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Is There Value in Maintaining Small Populations?

Example Of The Dual-Purpose Belgian Blue Breed

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Context: Genomic Selection and Small Breeds

- **Current thinking in genomic selection:**
  - Major breed (e.g., Holstein) centric
  - Traditional traits
- **Departing from this leads to different related issues:**
  - Lack of large training populations
  - Need for expensive recording of new phenotypes
- **Different lines / breeds?**

Context: Genomic Selection and Small Breeds

- **Current thinking in genomic selection:**
  - Major breed (e.g., Holstein) centric
  - Traditional traits
- **Very important question of this symposium:**

Context: Genomic Selection and Small Breeds

- Current thinking in genomic selection:
  - Major breed (e.g., Holstein) centric
  - Traditional traits
- Very important question of this symposium:

Is There Space for Genomic Selection in Small Populations?

Context: Genomic Selection and Small Breeds

- Current thinking in genomic selection:
  - Major breed (e.g., Holstein) centric
  - Traditional traits
- Very important question of this symposium
- Leads to the follow-up question:

Is There Value in Maintaining Small Populations?

Context: Genomic Selection and Small Breeds

- **Maintaining small populations linked to two major issues:**
  - Making good use of genomic selection
    - → **Adapting genomic prediction methods**
  - Exploring and using their potential for new and currently unexploited genetic variability
    - → **New phenotypes for novel traits**

Example: Dual-Purpose Belgian Blue Breed

- **Belgian Blue Breed**
  - Local breed from region around Brussels to Mid- and High-Belgium and near Belgian Border Area of France

Belgium in Europe

Belgian Blue Breed in Belgium

Dual-Purpose Belgian Blue Breed

- **Belgian Blue Breed**
  - Local breed from region around Brussels to Mid- and High-Belgium and near Belgian Border Area of France
  - Up to 1973, known as "Breed of Mid- and High-Belgium"
  - Renamed to "Belgian Blue Breed"

Dual-Purpose Belgian Blue Breed

- **Belgian Blue Breed**
  - Originally a dual-purpose breed with dairy emphasis
  - 19th century

Dual-Purpose Belgian Blue Breed

- **Belgian Blue Breed**
  - Originally a dual-purpose breed with dairy emphasis
  - 19th century
    - Crossbreeding of
      Shorthorn x Local dairy cows (mostly Friesian type)
    - Explains also the color pattern: Roan ⇒ Blue
      Three colors: White – Blue – Black & White
  - Up to the 1950s
    - At same level of milk production as Friesians

Dual-Purpose Belgian Blue Breed

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    - Moving slowly towards a more beef-type

Dual-Purpose Belgian Blue Breed

- **Belgian Blue Breed**
  - During the 20th century
    - Moving slowly towards a more beef-type
  - From the 1960s many breeders stopped looking for milk production, but not all
  - In 1973 with the name change
    ⇒ two distinct lines:
    - Meat Belgian Blue (M-BBB)
    - Dual-Purpose Belgian Blue (DP-BBB)

Dual-Purpose Belgian Blue Breed

- DP-BBB competition to specialized breeds
  - Milk ⇒ Holstein
  - Meat ⇒ M-BBB
- Very interesting somewhat related to both breeds
  - M-BBB ⇒ historically same breed
    also still same Herdbook (in Belgium)
  - Holstein (Friesians) ⇒ geographic proximity
    some admixture

Dual-Purpose Belgian Blue Breed

- **DP-BBB in Belgium competitive**
  - Market for lean meat
    - High price for DP-BBB calves (>300 €, Holsteins 50 €)
  - No excessive emphasis on milk components
    - DP-BBB lower in fat and protein content, other qualities (softer butter – Ardennes Butter) (?)
- **Despite this tendency to decline**
  - From 100 000 cows to less 5000 (over last 30 yr)
    - Including Flandern and Northern France
    - In France breed called “Bleu du Nord” separated from M-BBB

