Supporting genetic management of a live cattle population with gene bank material

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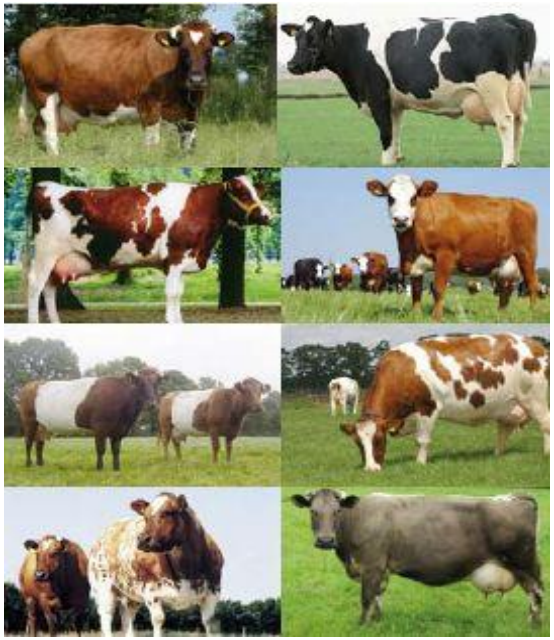
Centre for Genetic Resources, the Netherlands

CGN – Dutch Gene Bank

- Creation and management of genenbank collections
- Supporting rare breeds
  - Advise on genetic management
  - Software tools
  - Providing genetic material for Breeding
- …

Dutch cattle breeds – collection (2012)

Breed	#donors	total # doses	Used for breeding
Brandrood	34	5653	Yes
Friesian	177	26395	Yes
Friesian Red	48	17294	Yes
Groningen White Headed	77	17338	Yes
Holstein Friesian	4717	123805	No
Lakenvelder	30	1705	No
Maas-Rijn-IJssel	244	22052	No
Verbeterd Roodbont	13	1190	No
Witrik	12	3406	No



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Genetic management

- Small effective population size
  - High inbreeding rate
  - Loss of genetic diversity
  - Inbreeding depression and genetic defects
- Gene bank can help
  - More sires available
    - Larger N_e
  - Generation length increases
- How effective?

