“NO BULL” DISCUSSION ON GENETIC MARKERS

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Genetic Markers

- What are they ?
- What might they be used for ?
- What is available, and from whom ?
- Are they “fit for purpose” ?
- What will the future hold ?

What is a genetic marker ?

- DNA is the blueprint of life, and contains a wealth of information (and misinformation) that influences the performance of the individual and its offspring
- A typical genetic marker is a “signature” or a “signpost” that is unique to a precise small part of this large blueprint
- There are millions of genetic markers

What use is a genetic marker ?

- A genetic marker simply indicates whether a particular piece of DNA is present in a sample

- A commonly used kind of marker is a single nucleotide polymorphism (or SNP)

-AACTCGTACGTCA-
-AACTCGTACCTCA-

(A, T, G & C are nucleotides)

A polymorphism indicates various types vs monomorphic

Wealth of implications

- Identity and Parentage
  - A unique viral "signature" can prove an individual is infected by a virus (e.g. BVD)
  - Two (non mixed) samples that differ in signature must have come from different individuals
  - An individual that does not have the signature of its supposed parent is not an offspring
    - Collective signatures can be suggestive of ancestral origins (e.g. breed) or relatedness (genetic distance)

Wealth of Implications

- Genetic Makeup
  - A signature representing a known DNA "error" guarantees a defective gene
    - Many recessive diseases (e.g. BLAD, citrullinemia)
    - Coat color (e.g. black vs red)
    - Muscling (e.g. normal vs double muscled)
  - A signature sometimes associated with superior (or inferior) performance may help predict its own or its likely average offspring performance
    - Many such signatures have been observed in small studies

Applications in Cattle

- Quality Assurance and Source Verification
  - Not tamper proof
  - Not immediate
  - Useful as part of a “portfolio” approach
- Detecting Sub-clinical Disease
  - Direct evidence of pathogenic organism

Applications in Cattle

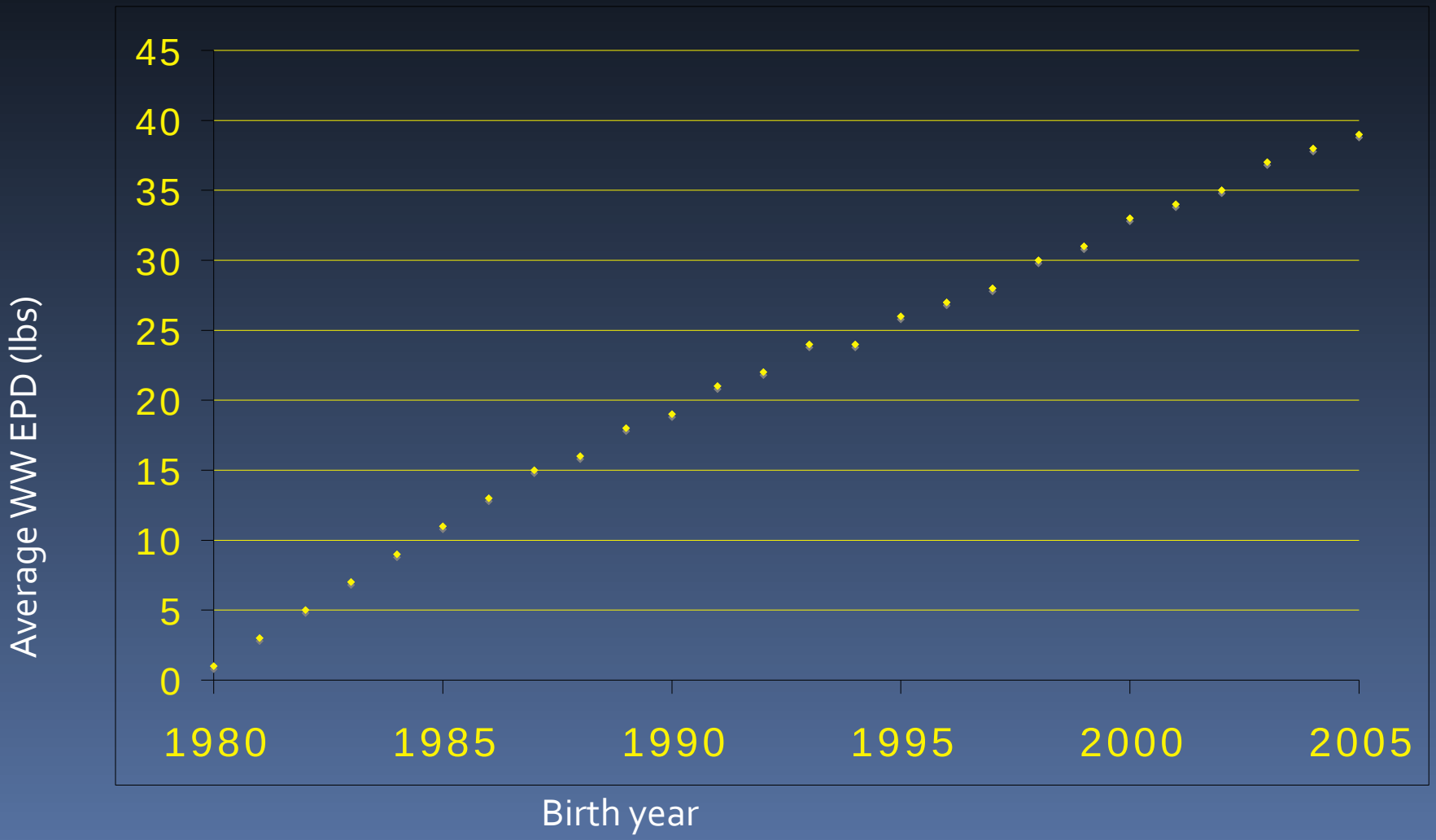
- Four Options
  - Reducing the Genetic Lag
    - Screening sale bulls
  - Increasing the Rate of Genetic Gain
    - Bull breeding herds
  - Parentage Testing in Multi-sire Pastures
  - Sorting Cattle for Alternate (optimized) Management

Applications in Cattle

- Ideal Outcome
  - Positive Value Proposition for all Stakeholders
- Prerequisite
  - Reliable, robust detection of signatures (Research)
  - Protection of Intellectual Property (Legal)
  - Genetic Testing Servicing (Business)

Reducing Genetic Lag

Angus WWD Genetic Change



Expected Progeny Difference

- An Angus bull with WW EPD of +60lb is expected to sire calves that weigh 60 lb more at weaning than the average base bull (Angus WW base is 1979 born)
  - Average '06 born regd bull had EPD +41 lb
  - Our bull would wean offspring 19 lb heavier

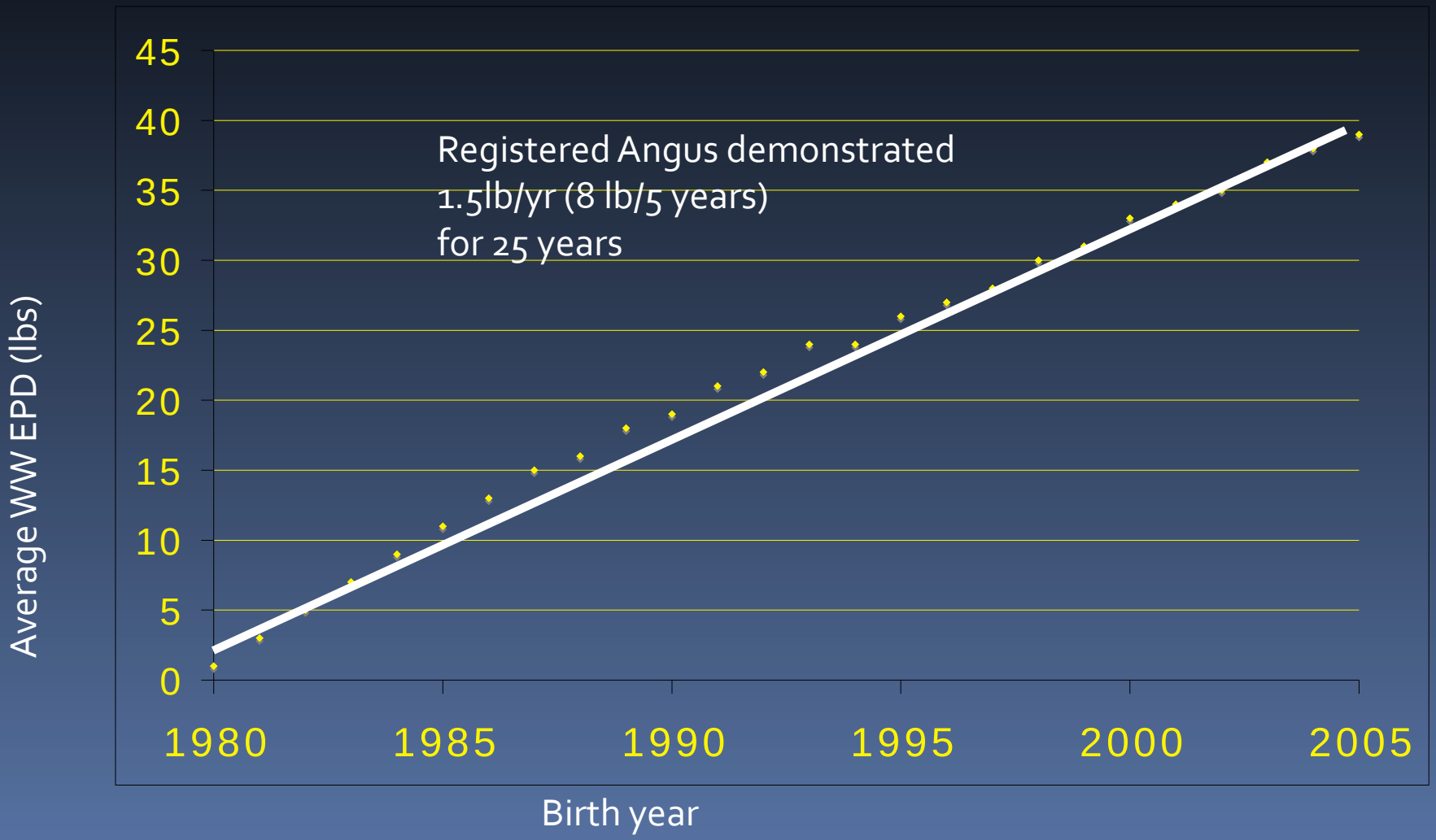
Offspring EPD

- The EPD of offspring is the average of the EPD of its sire and its dam
  - Genes are located on chromosomes
  - Animals have paired chromosomes
    - Cattle typically have 60 (ie 30 pairs)
  - An individual inherits one member from each chromosome pair from its sire, the other from its dam

