The implementation of modern genetic improvement methods in wildlife

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Selection is the most powerful tool in any breeders armour

A breed is not a static entity but a process

(Dobzhansky 1959)

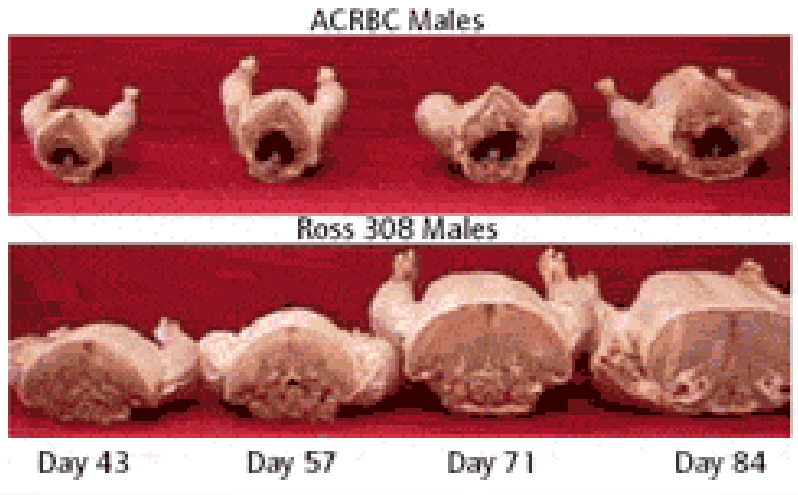
Genetic Variation - Dogs

vs

Genetic Variation - Horses

Thumbeline (42cm) vs Clydesdale (2.7m)

Figure 2 - Broiler carcasses from Ross 308 in 2001 compared to unselected controls representing performance in 1957 (Source: G.B. Havenstein 2006, Lohmann Information)

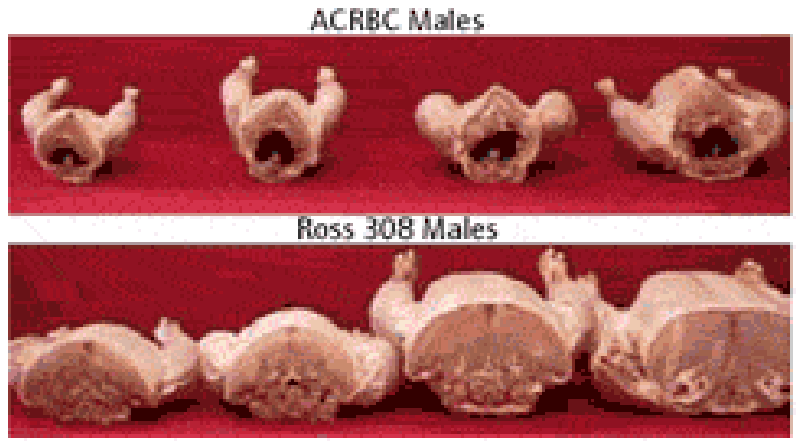


Unselected

Selected

- Average body weight of commercial broiler at 56 days of age:
  - 809 g in 1957
  - 3 946 g in 2001

Figure 2 - Broiler carcasses from Ross 308 in 2001 compared to unselected controls representing performance in 1957 (Source: G.B. Havenstein 2006, Lohmann Information)



Unselected

Selected

- Utilizing feeds typical for both years, it can be shown that 85-90% of this 4.87-fold improvement was due to genetics while the remaining 10-15% was due to nutrition.

What is needed for effective selection?

