Understanding Applied Beef Genetics

K-STATE Research and Extension

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Extension Educator Resources

- www.nbcec.org
  - Beef Sire Selection Manual
  - Brown Bagger Webinar Series (Archive)
- eXtension-Beef Cattle Clearinghouse CoP
  - Webinars (archive)
  - http://www.extension.org/beef_cattle
- ASI K-State
  - Across Breed EPD converter
  - Adj BW, WW, YW calculator
  - http://ksubeef.org

Guiding Principles

- If you don't measure it, you can't manage it!
- The best way to know how much something weighs…is to weigh it!
- Not all traits should be measured…
- Populations respond to selection.
- Selection without an objective that includes profit is a hobby.
- Sire selection should address additive and non-additive merit.

Selection Tools for Beef Cattle Improvement

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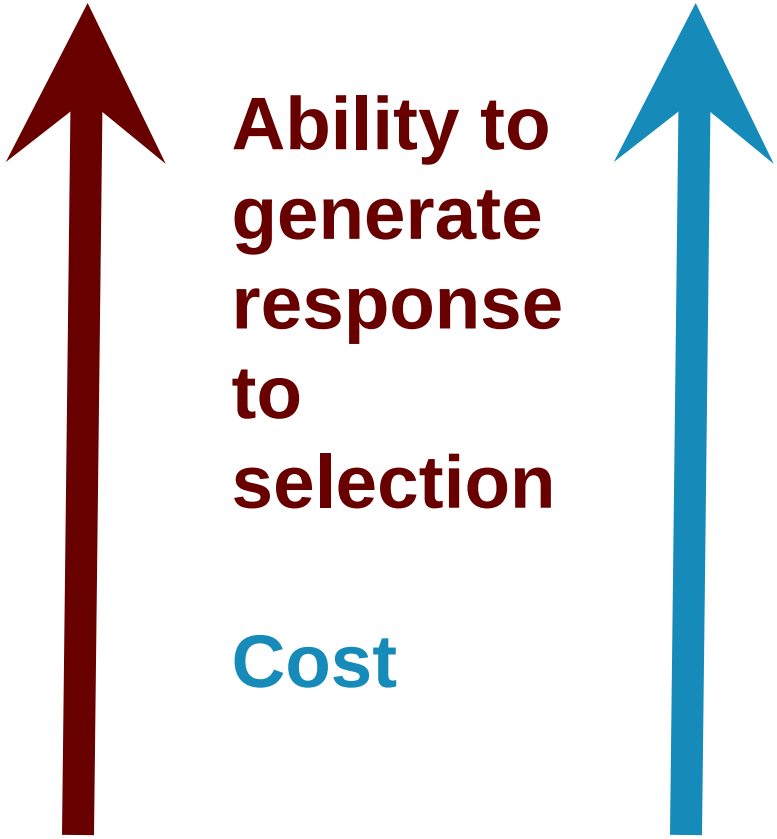
Sire Selection Tools:

- DNA Markers
- EPD
- Ratios
- Adjusted weights
- Raw Weights
- Visual Appraisal



Raw data

- Includes all sources of variation
  - Management (i.e. feed)
  - Differences in age
  - Sex
  - Age of dam
  - Climate
  - Genetics

Adjusted data

- What is the data 'adjusted' for?
  - Sex
  - Age of calf
  - Age of dam
- Why?
  - Compare 'apples to apples'

Ratios

- A way of comparing animals within a contemporary group
  - Contemporary group average = 500
  - Animal = 550
  - Ratio = 110
    - (550/500)*100
- Why not outside of that group?
  - Different environmental influences
  - Group averages may not be equal

EPD-Expected Progeny Difference

- Separates the 'wheat from the chaff'
- What information is included?
  - Pedigree information
    - (Parents, grand-parents, half –sibs, etc.)
  - Individuals' own record (very important)
  - Progeny information
  - Correlated traits (BW, WW, YW)
  - REMOVES ENVIRONMENTAL EFFECTS
  - Can be used across herds but only within a breed