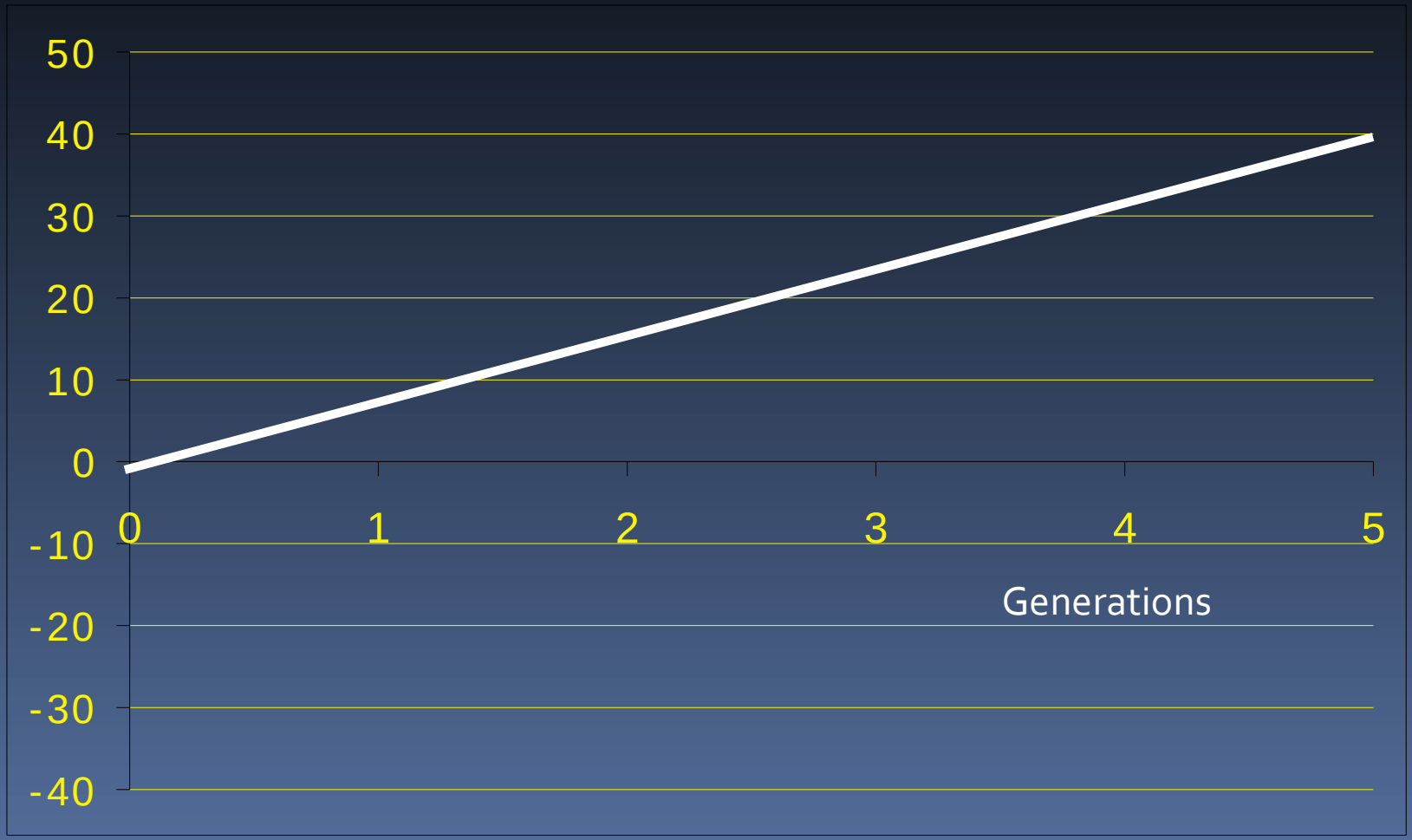
Offspring EPD

- Our bull with an EPD of 60 lb mated to cows with EPDs of 30 lb would produce calves with EPDs averaging 45 lbs (60+30)/2

Angus WWD Genetic Change



8 lb/5 yr Genetic Change



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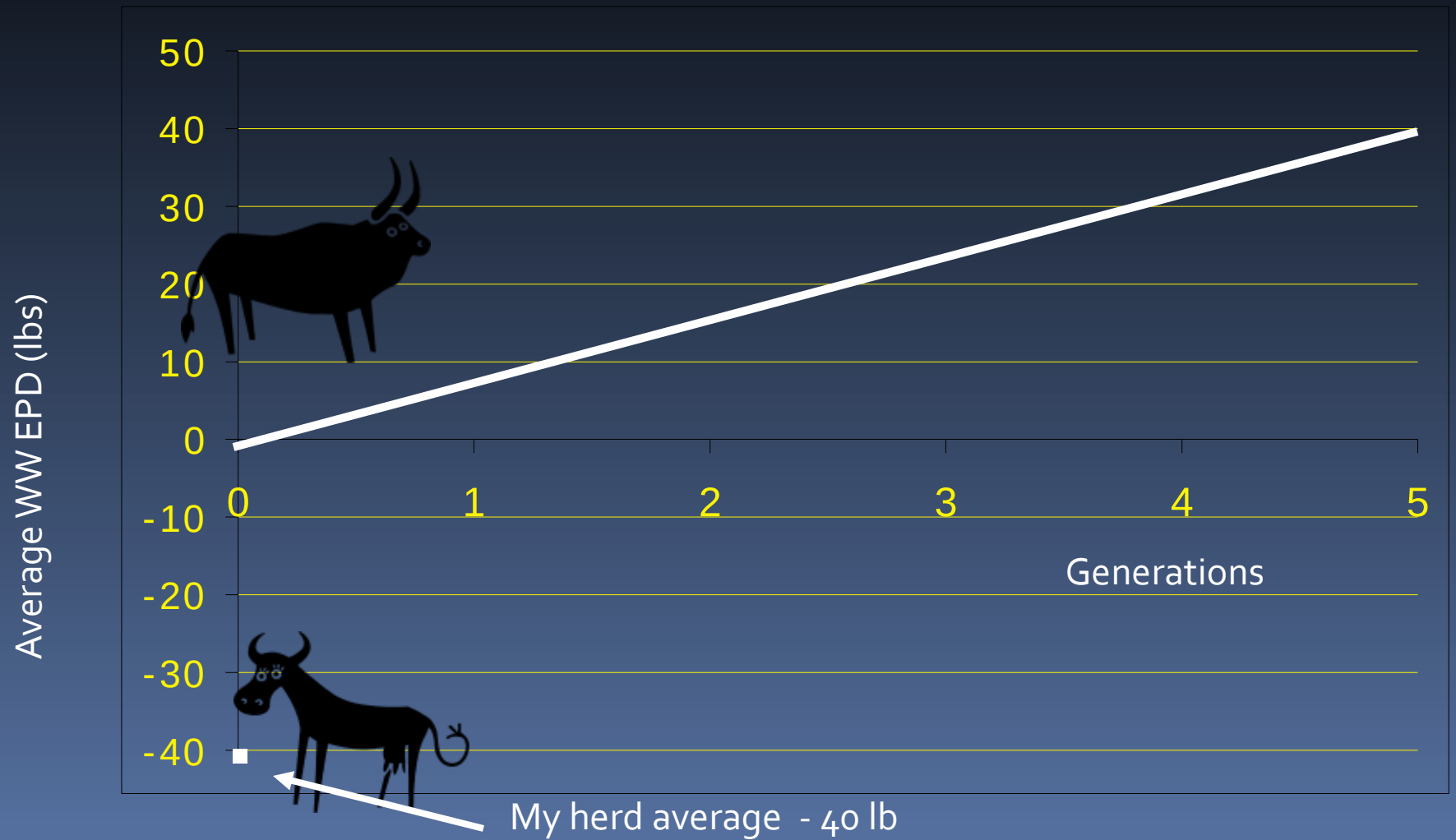

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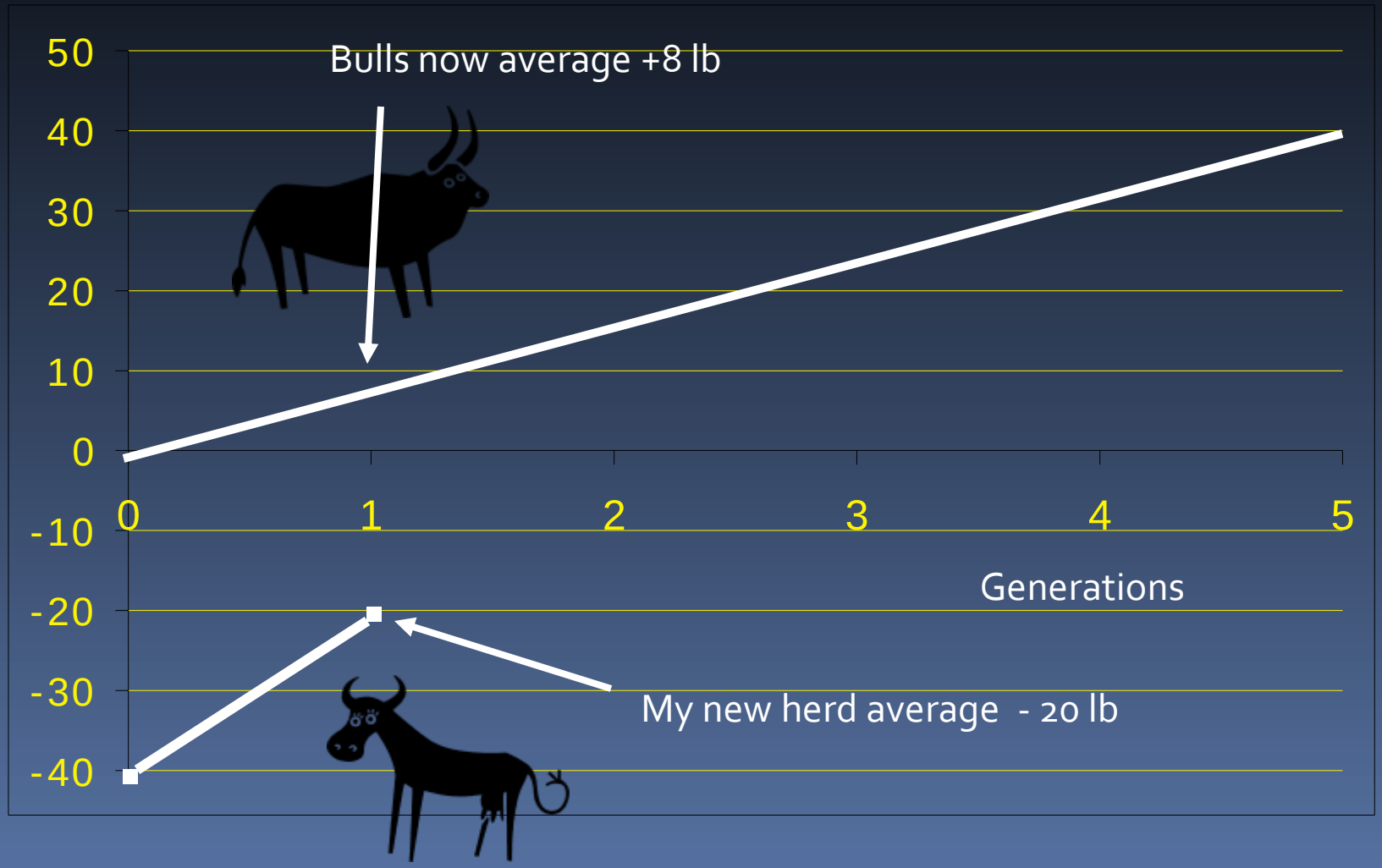