Accurate:

- definition of breeding goals
- identification of superior animals that will be parents in the next generation

Model

$$P = G + E$$

Model

$$P = G + E$$

Phenotype = Genotype + Environment

Model

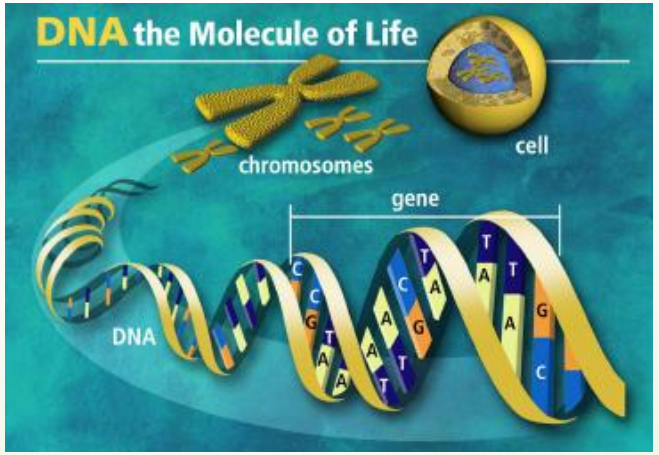
$$P = G + E$$

Phenotype

Genotype

Environment

=



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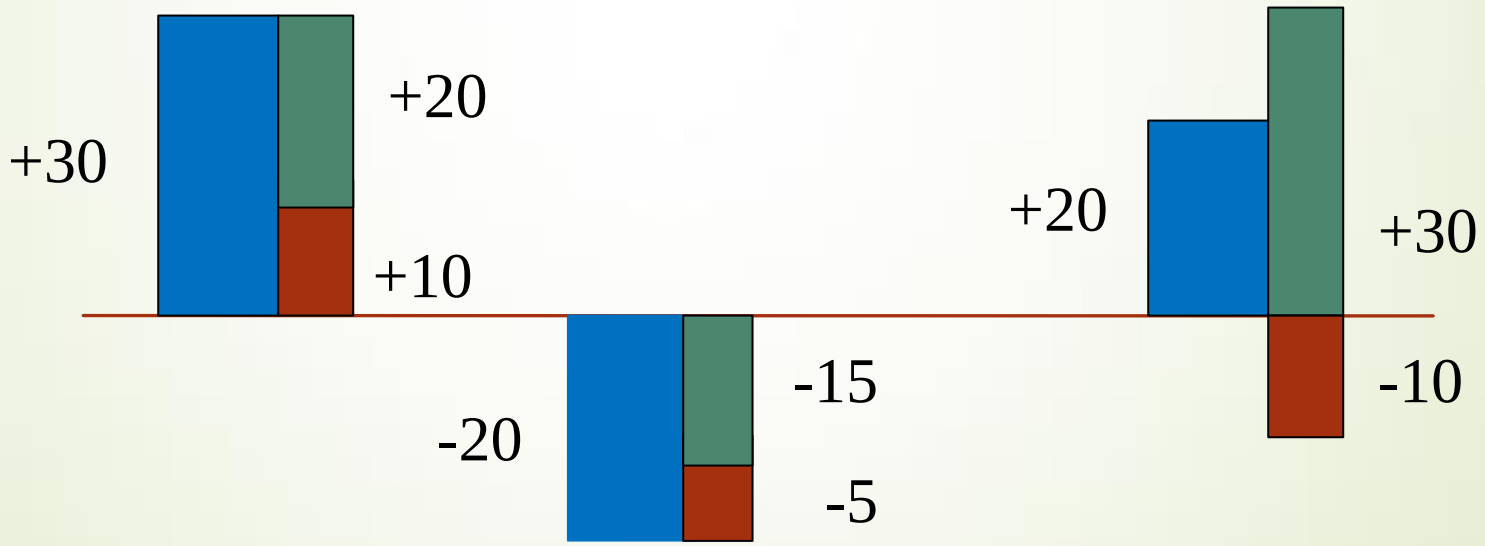
Genetic and Environmental contributions to weaning weights

$$P = G + E$$



What is BLUP?

- *Best Linear Unbiased Prediction* of **breeding values**
- Statistical model
- Uses all information from all animals

What is a breeding value?

- Genotypic values transmitted from parents to offspring
- Sum of the independent gene effects
- Value of an animal as a parent

Breeding value (BV): Example

Assumption: Contribution of gene B ⇒ +10g

gene b ⇒ -10g

Then **BV** for:

BB = 10+10 = 20g

Bb = 10+(-10) = 0g

bb = -10+(-10)= -20g

- **BV** of offspring = 1/2 **BV** of Sire + 1/2 **BV** of Dam

How does it work?

