EUROPEAN UNION
REFERENCE CENTRE FOR
ENDANGERED
ANIMAL BREEDS

Webinar Series: Breeding Wisely
Strategies to Reduce Inbreeding

The webinar will start shortly – thank you for your patience


info@eurc-eab.eu


www.eurc-eab.eu

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Webinar Series: Breeding Wisely
Strategies to reduce inbreeding

Coralie Danchin, Jan ten Napel, Marije Steensma, Mirjam Spoelstra

24-06-2025

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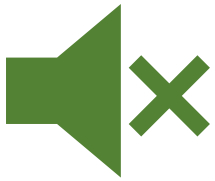
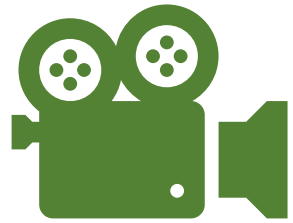
Before we start...



Microphones and cameras are automatically turned off

You can put your questions in the chat



Meeting will be recorded

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Scope of the EURC-EAB

Responsible for the scientific and technical contribution to the establishment and harmonisation of methods for the preservation of endangered breeds, and the preservation of the genetic diversity existing within those breeds

Endangered breeds of Bovine, Porcine, Ovine, Caprine, Equine species





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Outcrossing as a method to introduce genetic variation

Crossing or not crossing, that is the question

24/06/2025, Coralie DANCHIN, IDELE, France

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Previously….

Webinar Series: Breeding Wisely
Measuring and monitoring inbreeding

M. A. Schoon, J. J. Windig, M. Spoelstra

27-05-2025

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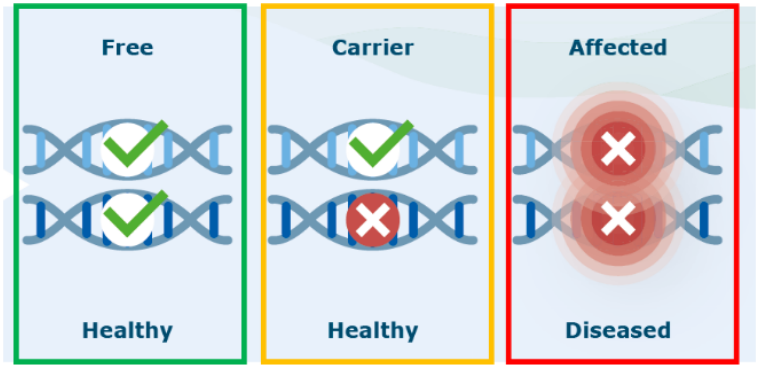
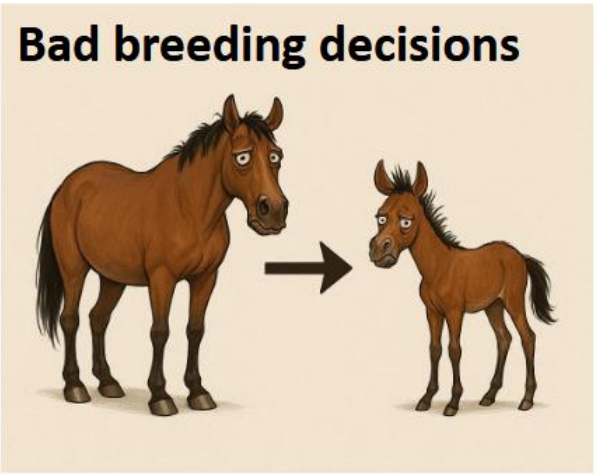
Previously….

- What is inbreeding and what are the risks?
- How to measure and monitor inbreeding
- Strategies to reduce inbreeding





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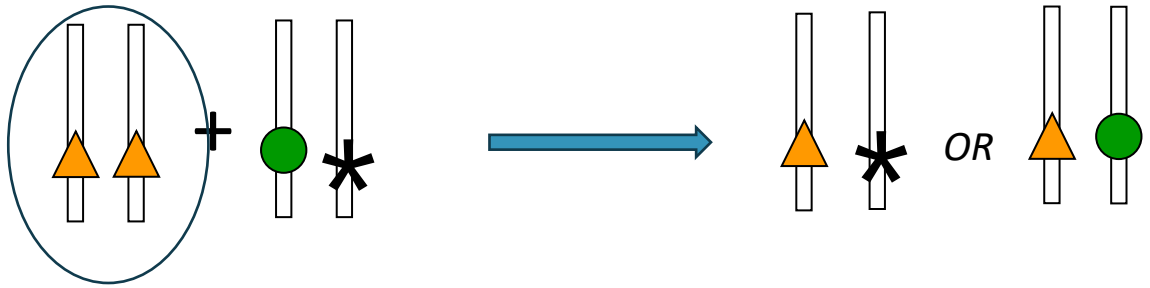
What are the motivations for outcrossing?

✓ **Limiting** the risks associated with inbreeding due to the limited population size



Inbreeding depression= proven negative impact on selection traits

Genetic abnormalities= creation of animals homozygous for abnormal mutations

✓ **Quickly** boost performance for one or more traits of interest

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An easy solution…numerous pitfalls

Strong consensus needed in the breeding organisation

Choice of breed for cross-breeding

?

?

Consensus on **trait(s)** to improve (if reason for cross breeding)

What is the breed's current assessment of the trait?

Loss of the endangered breeds' **subsidies** for the 3 first generations of animals

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An easy solution…numerous pitfalls

Clear management of the outcrossing needed

Definition of when an animal becomes purebred / EU regulation

Pedigree recording of the outcrossed animals over time

Definition of the animals to be integrated in the breeding program

Strategy on the number of animals to be outcrossed

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Cross-breeding, a source of controversy

- Identity loss of the breed

Example: German cattle breeds - cross-bred vs. pure bred breed

- Loss of… genetic variability!