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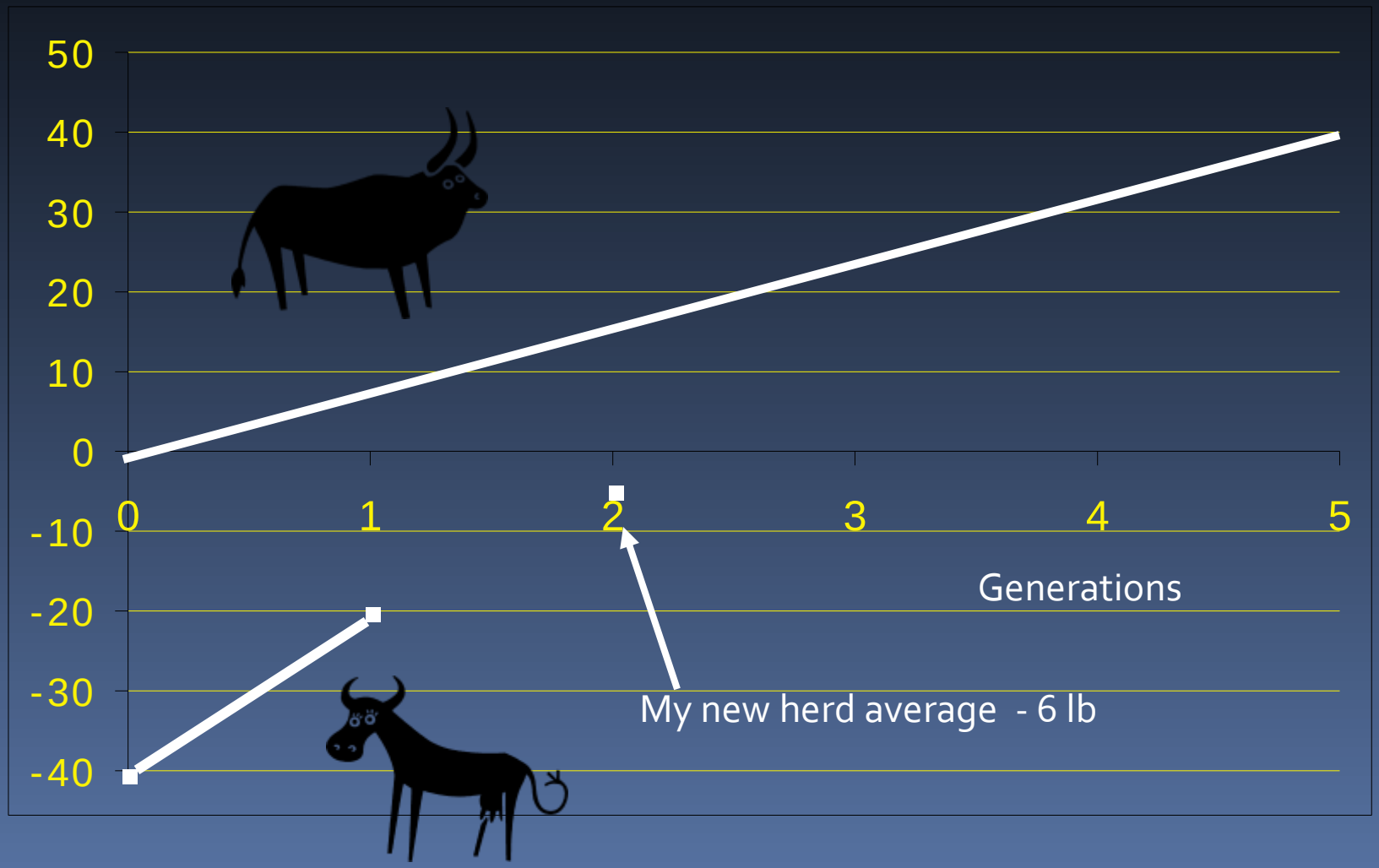

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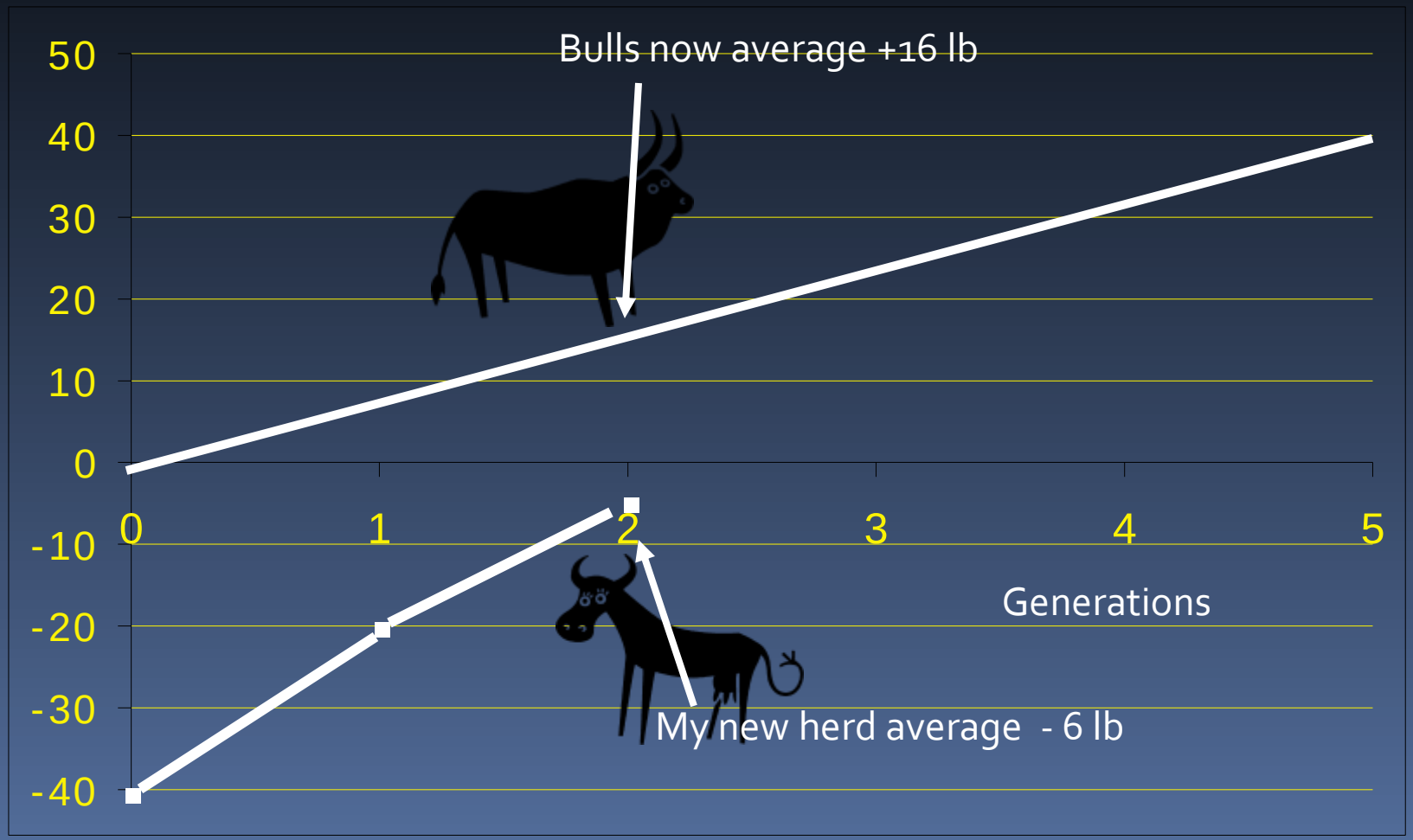

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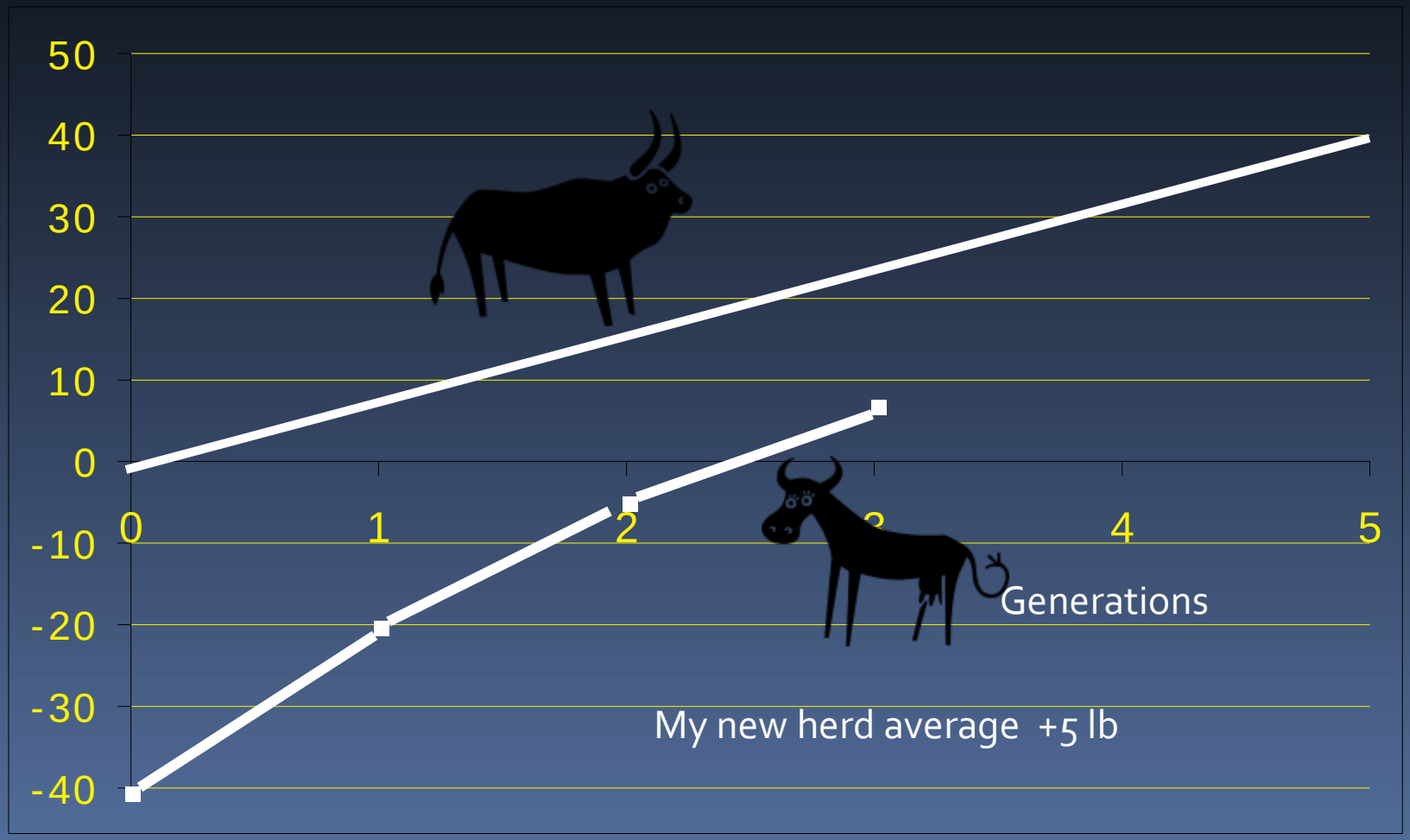

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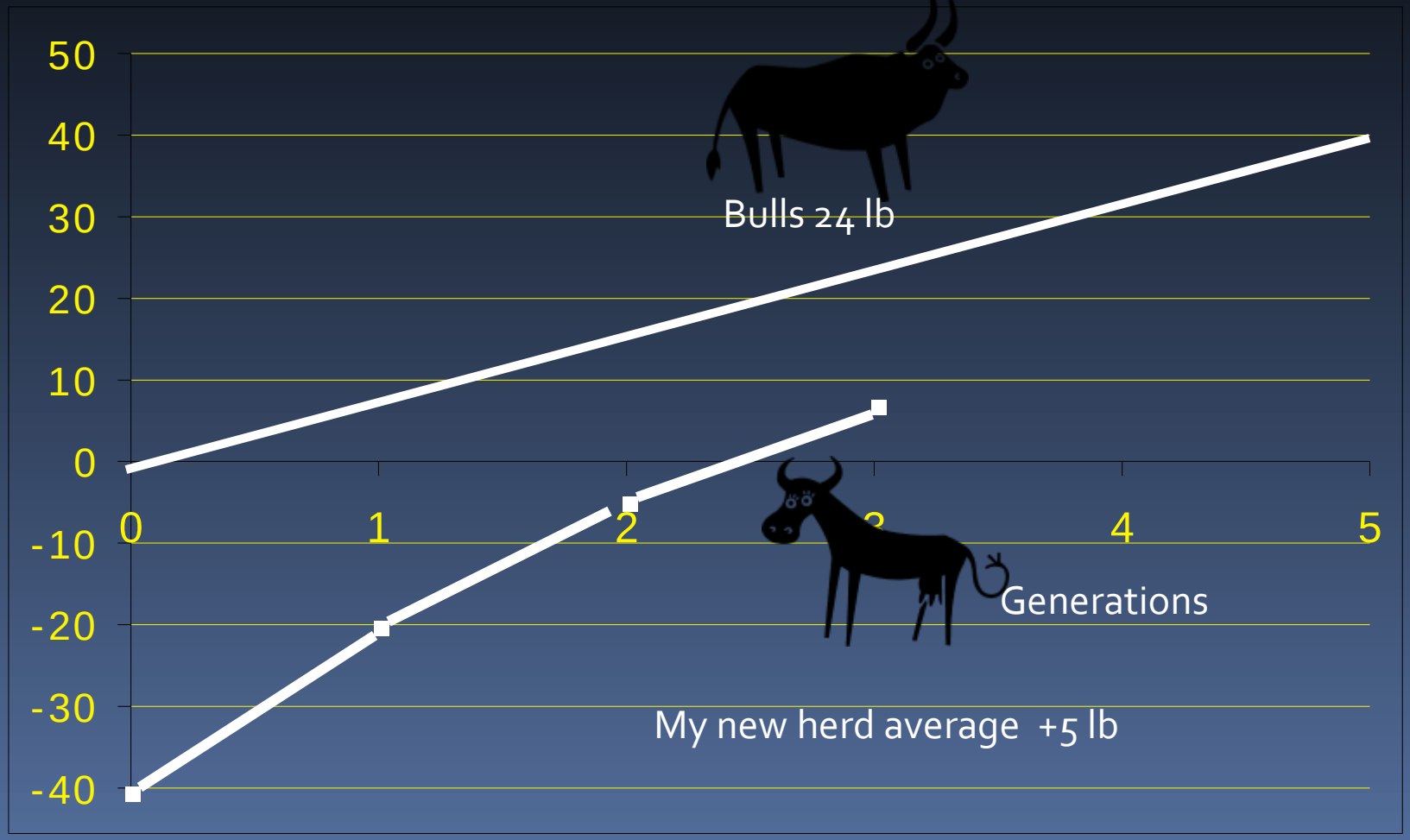

