KNOWLEDGE CENTRE FOR AGRICULTURE

Sustainable dairy breeding using genomic selection and crossbreeding

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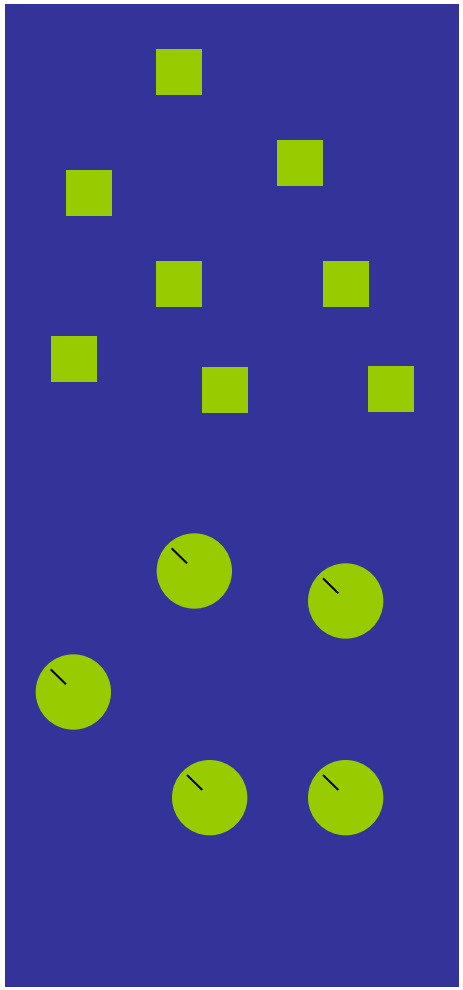
The breeding machine

Input:

- **Breed**
- **Biological circumstances**
- **Economic frames**
- **Political frames**
- **Resources**



Output:

- **Genetic gain**
- **Inbreeding**
- **Risk**
- **Costs**

Sustainable breeding

- **Broad breeding goals taking all economic important traits into consideration**
  - **Expectation of the future**
  - **Welfare issues**
  - **Non marked values**
- **Inbreeding**
  - **An acceptable future rate of inbreeding must be ensured**

    Use of optimal contribution selection methods

Total Merit Indices - history

- 1975-1985 TMI- introduced in Nordic countries including production and functional traits
- 1985-2007 TMI's in Nordic countries gradually improved more traits – better methods
- 1990-2000 TMI – based on few traits popular in many countries
- 2008 Joint Nordic TMI – called NTM
- Today – everyone see the need for having a TMI including all economic important traits

Gain from NTM for HOL

Correlations between EBV's for AI bulls born 2001-2003

Trait	Correlation with NTM
Yield	0.49
Growth	0.00
Fertility	0.39
Calving - direct	0.28
Calving - maternal	0.37
Udder health	0.46
Other health	0.47
Body	-0.04
Feet & legs	0.12
Udder	0.40
Milking speed	0.09
Temperament	0.03
Longevity	0.51

Overall aim of NTM

- **High yielding cow**
- **Improved genetic level for functional traits – health & fertility**
- **Leads to improved longevity and economically enhanced dairy cows**

Fulfilled!!

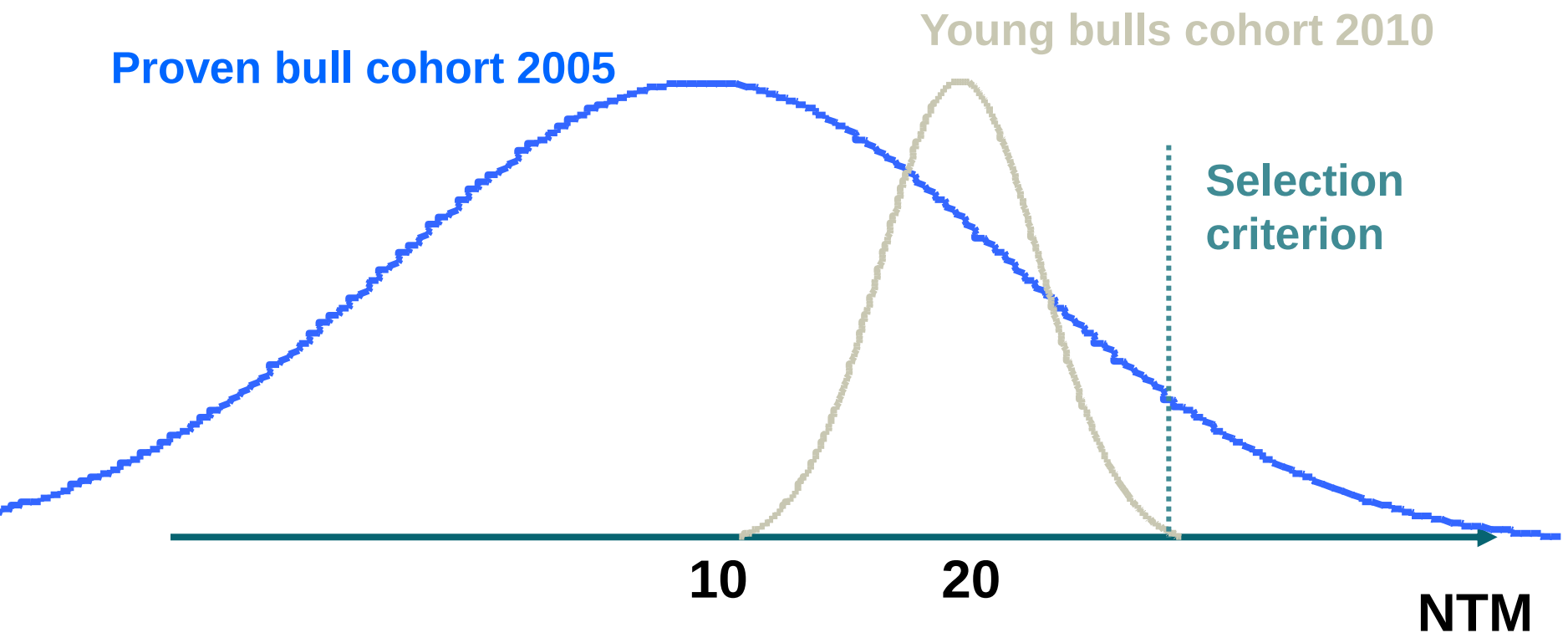
How does genomic selection affect genetic gain and sustainability?

