



# DNA technology in the Sheep CRC – results and opportunities for ram breeders

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# Outline



- Tracing “plate to mate”
- Rapid removal of genetic defects
- Towards genomic ASBVs
- Accelerating genetic gain with genomic ASBVs and JIVET

# The technology

- 50,000 DNA markers

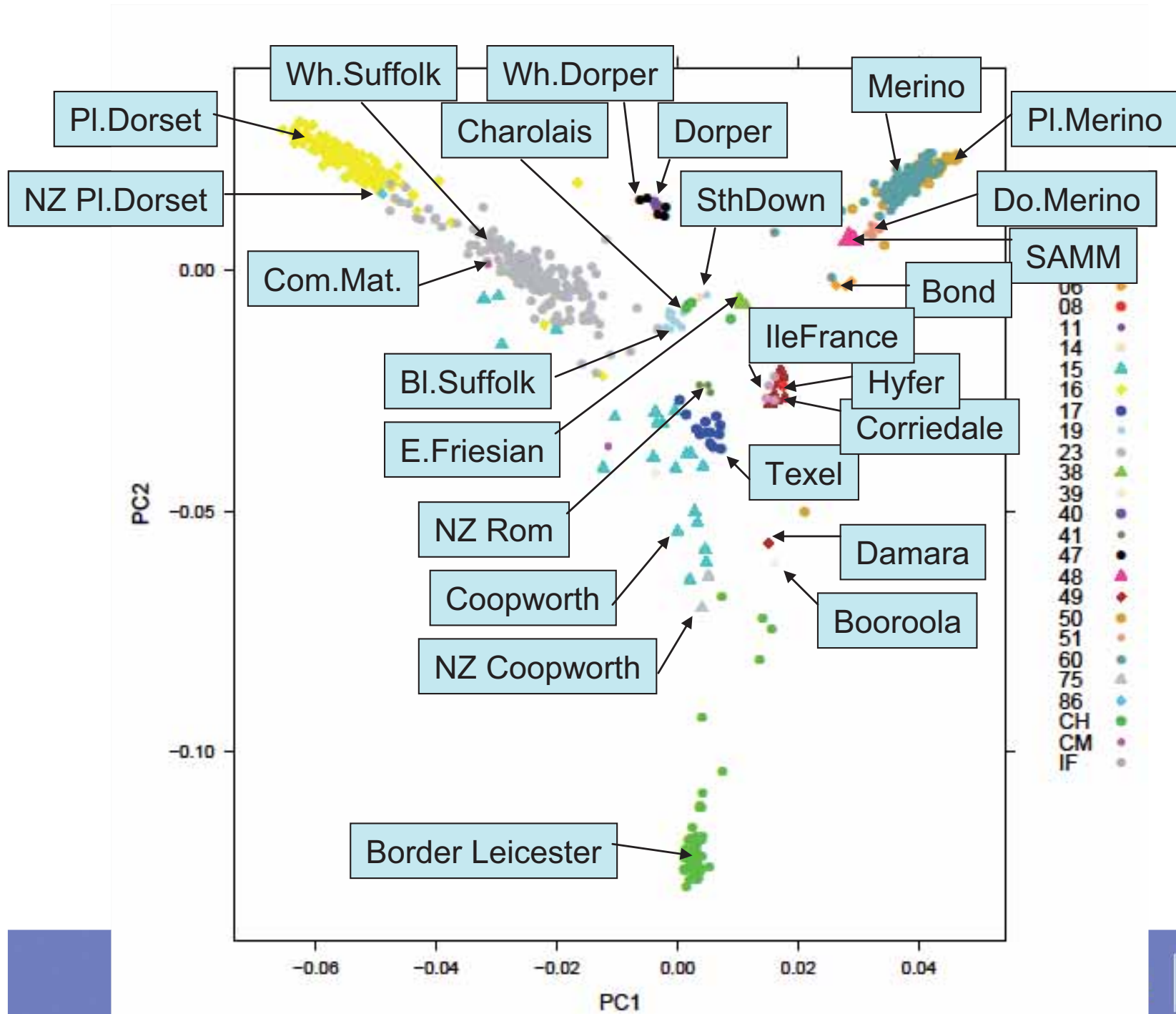


# Tracing “plate to mate”



# Tracing “plate to mate”





<https://genographic.nationalgeographic.com/genographic/lan/en/atlas.html>



10-5,000 B.C. | Introduction | 200,000 B.C. | 60,000 | 50,000 | 40,000 | 30,000 | 20,000 | 10,000 B.C.

ZOOM IN +

EUROPE ASIA NORTH PACIFIC INDIAN OCEAN AFRICA AUSTRALIA

MAP TOOLS

VIDEO TEXT

This interactive interface displays a world map with migration routes and a comparison of a modern man and a Neanderthal. The map shows orange markers and colored lines representing genetic lineages across Europe, Asia, Africa, and Australia. The comparison image shows a modern man with red hair and a Neanderthal with reddish hair and a necklace, set against a cave background.