Example: Abondance breed (France)

In the eighties: crossbreeding with the red Holstein

In the nineties: eradication of the red Holstein genes and associated origins

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Key messages

- Outcrossing should be a **last resort** in a breeding program

- It needs a **strong** breeding organisation and consensus to work out

- Term dependant on **generation interval**

Example: Baudet du Poitou

Started in the eighties, first F4 animals… nowadays

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Using mean kinship to optimize long-term genetic diversity

About control of inbreeding in practice

24th June, 2025 – Jan ten Napel

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Controlling the rate of inbreeding

- Aim is to keep rate of inbreeding below 0.5% per generation; below 0.25% per generation would be ideal
- What do you need to do?
  - Select every generation sufficient young breeding stock
  - Select animals that are as unrelated as possible
  - Limit the impact of a single individual on the next generation

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As unrelated as possible

- From outside the population: outcross
  - Animals from a different population that meet the true type as much as possible
- From within the population: mean kinship (MK) or average genetic relationship
  - Selecting individuals with the lowest MK retains the largest number of families for future generations

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What is mean kinship?

- Mean kinship is the average genetic relationship of an individual with a group of individuals
  - Most common: young animal with all breeding stock alive
  - Aim is to keep the average relationship among breeding stock as low as possible
  - MK class: what is high and what is low?

Animal	MK	Class
Arend	0.0%	1
Alfons	4.7%	5
Akim	3.7%	3

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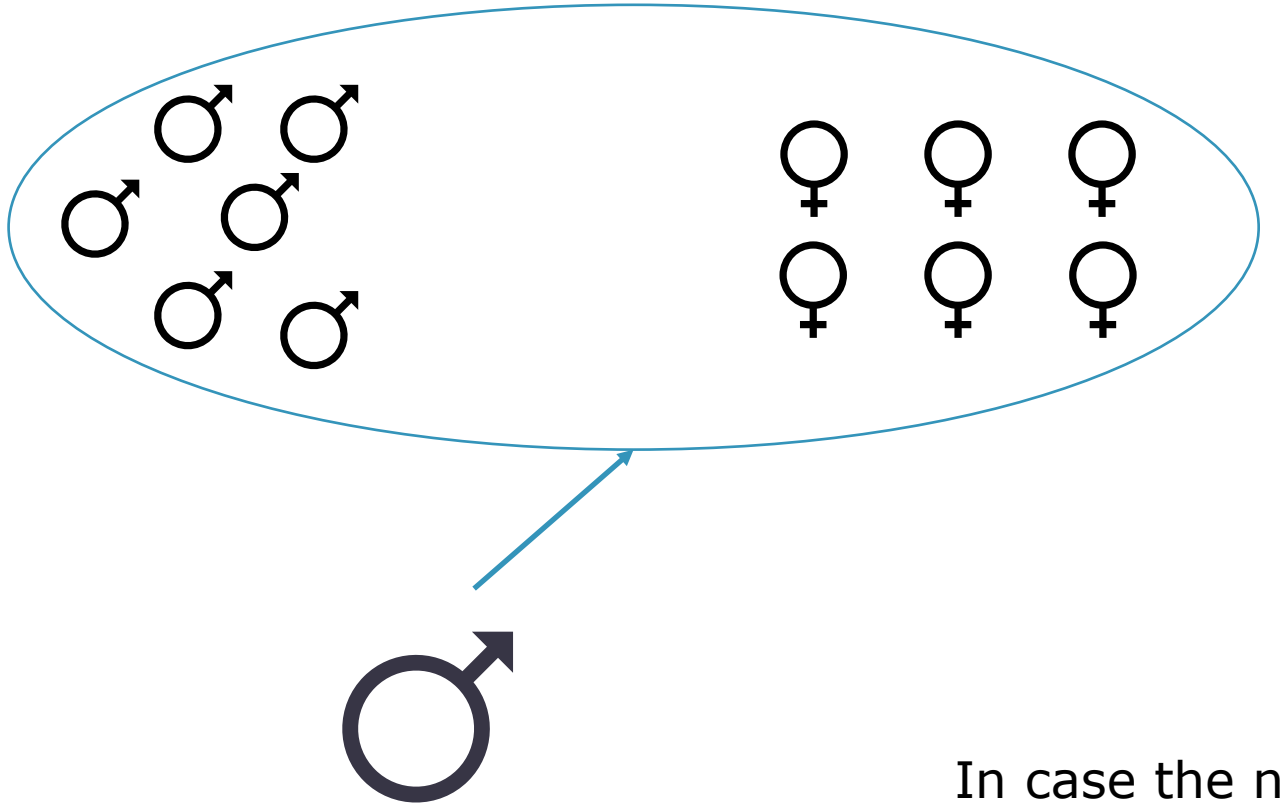
Use of mean kinship with breeding population



In case the number of breeding males and females per generation is largely the same

