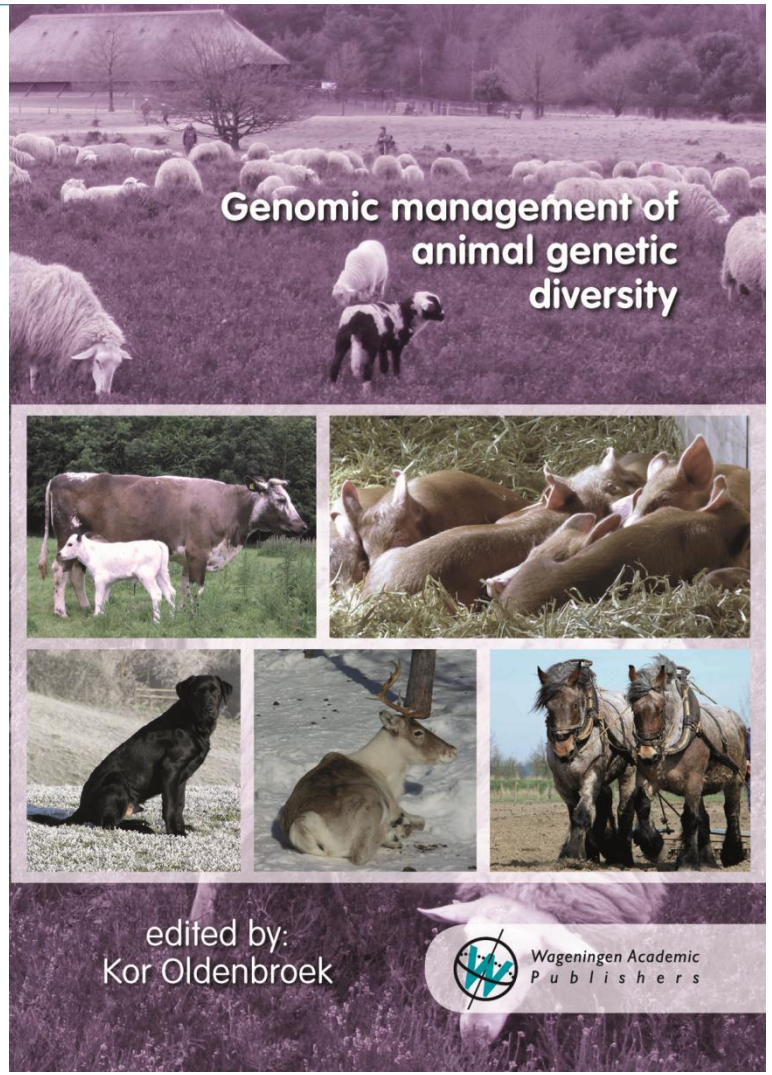
Genomic management of animal genetic diversity

- 15.00 hrs Welcome by Roel Veerkamp
- 15.05 hrs Kor Oldenbroek: Introduction & challenges
- 15.20 hrs Jesús Fernández: Genomic tools to define genetic diversity
- 15.35 hrs Theo Meuwissen: Breeding programs
- 15.50 hrs Peer Berg: Genebanks in the genomics ERA
- 16.05 hrs Jack Windig: Genomics to improve dog health
- 16.20 hrs Book presentation



Definitions

- **Genomics** is the detailed analysis of the DNA of an animal with high-troughput techniques (DNA-chips) from 10.000 SNPs (10k) > Whole Genome Scan (WGS)

- **Management** (in animal breeding) is: 1) the choice of the animals as parents for the next generation, 2) the choice of the sires and of dams for the individual matings and 3) the number of offspring each parent may produce

- **Genetic diversity** is the set of differences between species, breeds within species, and individuals within breeds expressed as a consequence of differences in their DNA

Genetic diversity is important .....

- Within a species and within a breed for **natural selection** that leads to adaptation to climate change, higher disease resistance and results in robust and fertile animals

- Between breeds for the choice of the right breed in the right livestock system and of efficient crossbreeding

- Within breeds it determines the efficiency of **artificial selection** and will diminish the occurrence of inbreeding effects: the expression of genetic defects and the decrease in health and fertility traits

Genetic diversity issues in animal populations in the genomic era

First chapter in the book:

"Genomic management of animal genetic diversity"

