

Breeding Programs to exploit Genomic Selection in Ireland

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What is genomic selection

- "The most promising application of molecular genetics in livestock populations"
- Involves the use of genetic markers across the genome that ideally lie close to genes
- Ideal situation → all genes are covered by the markers

Genomic Selection - the process

Training dataset:

1000s animals with known genotypes (SNPs) and reliable phenotypes (EBVs)

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Obtain effects for SNPs for each trait

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Accurate GEBVs for young selection candidates

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Obtain effects for SNPs for each trait



Accurate GEBVs for young selection candidates



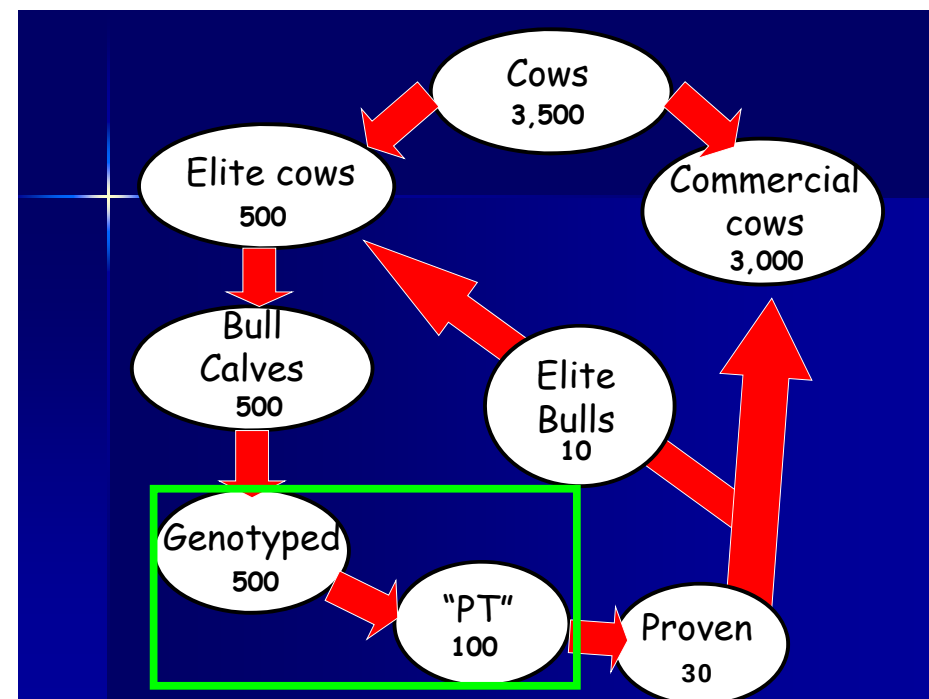
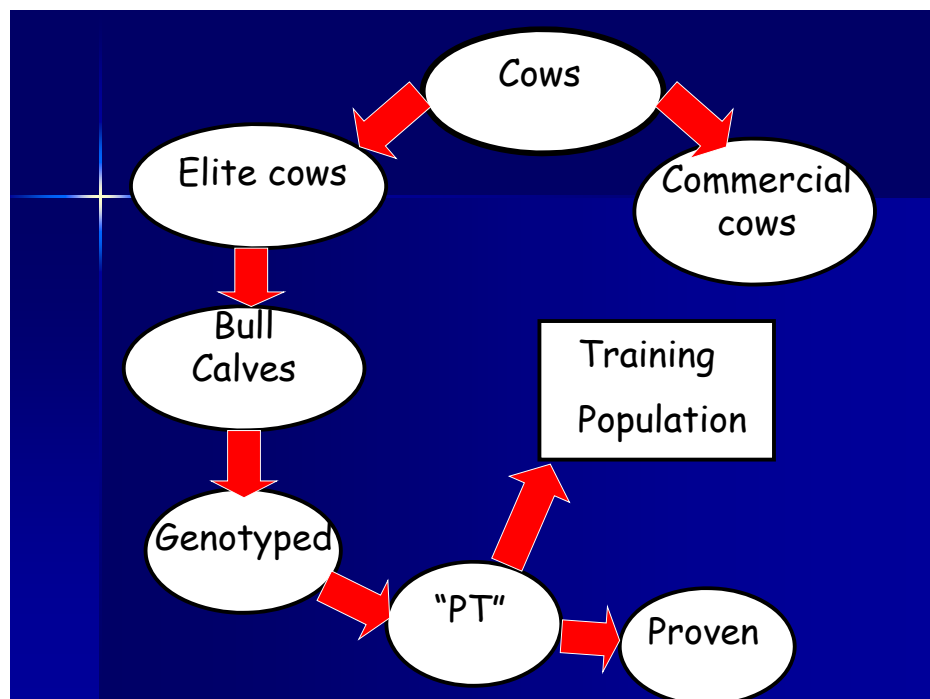
Young selection candidates with known genotypes (SNPs) but without performance records

Why use genomic selection

- Current methods of genetic evaluation based on statistical analysis of performance data
- Takes time for a bull to generate sufficient daughters to achieve high reliability
- Tool for more accurately identifying genetically different animals at a younger age, with no phenotypic information required
- Increased genetic gain, reliability and reduces the generation interval

Key Questions for Ireland

- Aim to design a optimal breeding program for Ireland, taking into account costs and benefits and the management of inbreeding
 - What age should genotyped bull calves be released for AI
 - How many bull calves should be genotyped per year
 - How many bull calves should be progeny tested
 - Possible role of females within the breeding program



General Scheme

- Initially 3,000 proven animals are genotyped to estimate marker effects
- Genetic marker effects are updated annually as more proven become available
- Population size;
 - Reduction in size of Irish dairy population to 3,500 cows.
 - 10 elite bulls chosen as SS
 - 30 bulls chosen as SD
 - ~5% elite females chosen as DS

Variations on General Scheme

- Age at which bulls enter AI
 - 2 versus 3 years
- Number of bull calves that are genotyped per year
 - 500 versus 1,000
- Number of bull calves entering AI per year
 - 30 → 60 → 100

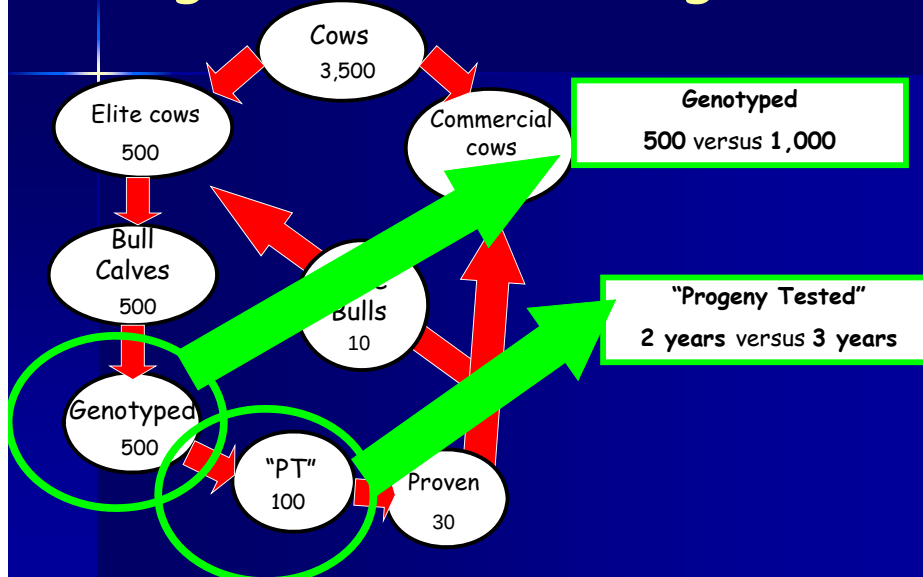
Genome Structure

- Genome assumed 3,000 cM in length
- 15,000 SNPs → density 5,000 SNPs/cM
- 3,000 QTL (100 per chromosome)
- Marker effects estimated using GW-BLUP
- Historical effective population size 200 animals
- Heritability of trait 0.15