# Outline



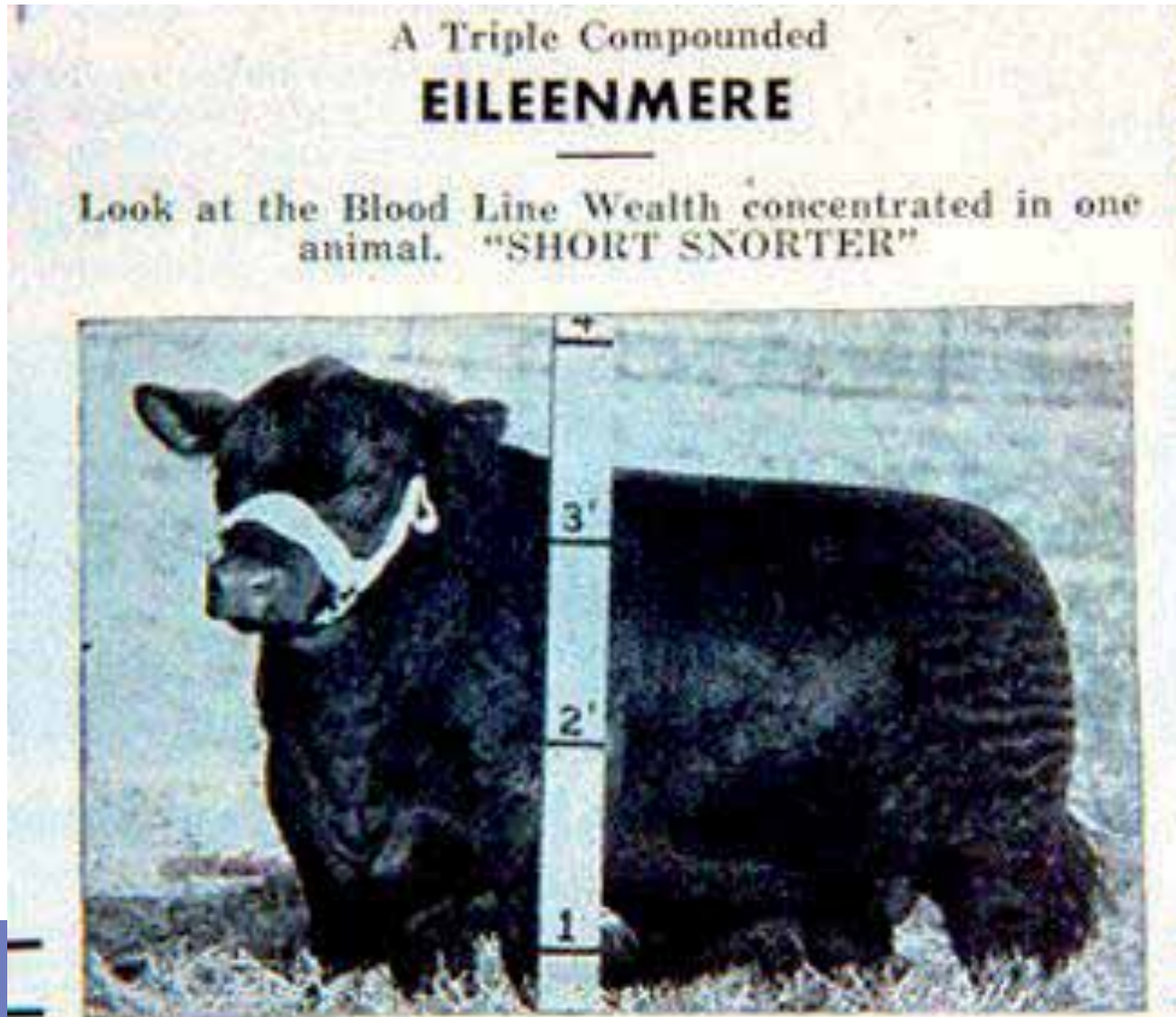
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# Genetic Abnormalities

<http://www.ag.ndsu.edu/williamscountyextension/livestock/genetic-defects-in-cattle>



# Compare dwarfism response in 1950s to response to curly calf



# Curly calf – Arthrogryposis multiplex (AM)



- Deletion of DNA that codes for entire gene
- This gene switched on at crucial time in the development of nerve and muscle tissue.
- Mutation arose in single Angus bull!





## Curly calf (AM disease)

- o From Sept. 8 – Nov. 3, 2008 identified genetic problem, developed test, and released carrier status of 736 bulls
- o In 10 months following release of test, Angus Association posted results of tests for AM on ~ 90,000 cattle (\$30).
- o Of these, almost 5,000 bulls and more than 13,000 heifers have tested as carriers of AM.
- o **That leaves more than 22,000 bulls and more than 50,000 heifers which tested as free of AM.** (Buchanan, D.S. Genetic Defects in Cattle.)



