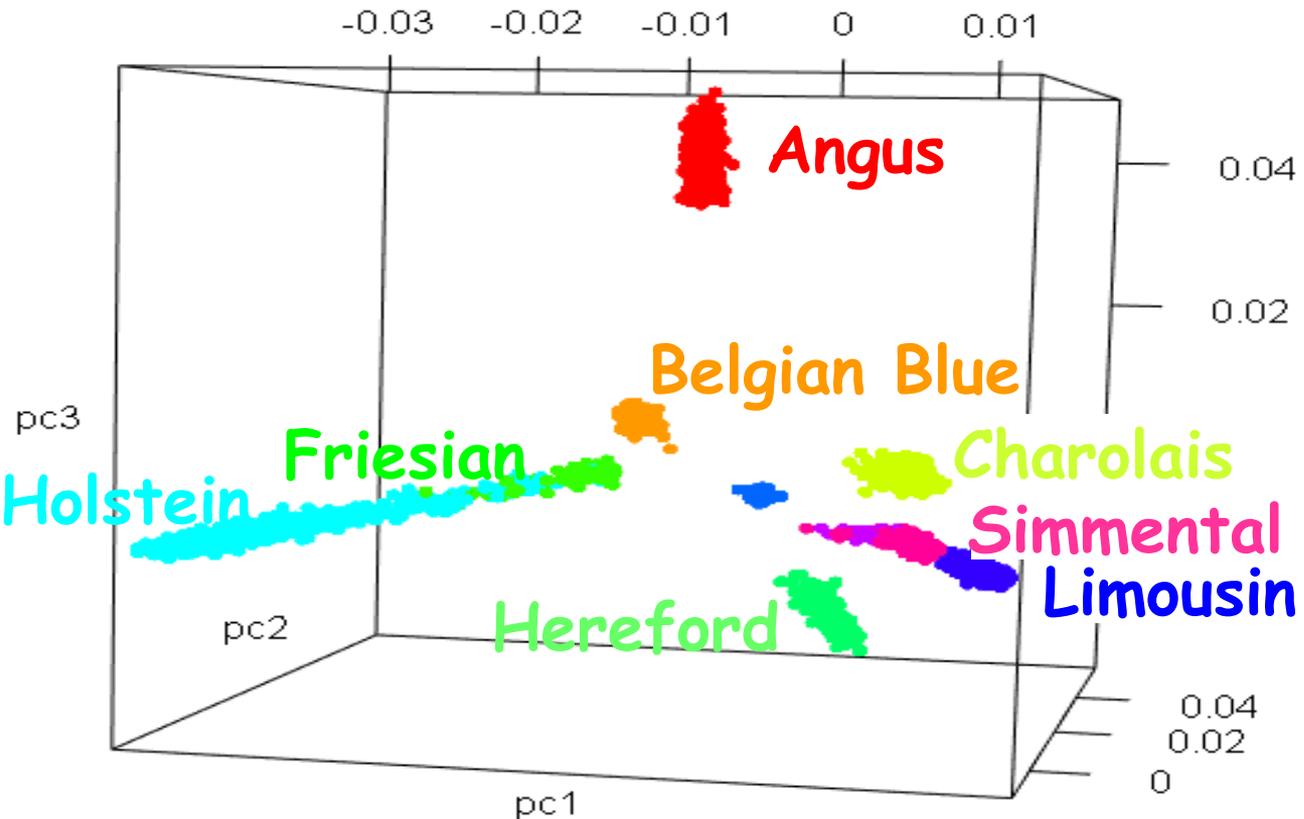
50% CH : 25% HF : 25% LM
50% CH : 50% HF : 0% LM
50% CH : 0% HF : 50% LM