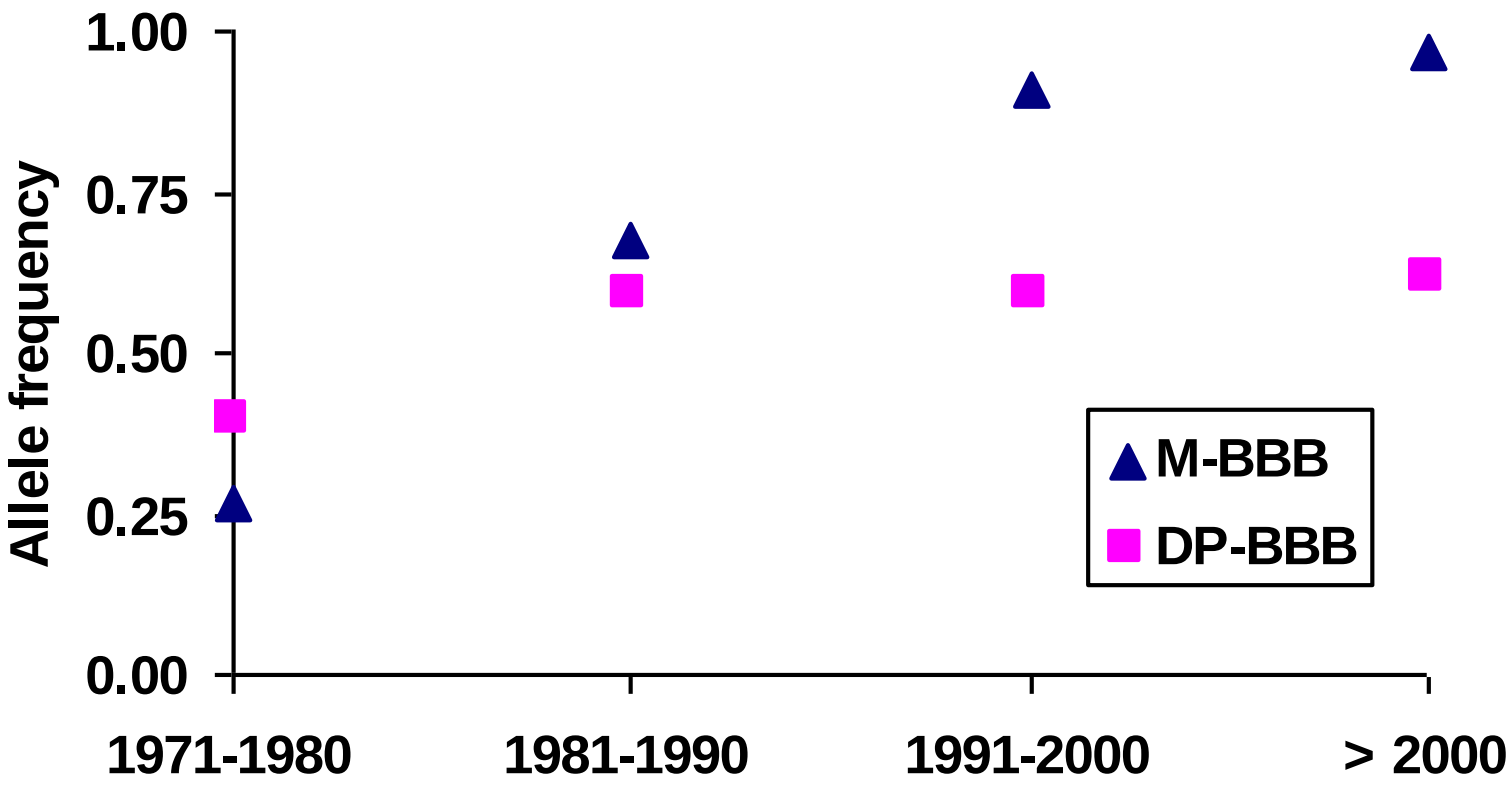
Dual-Purpose Belgian Blue Breed

- **Conversation and breeding programs**
  - First Walloon project, then European (Eureca + BlueSel)
  - Local support for genotyping
- **Now entering the "Genomic Era"!!!**
  - However extreme example how to react to this for a small and quiet different breed
  - This presentation: some insights

Dual-Purpose Belgian Blue Breed

- **Particularity of Belgian Blue**
  - Large presence of Myostatin mutation
  - Myostatin gene
    - Muscle differentiation and growth inhibitor
- **Different mutations in many cattle breeds**
  - Mutate gene called hereafter ‘mh’ (muscular hypertrophy)
  - Allows muscle cells to multiply, often rejected as creates health problems as calving difficulties
- **In Belgian Blue however**
  - Selection for increased muscle mass favored ‘mh’ carriers $\Rightarrow$ fast evolution towards beef breed