Trait	Description	Map Location	Contacts and Reference
Achondroplasia	Limb malformation in UK Cheviots	OAR3: Mb 153 – 157	James Kijas/Steve Bishop [2]
Chondroplasia	Dwarfism/Limb malformation in Texel	OAR4: 1 Mb region	Dorrian Garrick [3]
Microphthalmia	Ocular abnormality in Texel	OAR22: <i>PITX3</i> mutation	Cord Drogemuller [4]
Poll	Absence of Horns	OAR10: <i>RXFP2</i> gene	John McEwan [5] and Jon Slate [6]
Junctional Epidermolysis	Skin disease of German Black Headed sheep	OAR12	Ottmar Distl [7]
Yellow Fat	Yellowing of adipose tissue in Perendale	OAR15	John McEwan

# Outline



- Tracing “mate to plate”
- Rapid removal of genetic defects
- **Towards genomic ASBVs**
- Accelerating genetic gain with genomic ASBVs and JIVET

# DNA markers for breeding



- Some traits are easy to breed for.....



# DNA markers for breeding



- Others much harder.....



# DNA markers for breeding

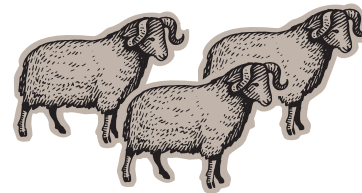


- For these traits DNA markers potential solution

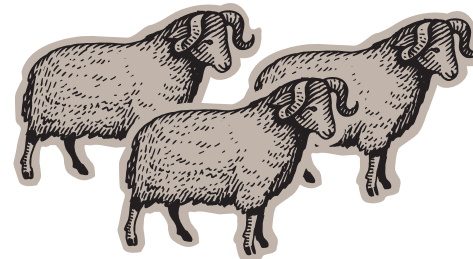
# A gene affecting growth....



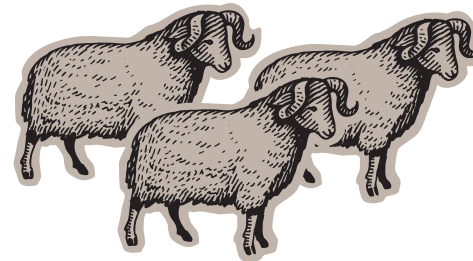
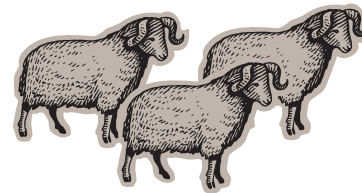
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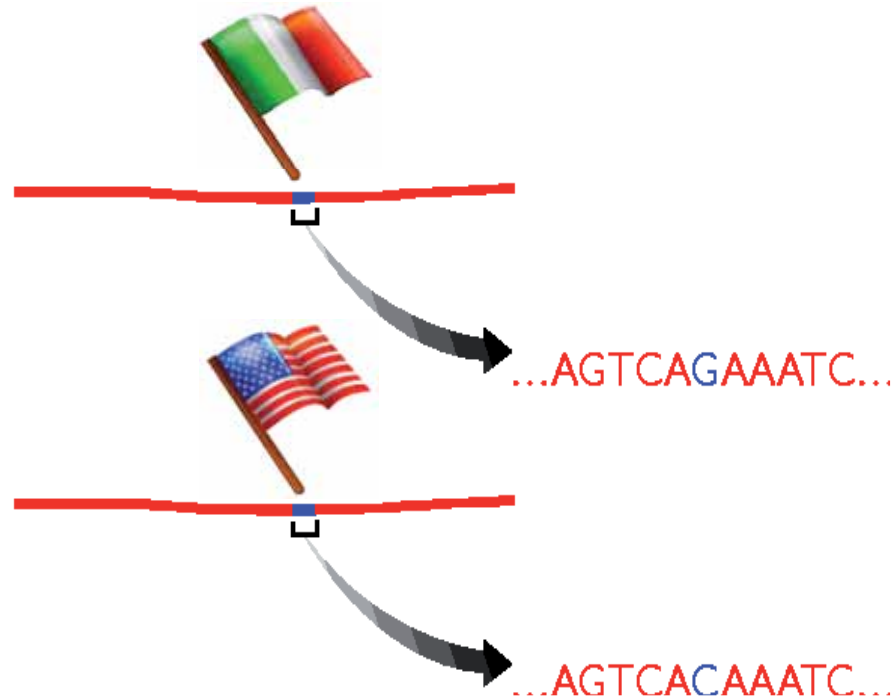
# DNA markers



# DNA markers

The flags are

- Single nucleotide polymorphisms (SNPs)