Theory and Practice

- When only current gene bank semen is used to inseminate all females for ever

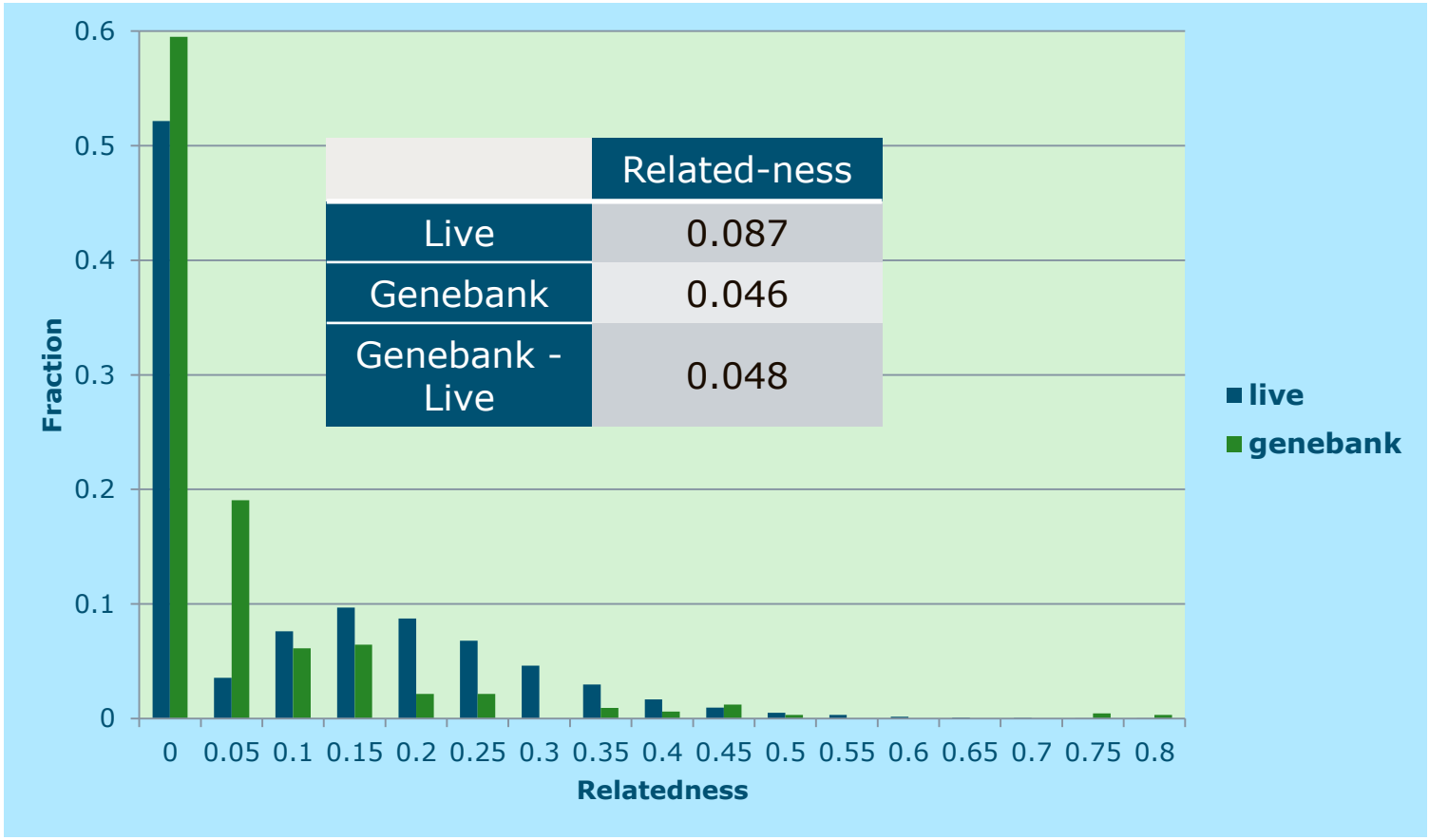
  Sonesson et al. 2002
  Genet. Res. 80: 27

  - F asymptotes to $1/2n_{sires}$
  - Delta F becomes 0
  - Generation length indefinite
  - Only genetic diversity in gene bank will be conserved
- Practice
  - Gene bank sires related and inbred
    - Higher F in the end
  - Stochastic variation
  - Living sires will be used as well
  - Semen stock not indefinite

Test based on real population

- Computer simulation
  - Brandrode Cattle
- Live population
  - About 1100 Animals
  - About 80 bulls available for breeding
  - In about 20 larger herds
  - Many small herds (<20 cows)
- Gene Bank
  - 34 Bulls available for AI
- Inbreeding and relatedness determined
  - Combination of SNP and pedigree data
  - All genebank bulls typed