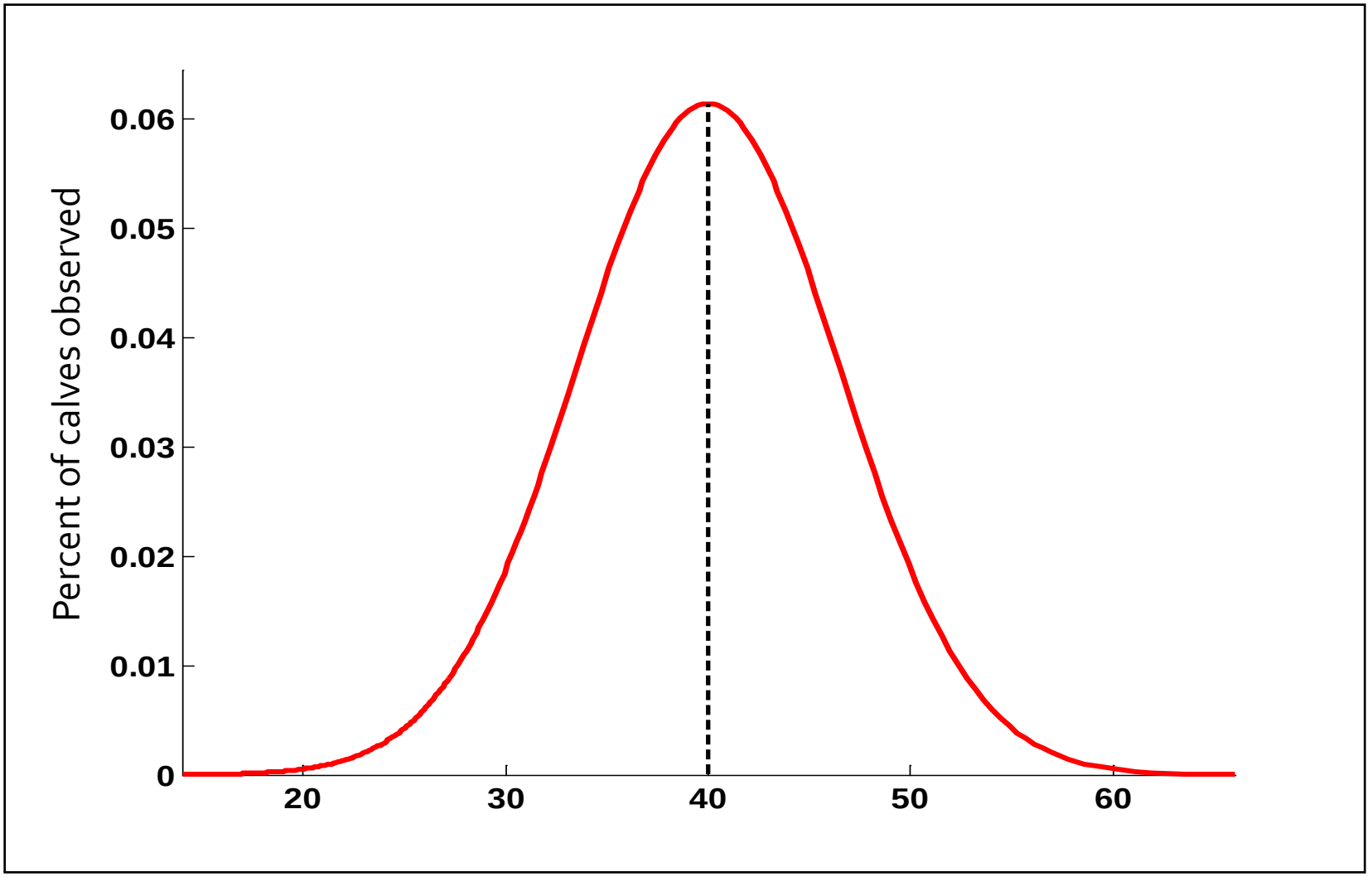
EPDs Defined

Expected
- Future, average, mean

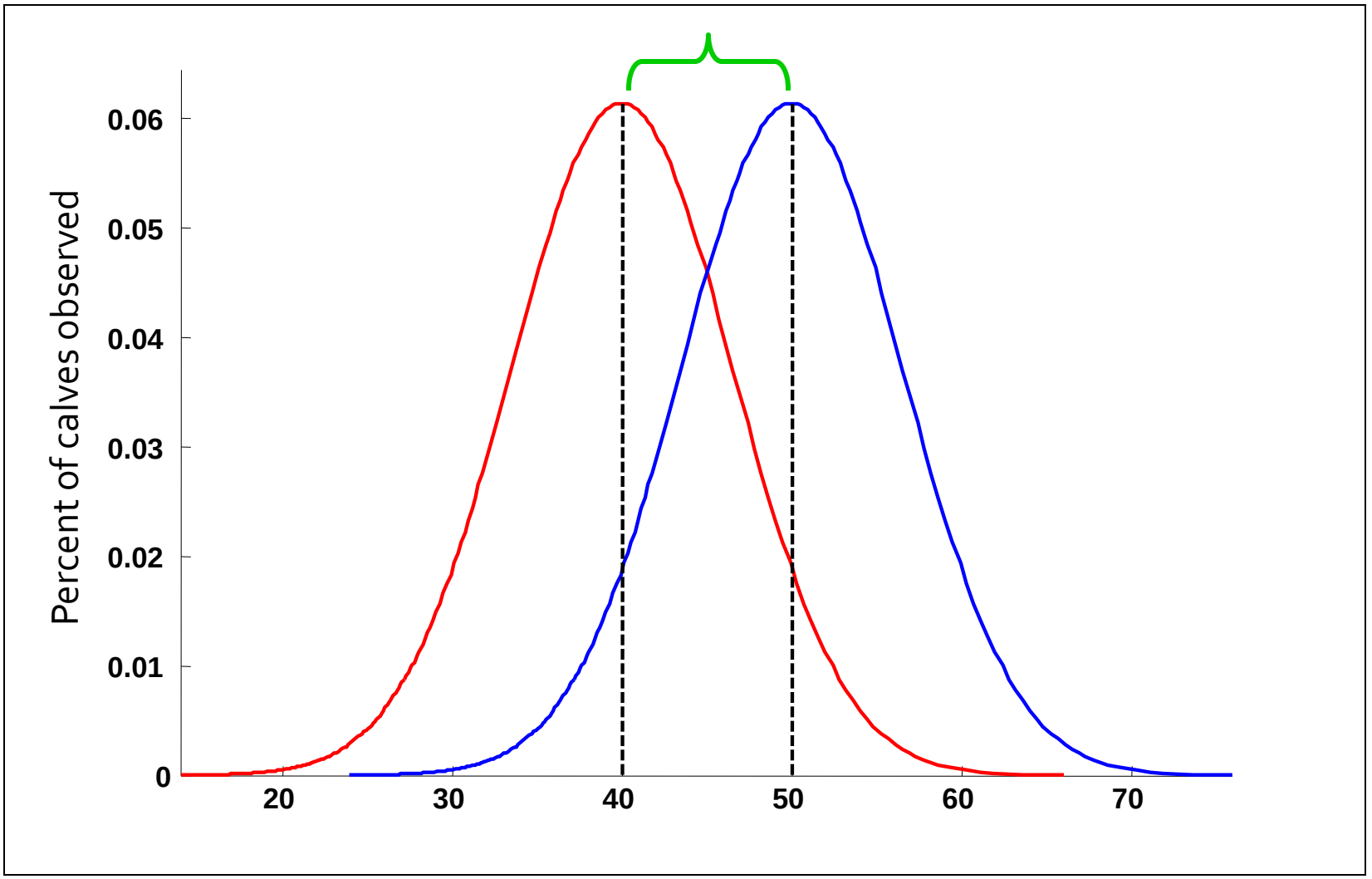
Progeny
- Offspring

Difference
- Implies comparison between animals
- NOT phenotypic performance

- *Measure of relative merit among individuals*
- *Estimate of average effect of animal as parent*
- *Estimate of average gamete genetic merit*



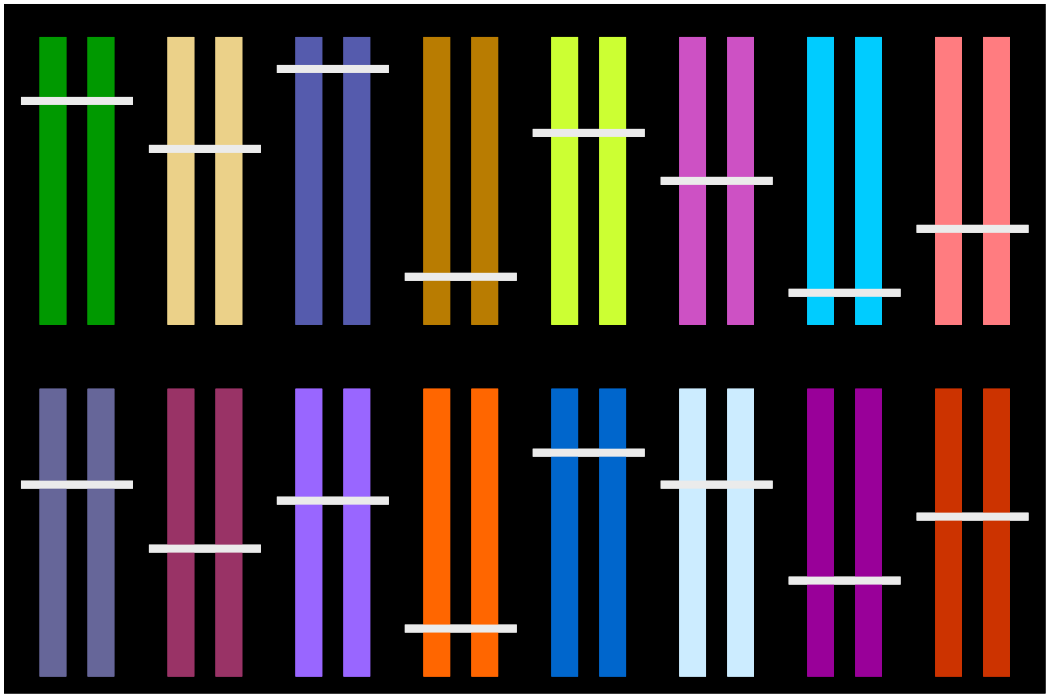
Average value of gametes
EPD = 40

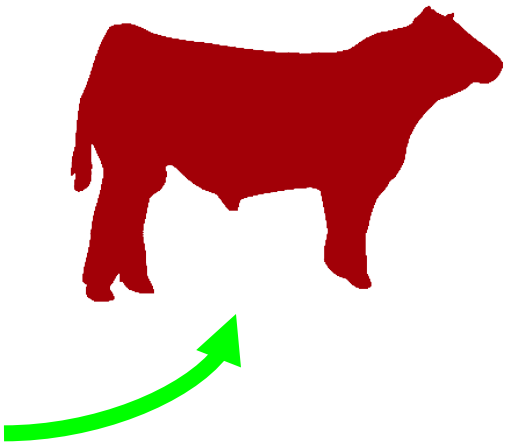


10 lb. Difference in EPD of Two Bulls

What an EPD Tells You:

Cumulative (net) effect of all genes and their interactions on a trait.





Using EPDs

Bon View New Design 878

TRAIT	CED		WW	YW	MILK
EPD				83	32

S A F at 9015

TRAI	CED		WW		MILK
EPD	6	2	58	6	30

KCF B tt 3008 M3

TRAIT	CED		WW	YW	MILK
EPD	5.5	0.8	51	91	24

How EPDs Are Computed: Contemporary Group

- Consists of animals that are:
  - Given **equal** opportunity to perform
  - Of similar age and sex
- Identify fair competition
- Formed from management information
- The basis of all genetic comparisons

Phenotype = CG + Genetics + e

Genetics = Phenotype - CG

Where EPDs fit in selection

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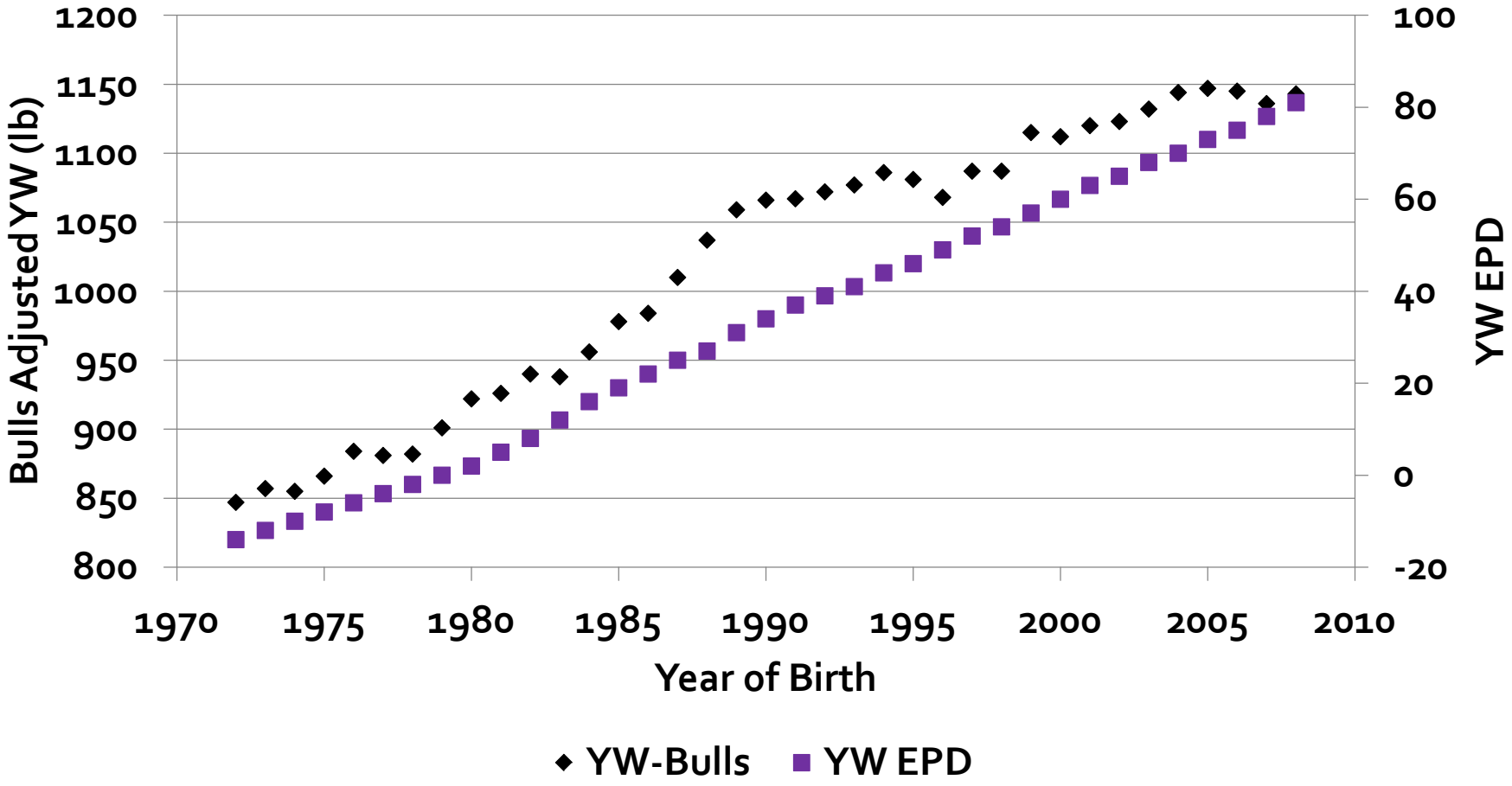
EPD's Work…