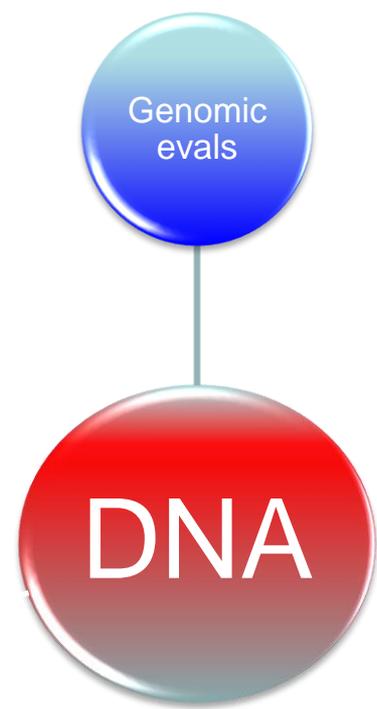


Breed composition

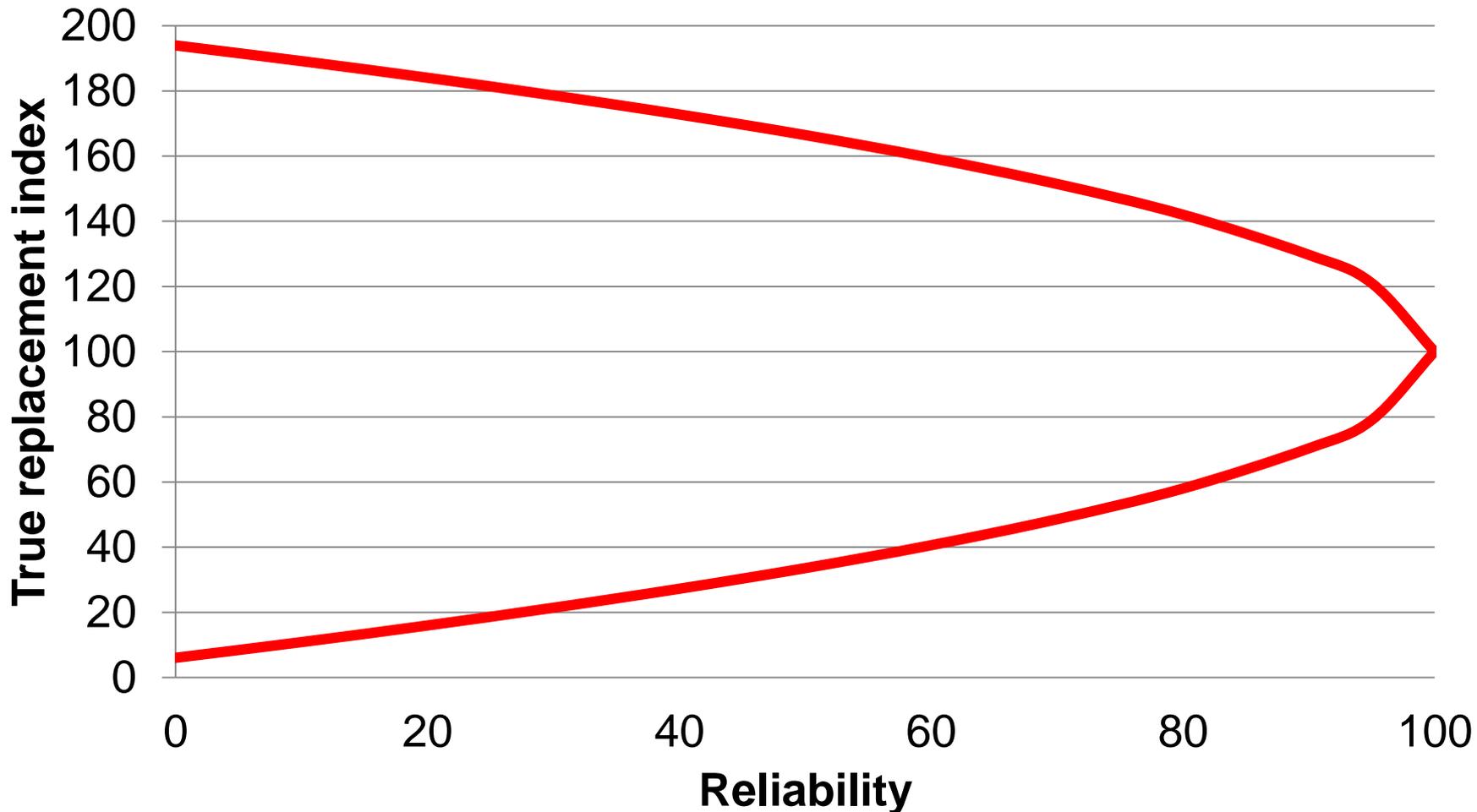


Breed composition



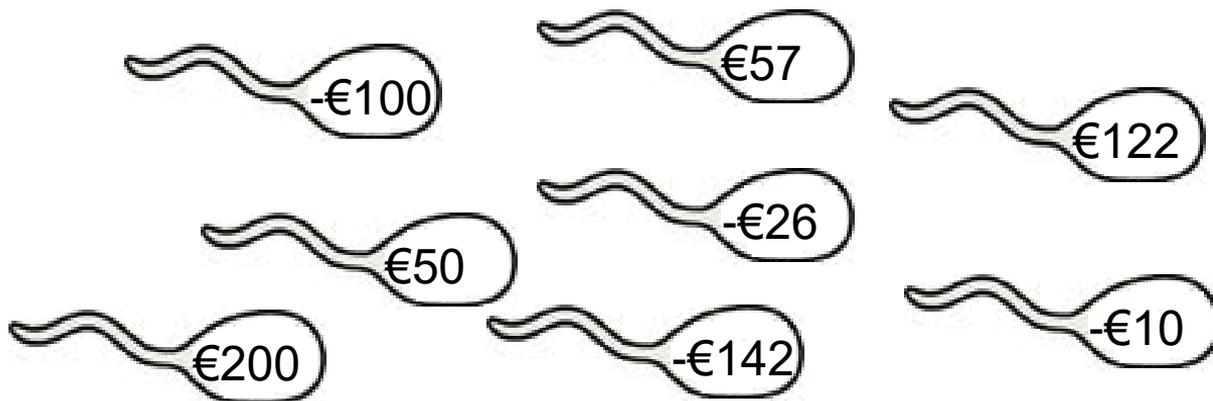


Reliability – a measure of confidence