# DNA markers



- Use SNP “flags” along the genome to track genes down



*ACTCGGGCCCGTTAATCGGGAAGGCTTCCGGGGCTCGGGGCCCGTTAATCGGGAAGGCTTCCGGGCTCGGGGCCCTCGGGGCCCGTTAATCGGGAAGGCTTCCGGGGGTTA*

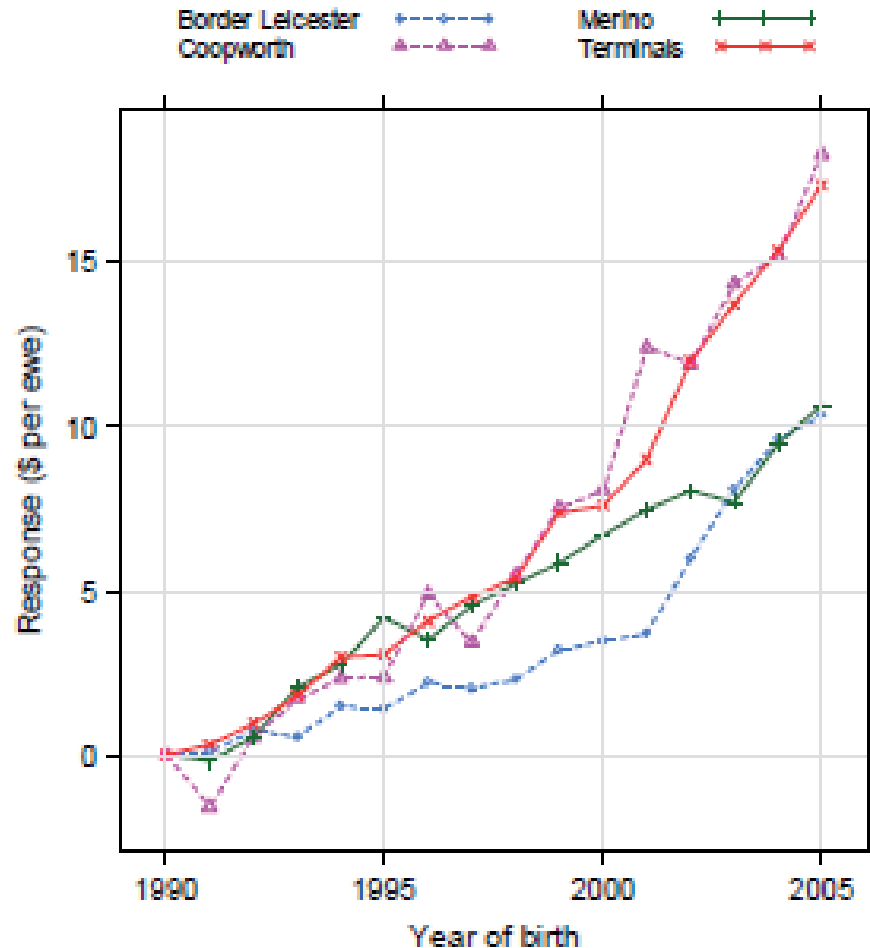
# DNA markers



- Use SNP “flags” along the genome to track genes down
- DNA marker technology is 1000 x cheaper than 3 years ago
- A 50K “SNP chip” has 50,000 Flags



# Towards genomic ASBVs



Swan et al. 2009. Proc 18<sup>th</sup> conf Assoc. Anim. Br. Genetic. 326.