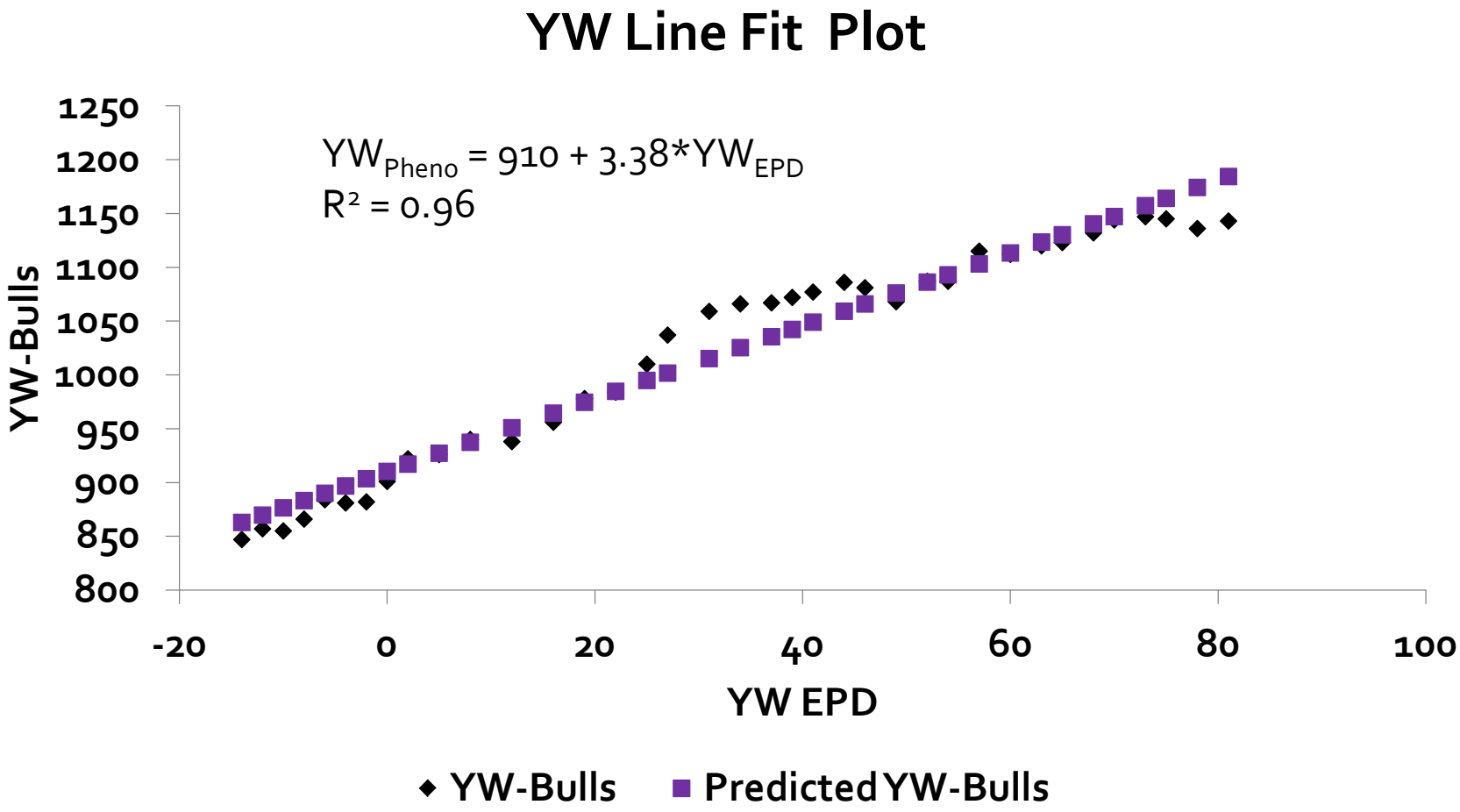
- 7-9 times more effective generating response to selection than phenotypic selection
- Can be used to:
  - Increase performance
  - Decrease performance
  - Optimize performance
- Do not select for maximum genetic expression w/o regard to other factors
  - Nutritional conditions

Yearling Weight Phenotypic and Genetic Trend



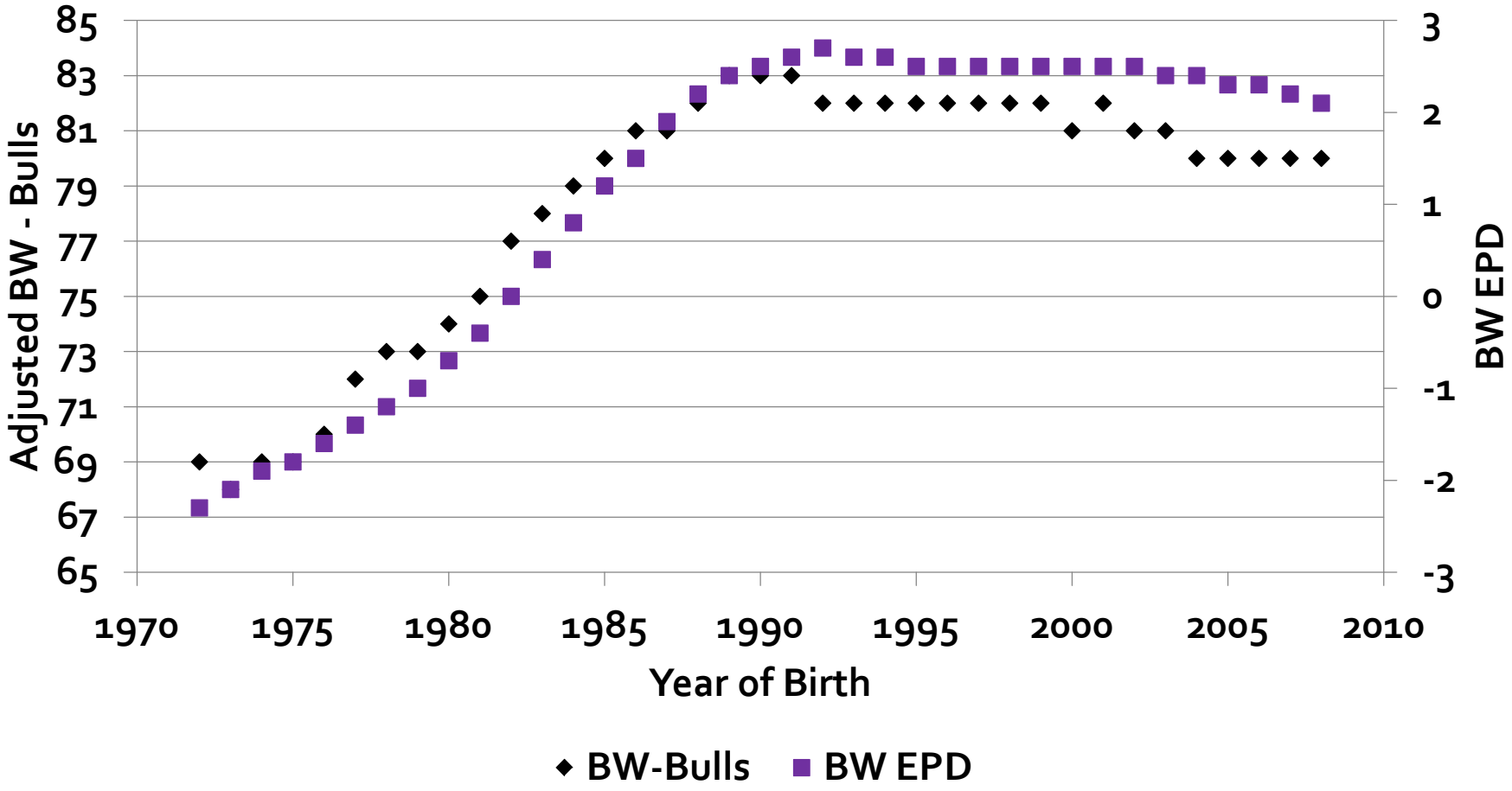
Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends