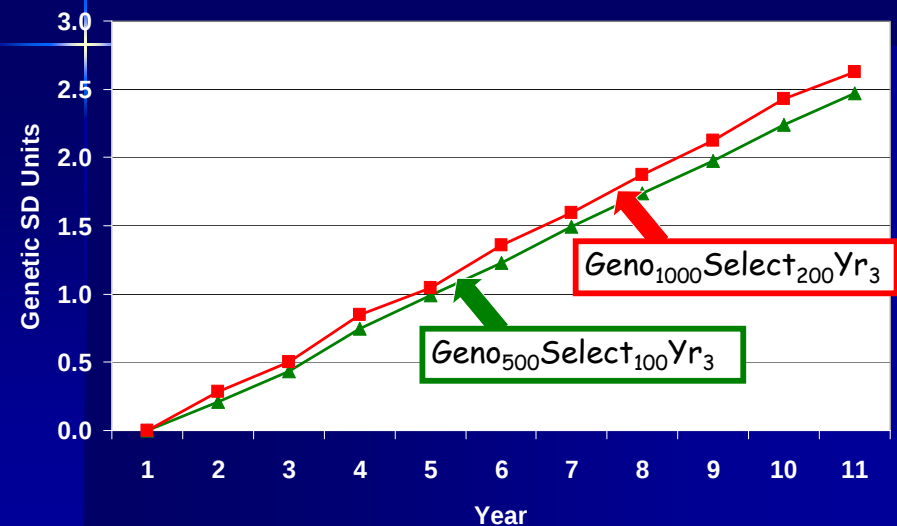
Age of Bulls entering AI

2 versus 3 years of age

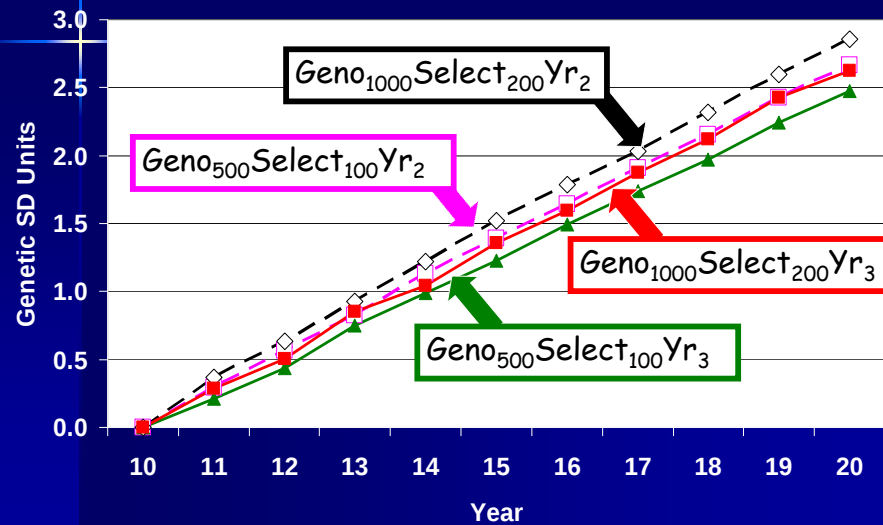
Age of Bulls entering AI



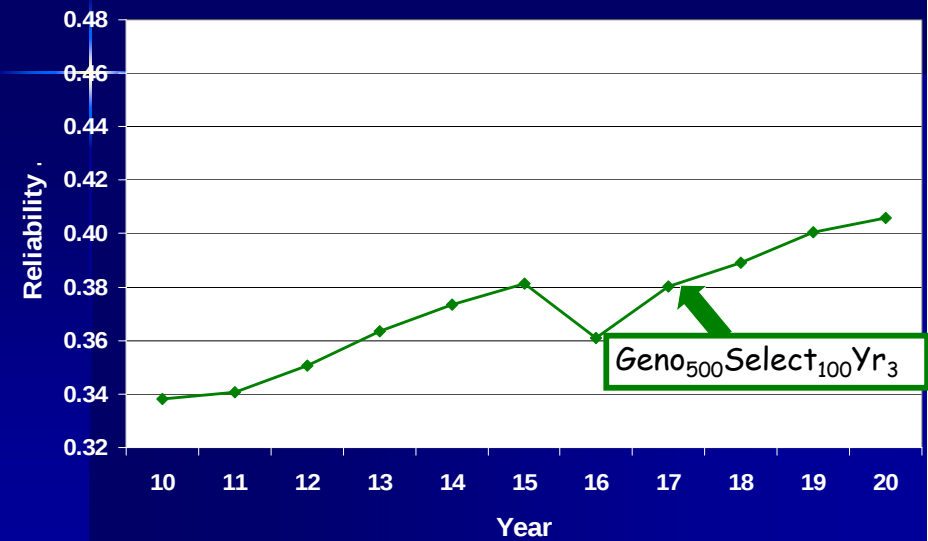
Genetic gain



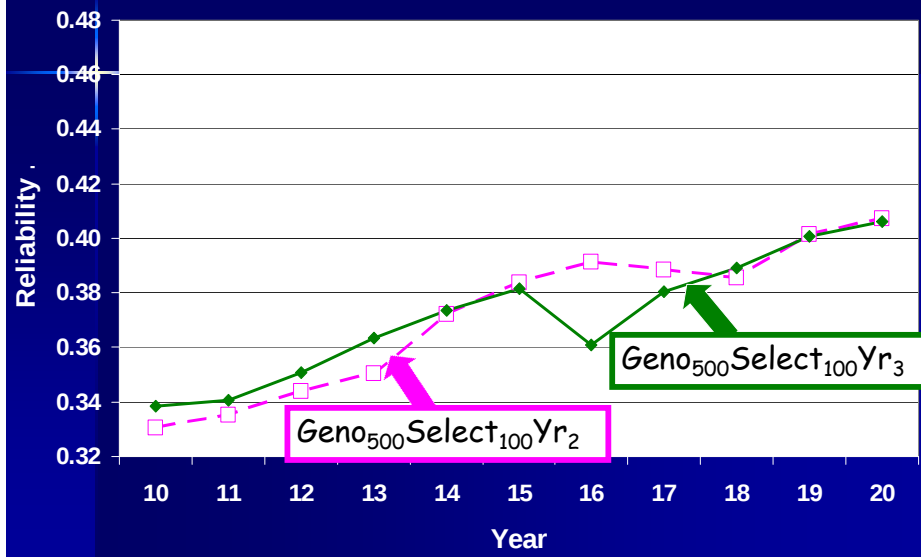
Genetic gain



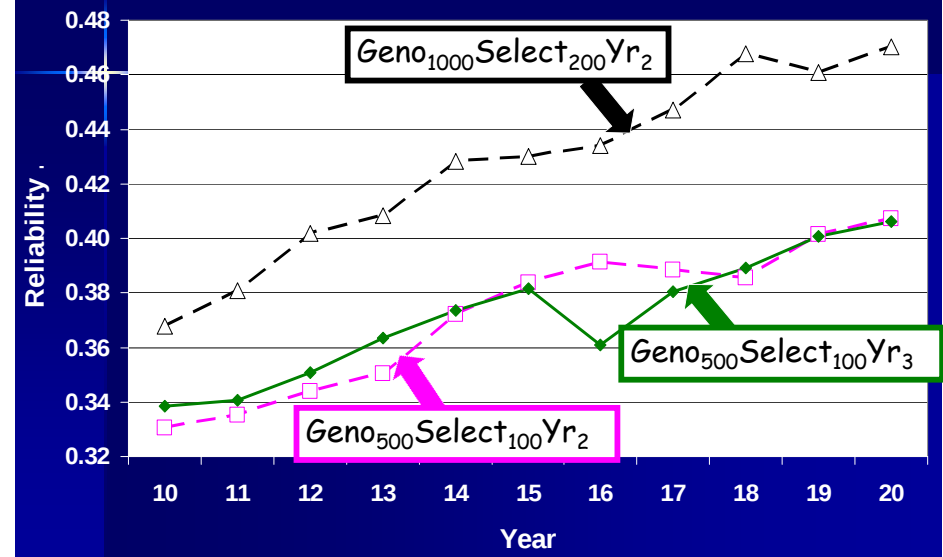
Reliability



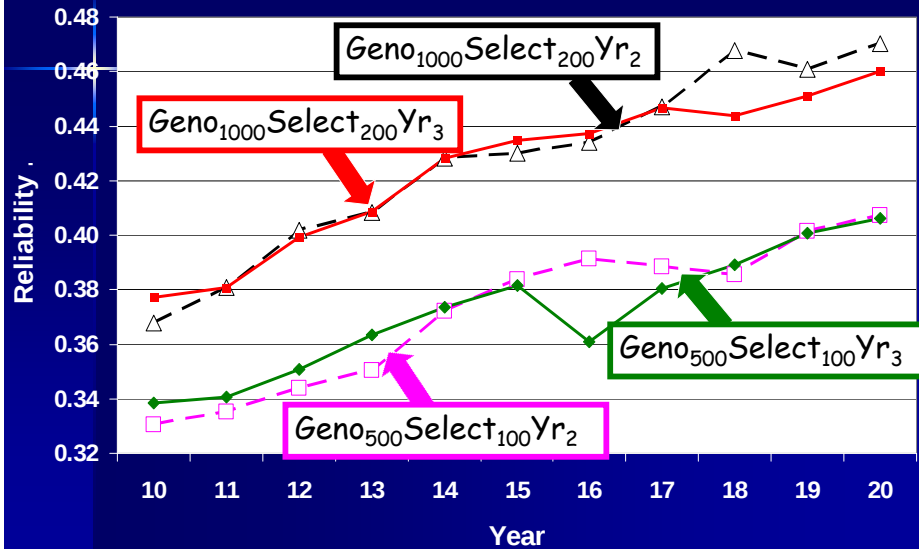
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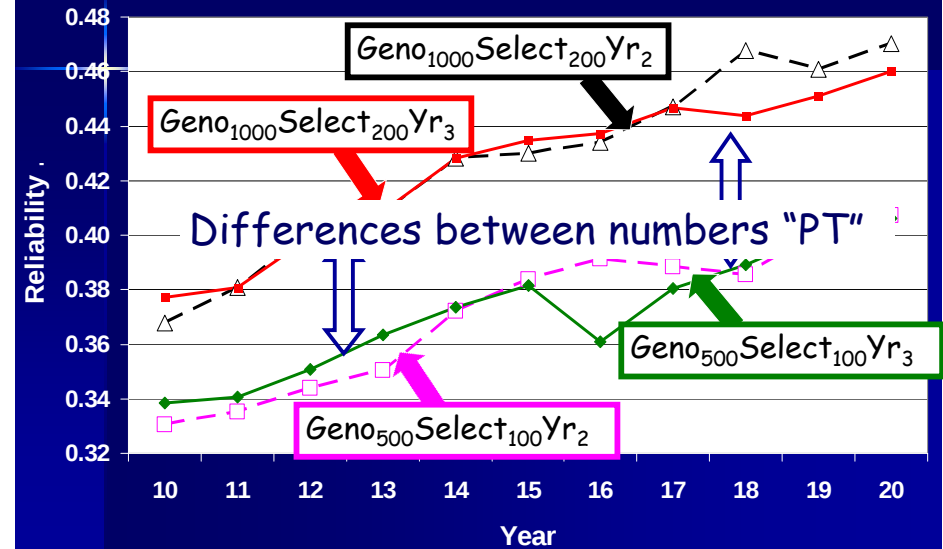
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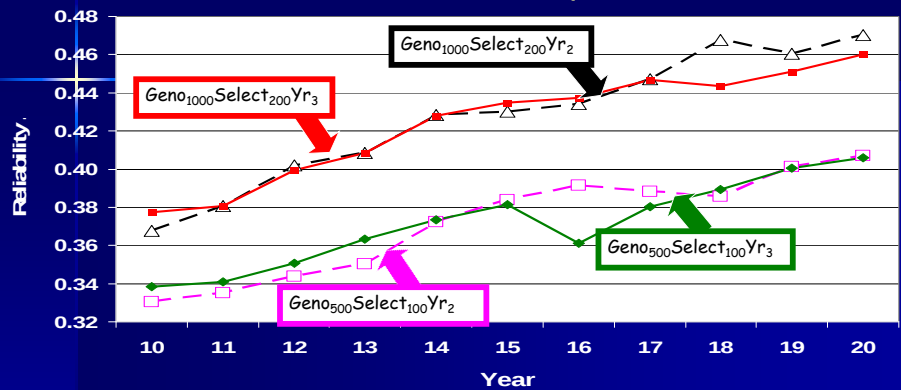