- Solving mixed model equations
- *Mixed* – models contain both environmental and genetic effects
- *Animal model* – Combination of own and all relatives' performances

Attributes of BLUP

- Accounts for genetic level of contemporary groups or "competition"
- Accounts for genetic trend
- Uses all data on all relatives
- Can be multiple-trait
  - Utilises correlations between traits
- Accounts for non-random mating
- Accounts for culling for poor performance

Applications of BLUP

- Genetic relationships between herds – comparable
- Whole breed analysis
- True genetic progress in breed or herd
- Environmental trends – Management decisions
- Inbreeding monitoring

What is needed for BLUP

- Full pedigree records
- Complete performance records
- All non-genetic factors that play a role in the animals' performance:
  - Herd
  - Birth year
  - Sex
  - Age of dam
- **Whole herd recording**

Pitfalls in Large-Scale Genetic Evaluation

Faulty data:

- Pedigrees
- Performance records
- Data used in adjustment / Inaccurate adjustment of data
- Contemporary groups
- Lack of connectedness
- Genotype by environment interaction
- Selective recording

Danger of single trait selection

(horns and head shape)

Trait categories

- Functional / fitness
- Production / growth
- Input (feed effiency)
- Product / quality
- Behavioral
- Type (current emphasis in game improvement)

Number of Buffalo and Sable animals on data base

	Buffalo	Sable
Years	22	23
Males	620	1264
Females	1138	1898
Total	1758	3162

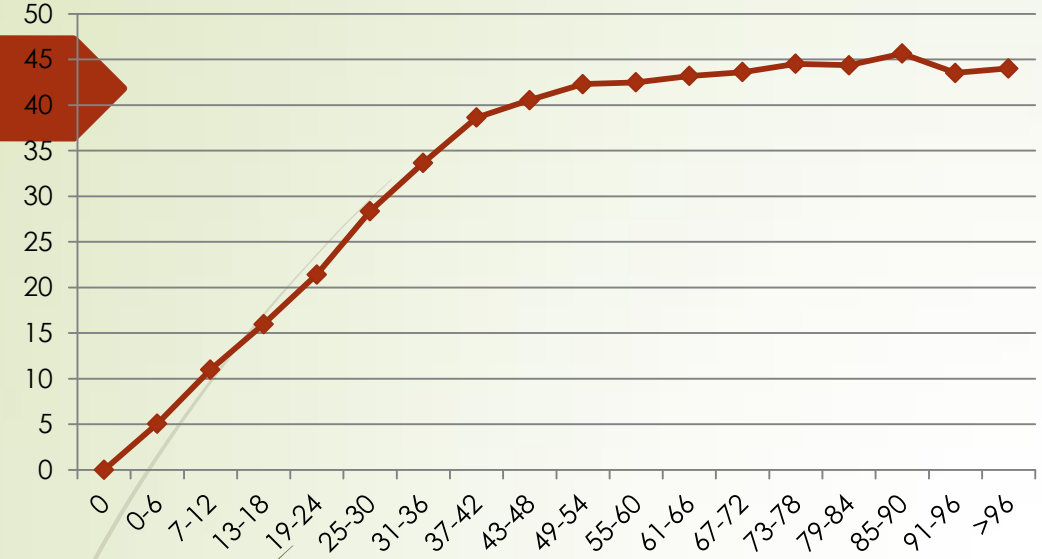
Current buffalo data on system

	n	Mean	Min	Max	STD
SCI	570	66.11	16.75	136.50	17.26
Tip to Tip	292	29.72	4.00	97.50	20.36
Width of Boss Right	665	9.96	4.25	39.38	3.57
Width of Boss Left	646	9.96	4.25	38.00	3.61
Greatest width outside	1406	27.92	2.38	625.00	21.20
Scrotal circumference	28	21.96	1.50	49.00	15.25
Horn Length Right	219	26.87	0.13	48.00	8.99
Horn Length Left	191	27.16	6.50	49.50	6.50