Genomic selection reduce the generation interval

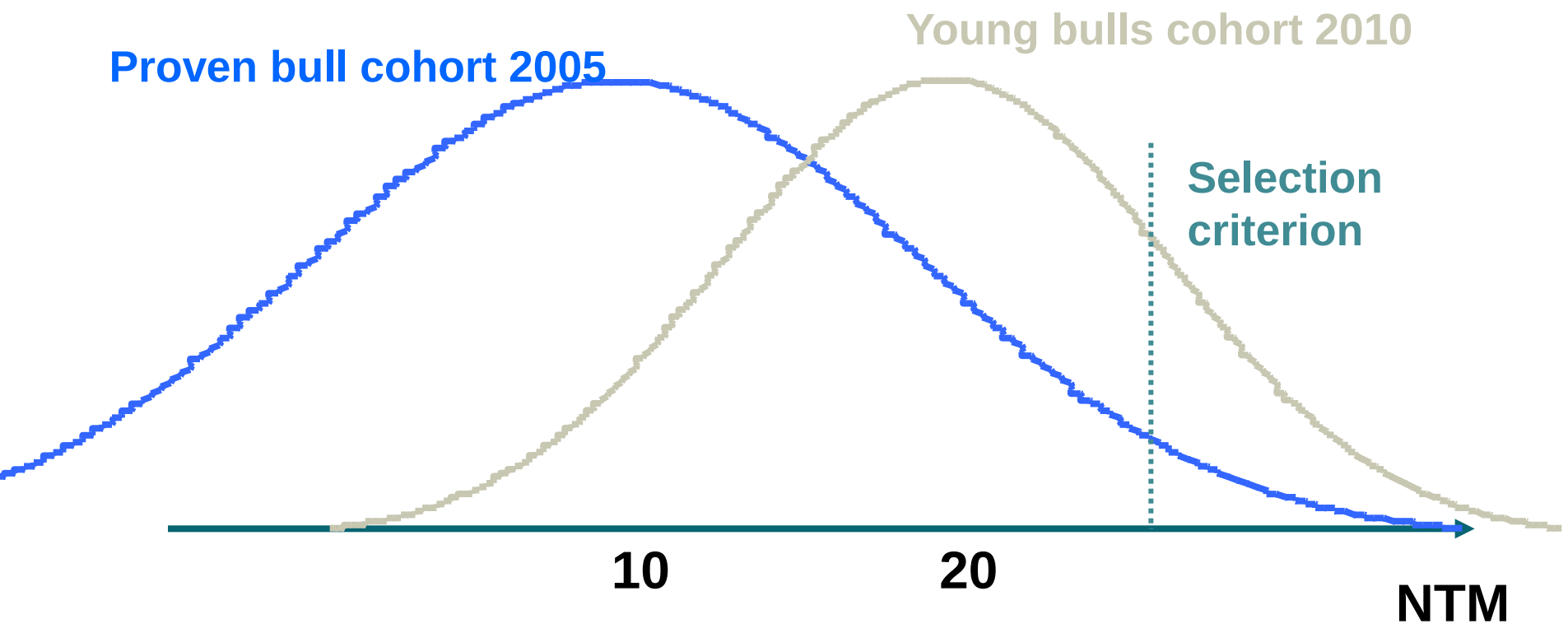
$$\Delta G = \frac{i \cdot r_{IA} \cdot \sigma_A}{L}$$

But do also affect the other factor!