Reliability



Reliability



Reliability



Size of Training Population

100 selected 3,400

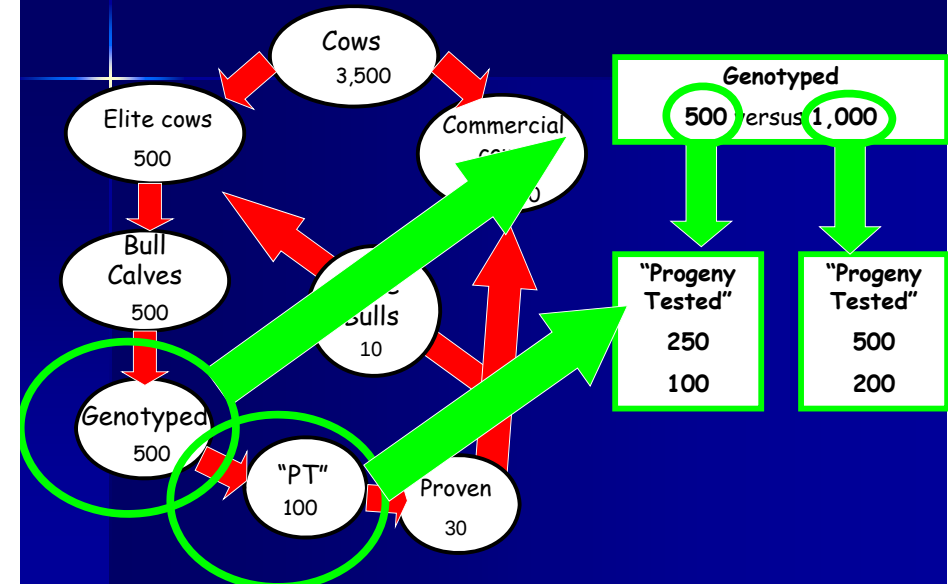
200 selected 3,800

Summary

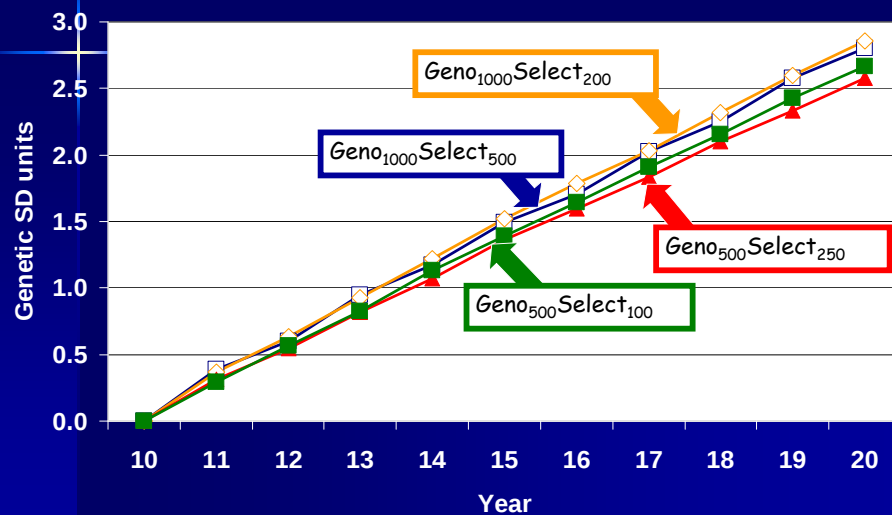
- **Genetic Gain**
 - Greater gain when selecting animals for AI at younger age
- **Inbreeding**
 - Higher inbreeding levels associated with animals selected at a younger age
- **Reliability**
 - Greater reliabilities for larger numbers entering "PT"
- **Generation Interval**
 - Lower generation intervals for animals selected at a younger age