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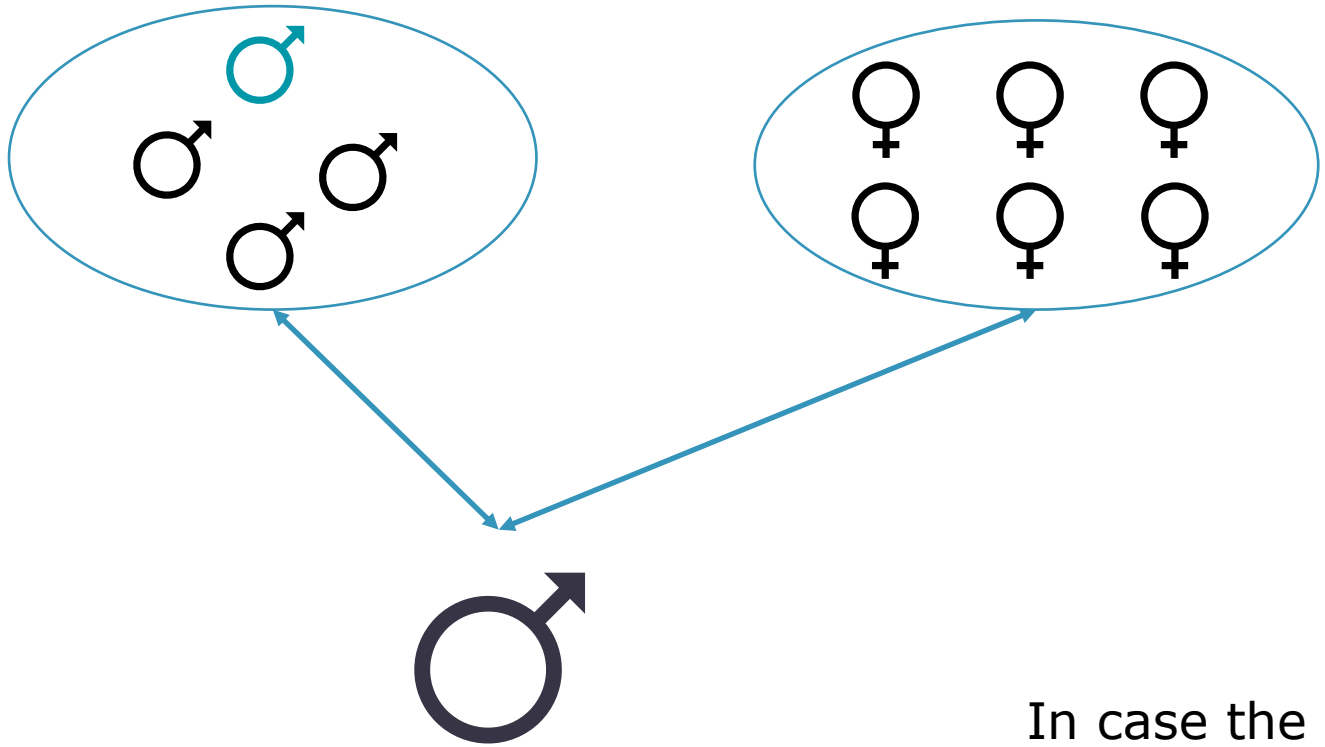
Use of mean kinship by sex



In case the number of breeding males and females per generation are very different

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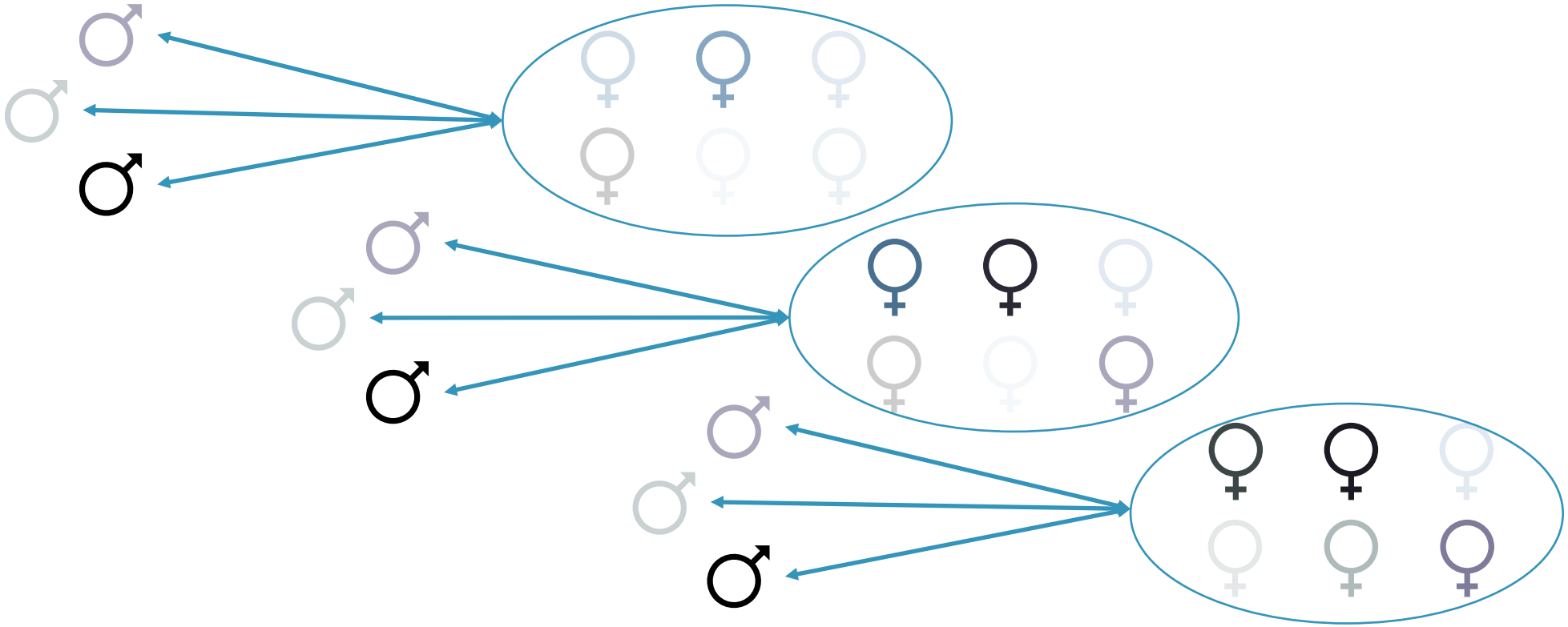
Other applications of mean kinship