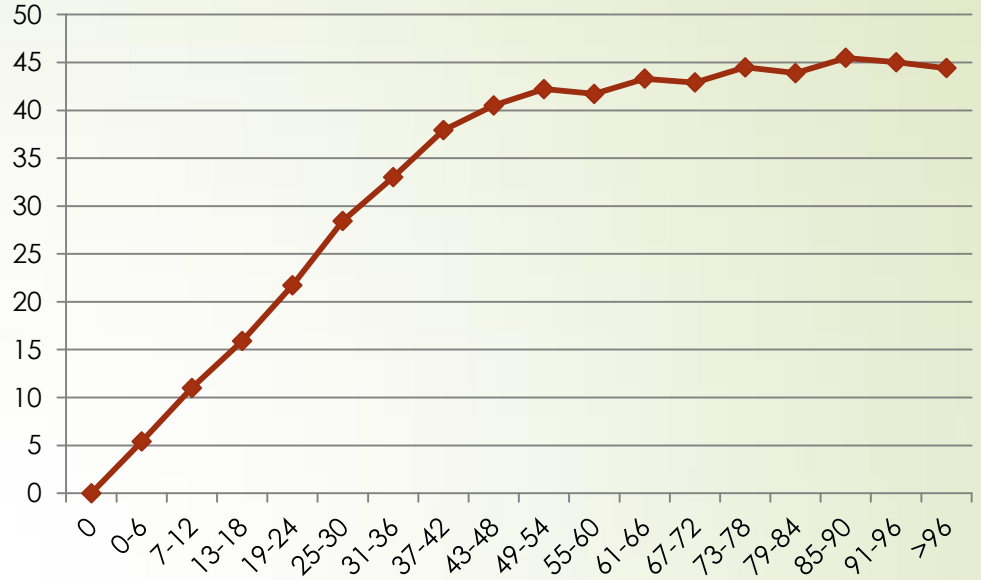
Current Sable data on system

Trait	n	Avg	Min	Max	SD
Circumference at base	1851	7.49	1.88	25	1.86
Circumference (right)	1842	7.5	1.88	40	2.05
Horn Length (Left)	2188	25.03	1.06	94	11.73
Horn Length (Right)	2194	24.97	1.06	94.5	11.7
Length of horn from first	3717	9.68	1	36	2.78
Number of Rings (Left)	1750	21.09	1	57	12.79
Number of Rings (Right)	1728	21.18	1	55	12.79
Scrotal circumference	77	20.55	5	41	5.92
Tip to Tip	1905	10.38	1	49	5.01

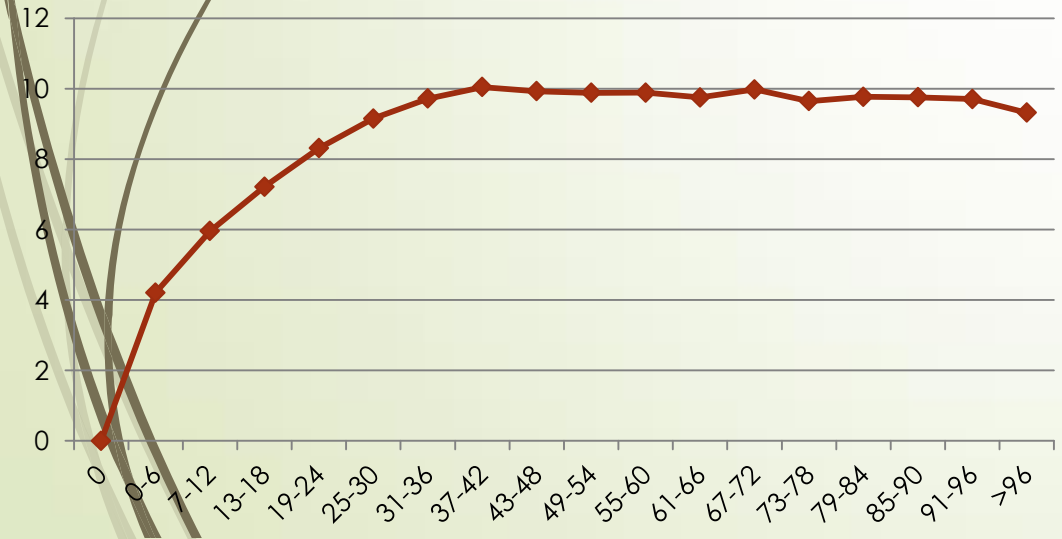
Horn Length Left (inches)