How can the calf of high reliability parents, itself have low reliability

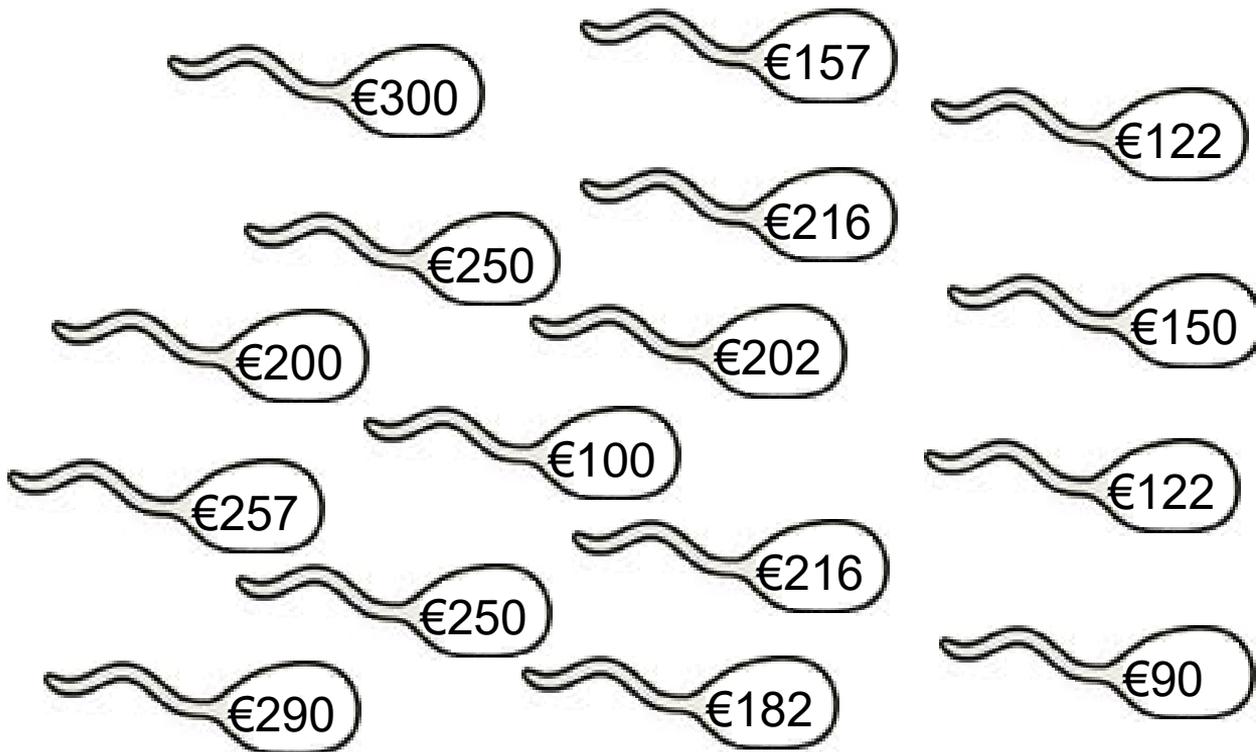
- **Animal reliability = $\frac{1}{4}$ sire reliability + $\frac{1}{4}$ dam reliability**
- **30% = $\frac{1}{4}$ 90% + $\frac{1}{4}$ 30%**