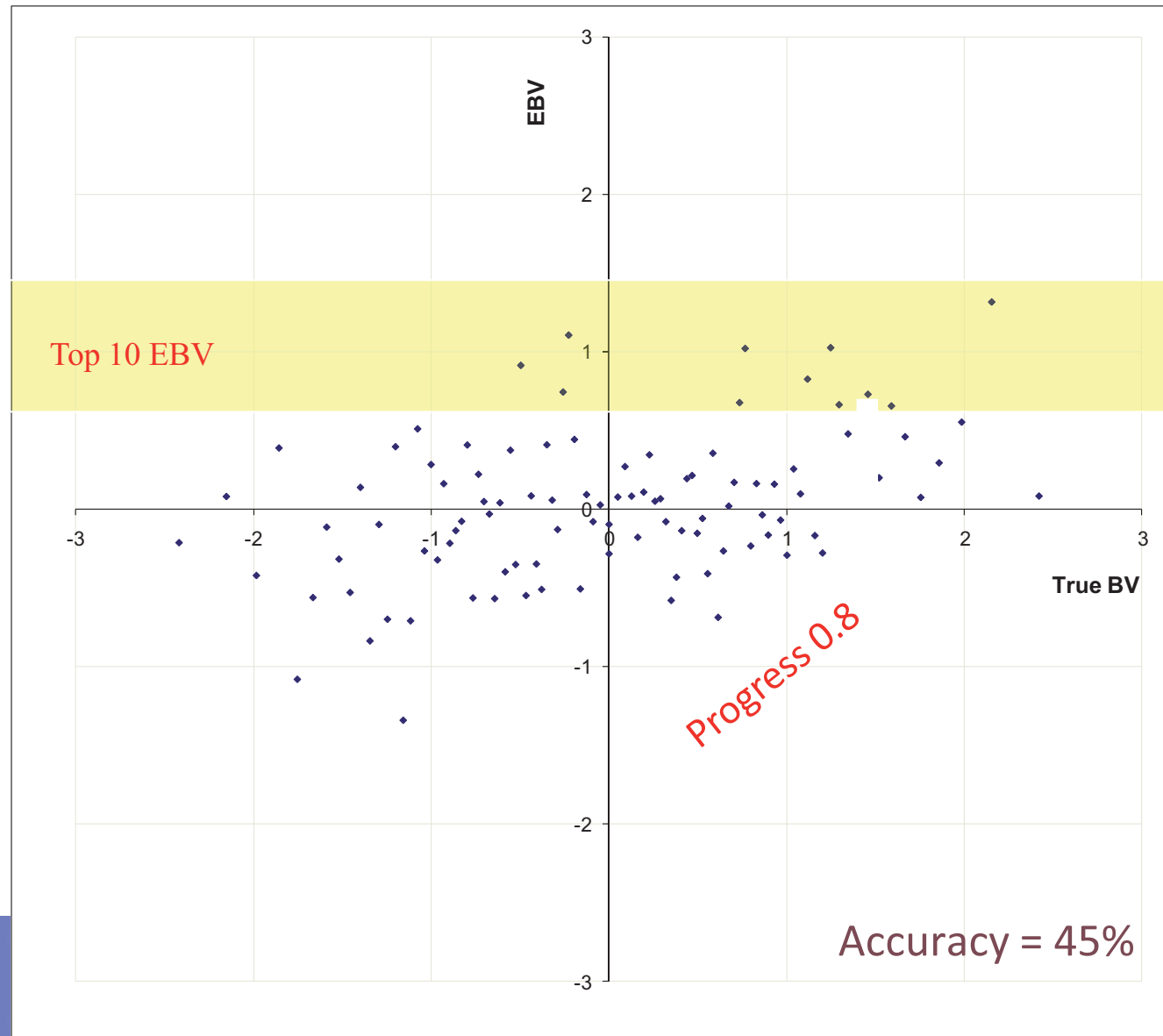
- Genetic gain ~ \$2.00 per ewe/yr
- Selection for
  - post weaning weight
  - scan eye muscle depth
  - scan fat