Kor Oldenbroek, CGN and John Woolliams, Edinburgh University

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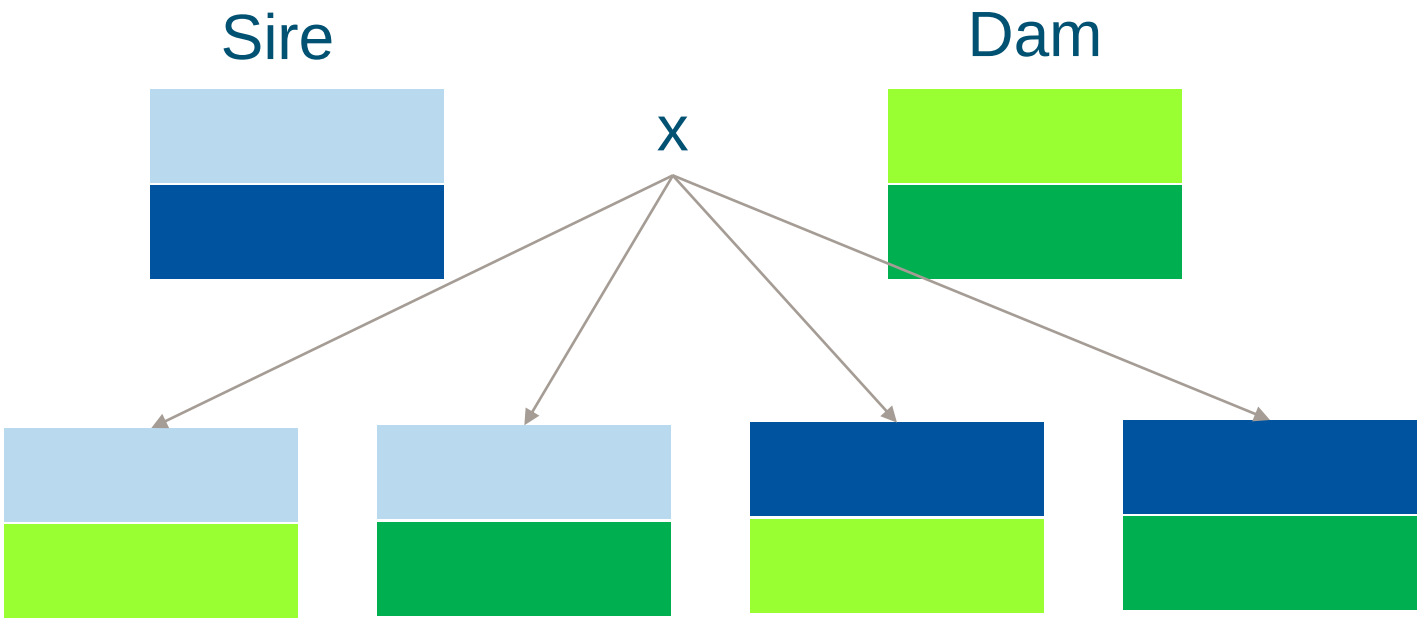
Centre for Genetic Resources, the Netherlands

Genomics: Mendelian sampling visible by DNA analysis

DNA

- Present in two copies (pairs of chromosomes)
- Always 50% submitted by the dam and 50% by the sire
- A random process determines which part from the sire and from the dam



Genomics determines which part from the sire and which part from the dam!

Use of knowledge on Mendelian sampling

- Improving pedigree quality (verifying pedigrees)
- A more accurate estimation of genetic relationships
- More effective use of genetic variation to obtain genetic gain (optimising gain and inbreeding)
- Identifying carriers of deleterious alleles
- Identifying carriers of interesting positive alleles or QTLs

Conservation of genetic diversity: past and future

- Past: Decisions based on pedigree and phenotypic information

  Genebank collections optimised based on pedigrees

- Genomics era: Decisions based on DNA information (SNPs en WGS) and phenotypic information

  Genebank collections optimised based on DNA-relationships

  Detection of interesting QTL's (link with QTL databases)

>> Compose core collection more efficient and is better characterised

Animal QTL databases under development

Species	Number of QTL's	Publications	Traits
Cattle	81652	710	519
Pig	16033	557	627
Chicken	5683	250	335
Horse	1197	66	41
Sheep	1336	119	212

Utilisation of genetic diversity: past and future

- Past: BV estimated based on pedigree and phenotypic information

  Selection based on estimated breeding values (EBV)

- Genomics era: BV estimated based on DNA information (SNPs)