**66% of sperm within
 \pm €34 of the bull**

**Bull reliability is
irrelevant**

Example: €180 bull @ 99% reliability



Average €180

**66% of sperm
between €146 and
€214**

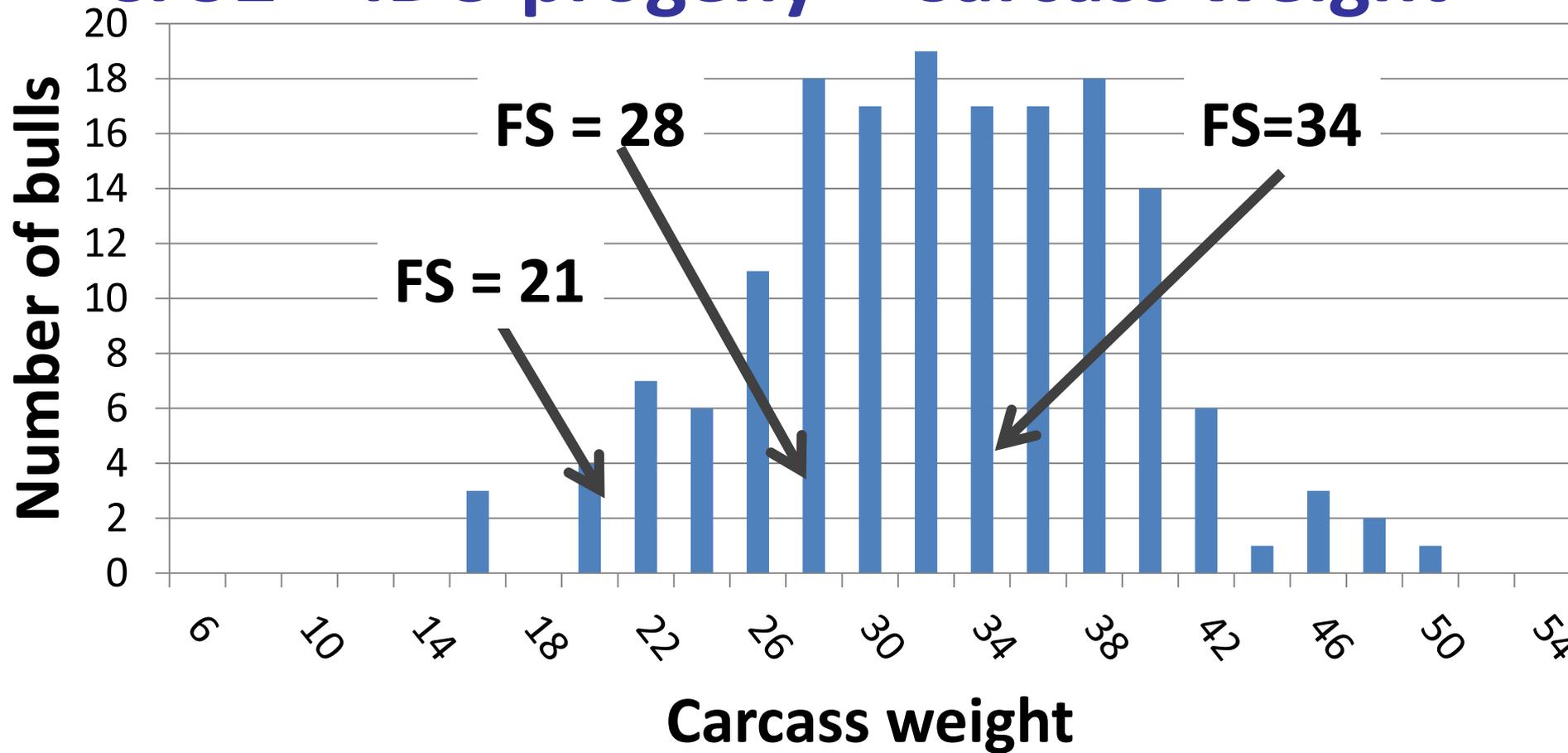
16.5% <€146

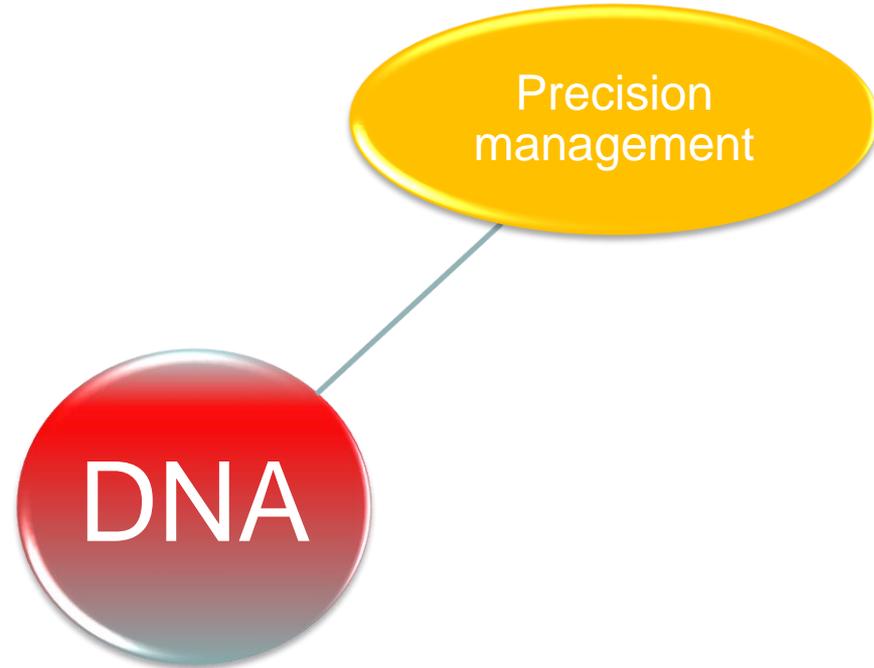
2.5% <€113

How can one twin be in the top 20% and the other in the bottom 20%

- Twins from a €100 sire (90% rel.) + €40 dam (30%) reliability
 - €70 @ 30% reliability (top 20%-40%)
- When genotyped
 - 10% chance of being bottom 20% or 11% chance of being top 20%
- When proven
 - 25% chance of being bottom 20% or 26% chance of being top 20%
- **Twins**
 - 2% chance one twin will top 20% & other will be a bottom 20%
 - 8% chance one twin will top 20% and the other will be bottom 40%

CF52 * IDU progeny – Carcass weight





Diagnosics??



A beef cross calf showing BVD signs – dull coat, diarrhoea and runny nose.



Diagnositics??



Doubters??



- **BRAC1 & BRAC2**
 - 5 times the risk of breast cancer
 - 10-30 times risk for ovarian cancer
- **Enhanced screening**
- **Prophylactic treatment**
- **Management/chemoprevention**

IDB19

INTERNATIONAL DAIRY & BEEF

19K SNP CHIP (VERSION 0.1)



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.