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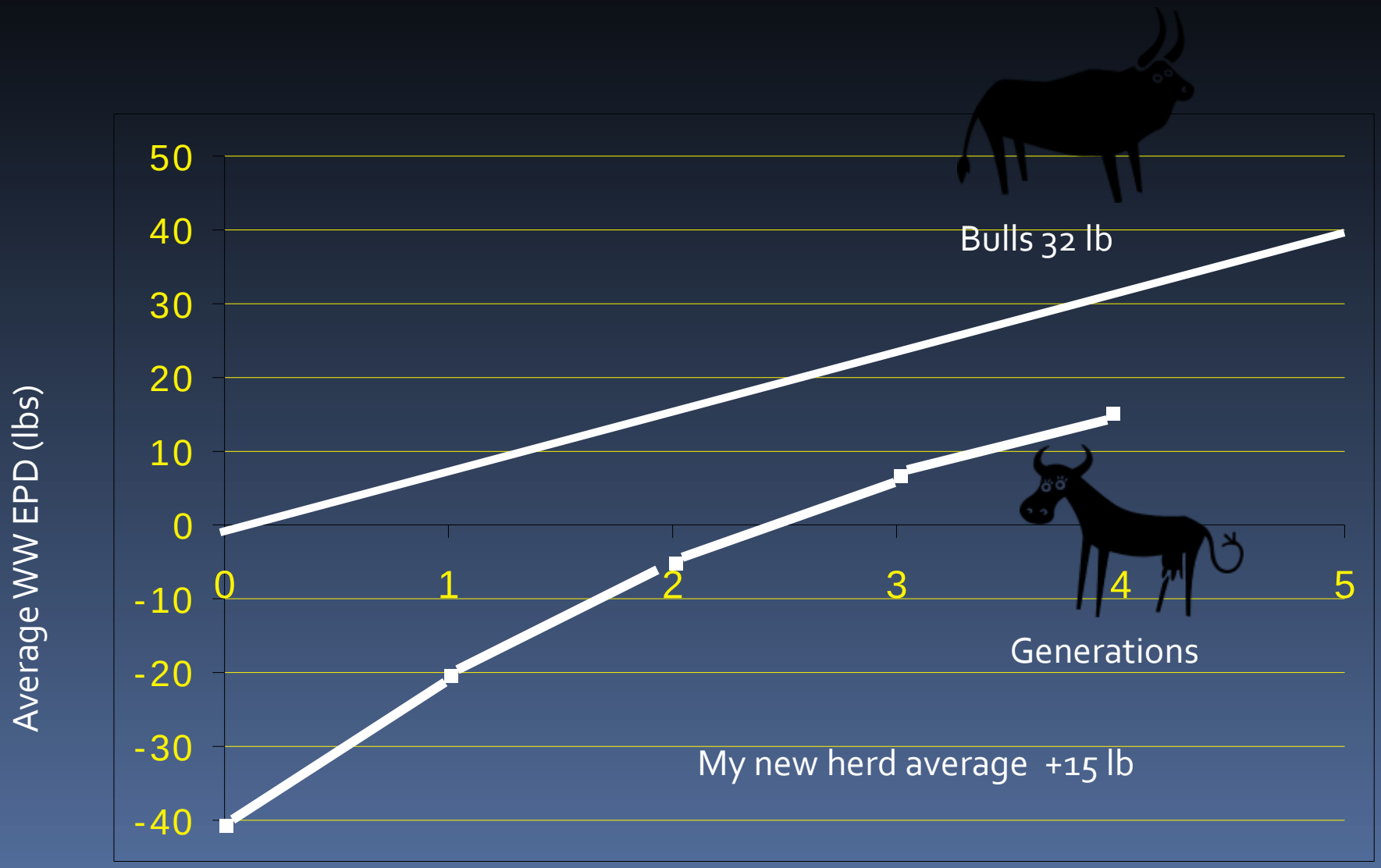

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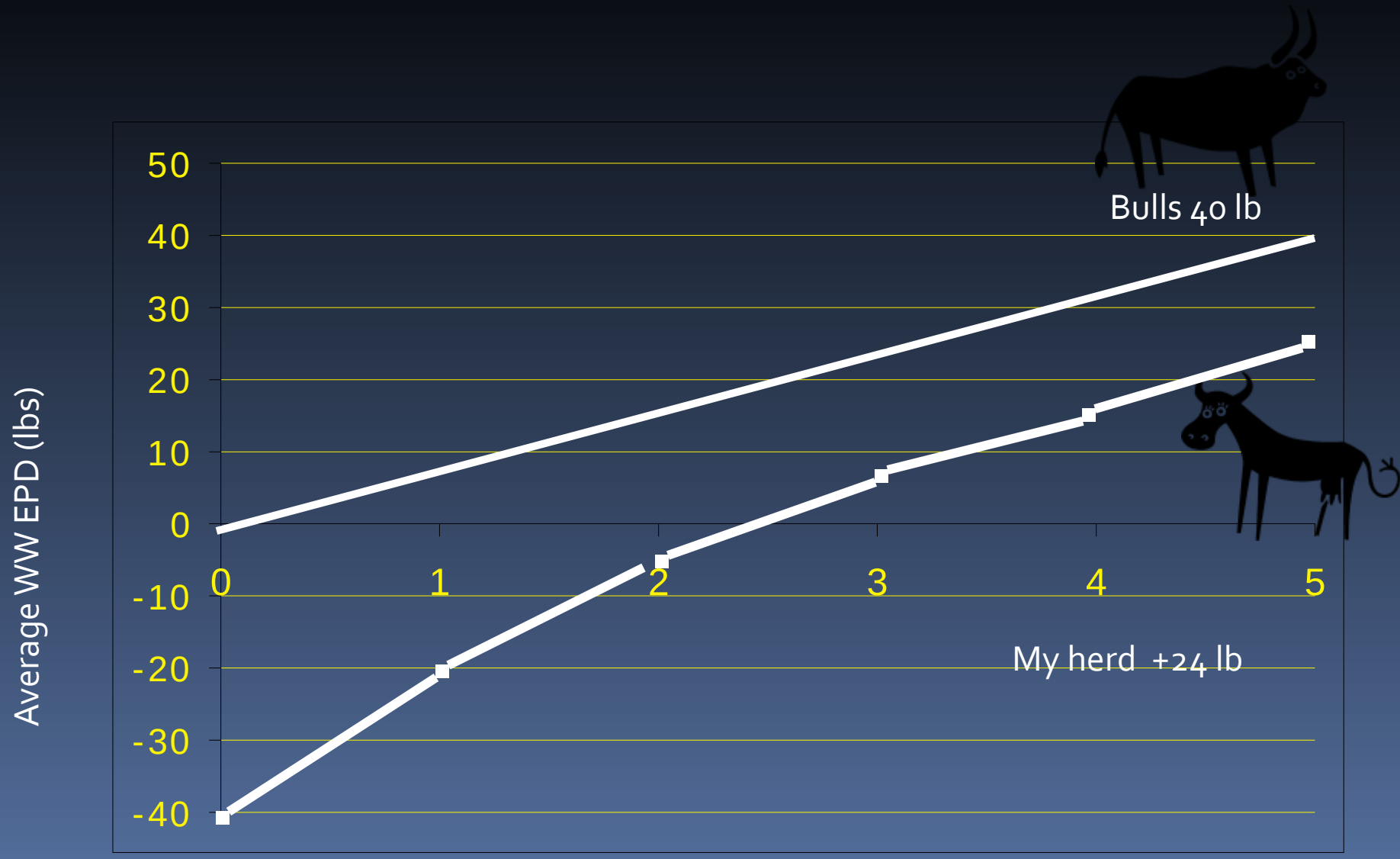

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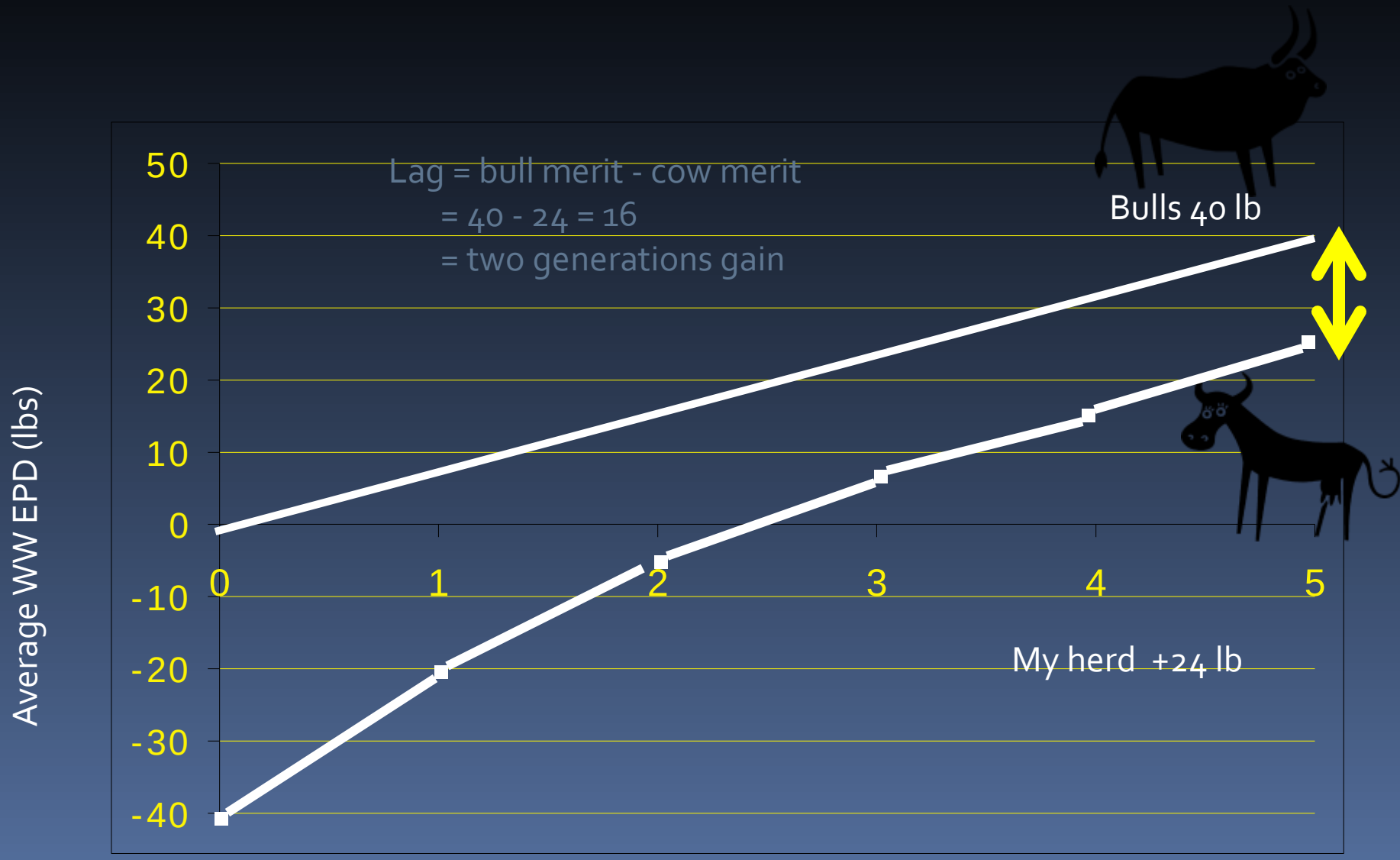