EPDs Work—Selection for increased growth



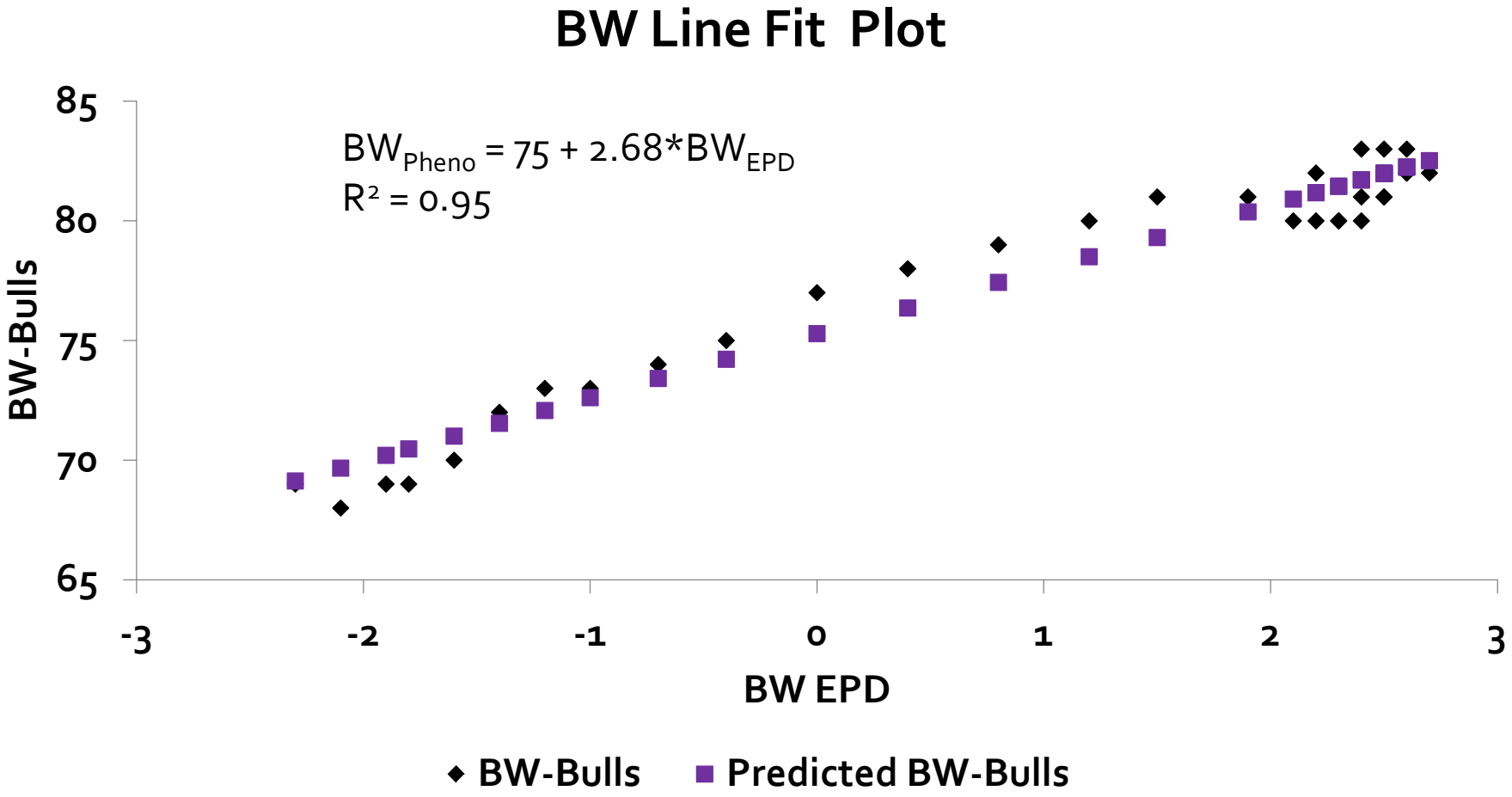
Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends

Birth Weight Phenotypic and Genetic Trend



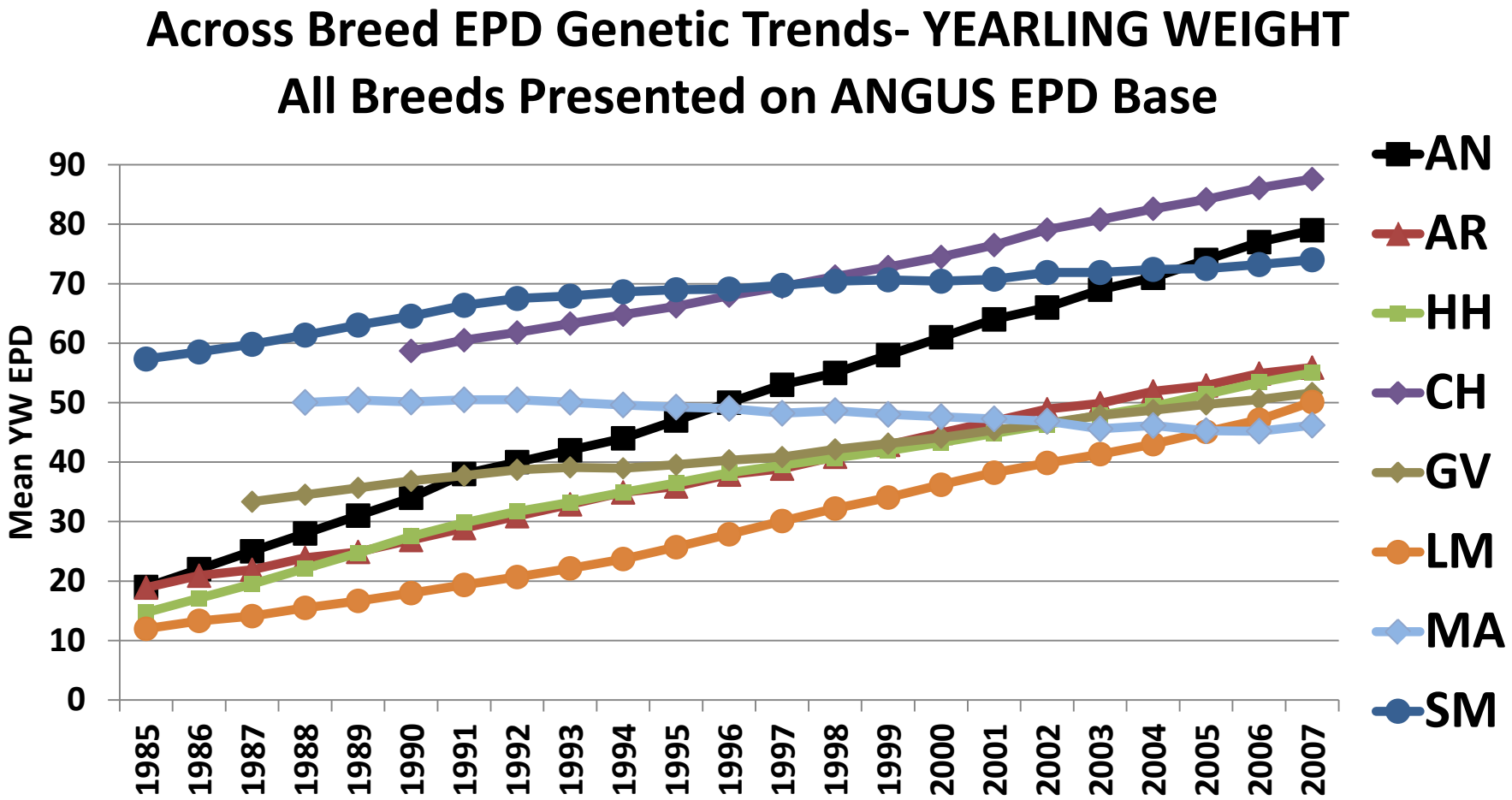
Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends

EPDs Work—Selection for Birth Weight



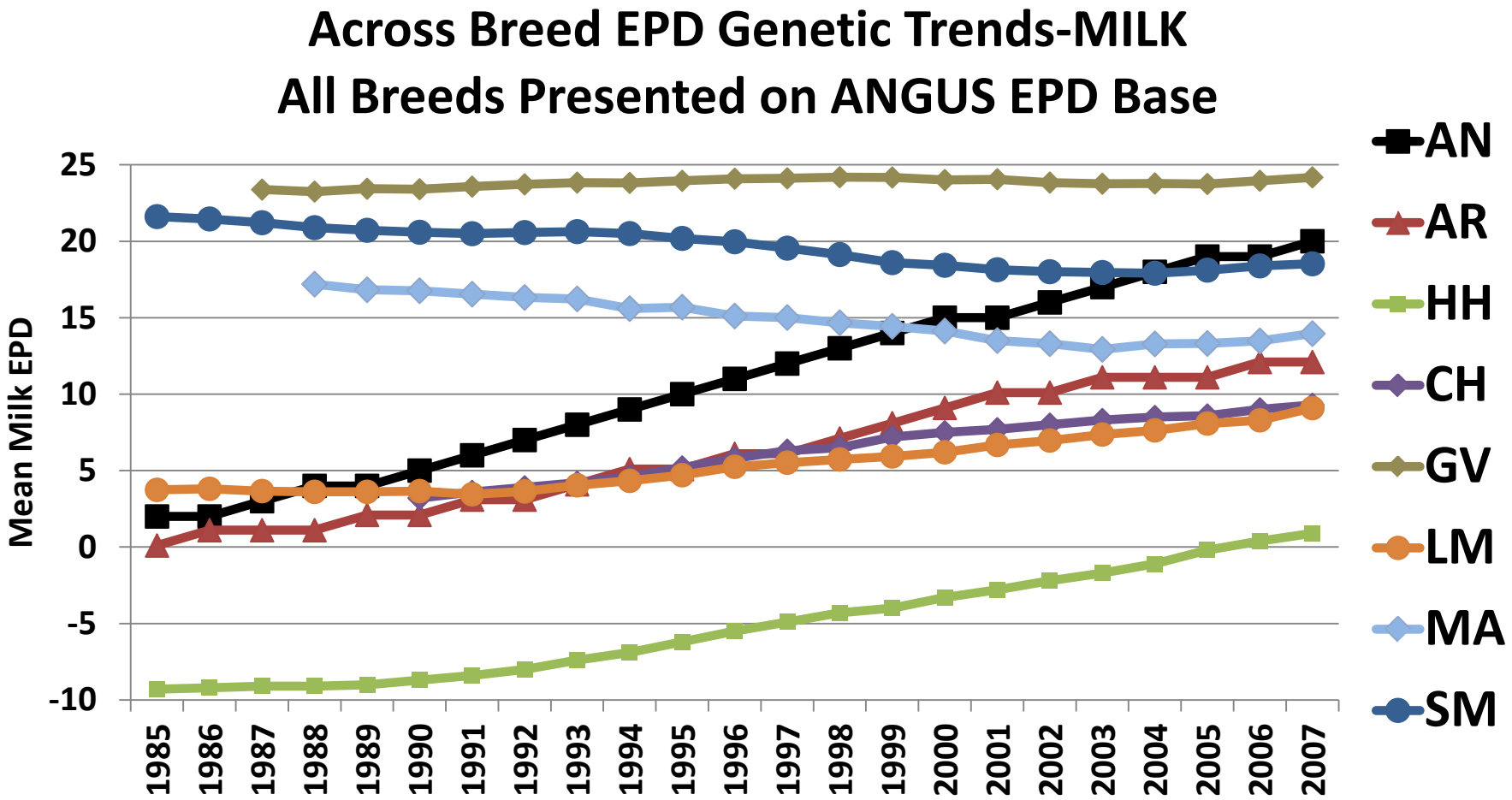
Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends