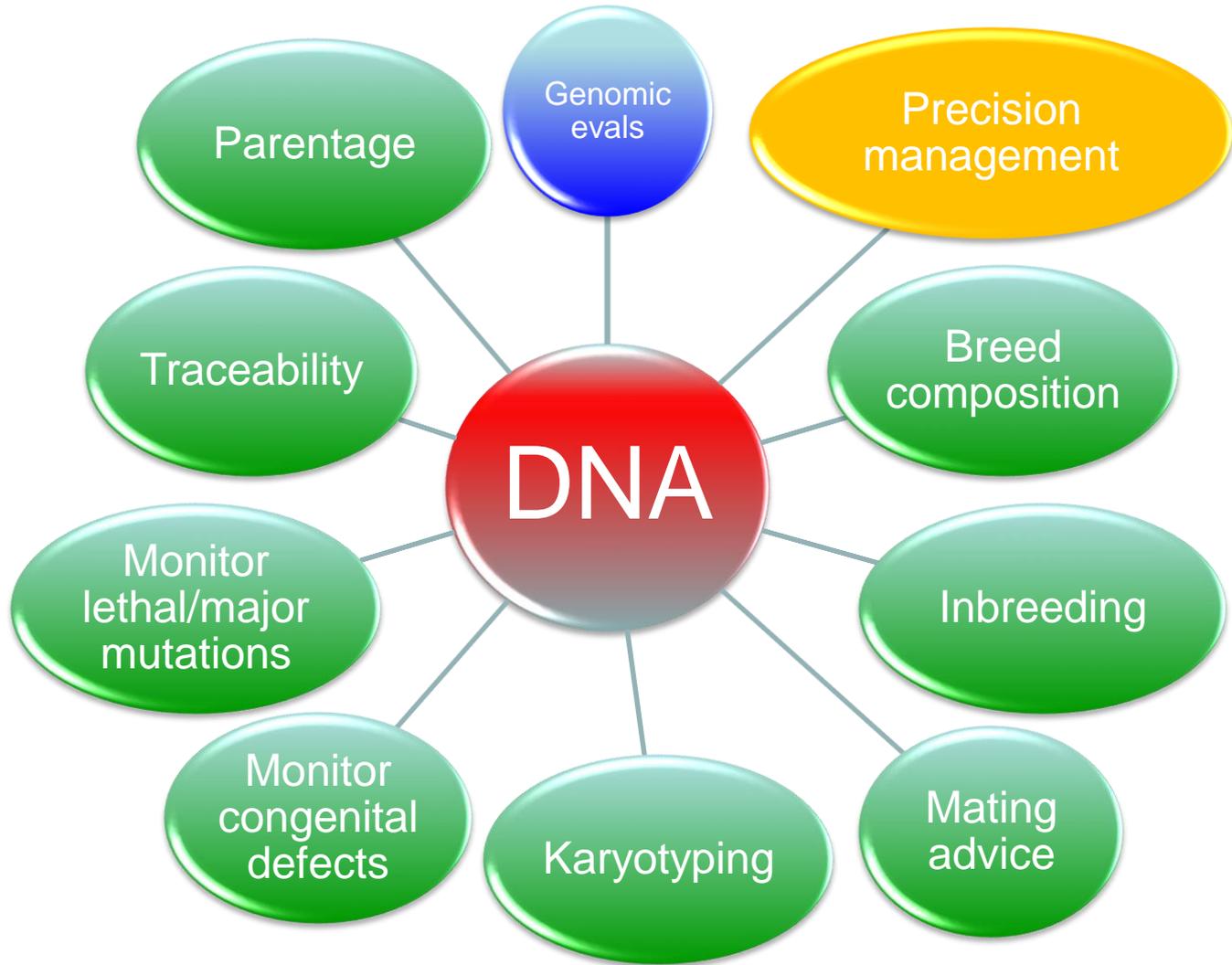
The chip consists of the Illumina LD (7K) base content plus a further 12,000 (12K) SNPs carefully selected to ensure very high imputation accuracy to HD & to convert to Microsatellite data for parentage verification. This extra panel of SNPs provides the very latest dual product for both Beef & Dairy breeds.

The ISAG recommended Parentage SNPs both the core and additional panels are present on the chip.

The IDB19 also contains a comprehensive selection of genetic markers to screen for genetic disorders & desirable traits.



For more details Contact: Weatherbys Ireland DNA Laboratory



Bespoke genotyping platform?

- **Why?**
 - Can dictate content, genotyping vendor/platform and service provider
 - Flexibility
 - Include proprietary content
 - Most useful for your population and wants/needs
- **Why not?**
 - Price per chip is volume driven
 - Frequency of updating
 - Awareness of new discoveries
 - Compatibility with other panels

Take home message

- **There's more to genomics than *genomic evaluations***
- **Producers generally prefer things they can “understand”**
 - **Parentage**
 - **Breed purity**
 - **Inbreeding & coancestry**
 - **Major genes**
- **Can of worms....**