Quantifying the impact of sires

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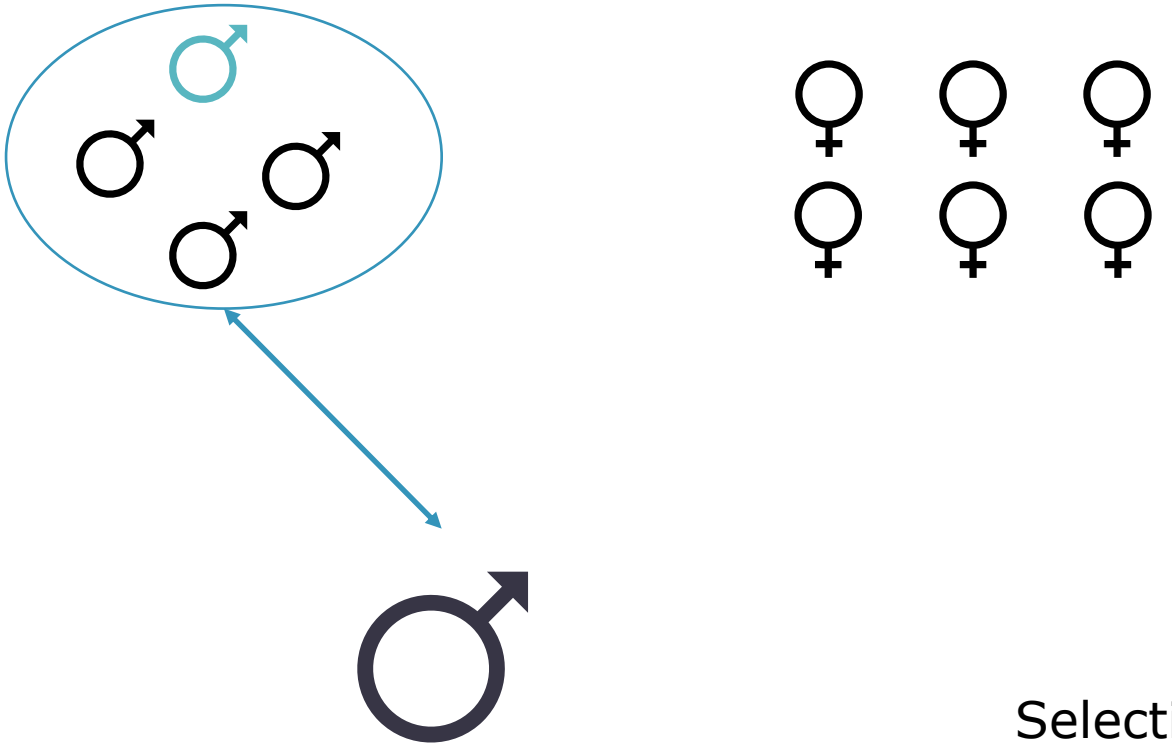
Other applications of mean kinship



Selecting males with potentially many progeny in short period of time (e.g. AI)

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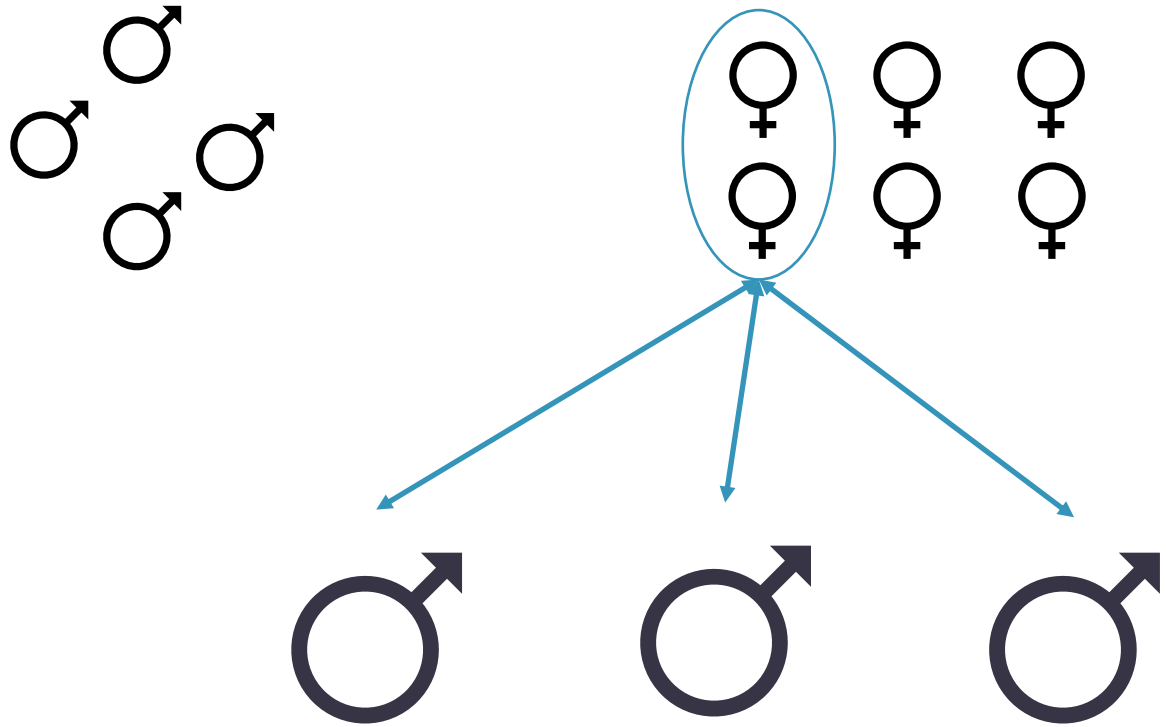
Other applications of mean kinship



Individual breeders looking for a young breeding male to buy

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Mean kinship calculation

Software? info@eurc-eab.eu

- Needed
  - Pedigree with animal, sire and dam of all known generations (1-10)
  - List of individuals (“candidate”; 7-10)
  - List of group (“active”; 1-6)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	A	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		MK	
2	**1**	1	0	0	0.5	0.5	0	0.25	0.25	0.25	0	active	16.67%	
3	**2**	0	1	0	0.5	0.5	0	0.25	0.25	0.25	0	active		
4	**3**	0	0	1	0	0	0	0.5	0.5	0	0	active		
5	**4**	0.5	0.5	0	1	0.5	0	0.5	0.5	0.25	0	active		
6	**5**	0.5	0.5	0	0.5	1	0	0.25	0.25	0.5	0	active		
7	**6**	0	0	0	0	0	1	0	0	0.5	0	active		
8	**7**	0.25	0.25	0.5	0.5	0.25	0	1	0.5	0.125	0	candidate	14.58%	
9	**8**	0.25	0.25	0.5	0.5	0.25	0	0.5	1	0.125	0	candidate	14.58%	
10	**9**	0.25	0.25	0	0.25	0.5	0.5	0.125	0.125	1	0	candidate	14.58%	
11	**10**	0	0	0	0	0	0	0	0	0	1	candidate	0.00%	
12														

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Selection with mean kinship in practice

- Step 1. Exclude runts and animals with a congenital defect
- Step 2. Calculate mean kinship for remaining candidates with breeding population
- Step 3. For each selection candidate: balance the value for breed-specific characteristics and its mean kinship
- Step 4. Give more weight to low mean kinship if it is likely that the breeding animal will have many progeny

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Making it work in real life

- Selection and control of inbreeding consist of a very large number of small decisions taken by a large number of people (and nobody else is watching)

- What is needed?