YW EPD Genetic Trends



Weaber and Fennewald, 2009

MILK EPD Genetic Trends



Weaber and Fennewald, 2009

How Do I Make EPD Work for My Herd?

Sire	WW EPD
A	40
B	49
C	52

Avg. 47

Average Adjusted 205 d Weaning Weight

560 lb.

EPDs-One Tool in the Tool Box

- Selection is challenging
- Not all economically important traits have EPD
  - Fertility
  - Disease resistance
  - Fescue fitness
  - Conformation traits
  - Mature weight
- Use the right tool for job!
- Multiple trait selection

Making the tools work together…

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Do You Have a Breeding Objective??

Our objective is to breed cattle that breed as yearlings, calve unassisted and rear a good calf for sale at weaning every year. We aim to breed functional cattle that flesh easily and can forage on the hills over winter but must have the temperament and soundness to be farmed intensively during calving and the breeding season.

The Role of Economically Relevant Traits

- A trait that has a direct cost or return associated with it is an Economically Relevant Trait (ERT).
- Traits that are correlated to ERTs are indicator traits.
- Example: Is Birth Weight or Calving East the ERT? Why??
- Weaning Weight or Yearling Weight?

Relative Economic Weights for Integrated Beef Firm

Reproduction:Growth:End Product

2:1:1

(Melton, 1995)

What's a Selection Index?

- $W - One number to use in selection that summarizes five
- Appropriately weights each trait for its influence of profit
- Selection on 'aggregate merit' (Hazel, 1943)
- Value of each trait - increase in satisfaction with one unit change in a trait, all others held constant
- Selection index is formal statement of trade-offs among traits used to evaluate selection candidates (MacNeil et al., 1997)

EPDs – *Future*

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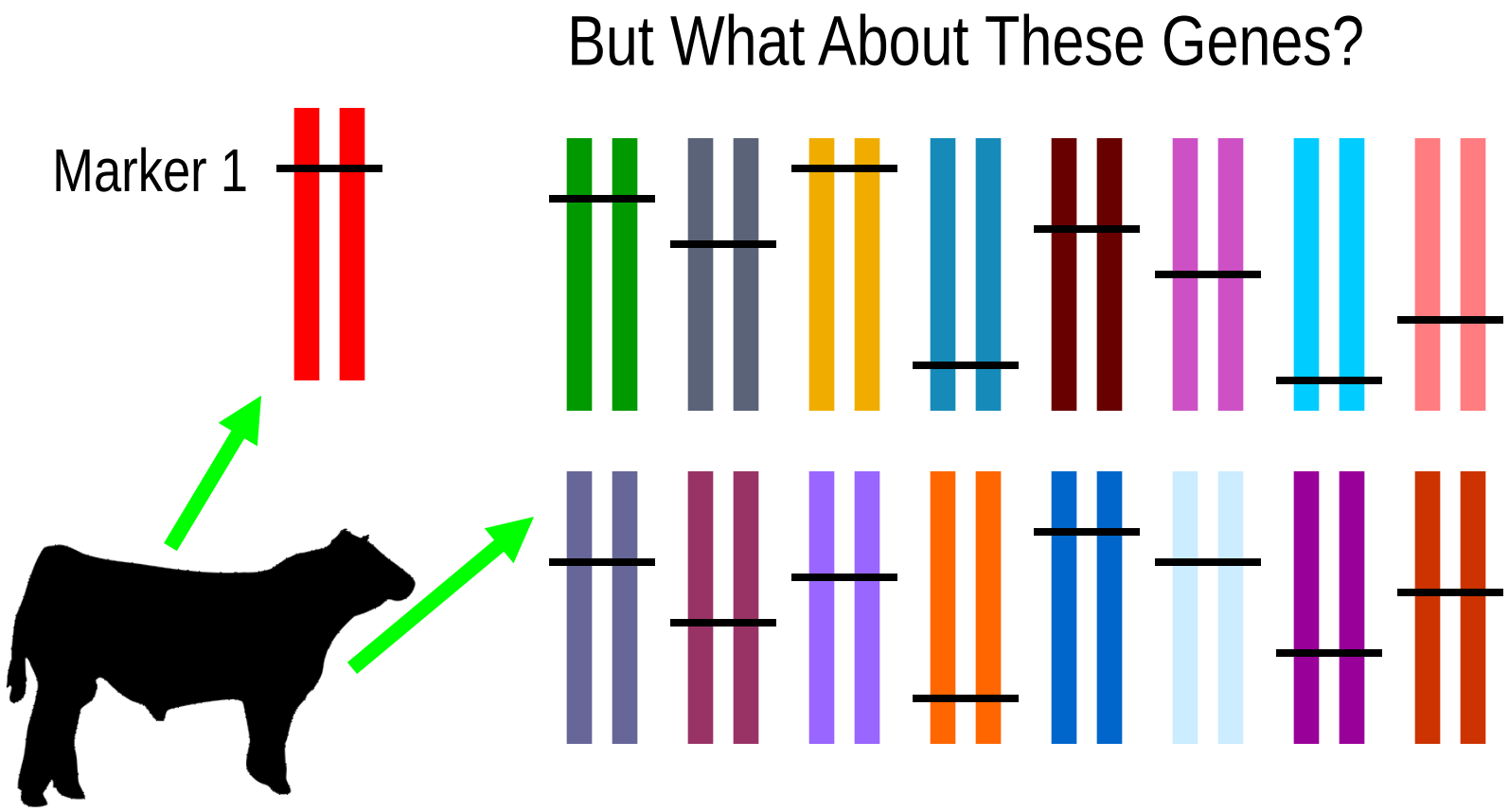
What a Marker Test Tells You:



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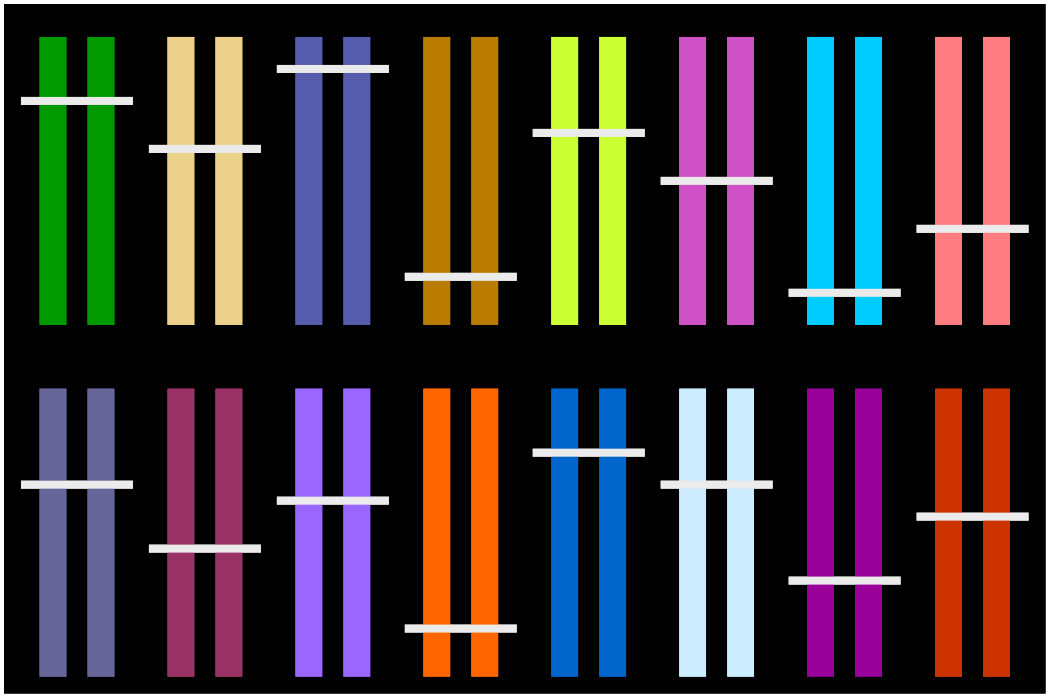