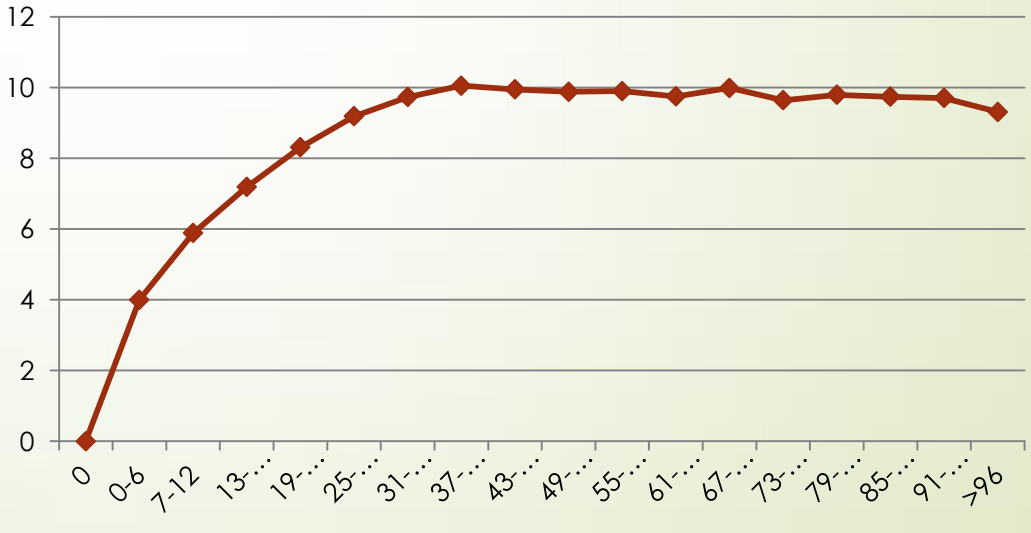
Horn Length Right (inches)



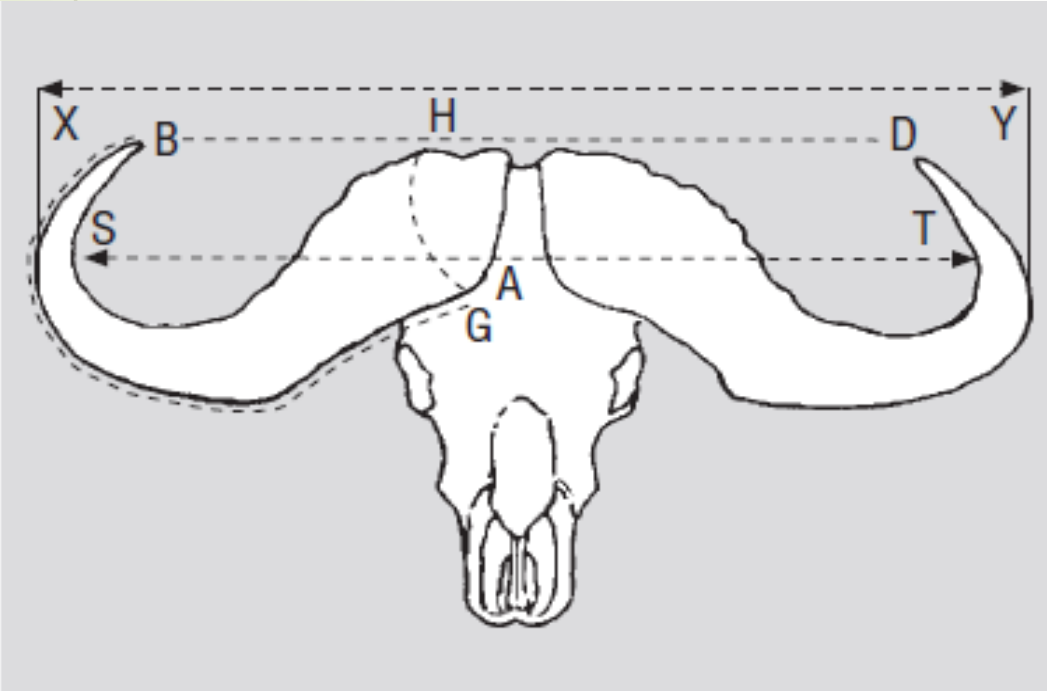
Horn Circumference Left (inches)