Number of Potential Candidates

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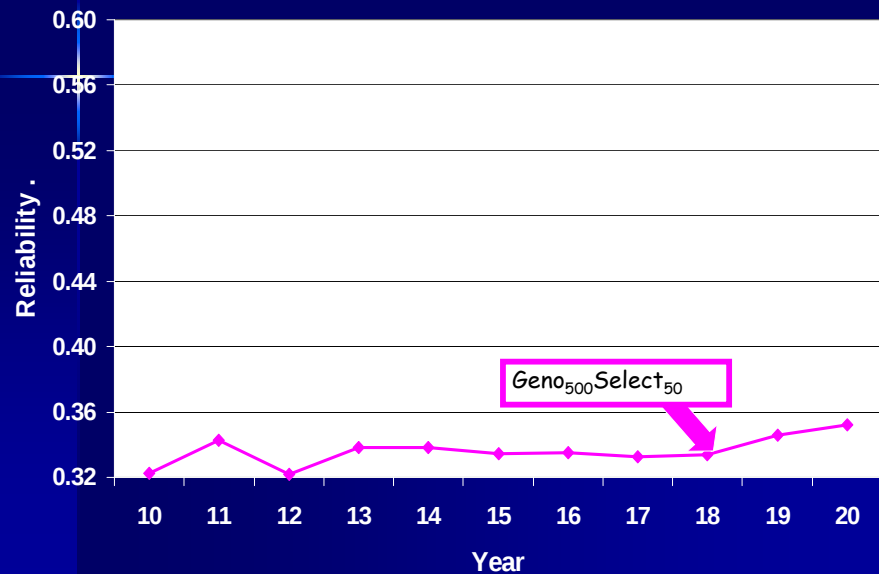
Genetic Gain



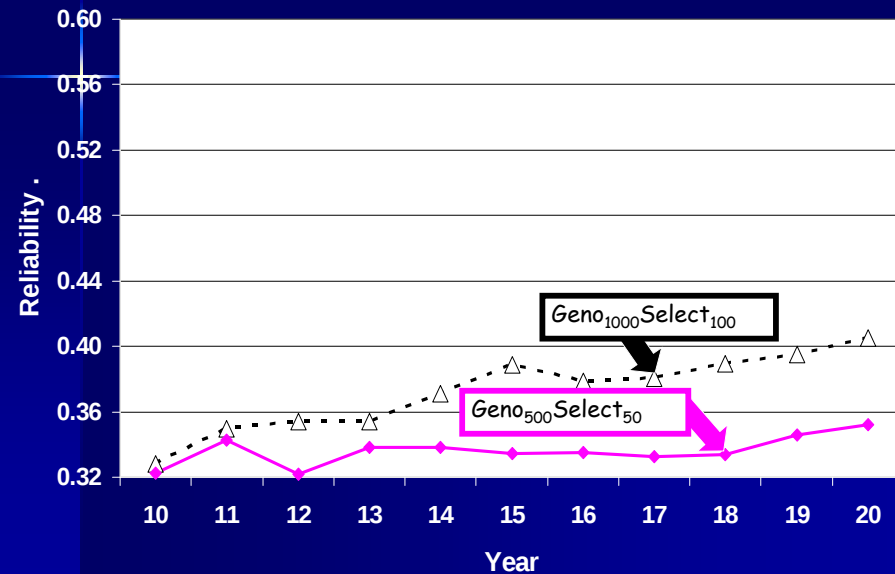
Genetic gain

Scheme	ΔG
1000Pre500	0.27
1000Pre200	0.27
1000Pre100	0.28
500Pre250	0.25
500Pre100	0.26
500Pre50	0.27

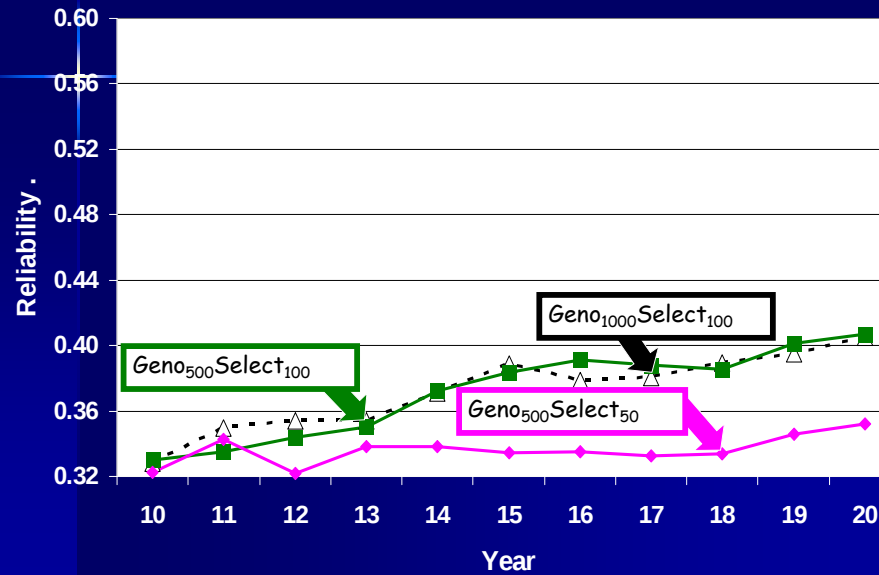
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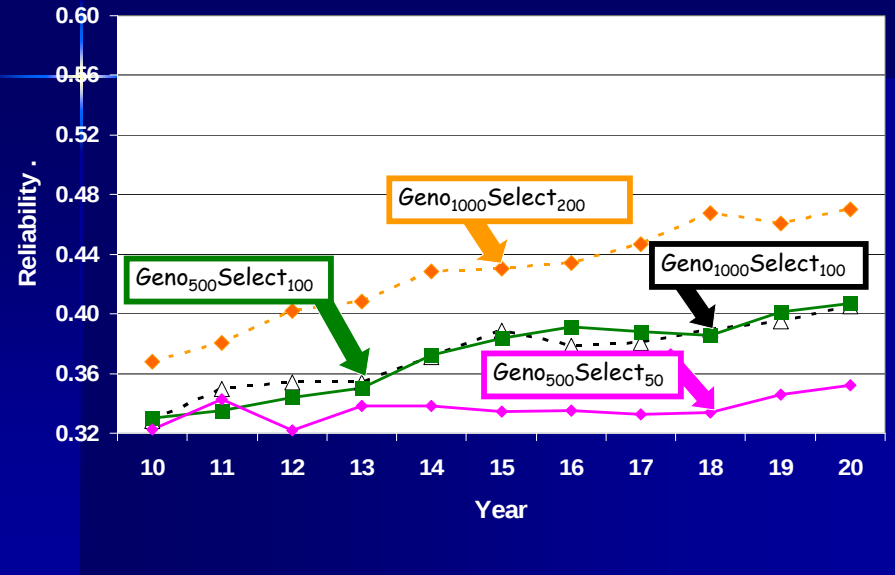
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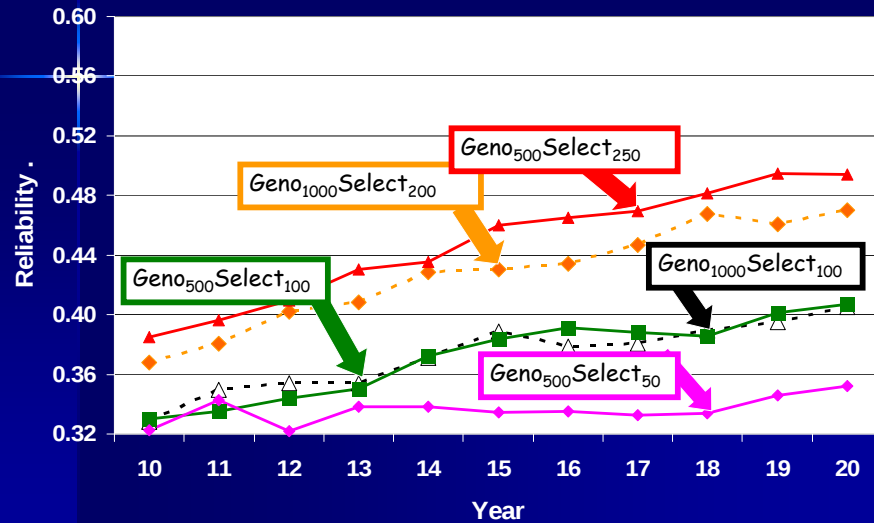
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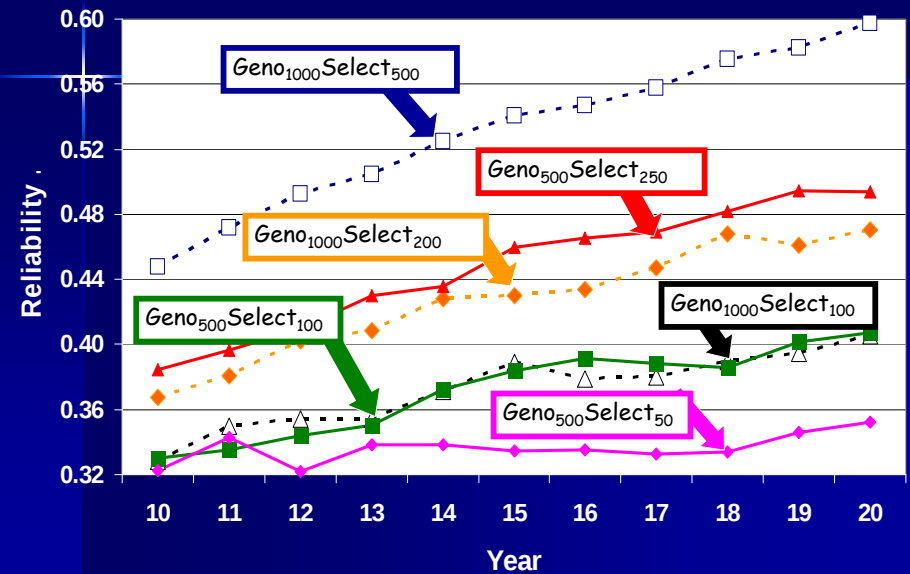
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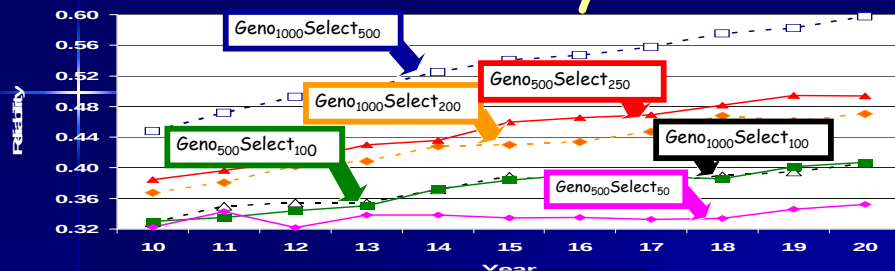
Reliability