Relatedness



	Related-ness
Live	0.087
Genebank	0.046
Genebank - Live	0.048

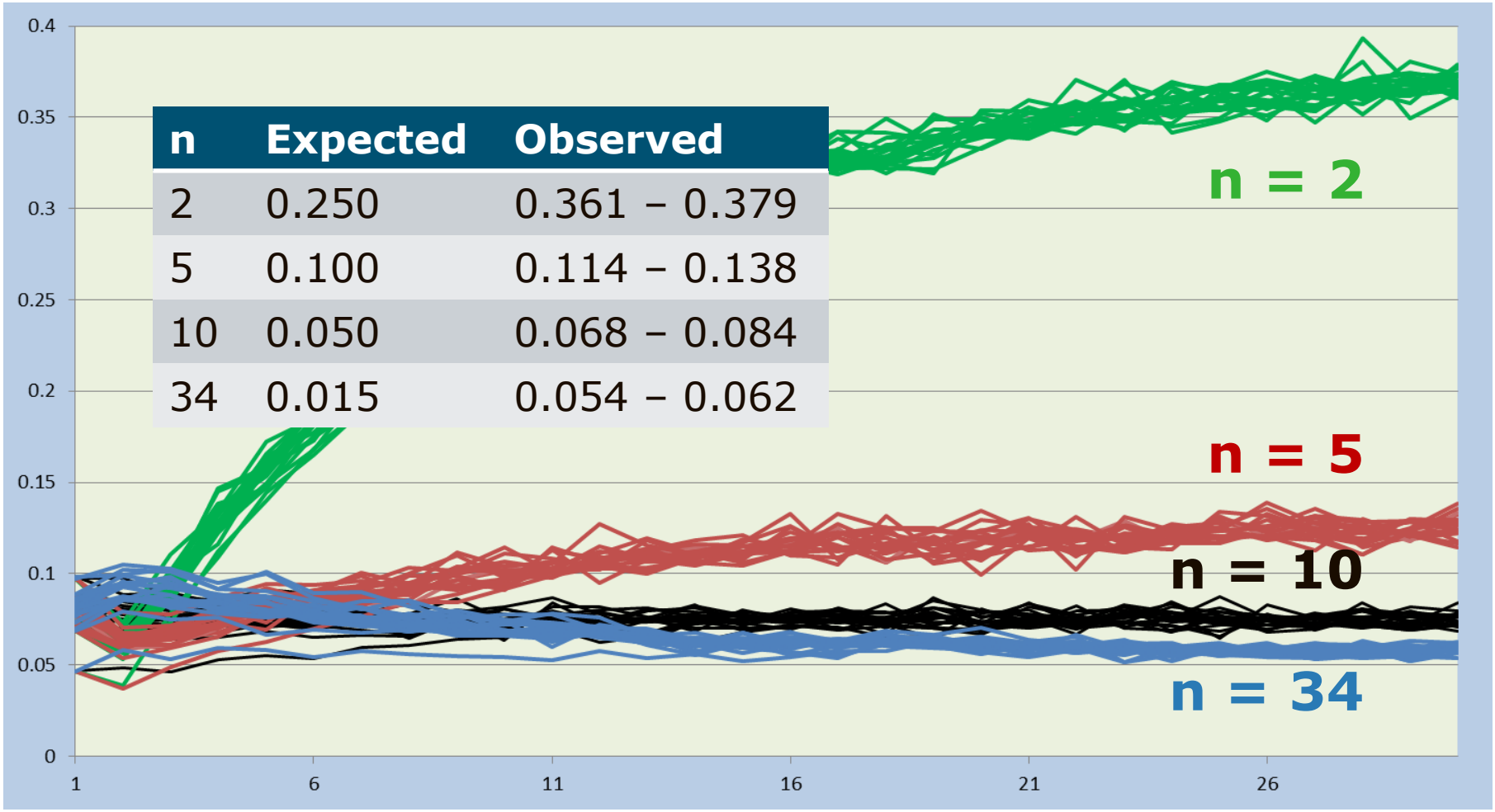
- Average relatedness among genebank bulls slightly lower than live population