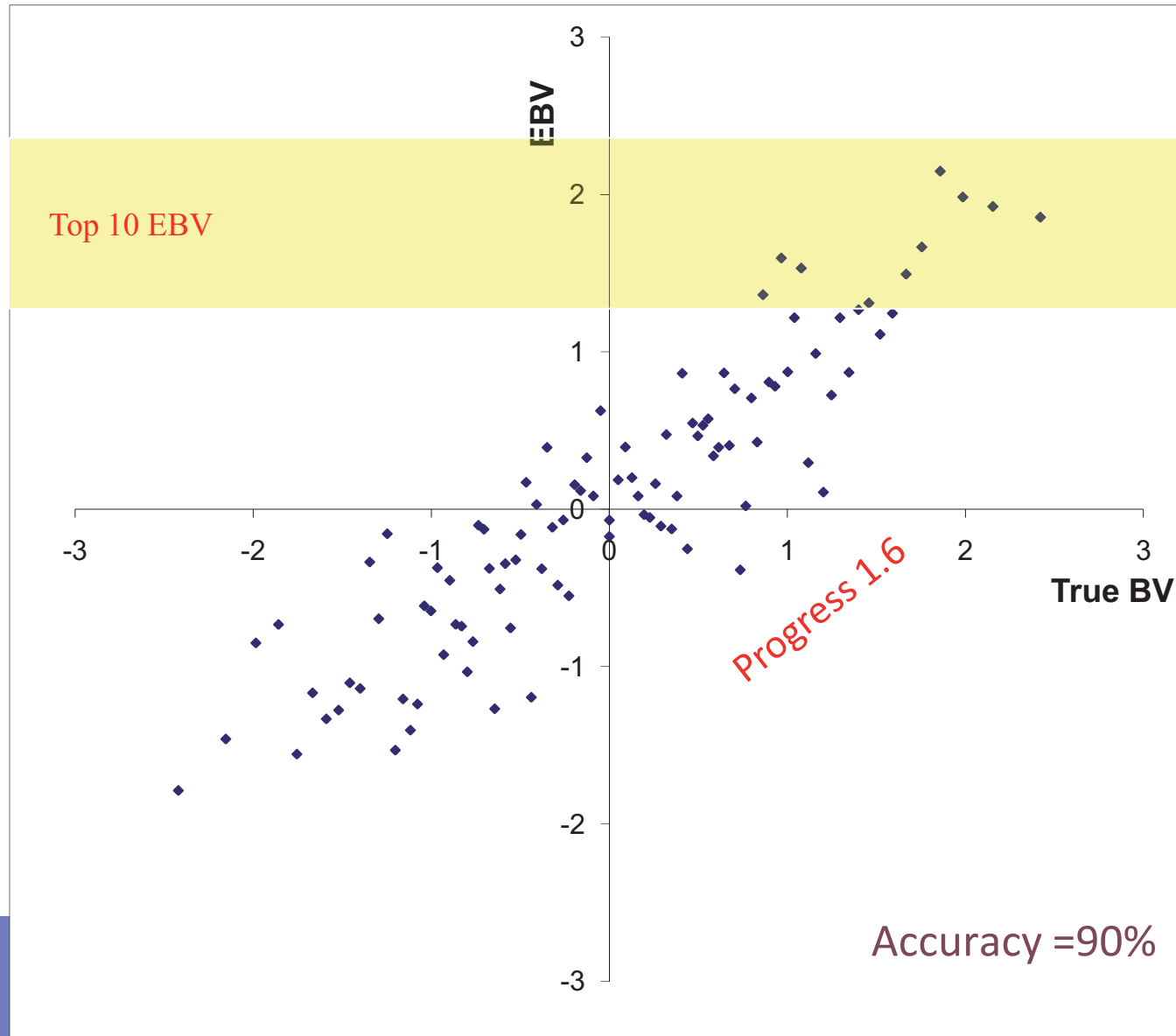
# Towards genomic ASBVs

- With DNA markers potential to breed for profit traits directly
  - ⇒ Lean meat yield
  - ⇒ Carcass fat
  - ⇒ Intra muscular fat?
  - ⇒ Faecal egg count?
- These traits are measured in *Sheep CRC Information Nucleus*
- Progeny have “SNP chip” data

# Accuracy of selection results in gain



# Doubling accuracy is doubling gain!





# Genomic BVs in Terminal

Trait	Accuracy
Eye muscle depth	0.43
Fat depth	0.28
Faecal egg count	0.50
Lean meat yield*	0.21
Intra muscular fat*	0.17

\*Limited records so far

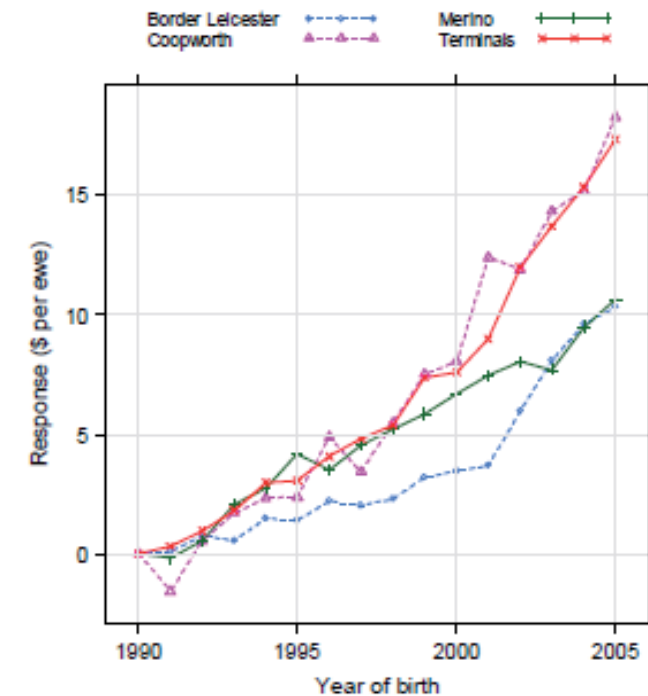
# Economic benefit?



- Without genomics
  - \$2 ewe / yr
  
- With current genomics
  - Increase gain by ~ 5-10%
  - \$2.10 - \$2.20 ewe / yr
  
- After 7 years of Sheep CRC
  - Increase gain by 30%
  - \$2.60 ewe / yr

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“Look over the fence” to see how technology is used in dairy cattle



# Dairy cattle breeding....



Screen '00s of calves on parental average EBV (accuracy 0.4)

Year 1	Year 2	Year 3	Year 4	Year 5
~ 100 bull calves selected	Daughters born	Daughters mated	Daughters milking	~ 10 Bulls chosen for industry wide semen sales

# With genomics



Screen '000s of calves on GEBV (accuracy 0.7)

Year 1	Year 2	Year 3	Year 4	Year 5
~ 100 bull calves selected	Daughters born	Daughters mated	Daughters milking	~ 10 Bulls chosen for industry wide semen sales
~ 10 elite bull calves selected on GEBV	Semen from elite bulls for industry wide sale	3 yrs advanced genetic gain		

# Wide adoption in dairy



## Press Release

Amstern, March 5, 2008

### CRV takes a leap forward in breeding Greater selection intensity and faster genetic progress thanks to genomic selection

The influence of genomic selection in CRV's breeding programme is growing fast and this will result in more accurate selection and faster genetic progress. Genomic selection tools are expected to be in full use by the organisation by the second half of 2008 and CRV is the international forerunner in the application of this advanced selection technique.