Evolution of mh Allele Frequency in BBB



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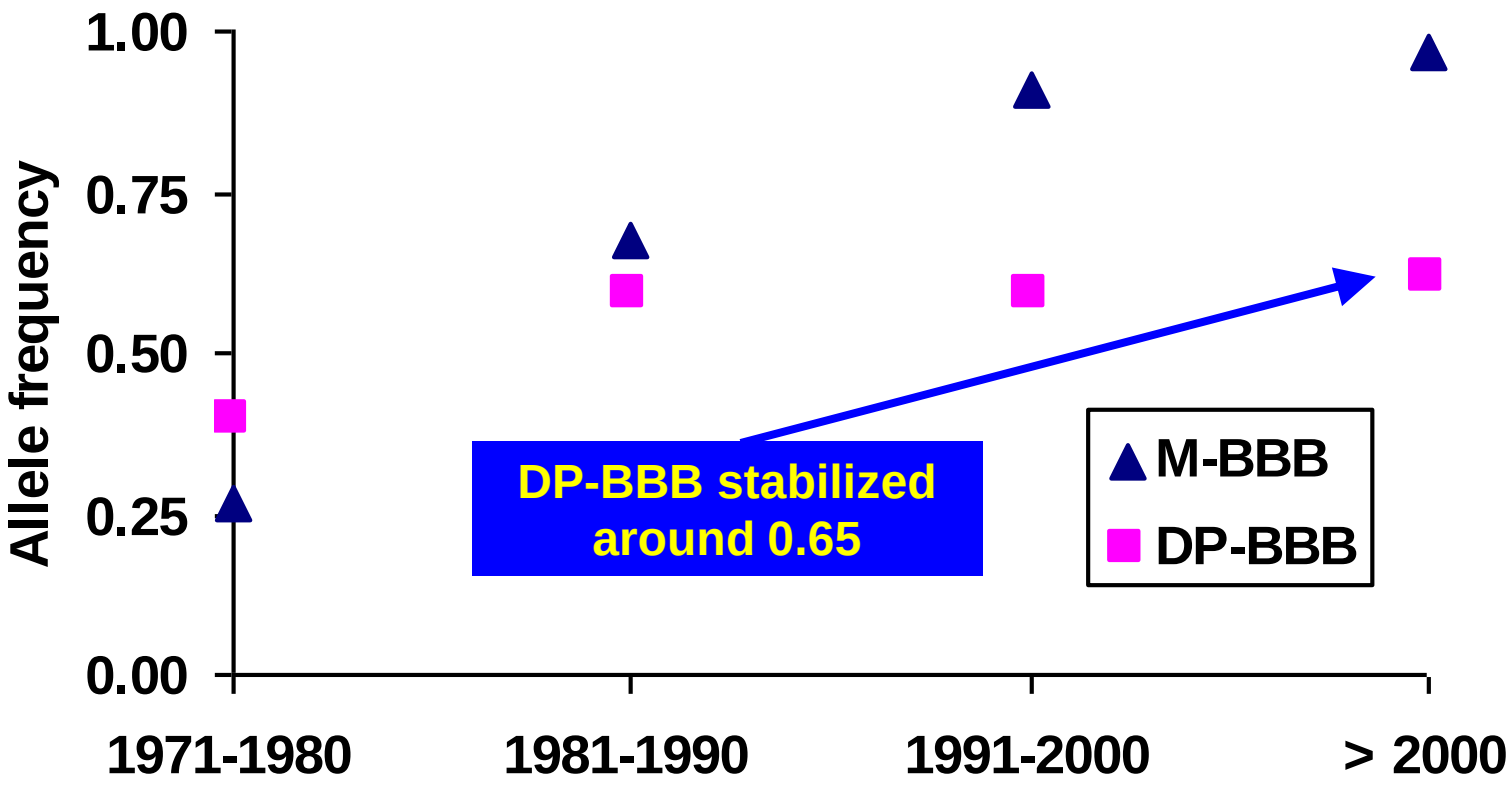