Reliability



Reliability



Size of Training Population

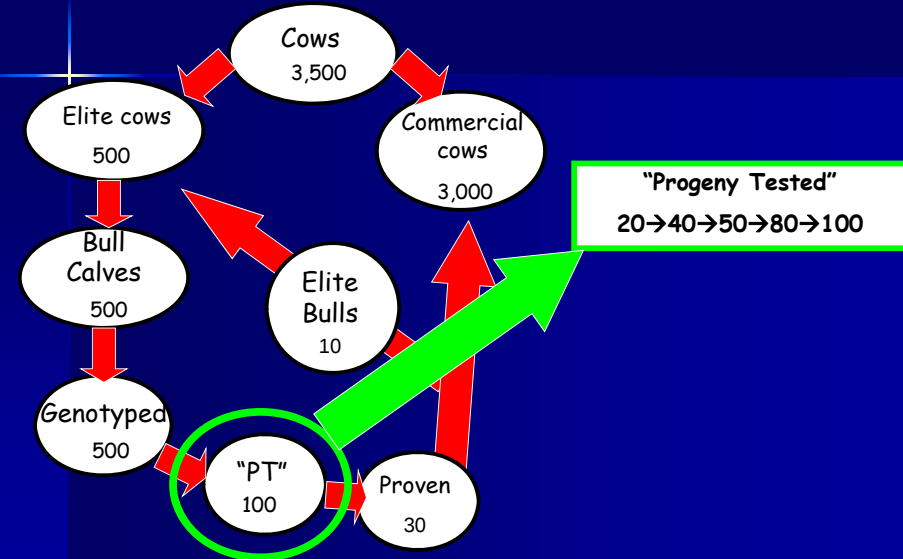
- 50 selected 3,200
- 100 selected 3,400
- 200 selected 3,800
- 250 selected 4,000
- 500 selected 5,000

Summary

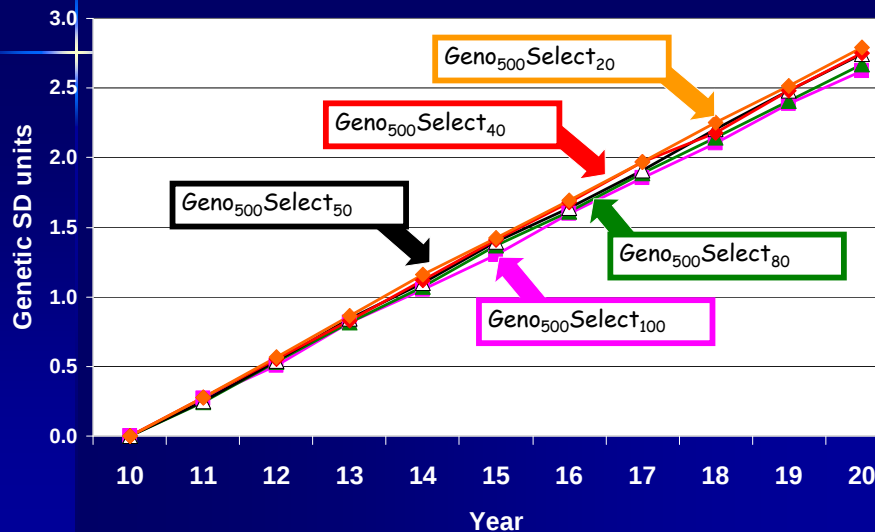
- Genetic gain
 - High selection intensity the greater gain
- Inbreeding
 - Lower numbers selected leads higher inbreeding
- Reliability
 - Greater numbers selected = greater reliabilities
- Generation Interval