The technique of genomic selection – the selection of animals through breeding values based on DNA-profiles – provides reliable information, at a young age, on potential breeding animals. This enables 'sharper' and more accurate selection and leads to faster genetic progress. CRV will implement significant changes in its breeding programme – which is known for its HG sires.



GENE TEAM: GENETICS AUSTRALIA'S  
FIRST GENETIC MARKER BULLS  
INFUSE, DEFIER AND WATCHDOG.



USDA - 30 SHEEP REPRODUCTION GENETIC MERIT BULLS

So Many New High Genetic Merit Bulls?

### Why Are There So Many New High Genetic Merit Bulls?

Genex provides the answers for this question and others relating to genomics.

#### Why are there so many new high genetic merit bulls?

This January, it is as if we fast forwarded through nine USDA sire summaries all in one release without a base change. With genomic selection now available, 34 new Holstein sires graduated that would not have been available for another two or three years if we had continued to use the old sire evaluation system. The advantage we gain from genomics is that we can now predict the genetic merit of our young animals at a much higher reliability earlier than we could with simply the use of traditional parent averages. This gives dairy producers the potential to make significant genetic progress in their herds.

#### What is genomic selection?

Genomic selection is predicting the performance of an animal's offspring based on the DNA of that animal. Recent breakthroughs from industry-supported research have resulted in new tests that look at thousands of DNA markers of an individual bull or cow. The DNA markers of the individual animal are compared to the marker profiles of thousands of bulls and cows with millions of offspring with known performance for the various traits of interest. This allows an estimation of breeding values of an animal based on associations between DNA marker profiles and milk yield, Somatic Cell Score, Productive Life and other important traits.

#### What is a genomic genetic evaluation?

A genomic genetic evaluation includes the information from the DNA marker testing of that individual. The evaluation also considers parent or pedigree information and may also include traditional information on the female's performance information. The



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### Holstein Association USA Genomic Testing Services

Offering a wide array of tests to meet your needs. Don't delay - order your genomic testing kits today! Call Holstein Association USA Customer Service at 800.952.5200.

Whether your animals are Registered or grade, Holstein Association USA can fulfill your testing needs. Holstein Association USA offers a full complement of genomic and other genetic testing services.

#### Genomic Testing Options

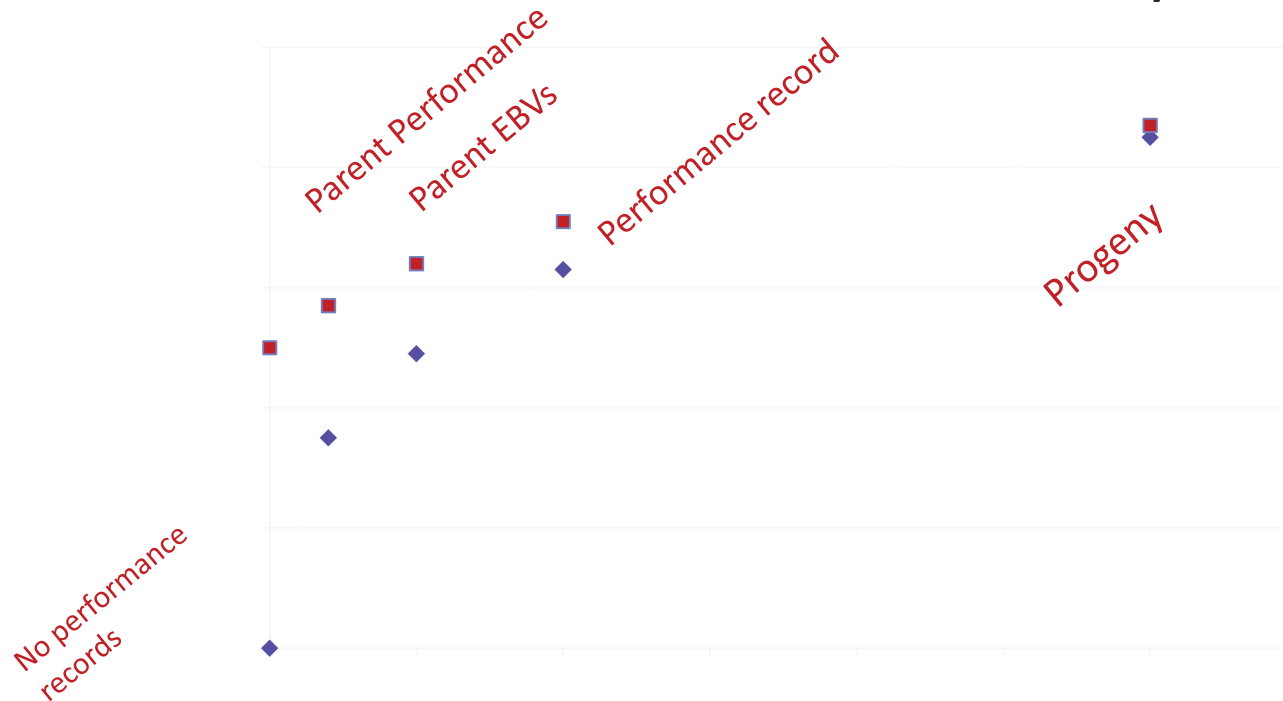
\*Pricing effective January 1, 2011

	U.S. Prices	International
3K SNP Test	\$45	\$55
50K SNP Test	\$150	\$160
800K (HD) SNP Test	\$365	\$375