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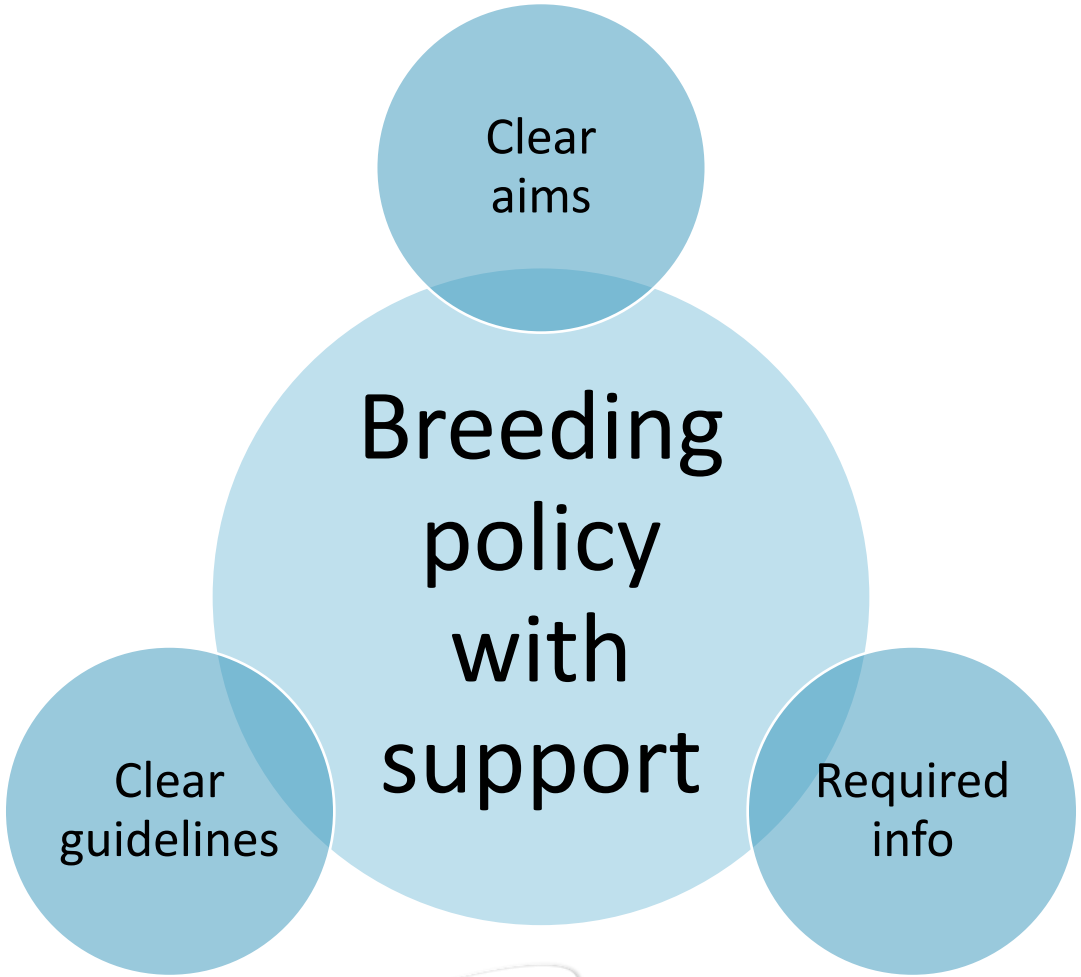
Breeders know exactly what to do



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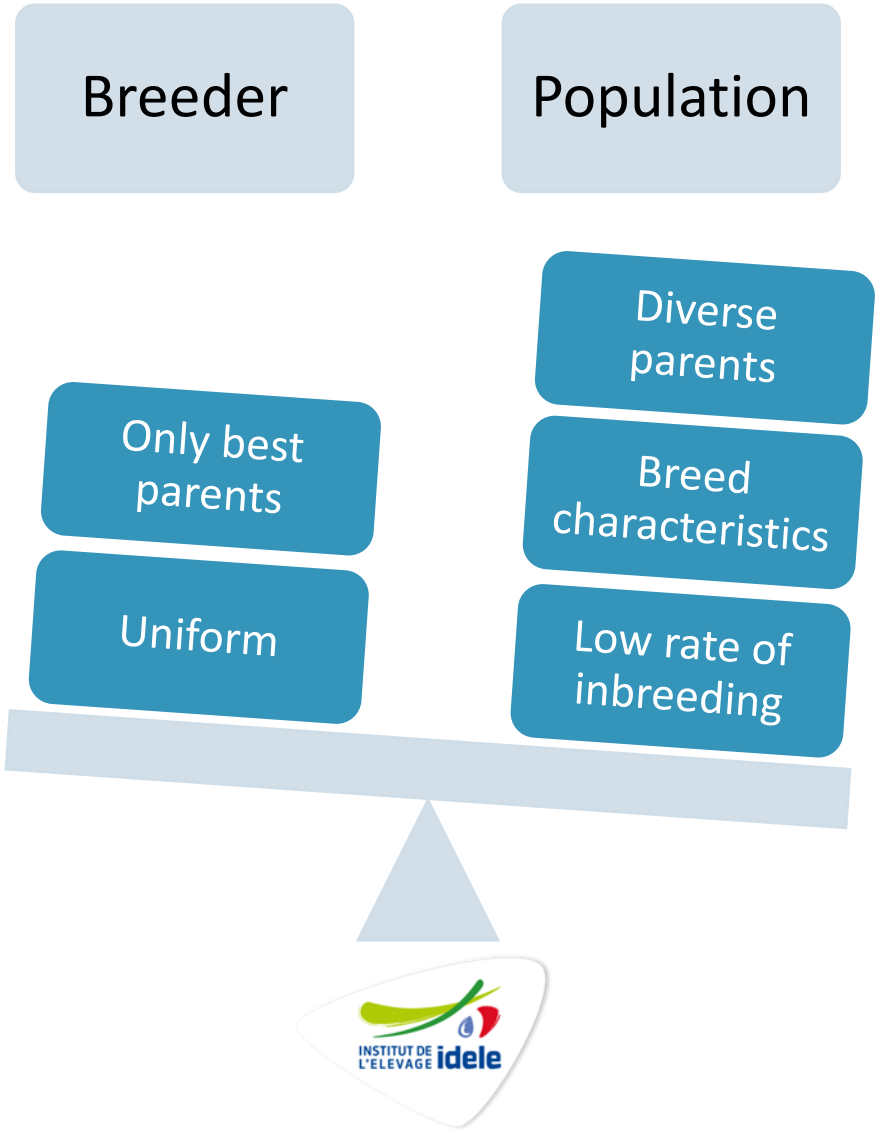
Breeders are highly motivated