Number of Bulls Progeny Tested

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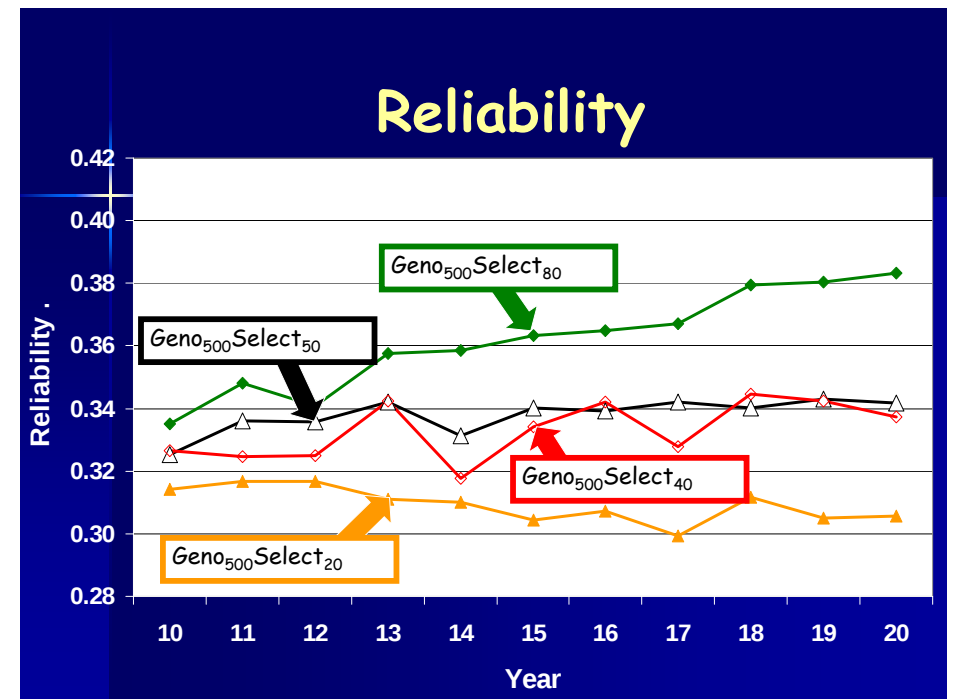
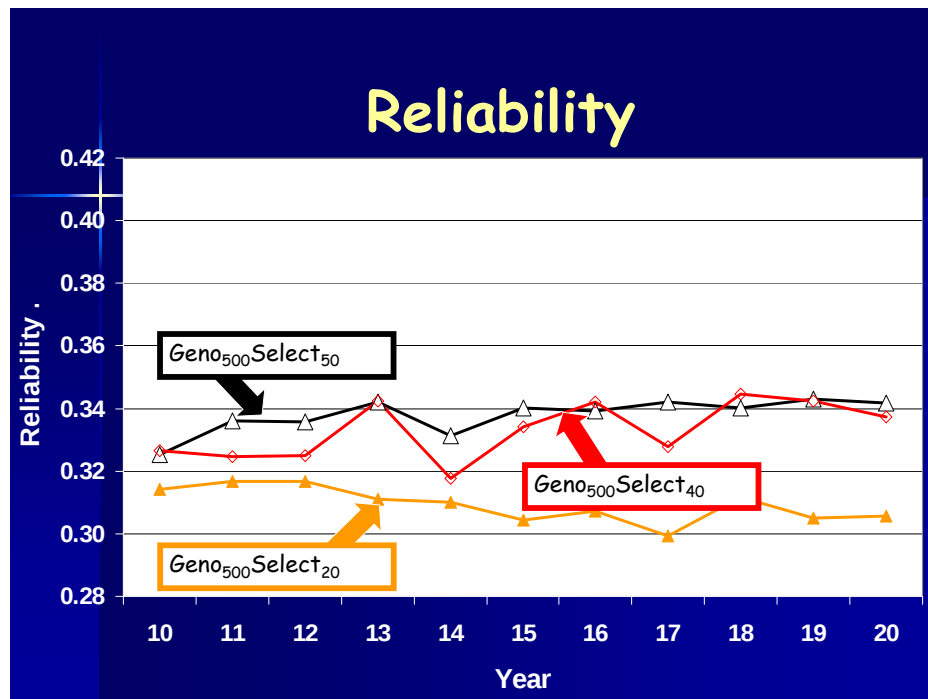
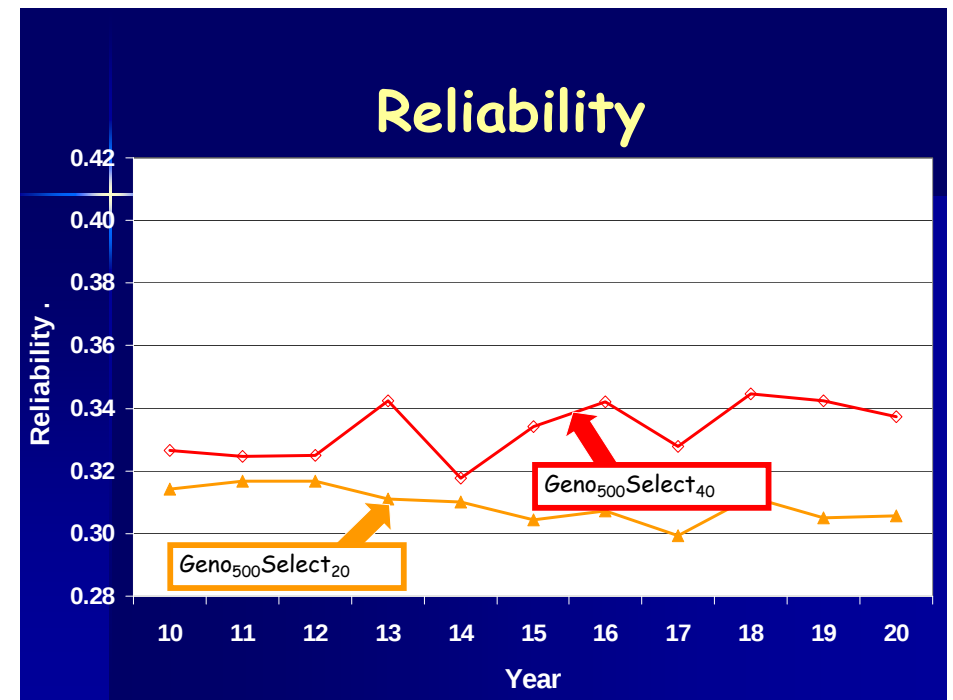
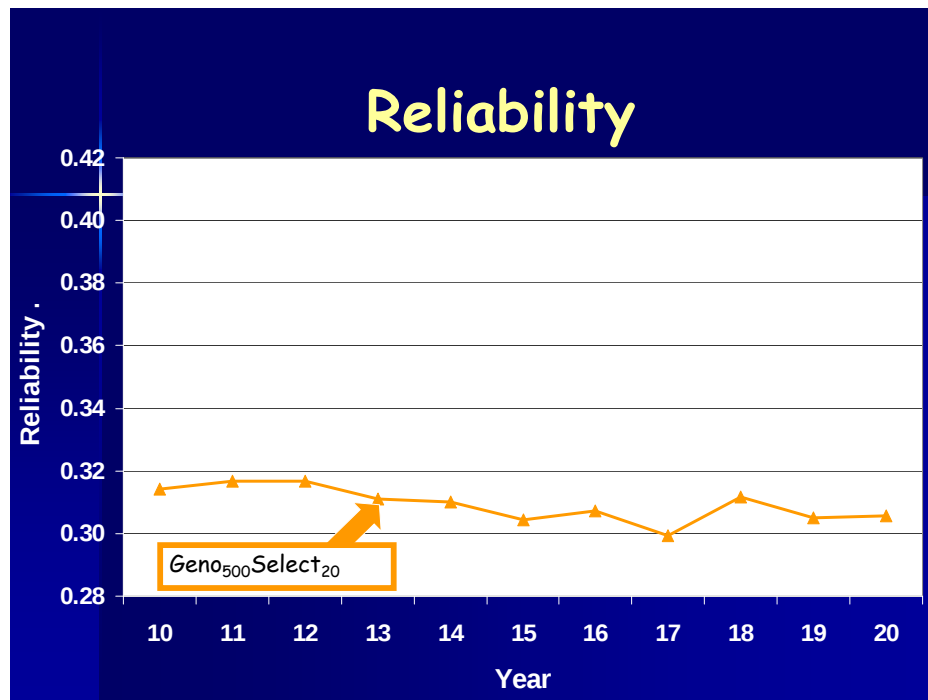