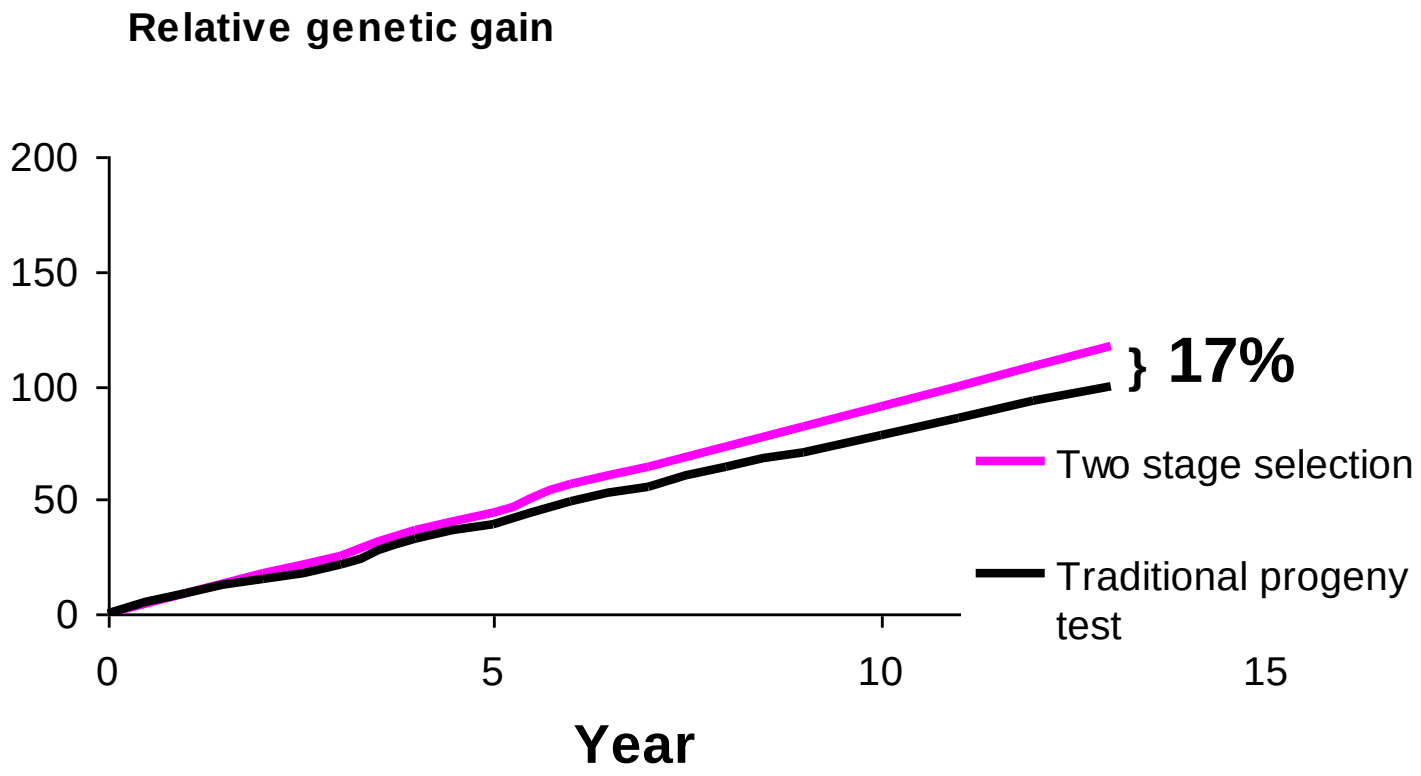
Traditional progeny test scheme



Traditional progeny test scheme and DGV's

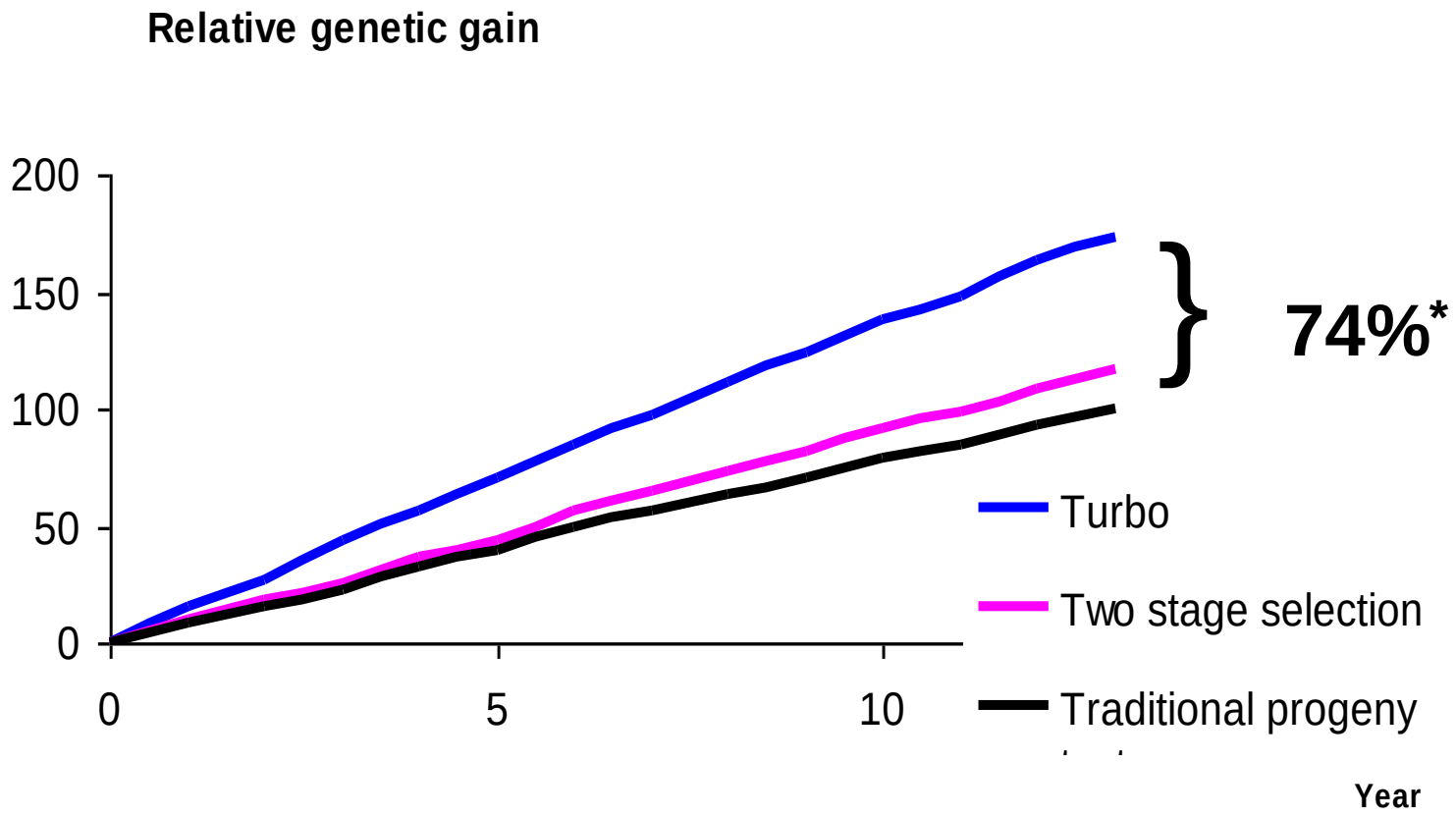


Effect of two stage selection



ACS, 2009

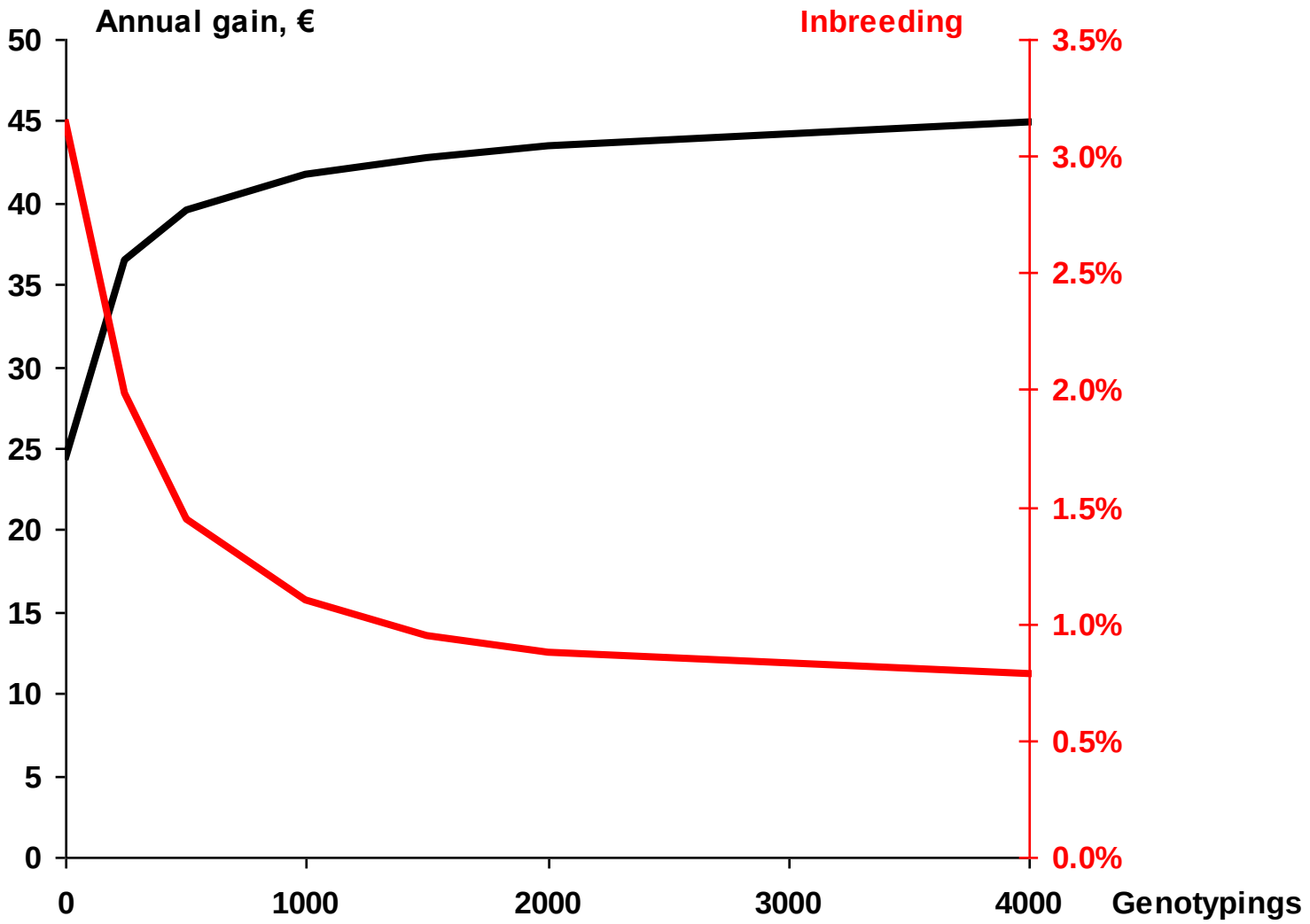
Effect of young AI sires - Turbo



*** apr. 50 mill DKK per year in Denmark**

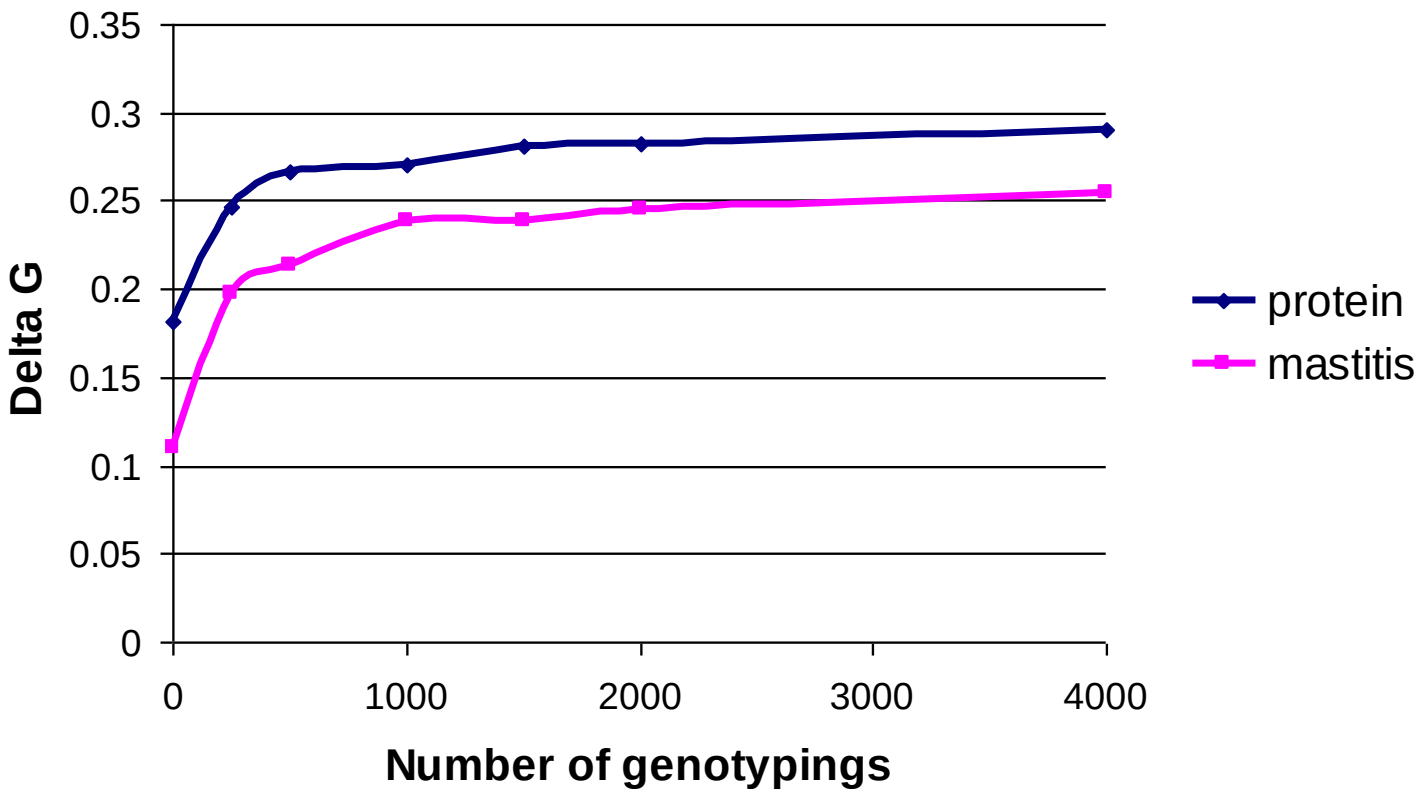
ACS, 2009

Overall effect of number of genotypings



ACS and MKS, 2010

Composition of total gain



ACS and MKS, 2010

Potential ”new” traits

- In the ”old” plan we couldn’t wait for information in later lactations