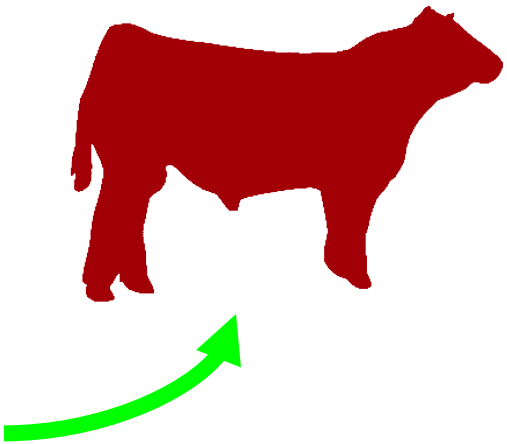

Paradigm—Disjoined Information

EPD

- Sum of the additive effect of all genes that influence a given trait divided by two
- Genes are unknown
- Time delay in collecting phenotypes

Spangler, 2011

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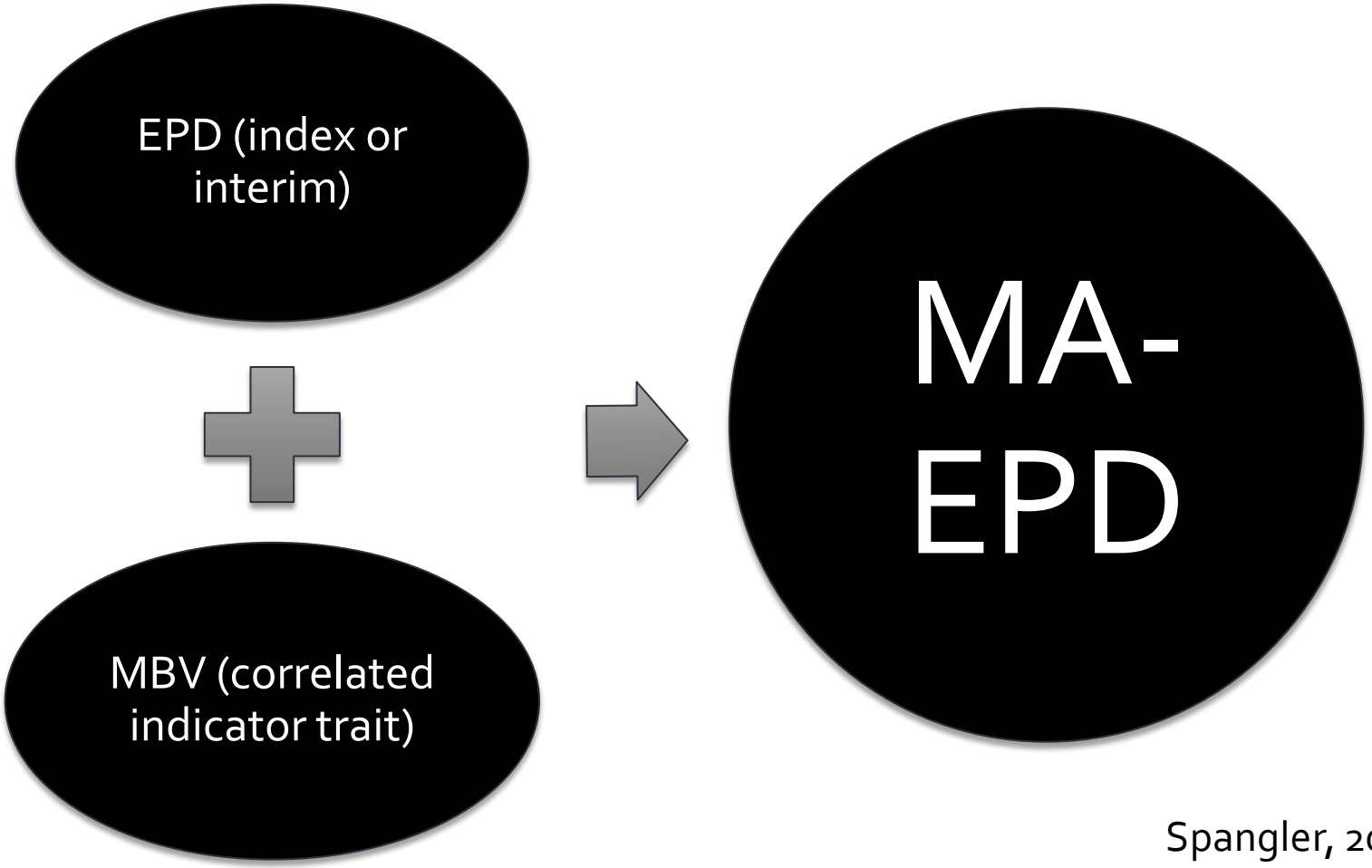
MBV (MVP, ETC.)

- Sum of the additive effect of SNP alleles (multiplied by copy number) that influence a trait
- These are not genes, but associated with genetic variance
- Can be collected at birth

Integrated Information



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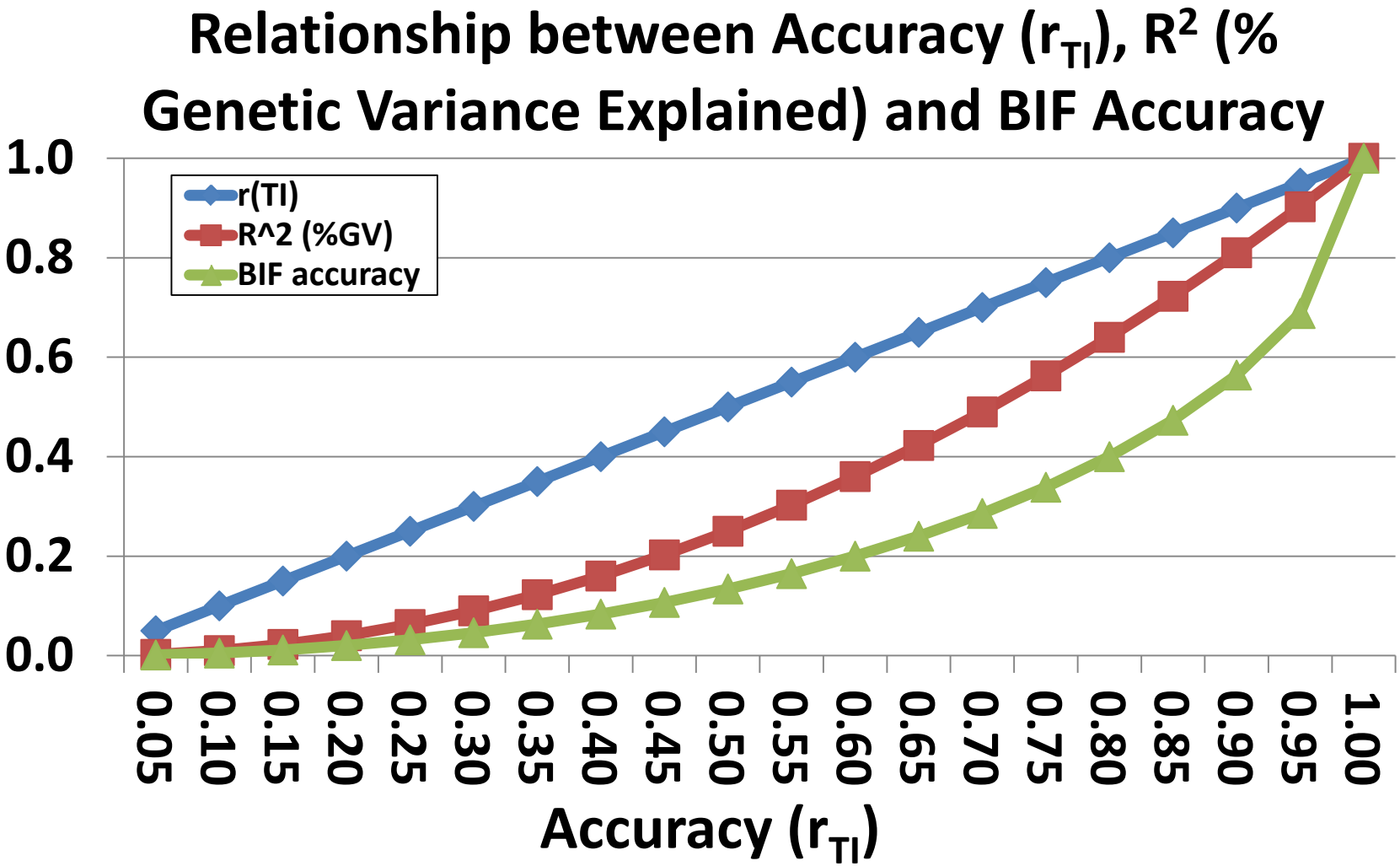
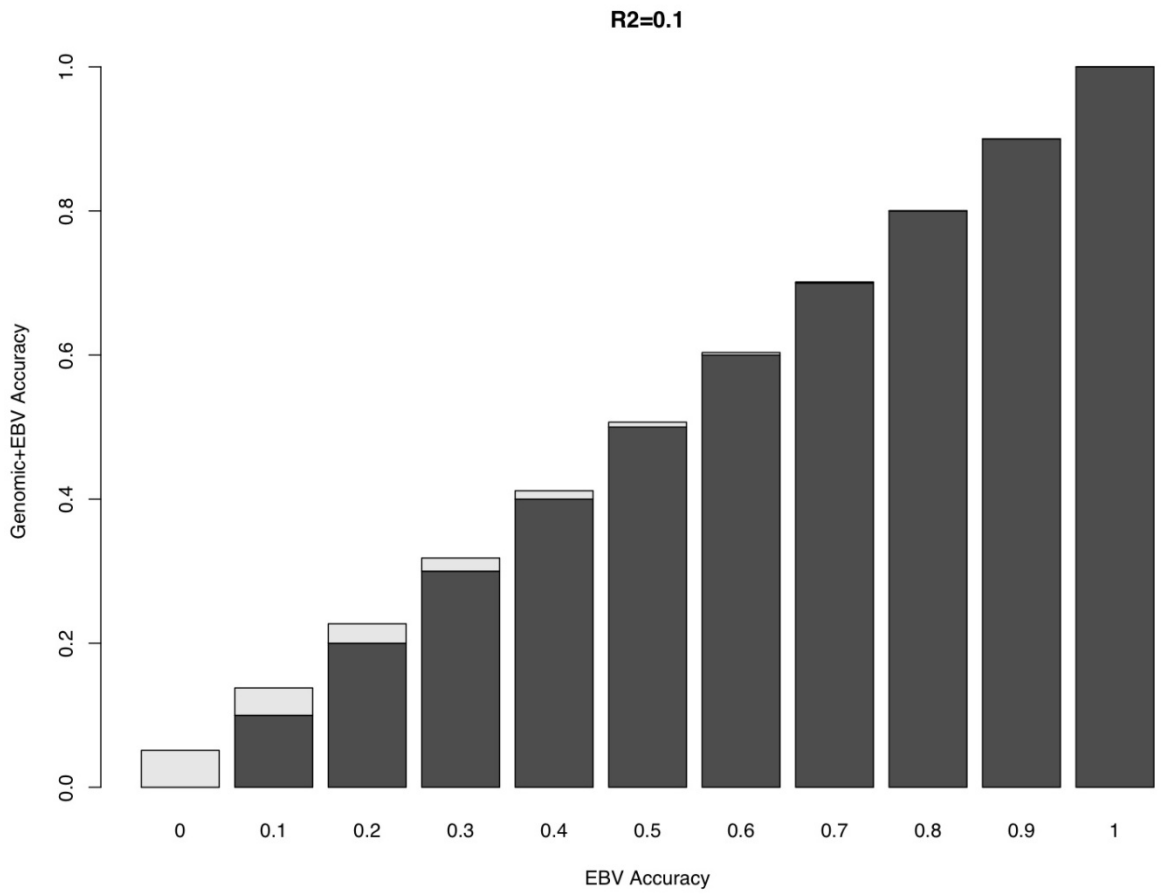
Relationship Between Accuracy, %GV and BIF Acc.