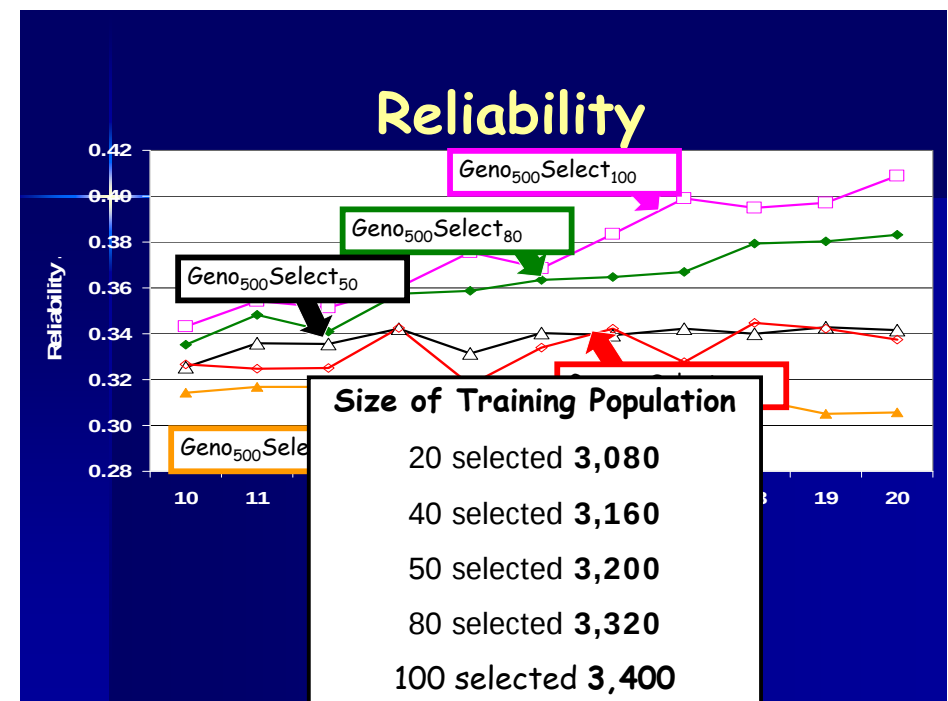
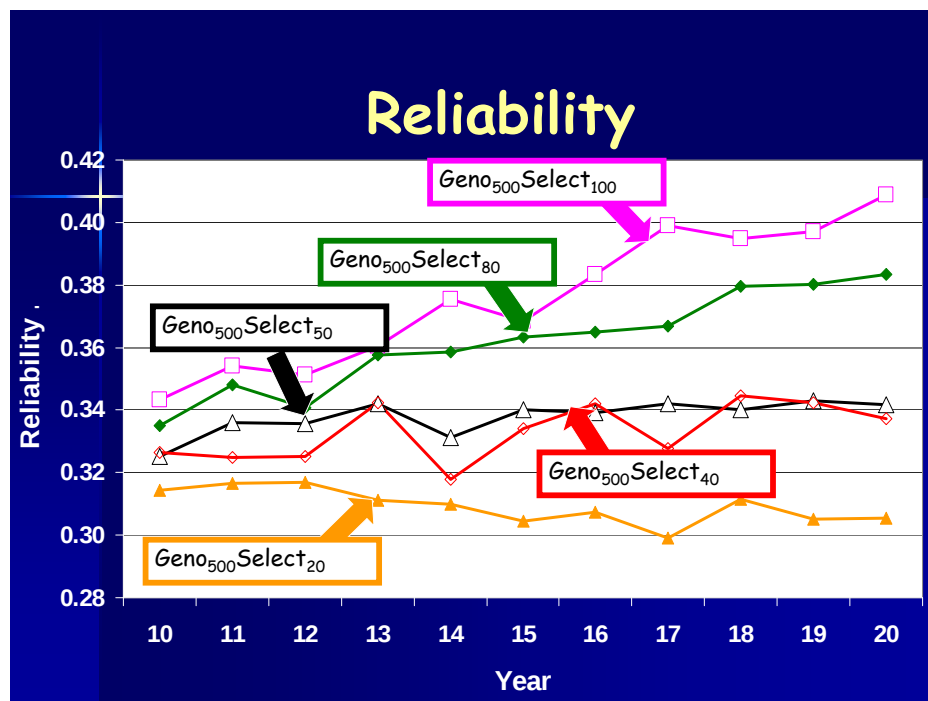
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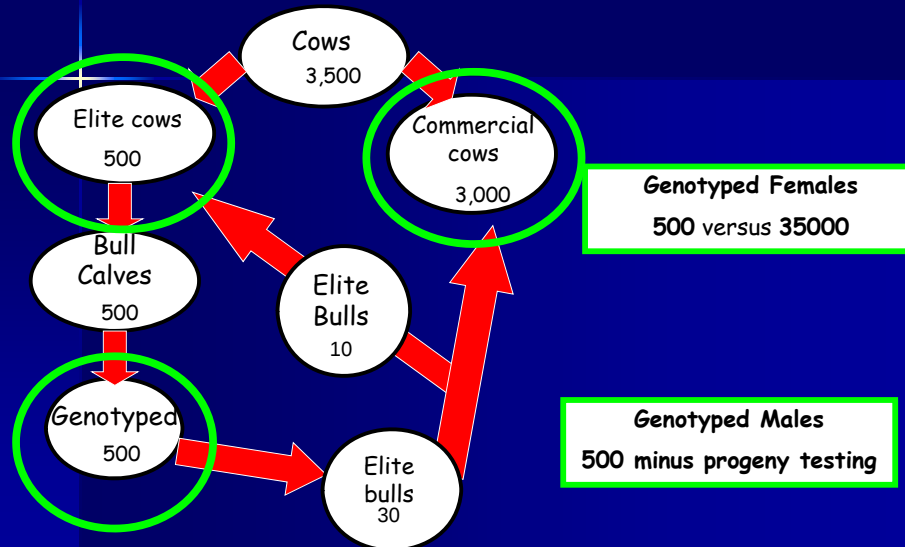


Summary

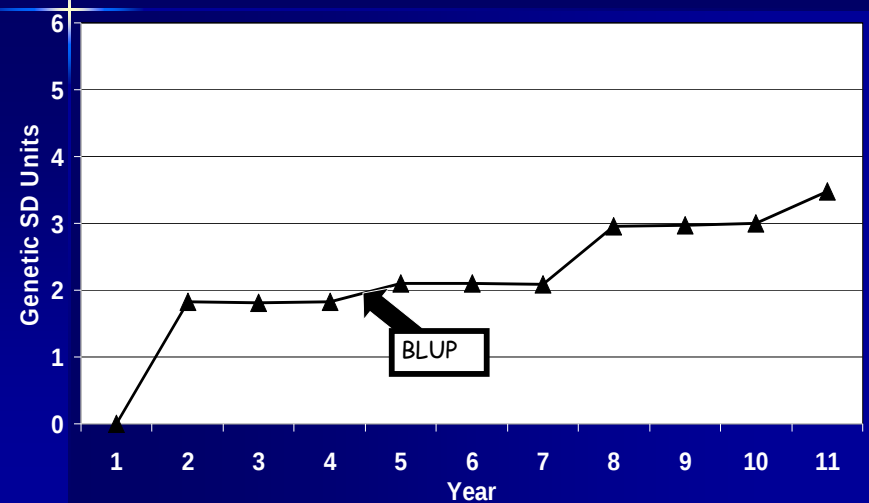
- **Genetic gain**
 - Little difference between schemes
- **Inbreeding**
 - Lower the number of animals selected
→ greater inbreeding
- **Reliability**
 - Higher numbers selected → higher reliability