Computer simulations

Windig & Oldenbroek (2015)
J. Anim. Breed. Genet. · April 2015 early view online

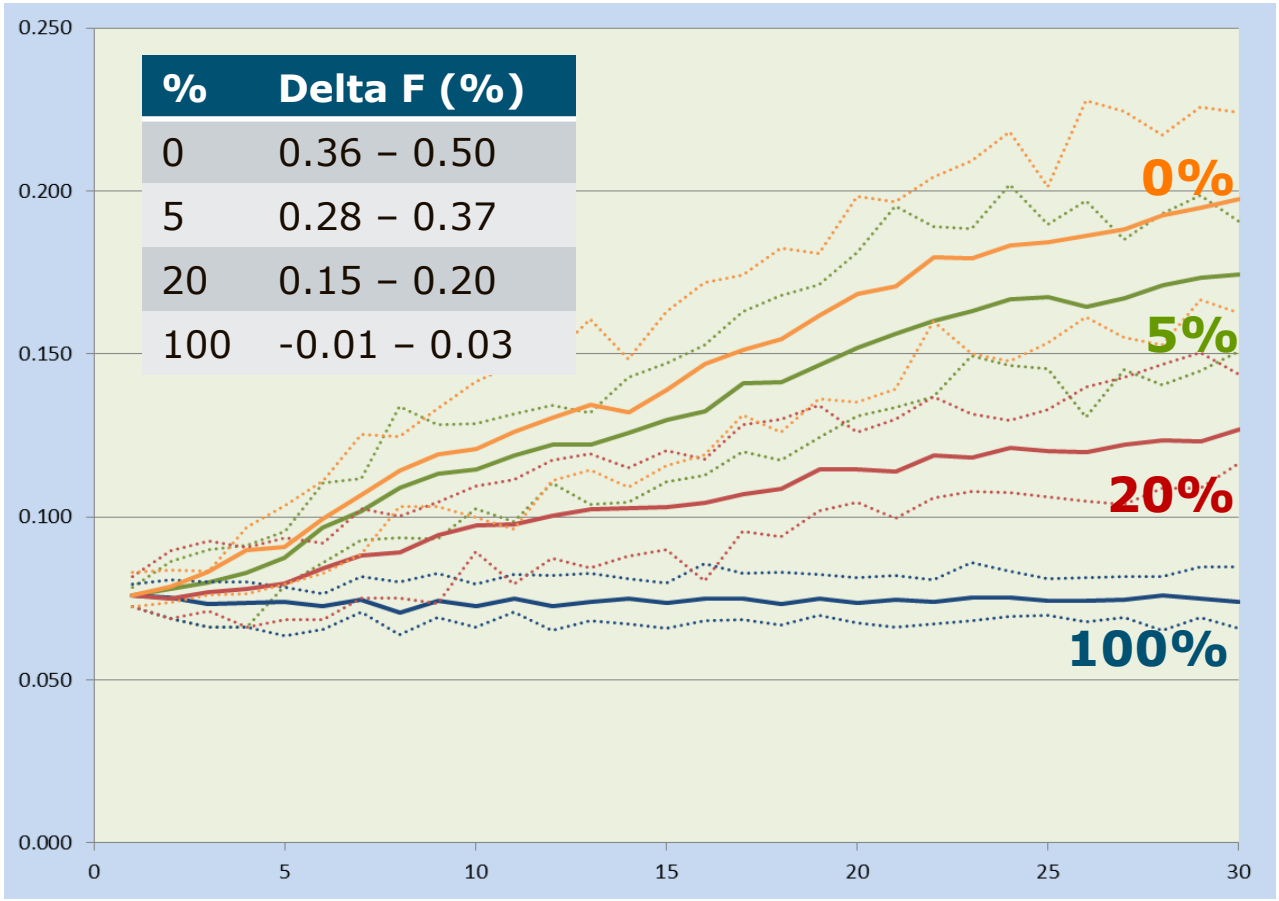
- Brandrode population simulated
  - First year real population
  - Next 30 years with genebank use
  - 20 runs to determine variation
- Gene-bank
  - Remains constant for 30 years
- Scenario's
  - Only genebank bulls (each bull same chance)
    - n=2, 5, 10 or 34
  - Ten genebank bulls and bulls live population
    - 100%, 20%, 5%, 0% gene bank bulls

Simulation results: only genebank sires



n	Expected	Observed
2	0.250	0.361 – 0.379
5	0.100	0.114 – 0.138
10	0.050	0.068 – 0.084
34	0.015	0.054 – 0.062

Simulations: fraction sired by gene bank bulls



%	Delta F (%)
0	0.36 – 0.50
5	0.28 – 0.37
20	0.15 – 0.20
100	-0.01 – 0.03

- Even moderate use of gene bank material decreases inbreeding rates

Discussion

- Exclusive use of gene bank material freezes the population
  - Inbreeding level stays constant
    - $1/2n_{bulls}$ + fraction due to relatedness bulls
  - Genetic level stays constant
    - Average breeding value of bulls
  - Genetic diversity stays constant
    - Only what is present in the bulls
    - Vital that genetic diversity of the population is captured in the gene bank
  - No adaptation and genetic progress
    - Renewal of gene bank material is needed

Conclusions

- Gene banks can help to manage live populations
- Important how many and which sires in gene bank
- Renewal strategy for gene bank needed

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