- Now a balance between expression in 1st 2nd and 3rd lactation is possible
  - Yield
  - Mastitis
  - Fertility

Genomic selection can

- Improve overall genetic gain
- Move the balance in genetic gain towards functional traits
- In theory reduce rate of inbreeding
  - But what about reality?

Crossbreeding
- also a way towards sustainability

Trait	Heterosis
Yield	2 - 3%
Fertility and calving ease and longevity	10 - 15%
Total merit	10%

Survey among dairy producers using crossbreeding

69 producers were asked about:

- **Crossbreeding system**
- **Why they started crossbreeding**
- **Benefit from crossbreeding**
- **Problems**

49 answers received

Crossbred herd have the same management level as purebred herds!

	Holstein cows in:	
	Purebred herds	Herds selected for the survey
305-day protein yield (kg), 1st lact.	274	269
Stillbirth (%), heifer	8.3	7.8
Days from 1st to last ins., cows	53	52
% of cows entering 2nd lact.	78	81

Breeds and crossbreeding methods

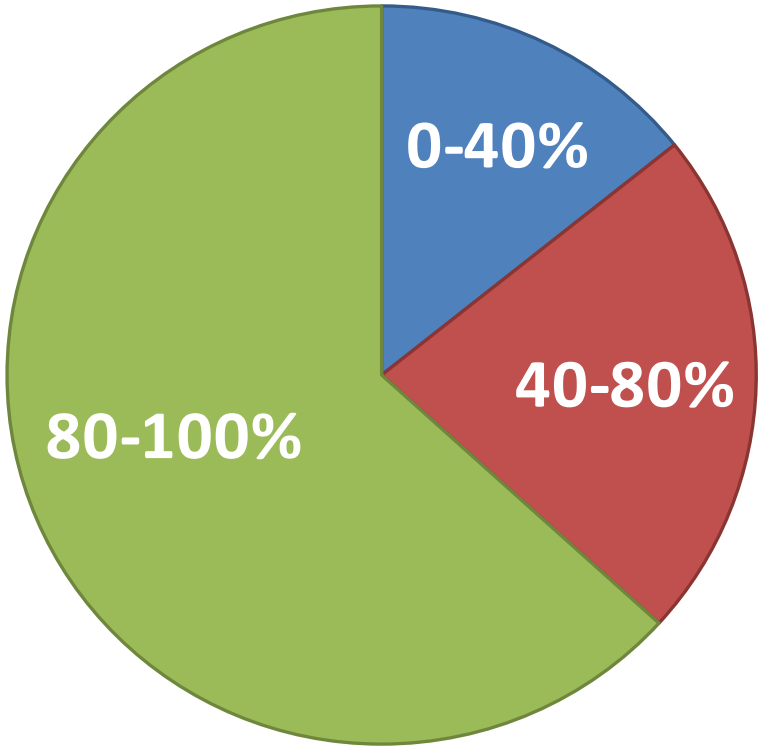
Methods

- **55% of herds use 3 breeds**
- **35% of herds use 2 breeds**
- **10% of herds use another system**

Breeds

- **RDM, Holstein, Jersey – many herds**
- **SRB, Montbéliarde, Finish Ayrshire – some herds**
- **Brown Swiss, Fleckvieh – few herds**

Parts of females being crossed



Answers

- 40 producers still apply crossbreeding
  - 34 producers have used crossbreeding programs for more than 3 years
- 9 producers have stopped crossing

Crossbreeding meet the expectations of dairy producers

- **33 out of 34 producers have a positive or really positive outcome**
  - **50 - 60% for longevity, health and feet and legs** 
  - **15 - 30% for fertility, economy, plus calf- and cow mortality** 
  - **All herds expect to have a ”crossbred” herd 5 years ahead**

”Crossbred cows have lower yield, but is much better for functional traits”