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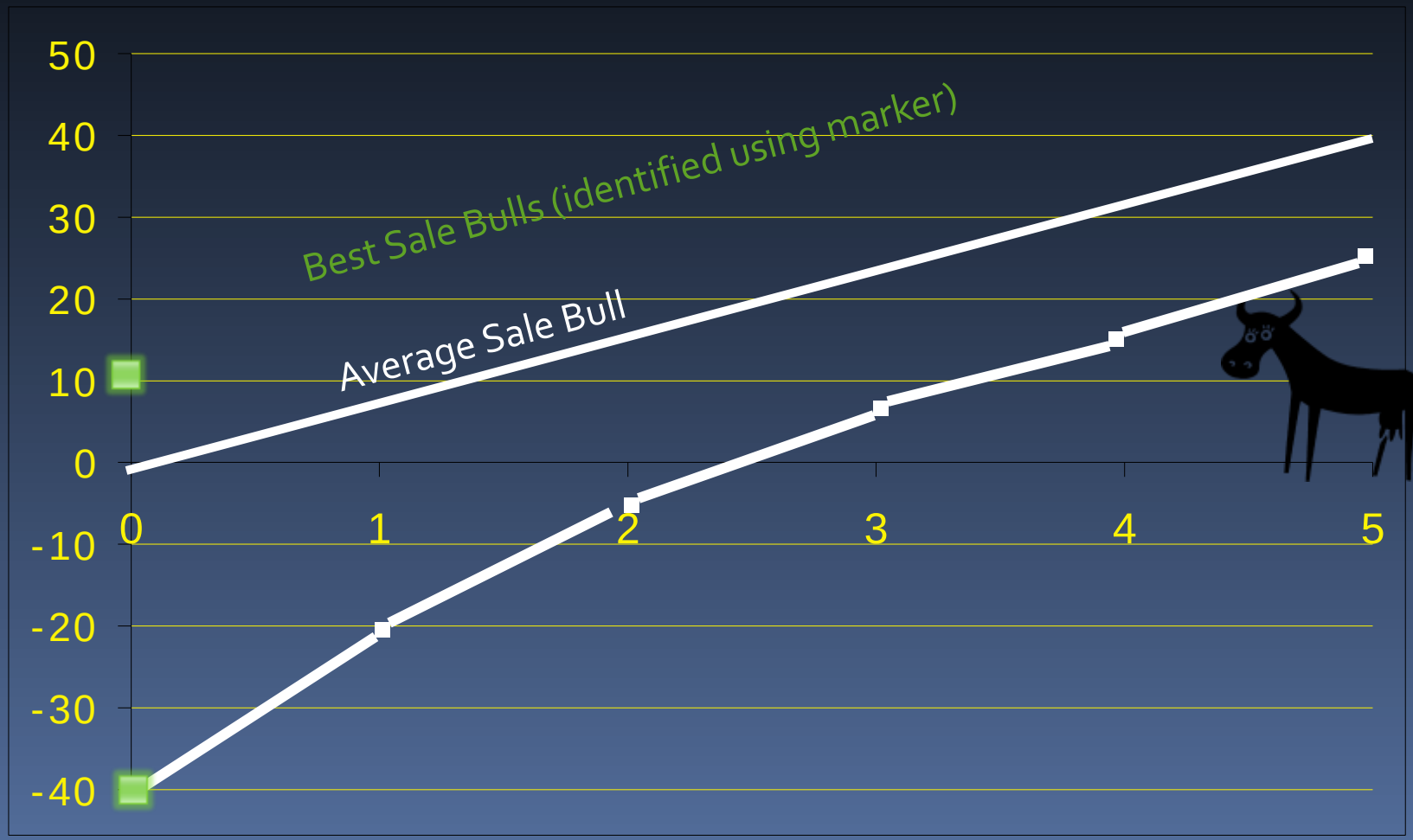

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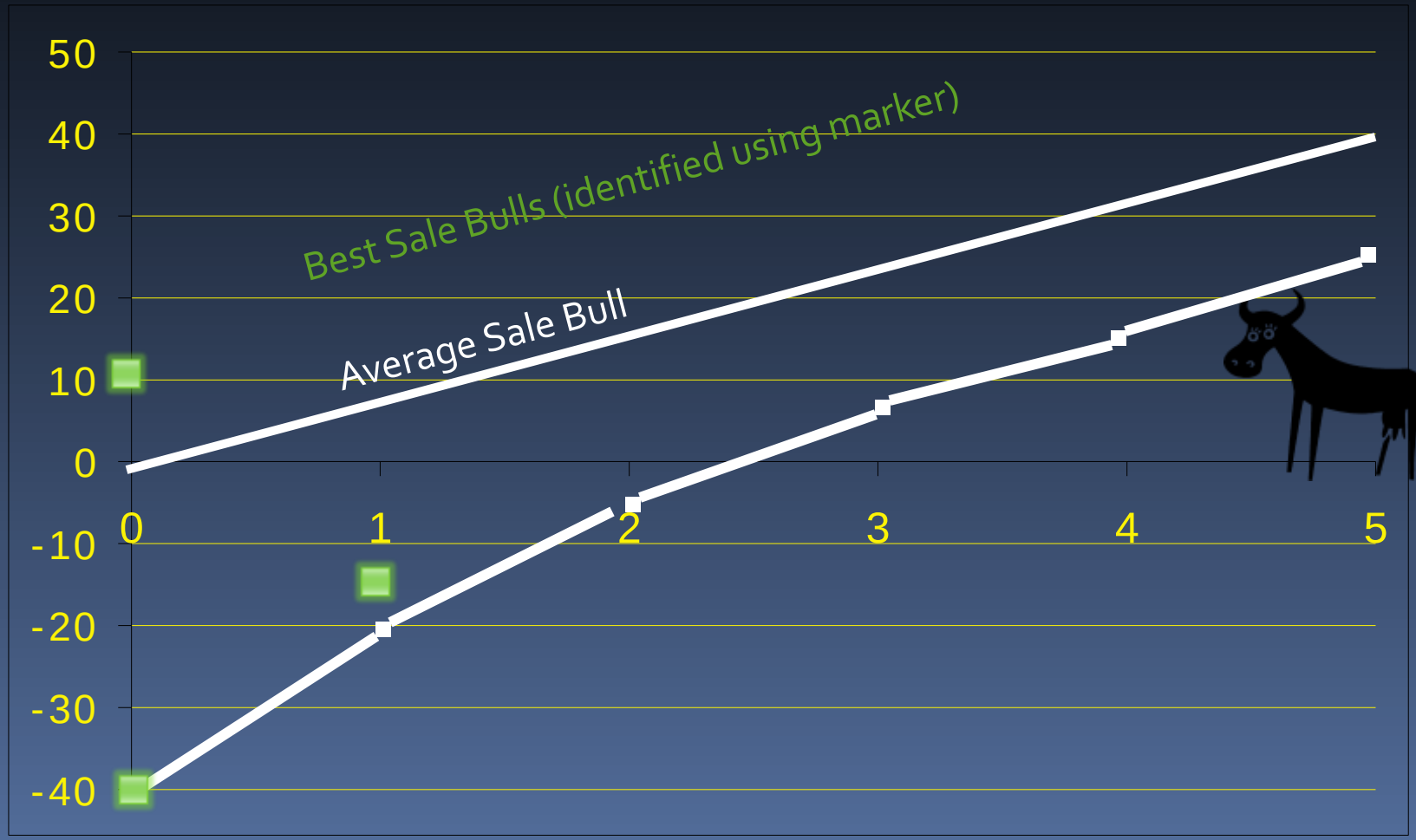

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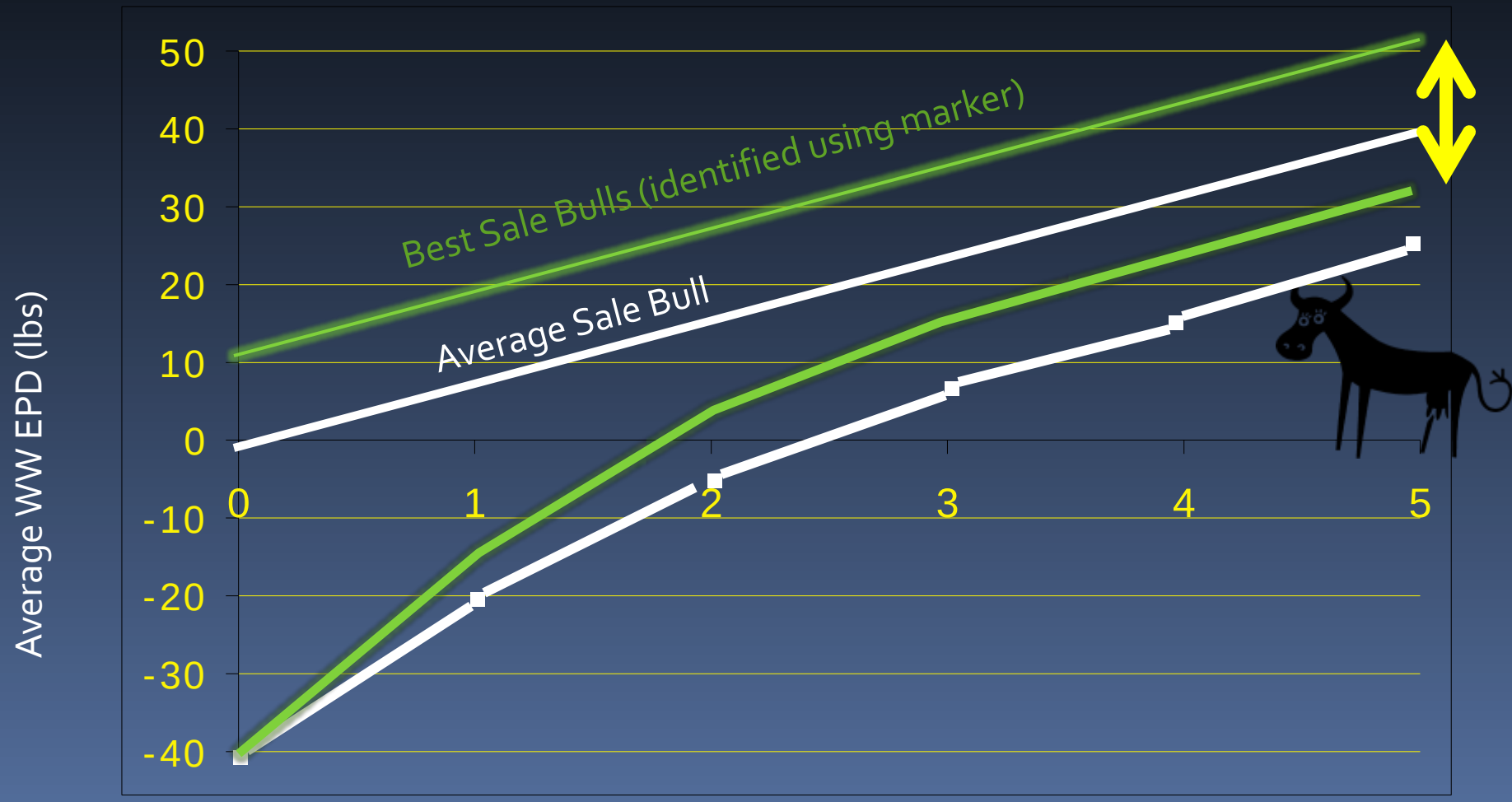