Potential roles of females

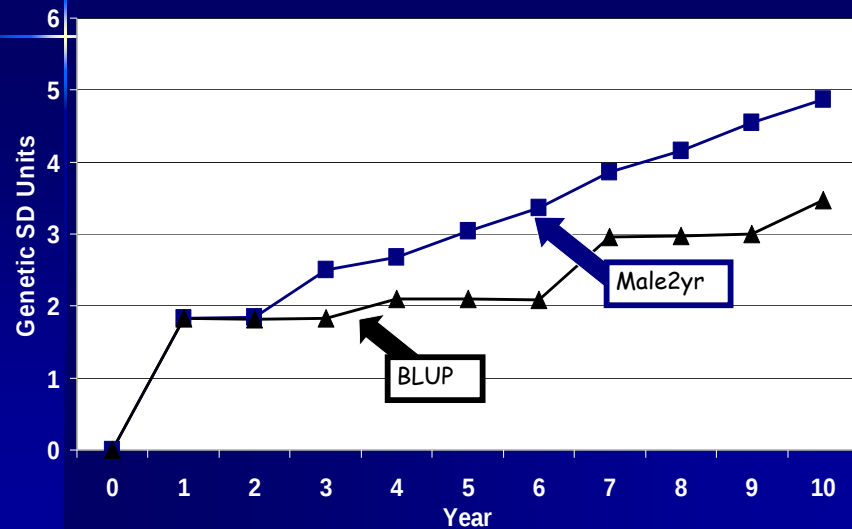
Number of Potential Candidates



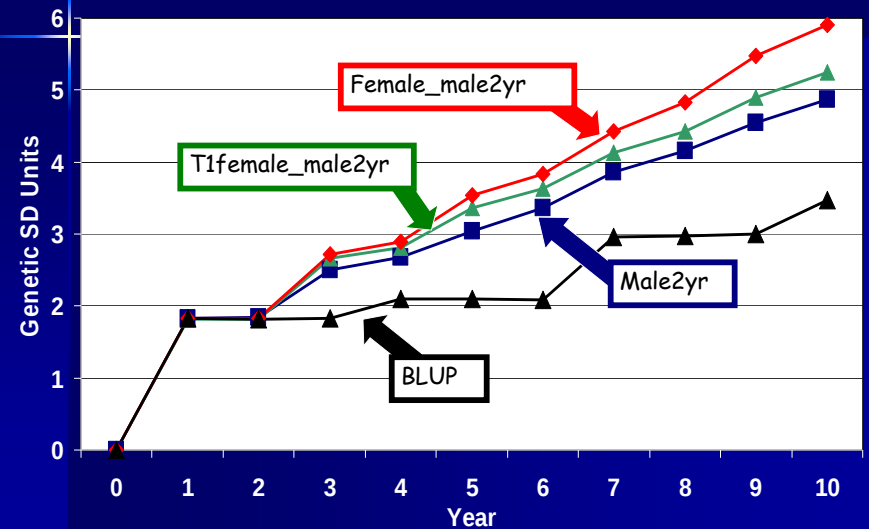
Genetic gain



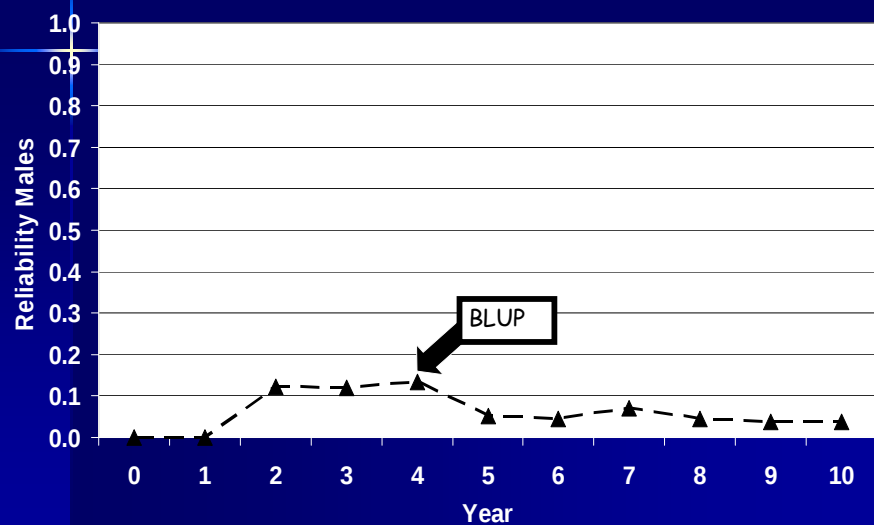
Genetic gain



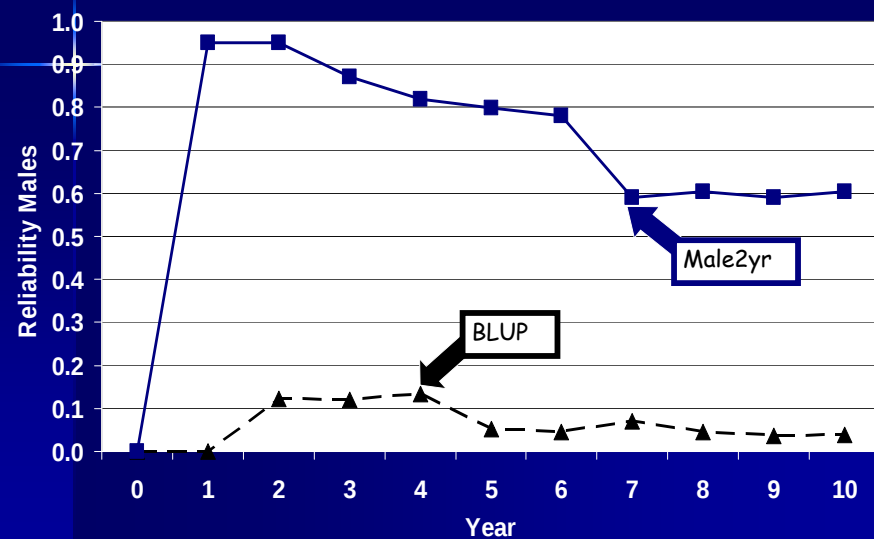
Genetic gain



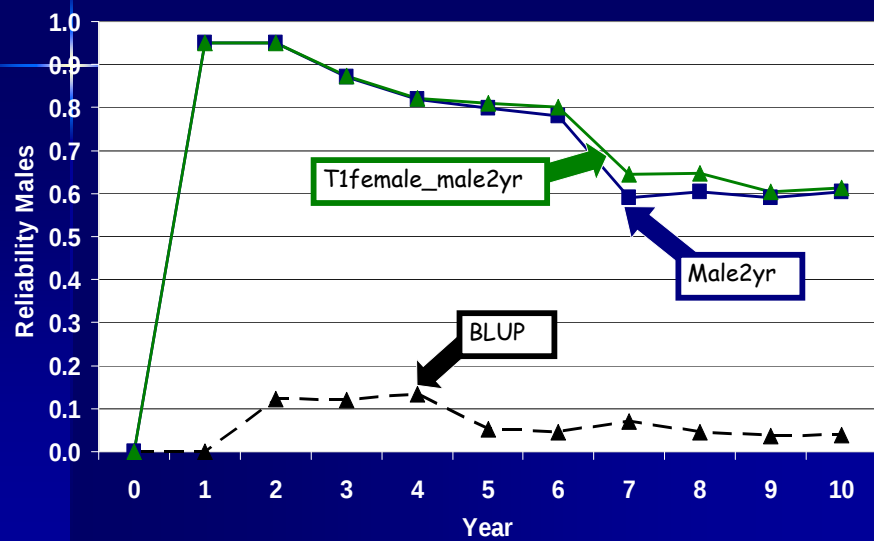
Reliability



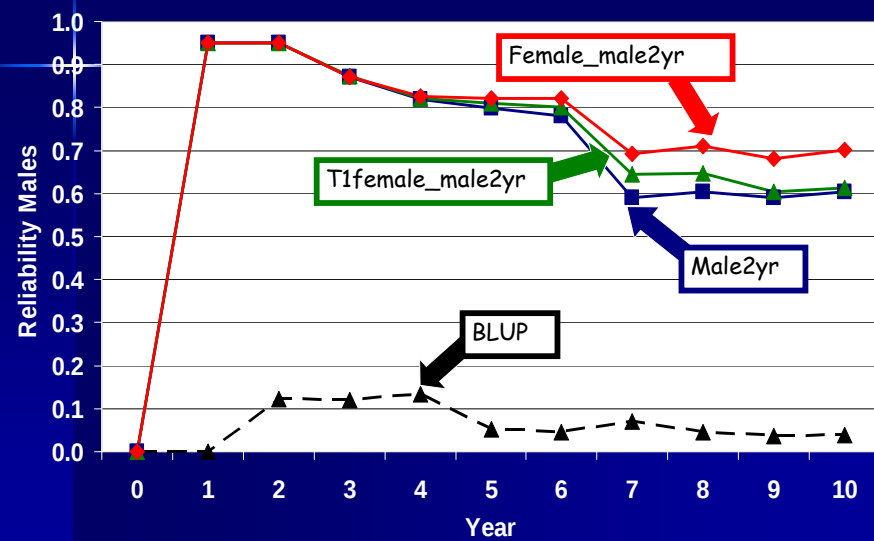
Reliability



Reliability



Reliability



Summary

- Genetic gain
 - Genotyping females increases genetic gain
- Inbreeding
 - Lower Levels associated with BLUP scheme
- Reliability
 - Higher numbers of males and females selected → higher reliability

Overall Summary

- To increase genetic gain genotyped females, select animals at a younger age, use high selection intensities
- The greater the number of animals selected the lower the inbreeding
- Higher levels associated with younger animals
- Reliability is a function of the number of animals selected.
- Reliability increases greatly if females genotyped

Recommendations

- Use genotyping as a pre-selection for potential AI sires
- Bulls that are selected to enter the progeny test should ideally become selection candidates at two
- The number of animals selected to enter the progeny test has little effect on overall genetic level
- There is major potential in the genotyping of females
- It is advisable to maintain some form of progeny test

Acknowledgements

ICBF for financial contribution towards travel and subsistence



Feedback ??