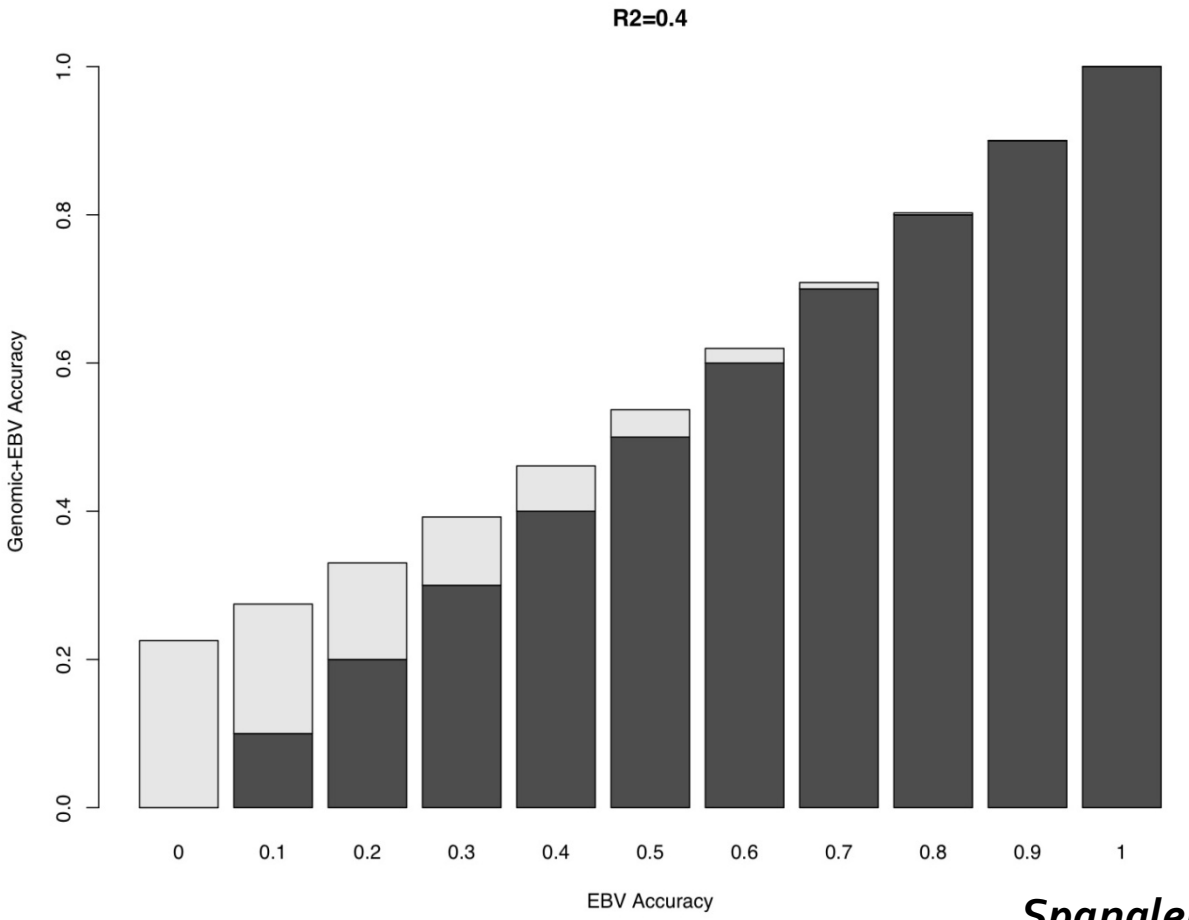


Impact on Accuracy-- %GV=10%



Spangler, 2011

Impact on Accuracy-- %GV=40%



Spangler, 2011

Thank You!

Questions?

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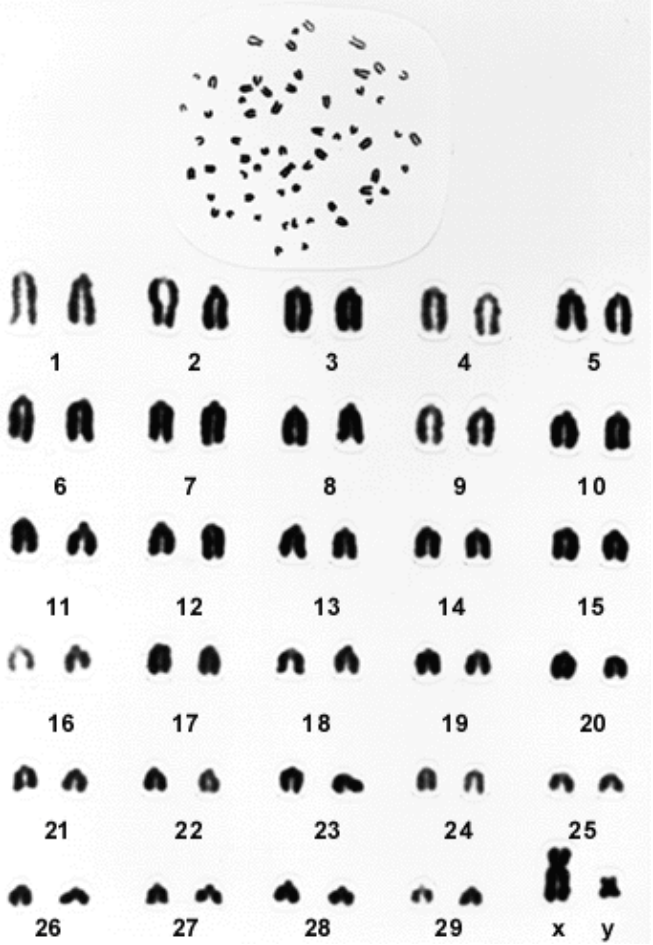
Overview

- Selection tools for beef cattle improvement
  - Measures used for selection
  - The basics of EPDs
- Where EPDs fit in selection
  - EPDs work! (and not just to increase a trait)
  - What they can and can't do
- EPDs – making the tools work together
  - Multiple trait selection
- EPDs – Future
  - New sources of genetic information
  - Old and new living together – convergence

The Biology Assures Variation in Progeny

- Cattle have 30 pairs of chromosomes
  - 29 autosomes, 1 sex determining
  - Diploid (2 copies of each chromosome)
- Meiotic cell division forms gametes
  - Eggs and sperm are haploid
  - 1 chromosome from each pair; random
  - Recombination or cross-over events
- Fertilization restores diploid chromosome count
- Two copies of each gene
  - Alternate forms are called alleles