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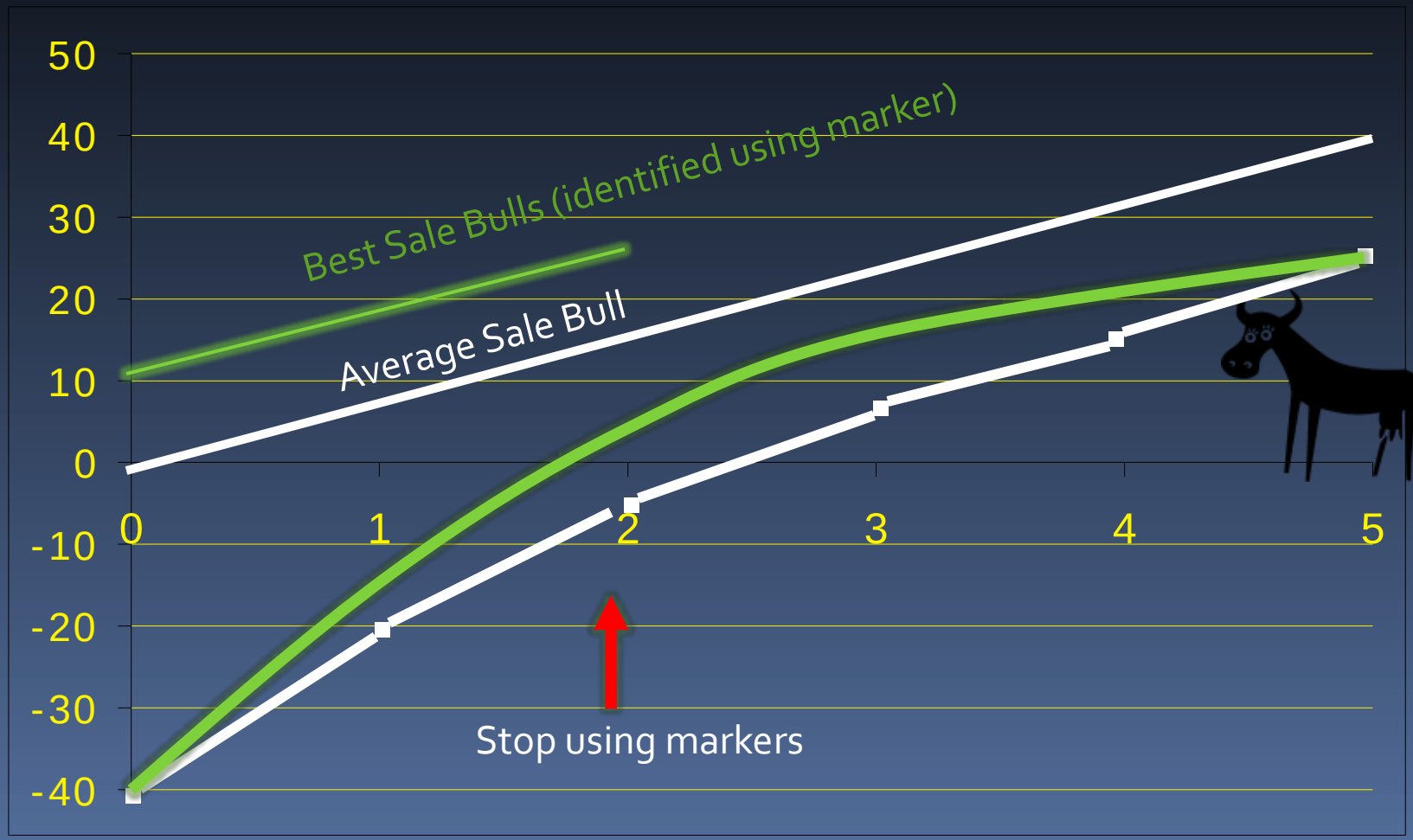
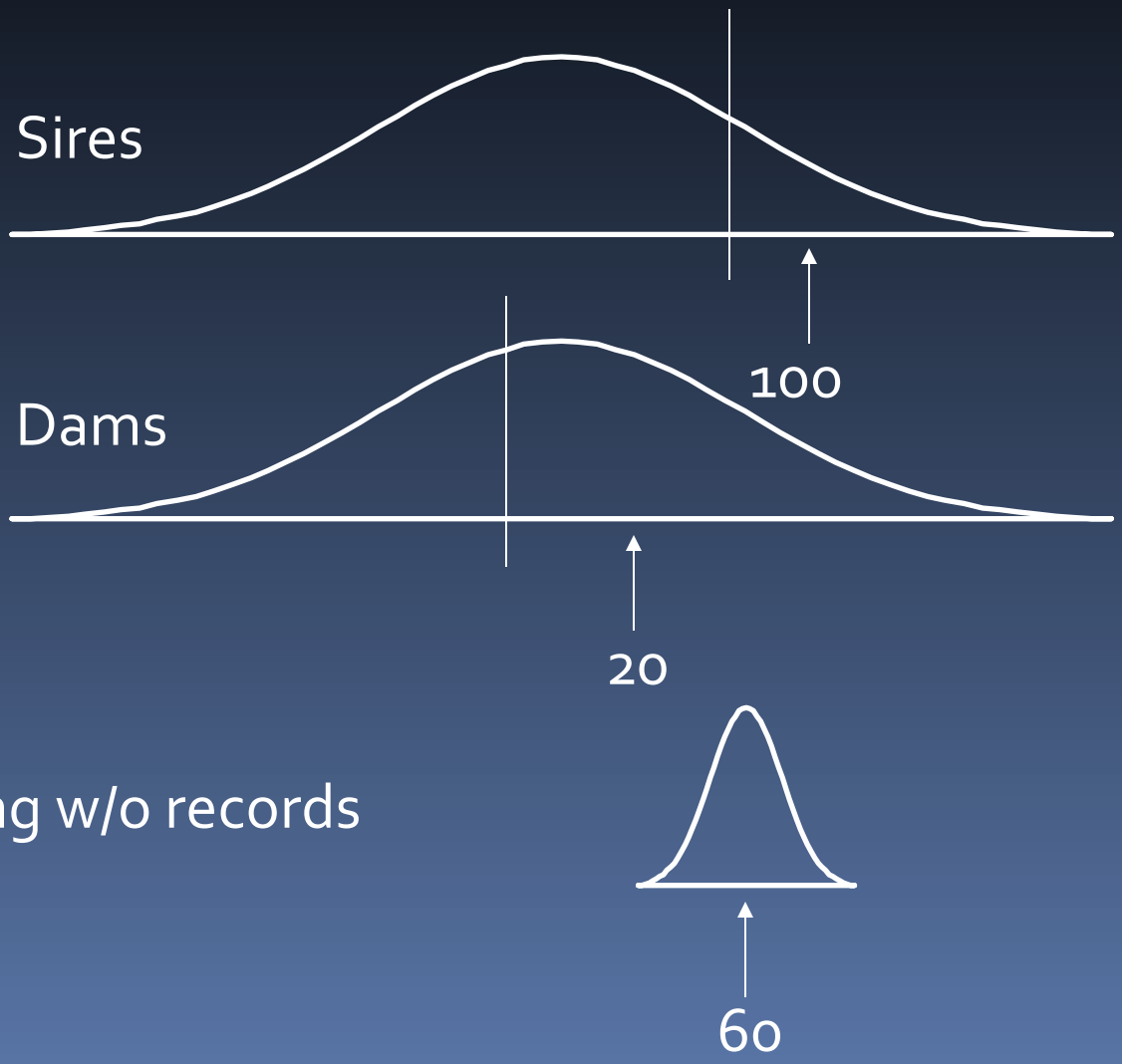


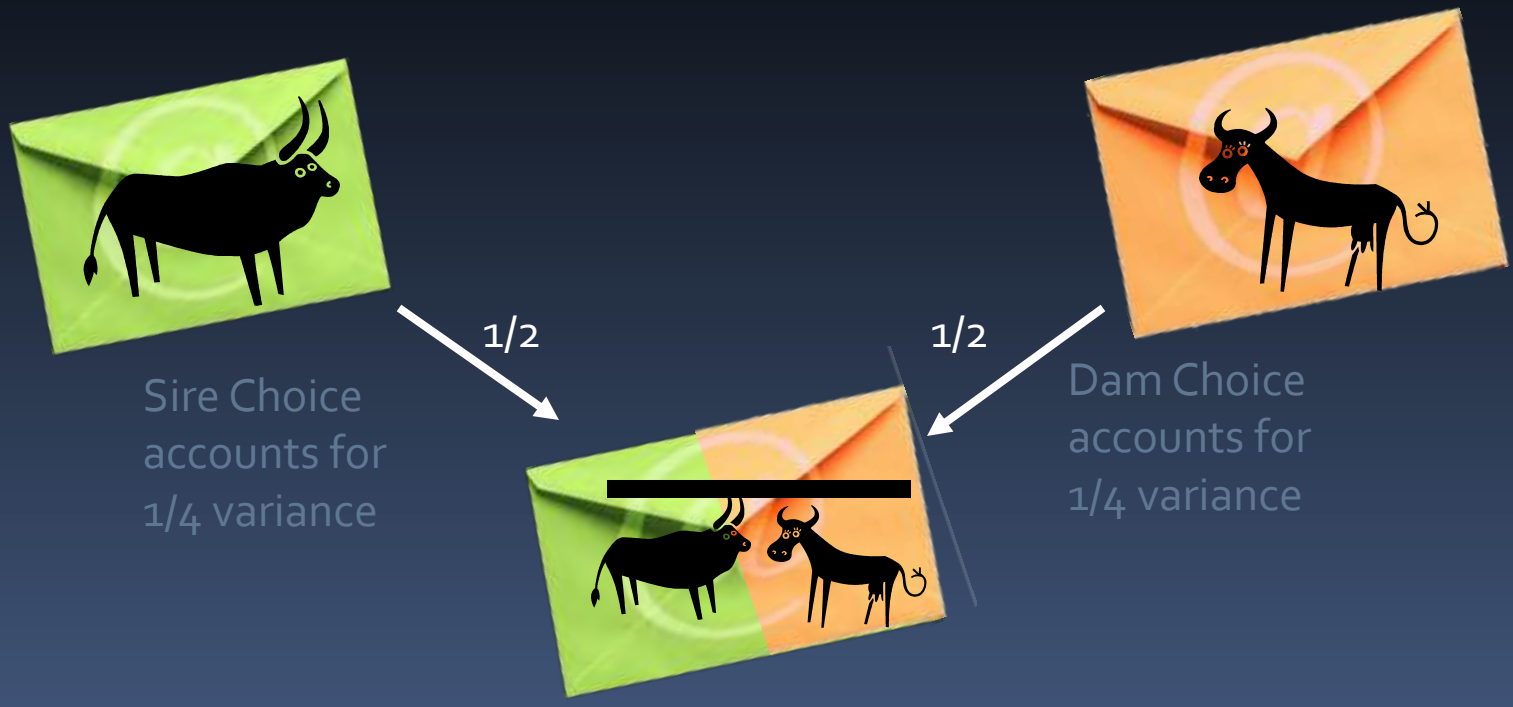
Increasing Genetic Gain

- Genetic gain comes about when above-average bulls are used as sires in bull-breeding herds