Important challenges

- **Unequal size among cows**
- **Lack of acceptance among colleagues**

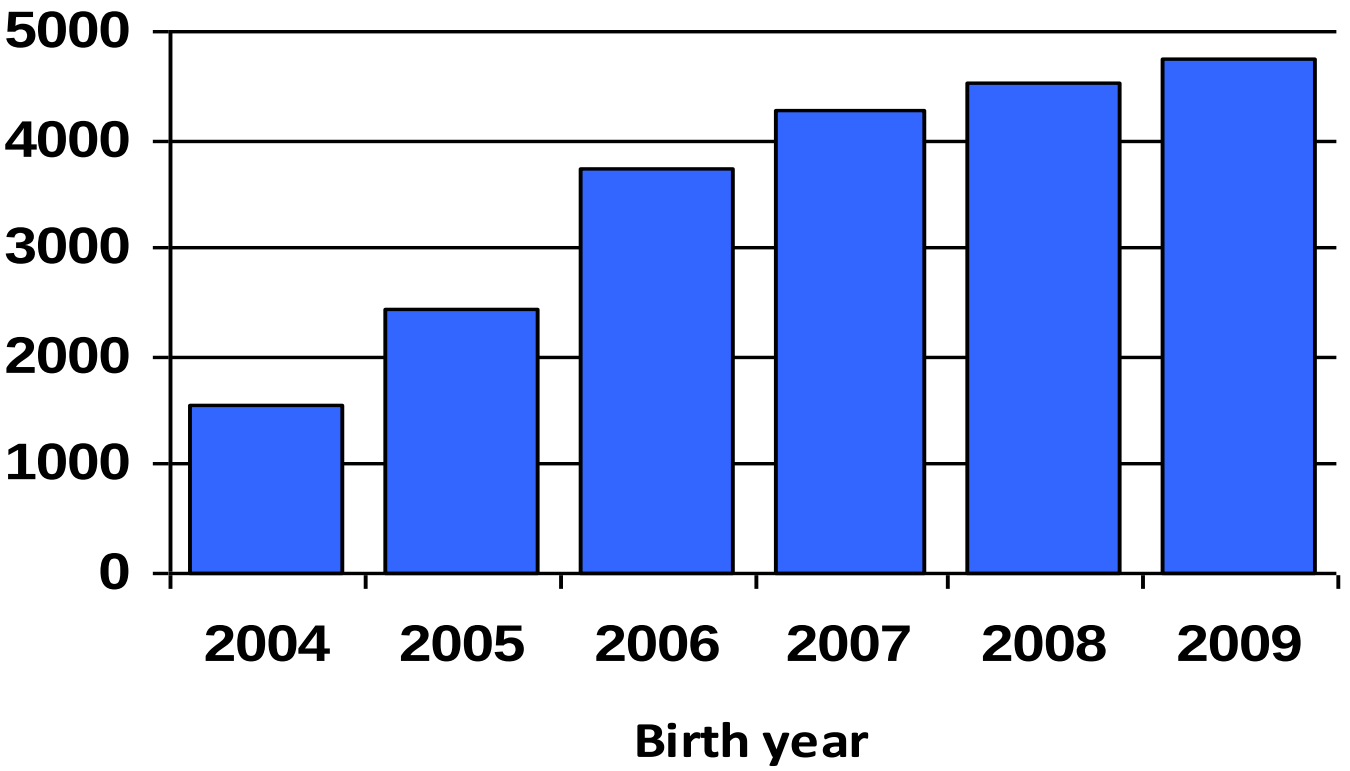
Challenges for the advisory system

- More information/knowledge
- Possibility for inclusion of more breeds
- Better management tools

Analyses of crossbred cows in Denmark

Increasing number of females with

and



Demands for animals included in the analyses

- At least 6 producing crosses and at least 6 producing Holstein cows per birth year within herd
- Crosses are defined as animals with ”red” sire and ”black” dam
- Animals born in 2004 and later

Data: 4,314 HOL and 1,979 crosses

About the results

- **Results are given as within herd differences between crosses and Holstein**
- **The level of crosses is:**

½ X  + ½ X  + heterosis

- **The level of pure bred is:**

½ X  + ½ X 

305 days yield

	Milk, kg	Fat, kg	Protein, kg
1st lactation	- 177	+ 4	- 1
2nd lactation	- 203	+ 6	+ 1

Survival until second calving

+ 2 percentage point

(78 % versus 76 %)

Stillbirth and calving ease

	Stillbirth%	% easy calving
First calving	- 1.3 %*	+ 5 %*

* Given in percentage point

Fertility traits

	Age at first ins.	Interval from first to last ins.	Number of ins.
Heifers	- 8 days	- 2 days	- 0.06
1. parity	- 5 days*	- 8 days	- 0.10

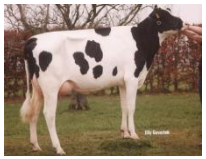
* Days from calving to first insemination

If the analyses were based only on crosses with high SRB contribution

869 animals **1.991 animals**


SRB

X



-

X

- then results were more favorable for the crosses

305 days yield 1st lactation:	
Milk, kg	- 34
Fat, kg	+ 8
Protein, kg	+ 5

Heifer calving:	
Stillborn, percentage point	- 2 %
Easy calving, percentage point	+ 4 %