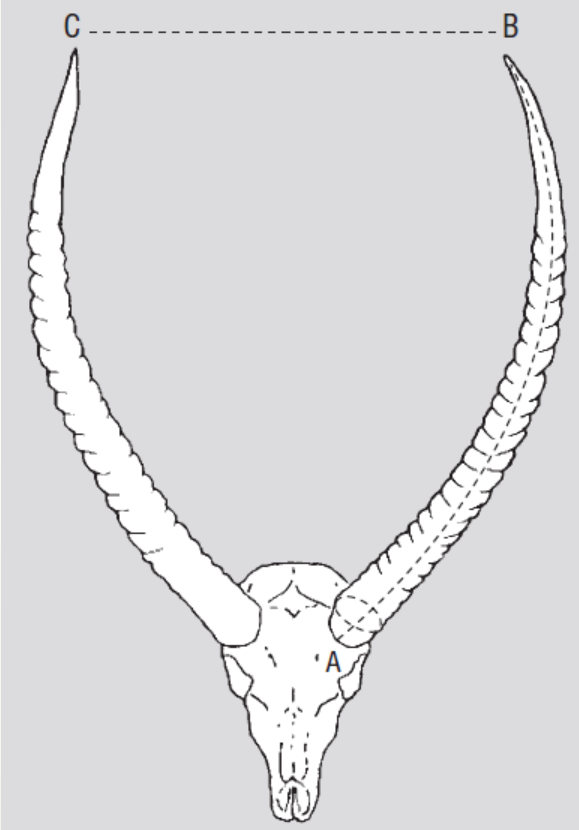


Horn Circumference Right (inches)



Standardize Recording



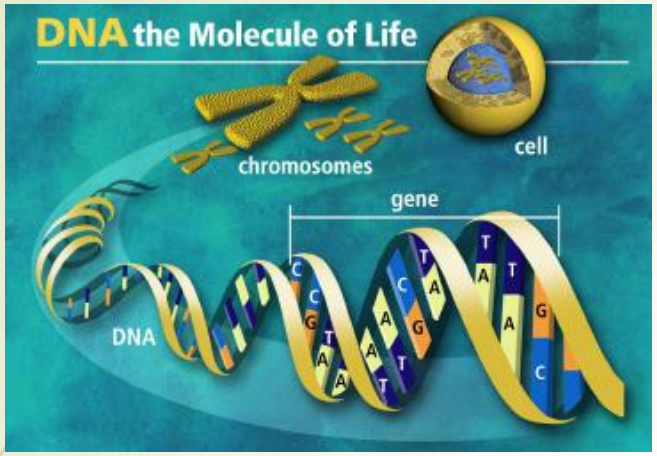


Traits

- Standardize traits
  - Age of animal, and method of measurements
- Many traits determine the value af an animal
- Too many traits in selection program – slow progress
- Choice of traits NB
- Use an economic index:
  - $I_T = -1.60BW_D-1.95BW_M+2.23WW_D+1.75WW_M-0.54FW-2.01MCW$ $-\mathbf{13.21DC}+4.97BF -2.36T+12.66M$

Take home message

- MEASURE - **Phenotypes** (Traits) with **Pedigrees** of all animals
- DATA - **BLUP for BV's**
- GOALS – Set up a balanced **selection index**
- SELECT – Superior animals to be **parents of next generation** based on BV's
- BREED - Use these animals in a **mating system** to **achieve the goals**



Model

$$P = G + E$$

Genotype

Environment

Phenotype

Thank You