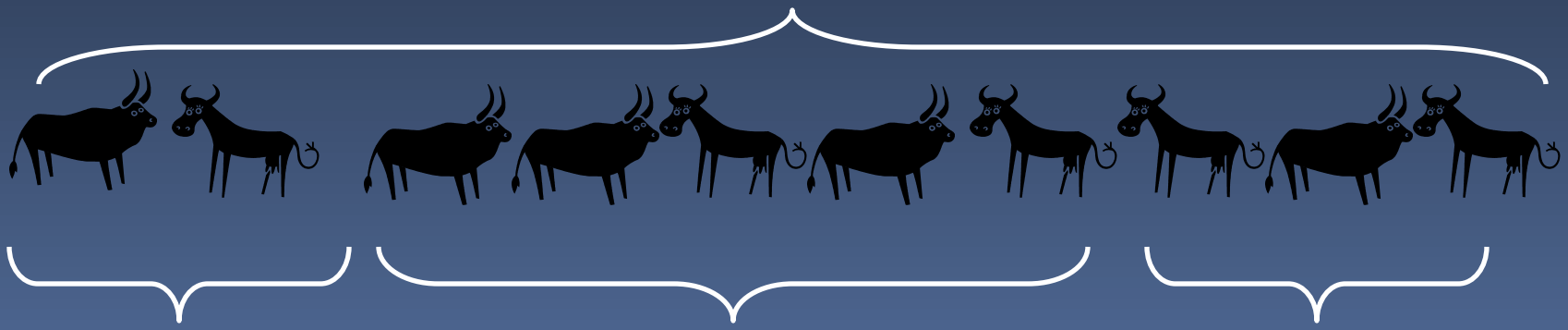
Illustration



Genetic Basis

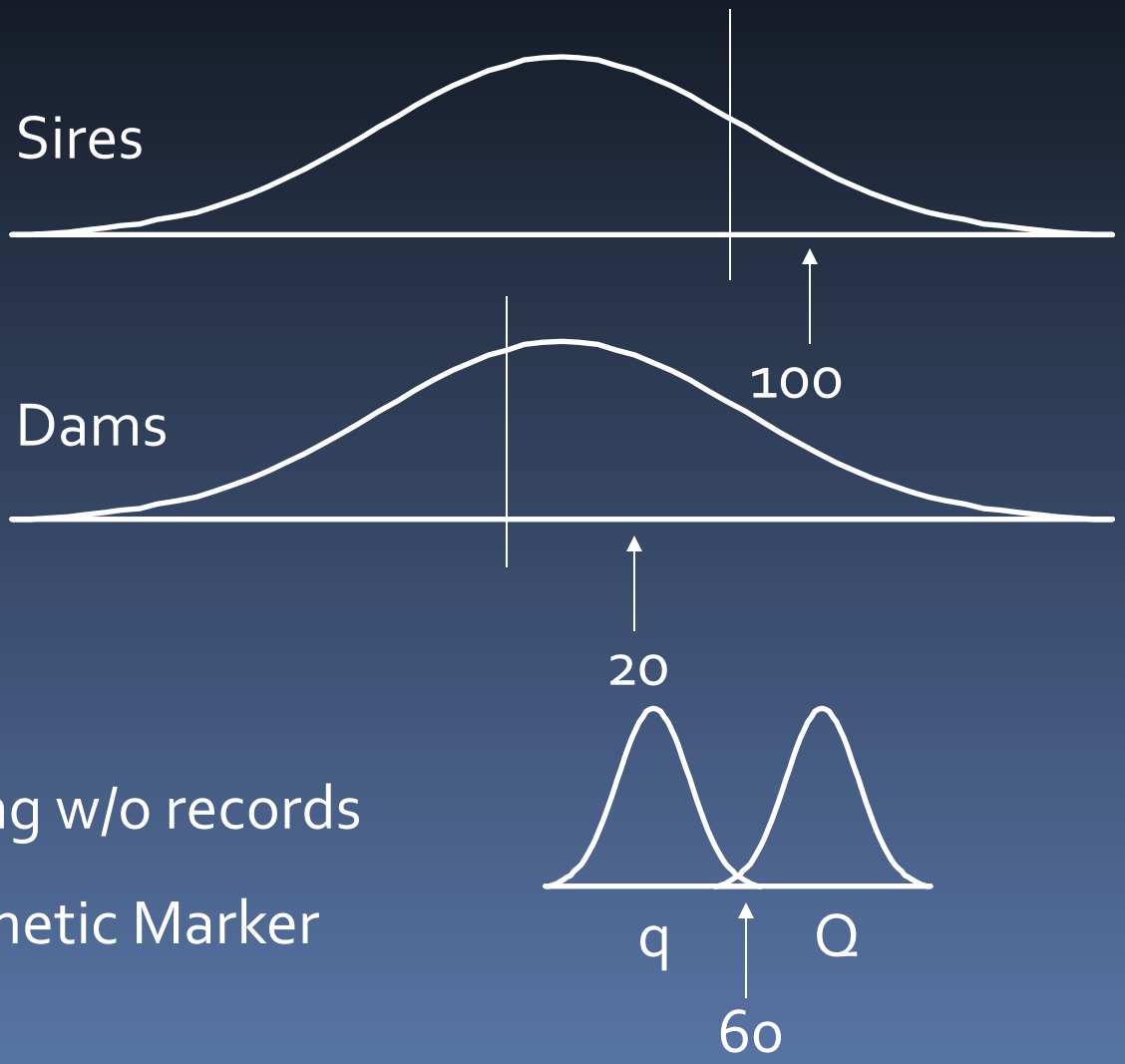


Gene Assisted Selection (GAS)