Fertility 1st lactation:	
Interval from calving to first ins.	- 4 days
Interval from first to last ins.	- 7 days

Equality between Danish breeds

- **Calculations based on:**
  - **Registrations for:**
    - **Yield**
    - **Health**
    - **Fertility**
    - **Still birth etc.**
  - **Actual economic values**

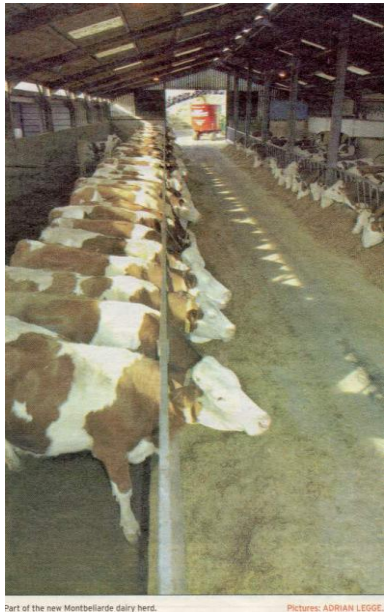
The difference between breeds is less than 25 euro per cow year

Economical results from a selected group of Danish Dairy farms (Centrovice, 2009)

	Jersey	HOL	RDM
No. herds	55	33	23
Herd size	164	178	154
Avr. kg ecm	8549	9933	9016
Animal sale	+ 135 $	+ 211 $	+ 432 $
Profit per year cow	2586 $	2590 $	2821 $

Recommended breeds:

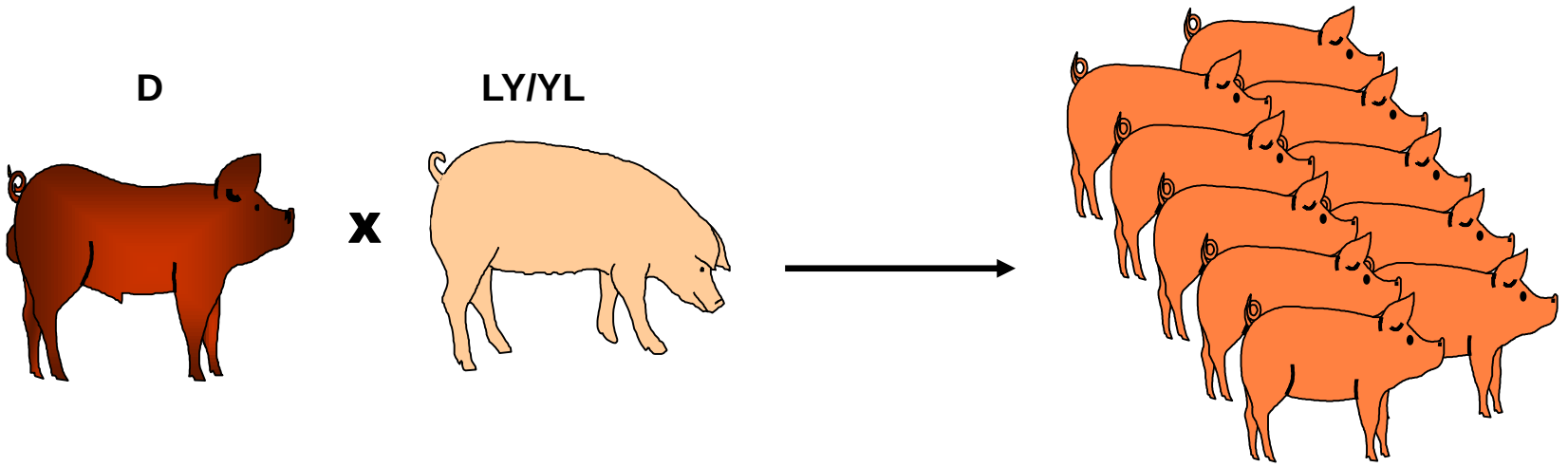
- **Breed group I:**
  - **Holstein**
- **Breed group II:**
  - **Danish Red**
  - **SRB (Swedish Red)**
  - **FAY (Finish Ayrshire)**
  - **NRF (Norwegian red)**
- **Breed group III:**
  - **Montbéliarde**
  - **Jersey**



Part of the new Montbeliarde dairy herd. Pictures: ADRIAN LEGGE

Traditional crossbreeding system

Can it be done another way?



COMBI CROSS

Level 1
Pure breeding

Level 2
Two breed cross

Level 3
Three breed cross

Level 4
Terminal cross

Distribution of breed groups using COMBI CROSS in a 200 cow herd

70 pure bred cows

50 two bred cows

80 three bred cows

80 beef cross per year

Conclusion

- Those producers applying crossbreeding are satisfied
- Cross bred animals are competitive
- Heterosis is also expressed in well managed herds
- Equal breed are available
- Pure breeding is necessary
- New systems in line

Crossing is a strong alternative which increase sustainability in dairy farming