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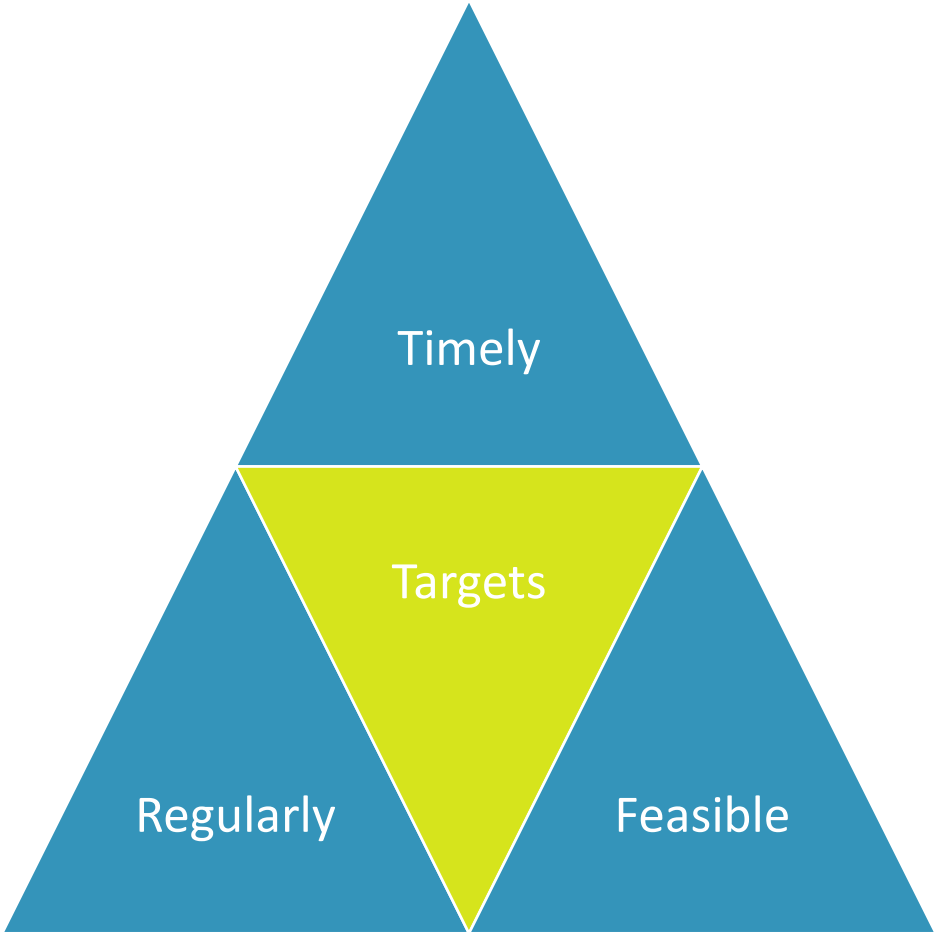
Breeders receive feedback



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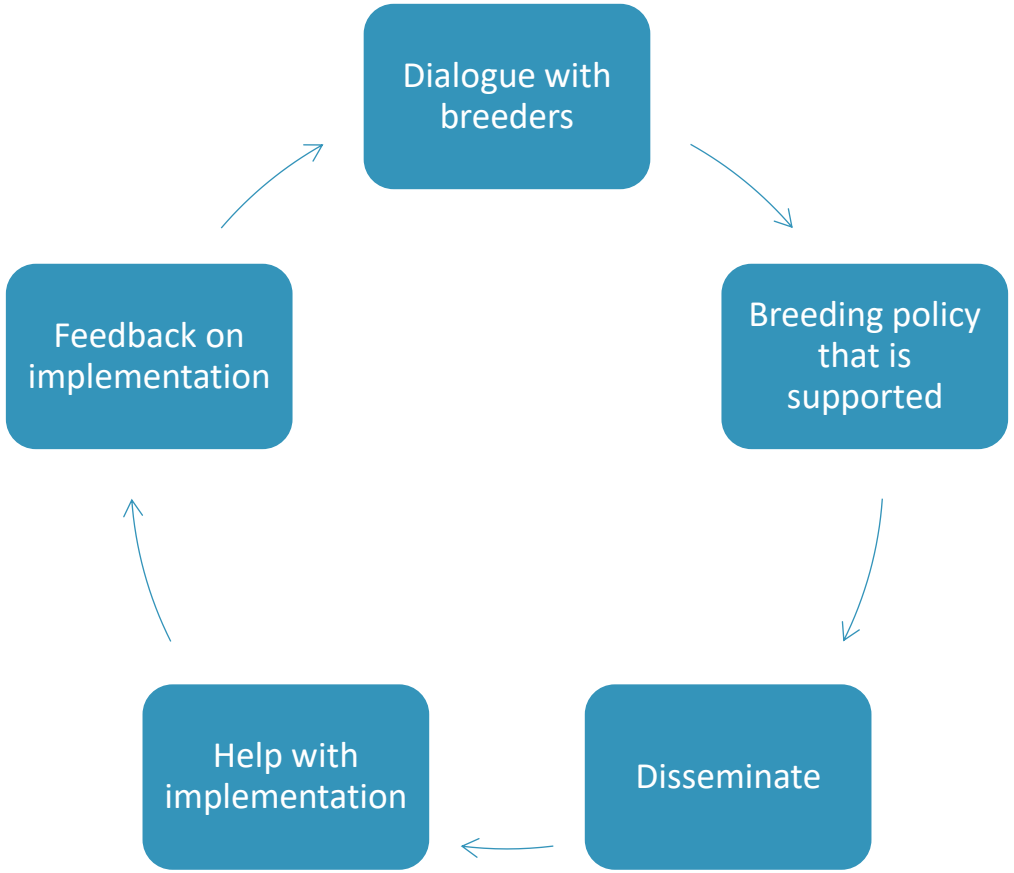
Role of board and technical committee of breed organisation