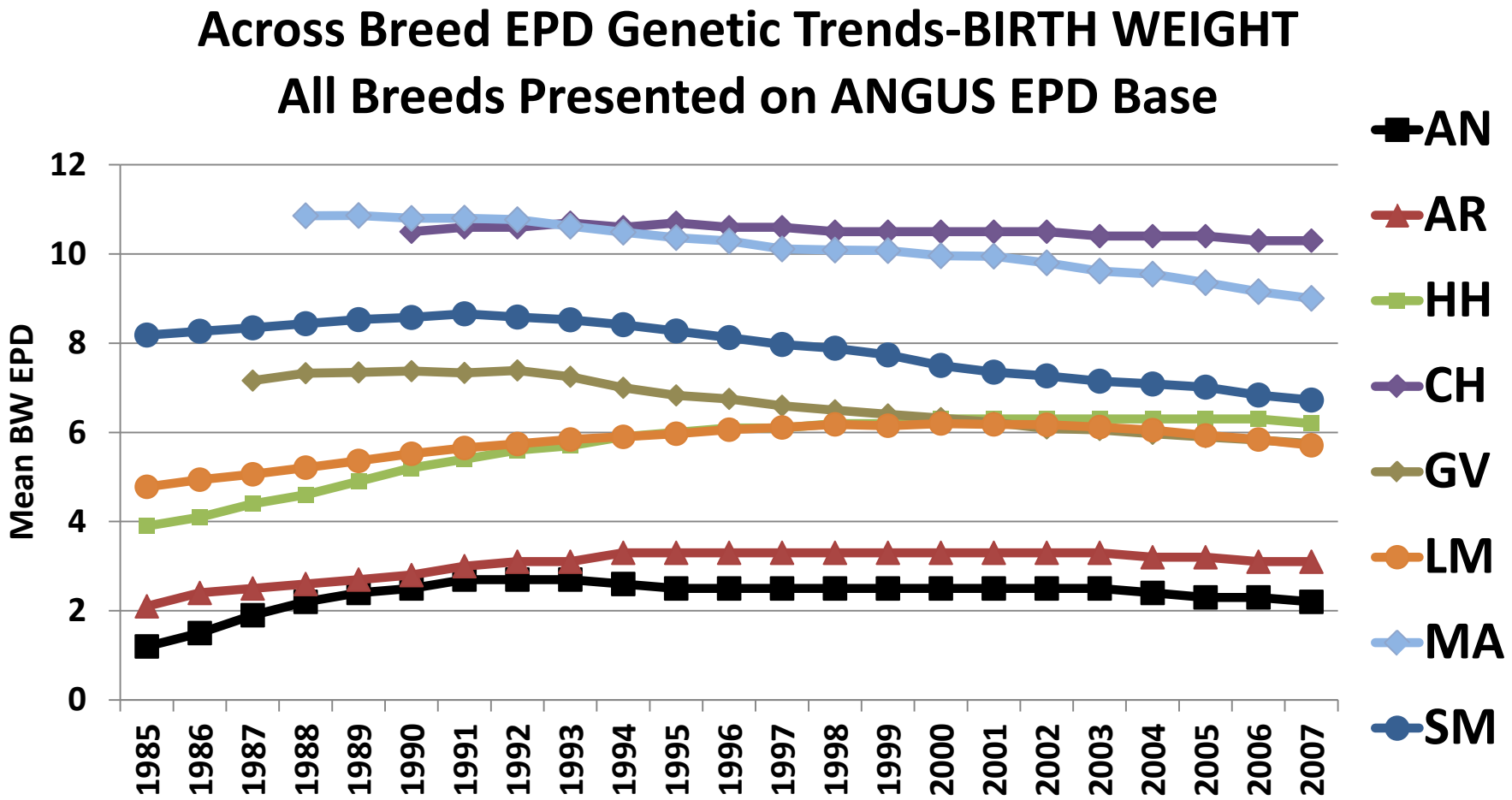


Genet. Mol. Biol. 1999, vol.22, n.3, pp. 369-373

Why is multiple trait selection..

- Difficult?
  - Lots of EPDs
  - Some for Economically Relevant Trait (ERT) some for Indicator Traits
- Important?
  - More than one trait is important for enterprise, operation or industry profitability

BW EPD Genetic Trends



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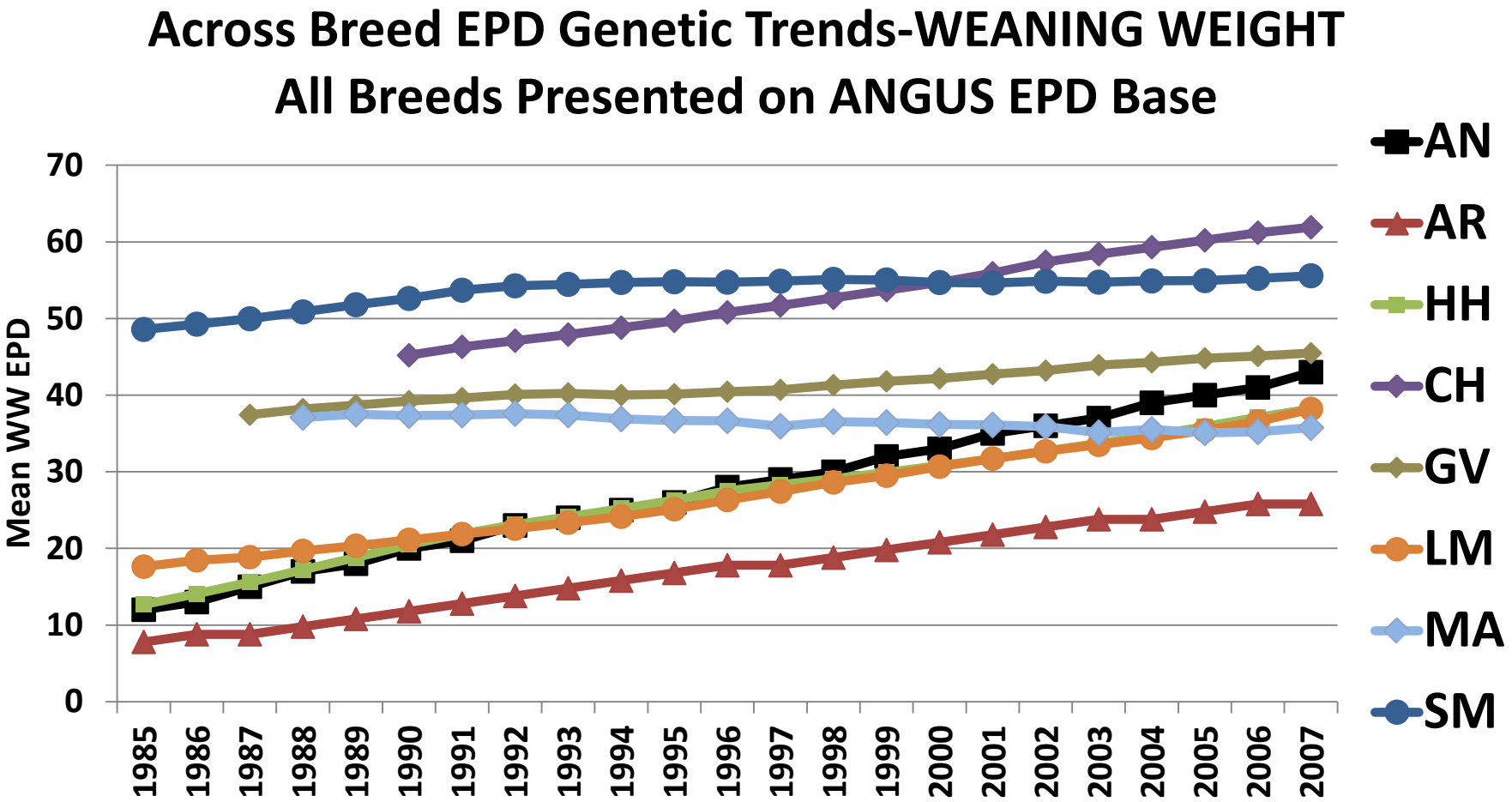

Weaber and Fennewald, 2009

Genetic Correlations

▪ BW – Mature Wt.	0.61
▪ WW – Mature Wt.	0.65
▪ YW – Mature Wt.	0.65
▪ Feed Intake – Mature Wt.	0.75

Do Guns Kill People?

- Did EPDs make big cows??
- NO, people made big cows!
- Selection works!
  - So does correlated response
- We can use EPDs to:
  - Increase performance
  - Decrease performance
  - Maintain performance

Selection Index

- Two Step approach by Henderson (1950s)
  - Calculate predictions of merit (EPD) for each trait in selection objective
  - Weight each prediction by it's Relative Economic Value (REV)
- Equivalent to Hazel (1943) approach

$$H = a_1 EPD_1 + a_2 EPD_2 + \ldots + a_n EPD_n$$

Convergence

- Large marker panels or whole genome selection system
- Incorporate marker data into EPD calculation
  - Am. Simmental used WBSF markers in computation of EPD
  - Am. Angus Association debut of Genome Assisted EPDs
- Improves accuracy for young animals/selection candidates
- Reduces need to collect expensive phenotypes

MBV BIF Accuracy

Genetic Correlation	% GV	BIF Accuracy
0.1	1	0.005
0.2	4	0.020
0.3	9	0.046
0.4	16	0.083
0.5	25	0.132
0.6	36	0.2
0.7	49	0.286

Spangler, 2011