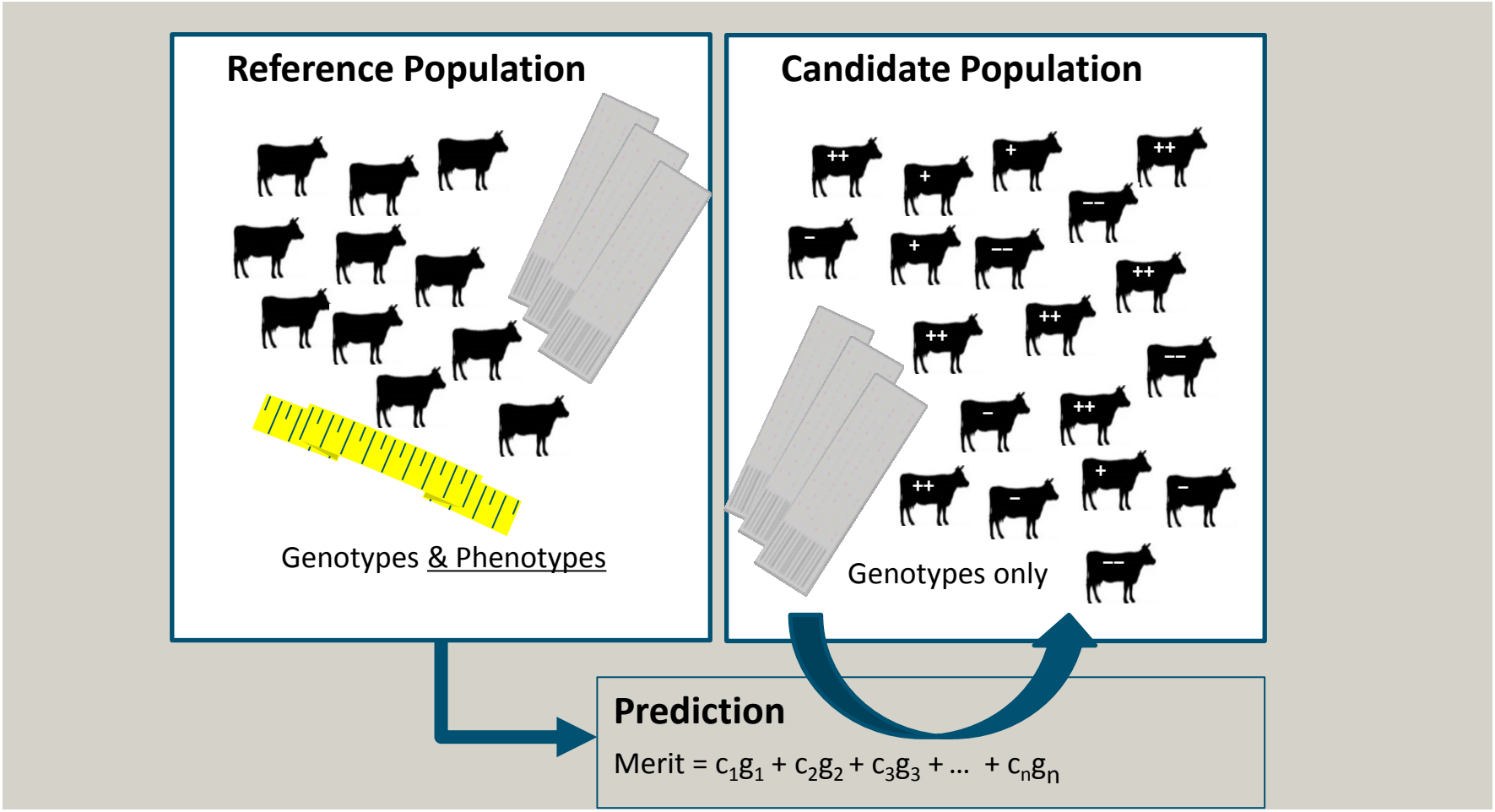
  Phenotypic information still required!

  Selection based on prediction formula with SNP-input

  Detection of heterozygous carriers of recessive lethal alleles

>> Genomic selection possible at a young age of the animals

Genomic selection



Genetic defects: source OMIA,

- Genomics: carriers of recessive genetic defects can be detected

Species	Total defects	Monogenic	Mutation known
Dog	686	285	211
Horse	226	51	37
Cattle	502	231	132
Pig	247	66	31
Sheep	241	100	47
Goat	81	16	10
Chicken	212	129	43

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Threats of genomics to genetic diversity

- Concentration on mainstream breeds through GS
- Achieving a high accuracy in genomic selection: this accuracy depends of the relationship between the reference population (past parents) and the population of candidates (future parents) > less diversity > higher accuracy
- (Too) strict definitions of breeds based on SNP info
- Intense selection against genetic disorders

Challenges: Genomic management of animal genetic diversity

- Genetic diversity issues in animal populations in the genomic era: John Woolliams and Kor Oldenbroek
- Defining genetic diversity based on genomic tools: Jesús Fernández and Jörn Bennewitz
- Genomic diversity in the domestication process: Miika Tapio and Saber Qanbari
- Tracing domestication and selection in animal genomes: Saber Qanbari and Miika Tapio
- Management of genetic diversity including genomic selection in small *in vivo* populations: Theo Meuwissen and Kor Oldenbroek
- Management of cryo-collections with genomics tools: Peer Berg and Jack Windig
- Dog breeds: towards genomic management of populations with a high incidence of genetic defects: Tom Lewis and Jack Windig