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My message

- Selection of better animals implies a larger effort to control the rate of inbreeding
- Selection of breeding stock with a low MK works, so use it well!
- Breeding is a human effort, so involve individual breeders in the process!

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Breeding limits, when are they effective?

Examples in the Friesian horse and Mergelland sheep

24-06-2025, Marije Steensma

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Ideal population

- Large number of fathers
- Large number of mothers
- Same number of offspring per breeding animal

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Friesian horse population (in theory)

- 90 approved breeding sires deliver 3,500 foals/year

ΔF = 1/8Nm + 1/8Nf

Nm = number of breeding sires (N = 90)

Nf = number of breeding mares (N = 3,500)

ΔF = 1/(8*90) + 1/(8*3500) = 0.14% per generation **<0.5%**

Assumption: every parent delivers the same number of offspring and there is no selection

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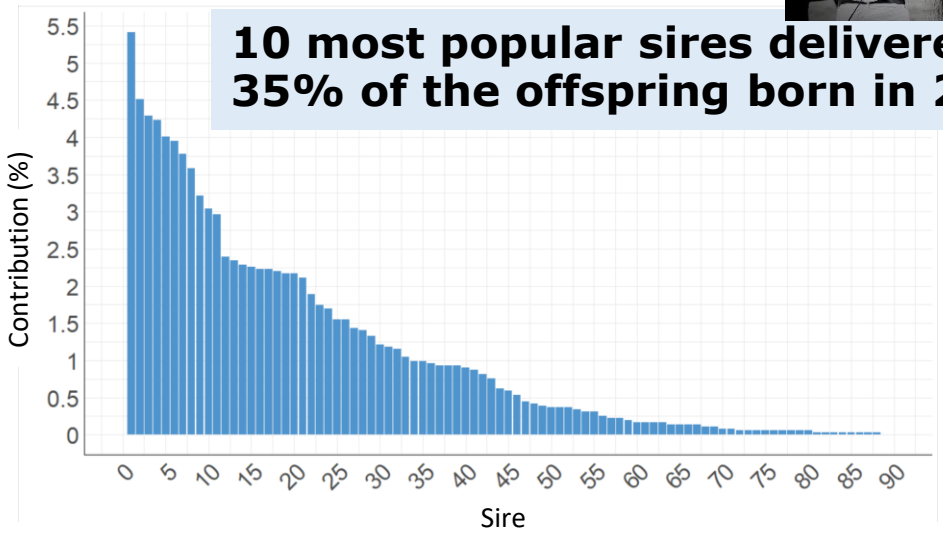
Friesian horse population (in practice)

- Current inbreeding rate 0.72% per generation
  - Selection
  - Breeders want a “champion”

>0.5%

10 most popular sires delivered 35% of the offspring born in 2022



- Correct the skewed distribution in use of sires → breeding limits

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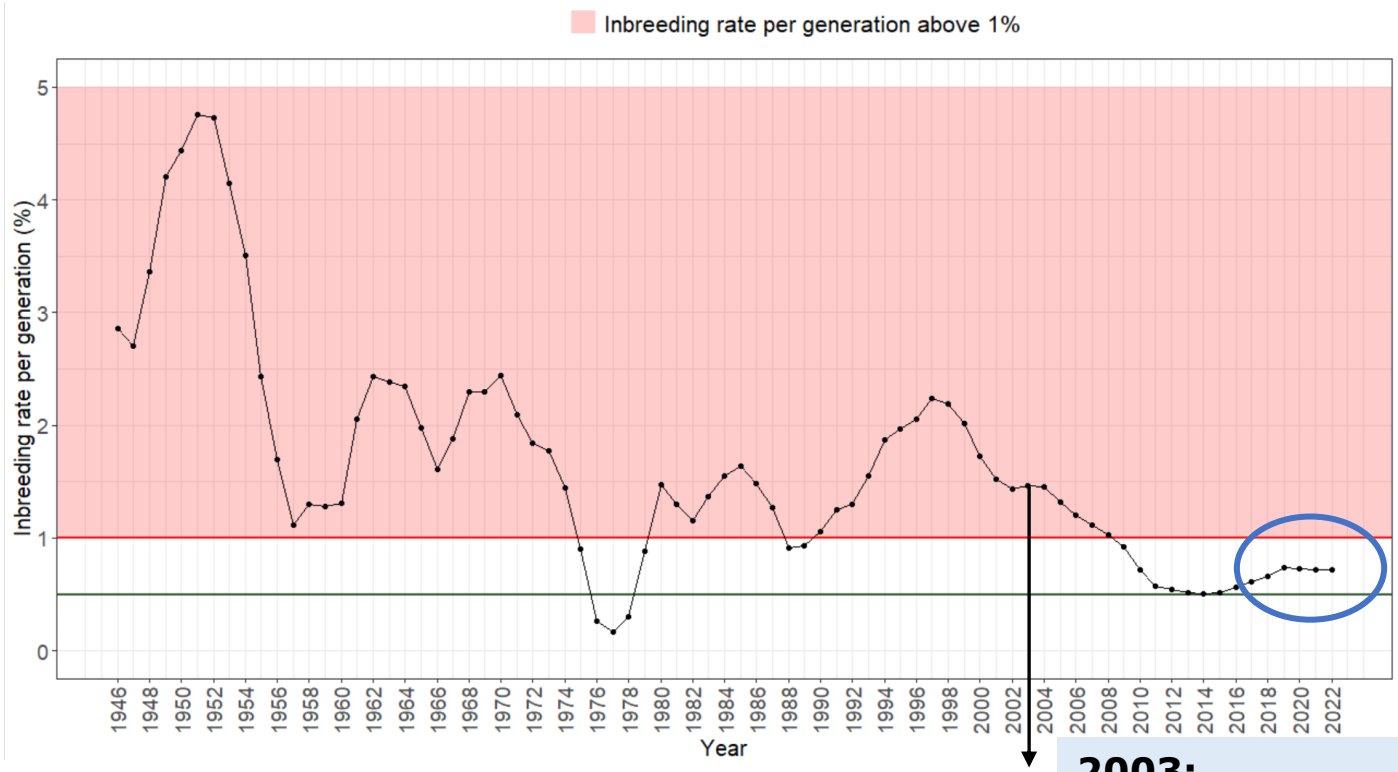
Breeding limits effective in Friesian horse