# Reduce generation interval in sheep?

- Young sire programs
  - ⇒ More accurate selection of young rams



Assumed heritability = 25%; Accuracy of genomic test = 50%

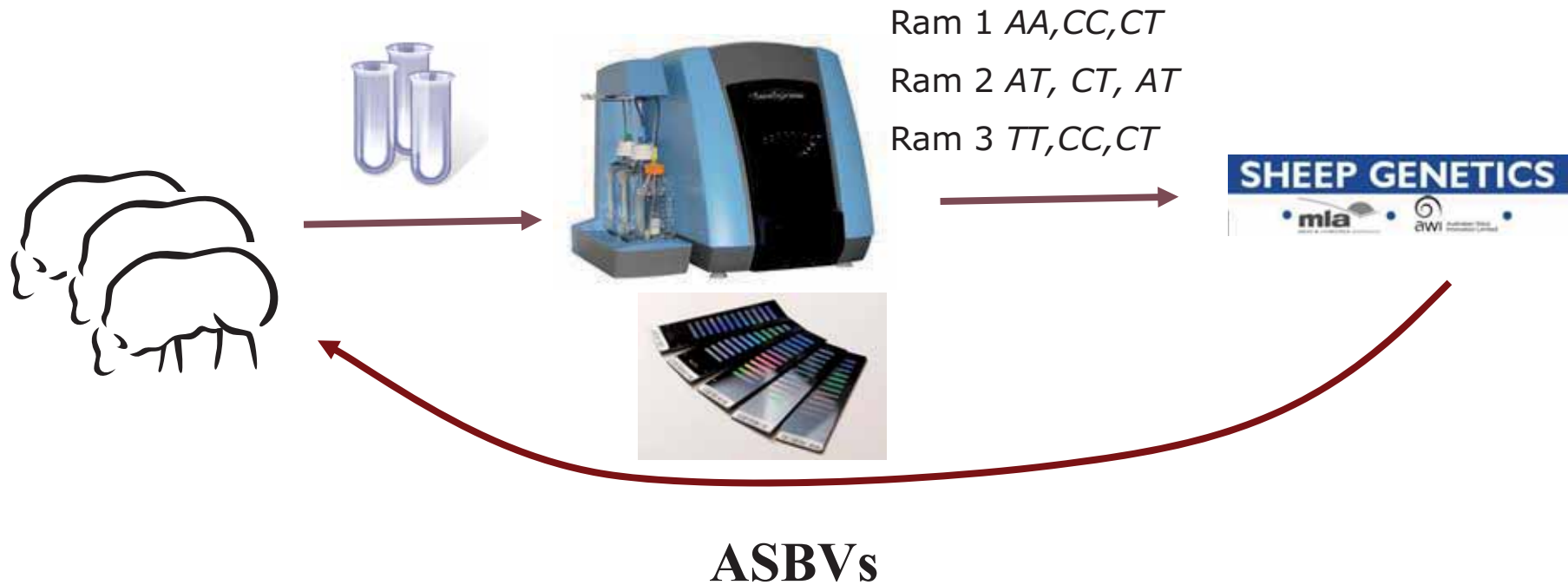
# Reduce generation interval in sheep?



- Young sire programs
  - ⇒ More accurate selection of young rams
- Juvenile In vitro Embryo Transfer (JIVET)
  - ⇒ Oocytes from ewe lambs (4-8 weeks), fertilise, embryos in recipients
  - ⇒ Choose females with genomic ASBVs!
  - ⇒ Need quick lab turnaround.....
- Halve generation interval (~ 1 yr)
- Towards 100% increased gain (\$4/ewe/yr)?



# Delivery – Sheep Genetics



# Conclusions



- ⇒ Rapid development in DNA marker technology
- ⇒ Genomics for “plate to mate”
- ⇒ Rapid removal of genetic defects
- ⇒ Genomic ASBVs on the way
  - ~ 30% gain by end of Sheep CRC
  - Delivered through Sheep Genetics
- ⇒ Synergies with young sire programs, JIVET, double rate of gain?

# Conclusions



- ⇒ Practical stuff (making it happen faster for WS)
  
- ⇒ As a breed society, build a DNA bank (semen/ear punches) from
  - ⇒ widely used sires, donor ewes
  - ⇒ Anything with a genetic defect
  - ⇒ Take pictures!
  
- ⇒ Get sires into the sheep CRC Information nucleus!