Sort by:Q Q Q q q q

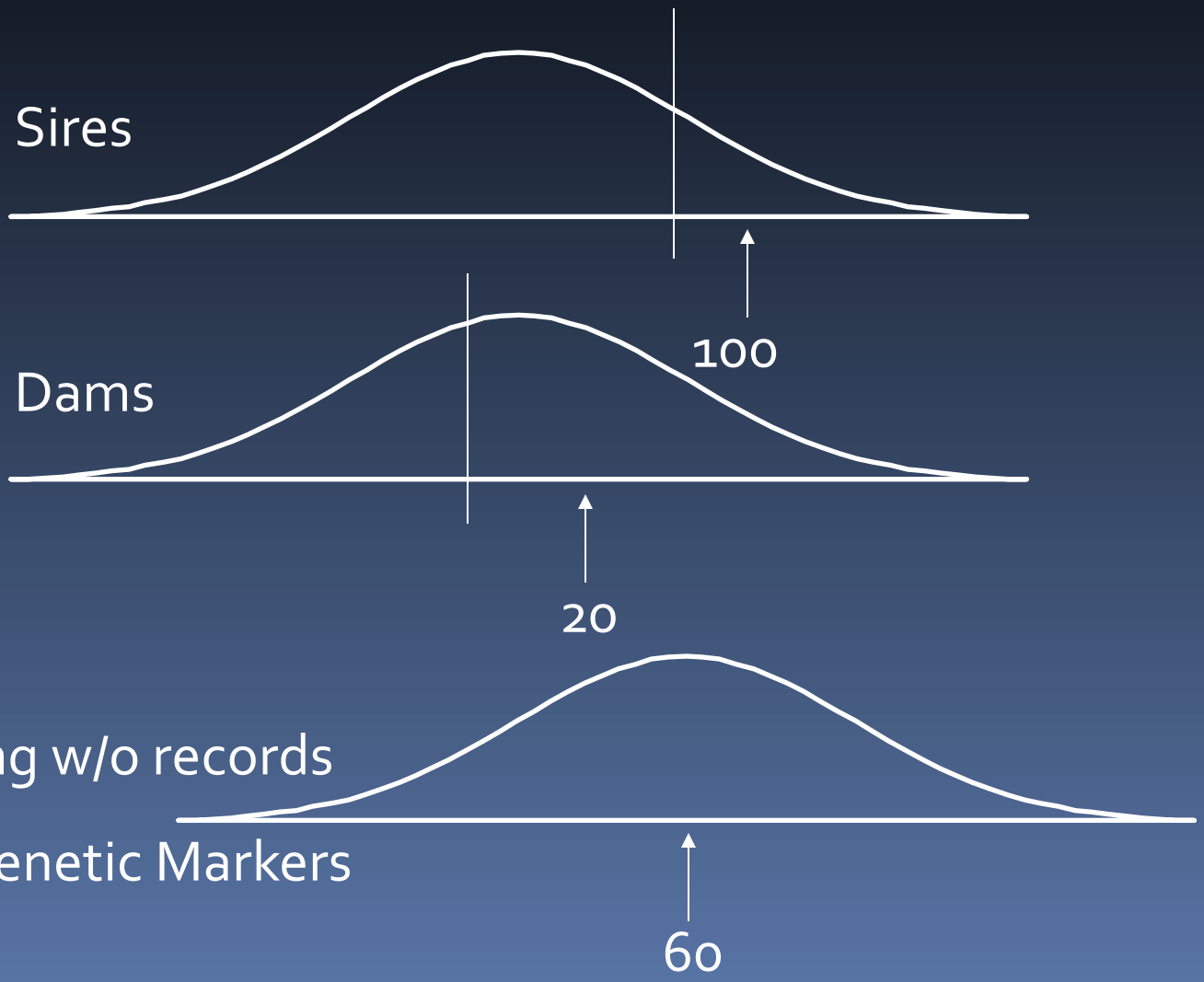
Illustration



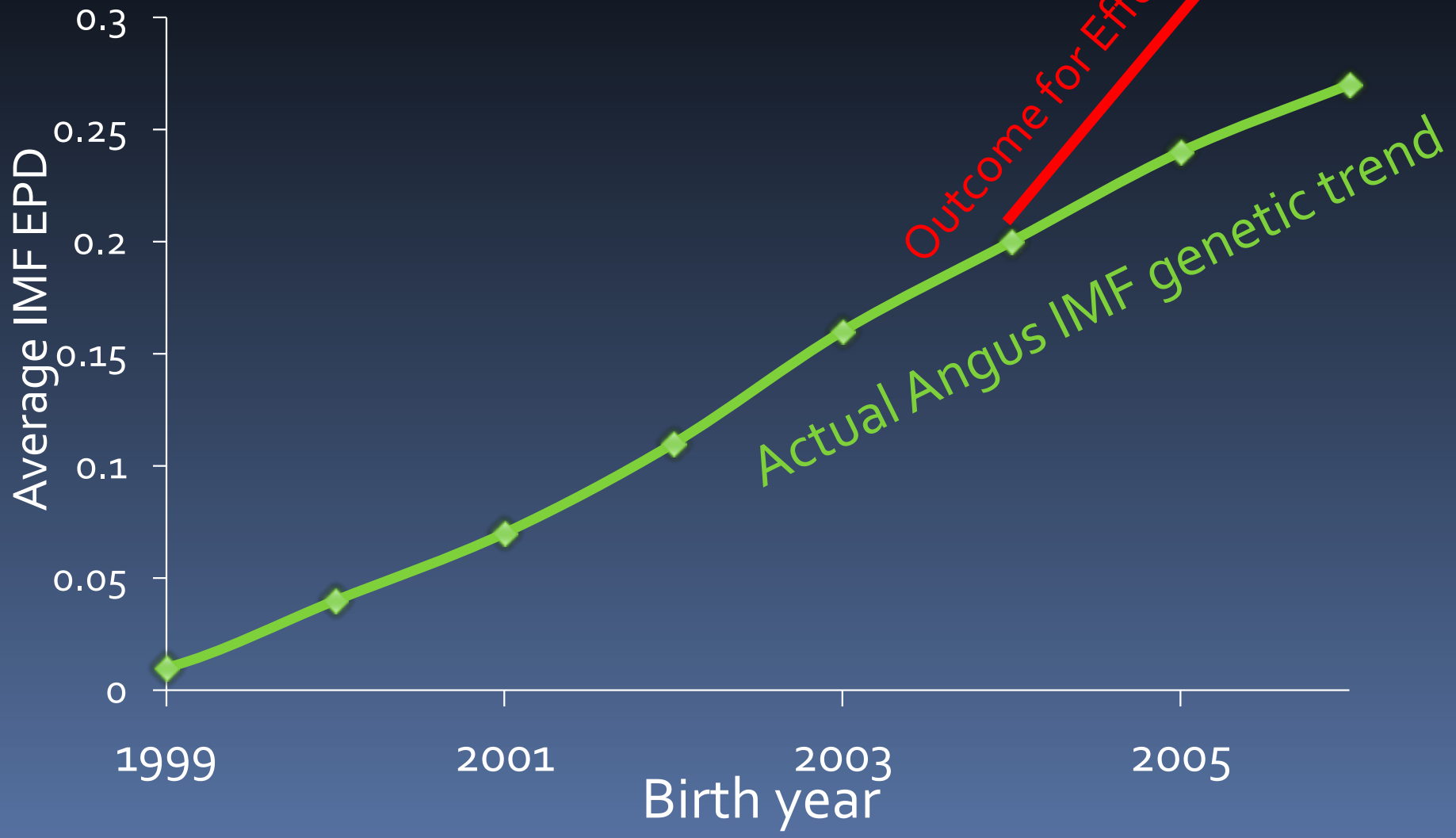
Offspring w/o records

One Genetic Marker

Illustration



Increasing Genetic Gain



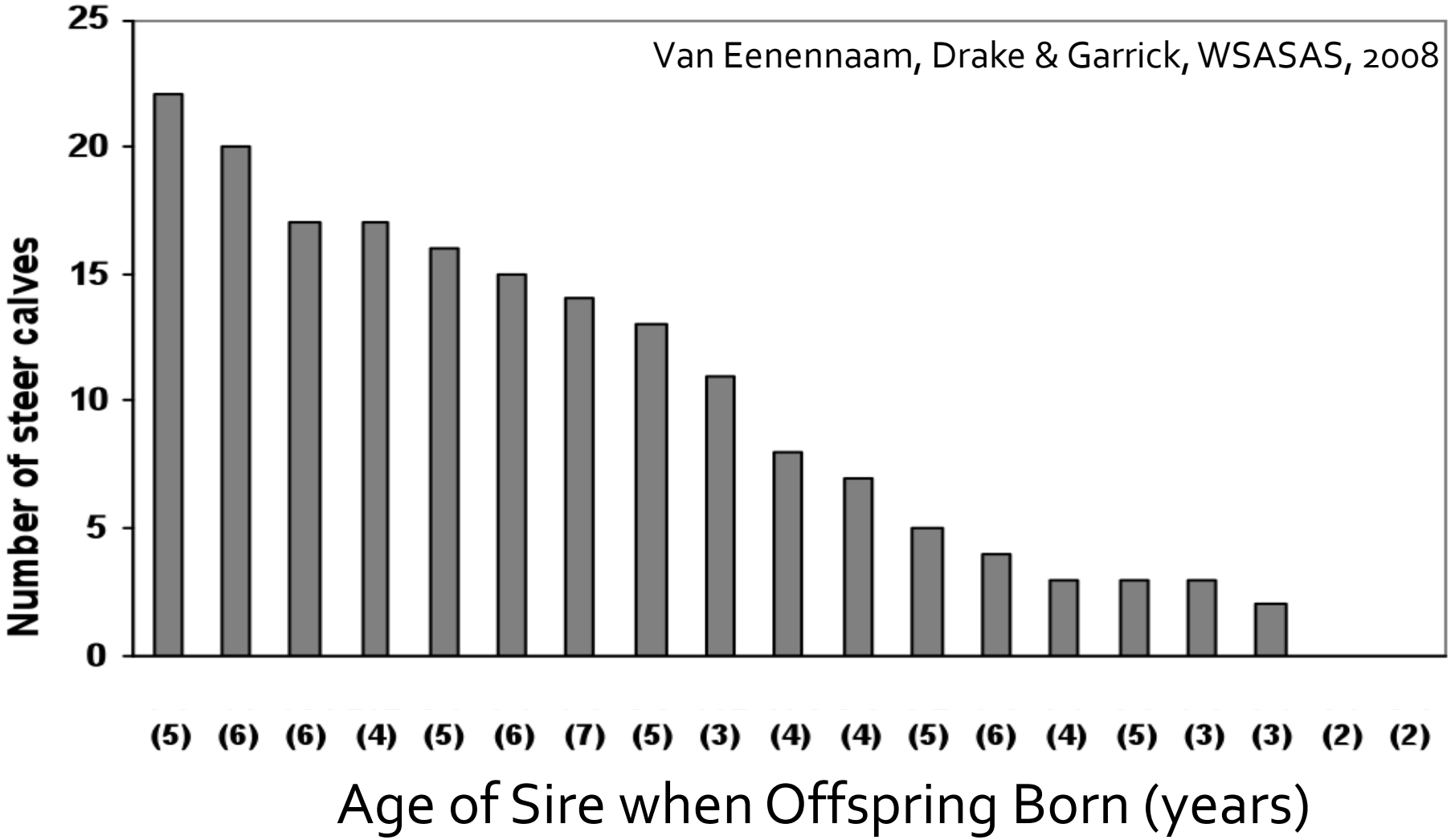
Increasing Genetic Gain

- No evidence that genetic markers have increased the rate of genetic gain in bull breeding herds of beef cattle
- In theory, genetic markers could increase gain if we had enough of them and they were reliable

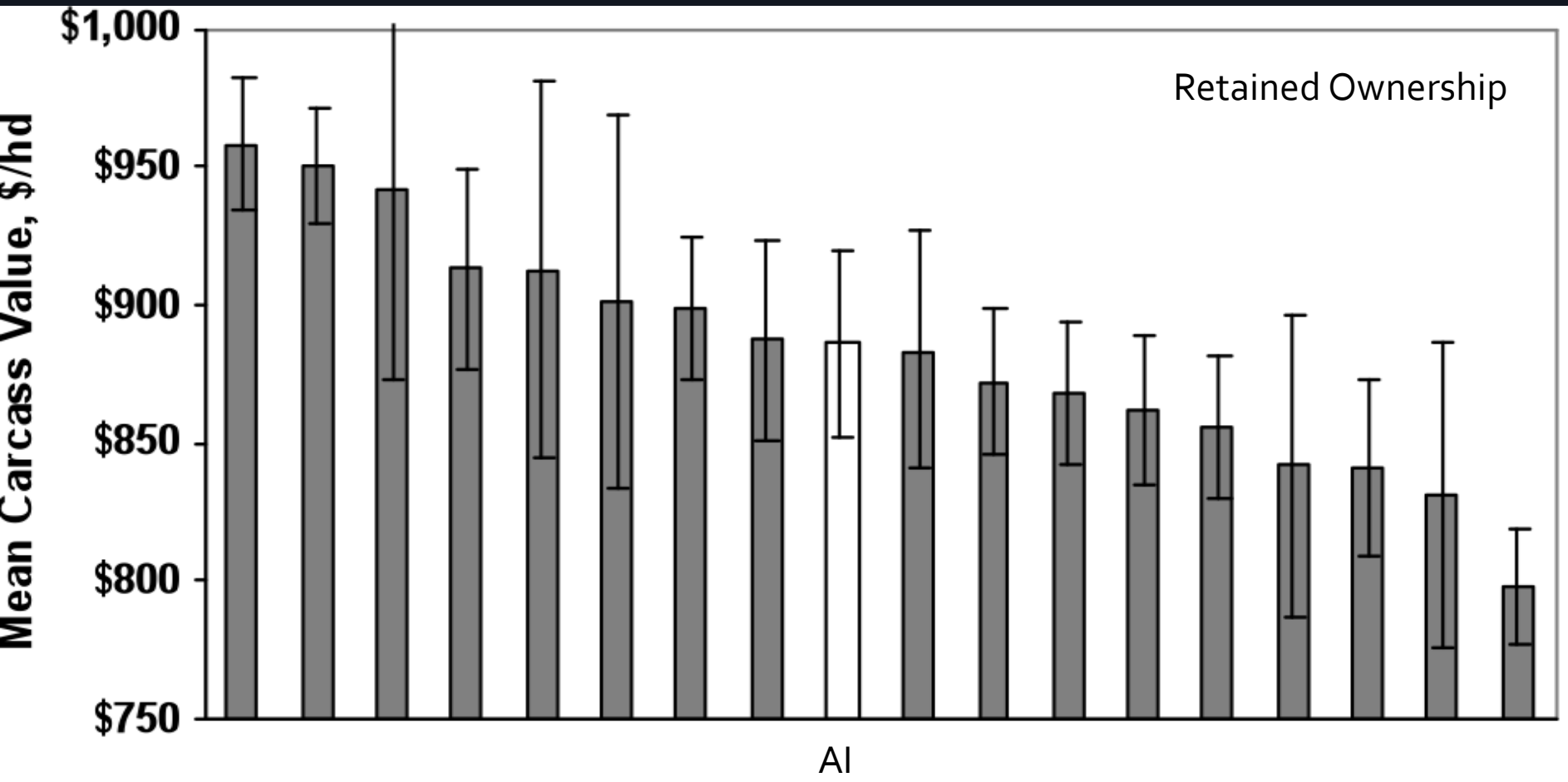
Multi-Sire Mating Groups

- Bulls can be an investment or a liability
  - Distinguishing the bulls that add value from those that simply drain resources requires
    - Quantifying the number (& timing) of breeding success among bulls competing for the same cows
    - Accumulating the value of each bulls offspring
    - Perhaps using these records to progeny test the bulls and obtain EPDs

Steer Calves per Bull



Average Carcass Value per Bull



Total Steer Offspring Value

Management Sorting of Cattle

- Feedlots are more efficient if cattle in each pen can be harvested together
  - Partly harvesting pens reduces performance
  - Partly filled pens lose yardage revenue
  - Mixing pens reduces performance
- Markers could be used to sort cattle into likely harvesting date, based on knowledge of weight gain, marbling or fat accumulation
- Not a new idea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What markers are available ?

- Principally three companies
  - Merial-owned Igenity
  - Pfizer-owned Bovigen
  - MetaMorphix

Merial

- Parentage (Any markers) & Genetic Evaluation
- BVD-PI (Actual viral sequence)
- Horned-Polled (Association)
- Coat Color (Actual gene)
- Docility
- Maternal Traits
  (Heifer Pregnancy, Stayability, Calving Ease)
- Carcass Composition
  (Tenderness, Marbling, QG, YG, c/c wt, BF)
- Tenderness Validated
  (Several Calpain and Calpastatin markers)

Bovigen

- SureTRAK (Any markers)
- SireTRACE (Any markers)
- BLACK (actual gene)
- FEED EFFICIENCY (4 markers)
- GeneStar TENDERNESS (3 markers) Validated
- GeneStar QUALITY GRADE (4 markers) Validated
- Elite Tender (beef product guarantee)

MetaMorphix

- Parentage and Identification (Any markers)
- Tru-Coat Color (Actual gene)
- Tru-Polled (Association)
- Tru-Marbling (128 markers)
- Tru-Tenderness (11 markers)

Will they work in my breed/herd ?

- It depends !
- Tenderness (based on calpain and calpastatin) has been validated but the association is different in *Bos indicus* vs *Bos taurus* breeds
- Quality Grade test from Bovigen has been validated
- New tests such as feed efficiency are difficult to validate – require an independent data set
- New tests are tending to use larger panels of markers

Should I use them in my herd?

- Value proposition is different depending upon whether you are using them for marketing, to reduce lag, increase gain or for management
- Be wary if you will not be able to produce data in your circumstances to confirm their value and the tests have not been independently validated
- Read the information on the company websites and at University of California, Davis, and National Beef Cattle Evaluation Consortium websites (see written paper for url addresses)
- Ask the company for validation results

Markers of the future

- In January 2008 Illumina released a panel that can undertake 50,000 tests spread throughout the genome for around $200
- This panel will herald a new era in genetic markers, known as genomic selection
- Studies using various datasets are currently underway, including 3,500 Cycle VII animals from US MARC and 2,000 AI bulls from 8 breeds
  - Much more information will be available in the next 12 months

Summary

- Genetic markers offer a number of opportunities in beef cattle production and improvement
  - Real opportunities for characterizing and improving bull management in multi-sire pastures
- Several companies are competing in the marketplace with new services
  - Simple tests are being replaced with panels
- New genotyping approaches will likely revolutionize the nature and scope for the use of genetic markers over the next year or two