2003:
- Breeding limit of max. 180 matings/year/sire
- Publication of kinships

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Breeding limits in numbers or %

- **2002 – 2009:** more than 6,000 foals born per year
- **From 2017 onwards:** 4,000 foals born per year

- Breeding limit of 180 matings based on 6,000 foals per year
  - Maximum contribution sire = 3%
  - 4,000 foals/year results in a maximum contribution of 4.5% per sire

  (with a breeding limit of 180)

Maximum contribution sire of 3% with 4,000 foals → breeding limit of 120 matings/year/sire

- Breeding limit in % → correct for the number of offspring born per year

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Inbreeding control in Mergelland sheep

- 830 adult female animals, ~400 offspring per year
- Top 10 sires deliver ~60% of all offspring in 2022

Measure	Inbreeding rate per generation (simulated)
No restrictions	0,89%

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Current breeding limit: 6 sons per sire	**0,85%**

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Breeding limit for entire lifespan	
Breeding limit: 50 matings per sire	0,66%

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Minimalize inbreeding in the offspring	**0,60% only short-term effect!**

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Breeding limit for entire lifespan	
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Breeding limit: 10 matings per sire	0,45%
Minimalize inbreeding in the offspring	0,60% only short-term effect!
Mean kinship	0,39%

Breeding limit for entire lifespan:
sire will be faster replaced by its son

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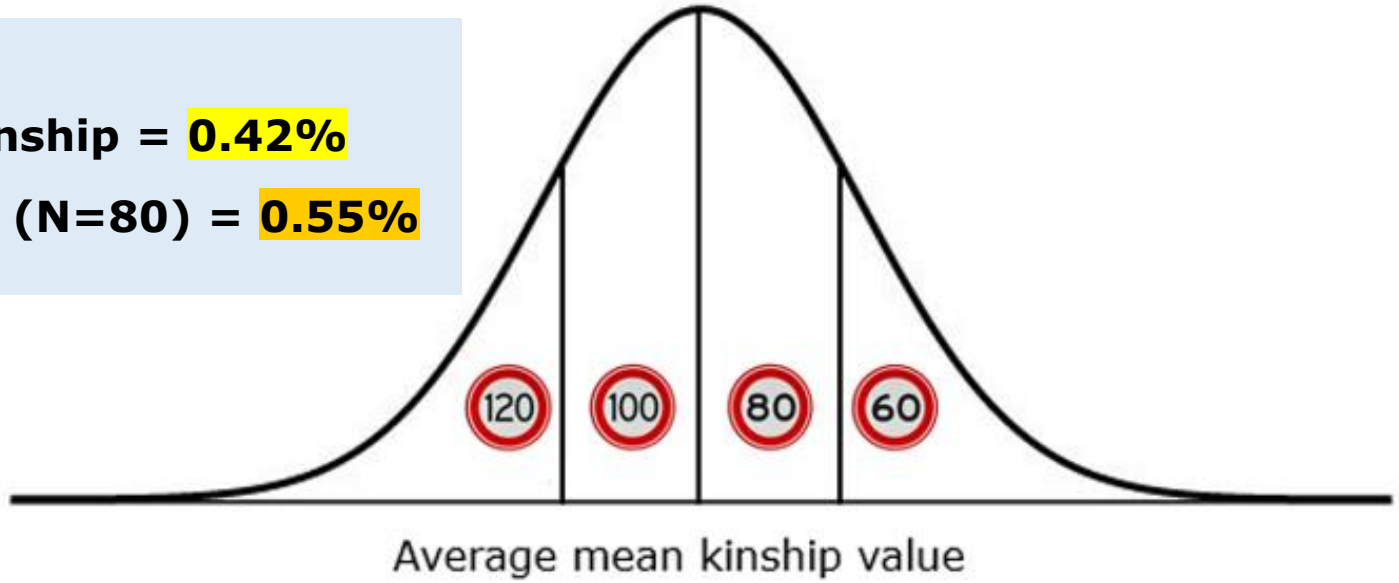
Breeding limit/year based on mean kinship

- Sire with higher mean kinship: stricter breeding limit
- Sire with lower mean kinship: less strict breeding limit

Effect inbreeding rate per generation:

- **4 classes breeding limits based on mean kinship = 0.42%**
- **General breeding limit per year for all sires (N=80) = 0.55%**



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Take home message

- Breeding limit effect if skewed distribution of sires
- Breeding limit in % corrects for variation in number of offspring born
- Breeding limit/year based on mean kinship seems most effective

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Thank you for your joining

Questions? Please put them in the chat





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Webinar Series: Breeding Wisely

Registration form

Webinar 3: Balanced Breeding Programmes for Endangered Breeds

Date & time: 2nd of October 12:00-12:45

Webinar 4: Breeding Programme Assessment Tool

Date & time to be determined

All webinars will be recorded

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