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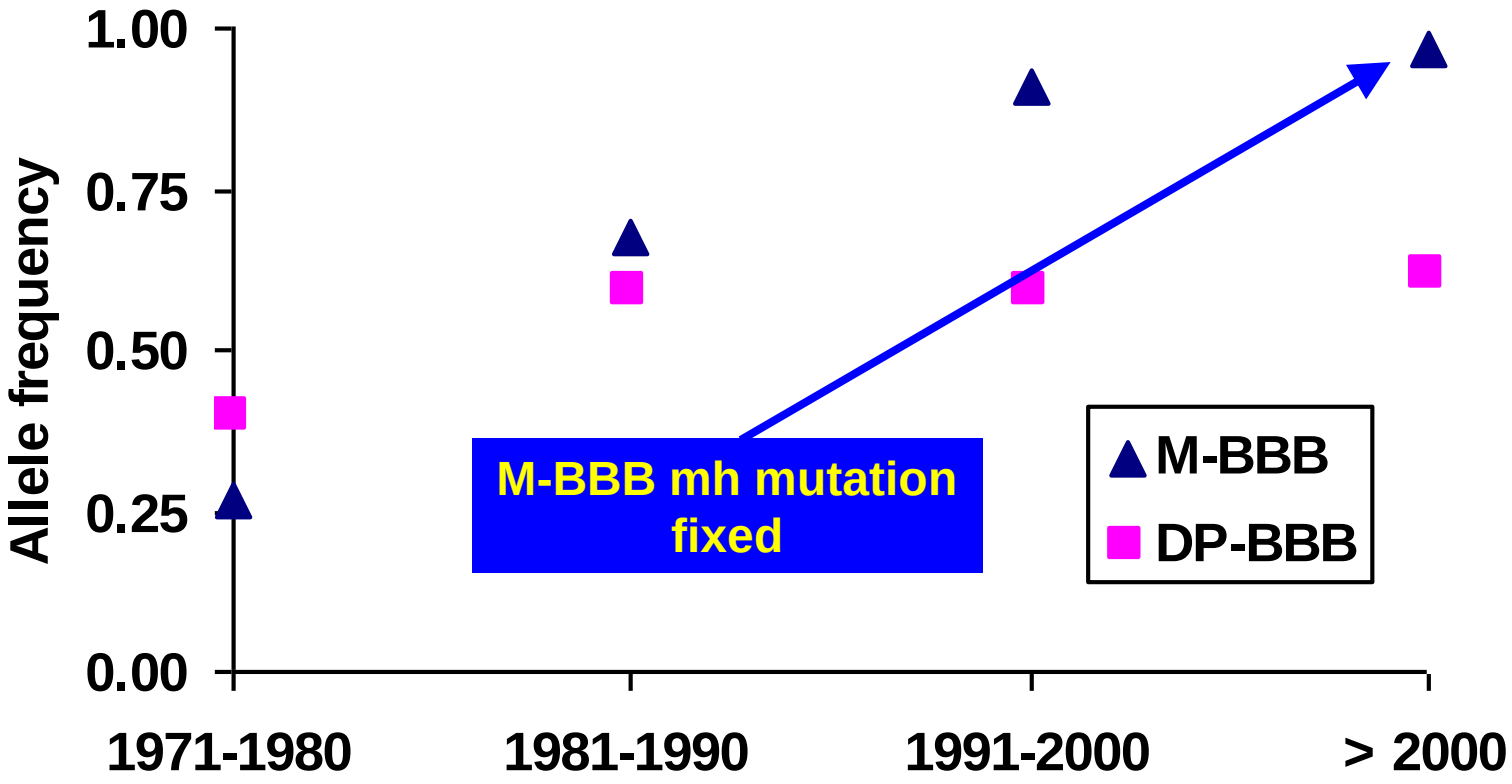

Some Consequences of mh Mutation

- More muscles, obviously
- Also
  - Less fat and more unsaturated fat in meat
  - Question: Also true for milk?
- Since end of 1990s mh mutation known
  - Created controversy in DP-BBB:
    - With or without mh ? also because mh considered having pleiotropic effects on many (not desired) phenotypes
  - Therefore:
    - All DP-BBB sires required to be genotyped for mh

DP-BBB Breed Currently

- Strong muscling and average 4000 kg milk
  - Best cows over 6000 kg milk
- Selection against calving difficulties
  - Genetic evaluation including 'mh' effect
- Mh gene frequent in Walloon DP-BBB, less frequent in Flandern and France
  - Most recent females genotyped for mh
  - Males are required to be genotyped for mh

DP-BBB Breed Currently

- DP-BBB used to molecular information
  - However, misperception about ‘mh’
  - Knowledge of mutation has created sub-types
- Three types and three perception:
  - mh/mh ⇒ beef
  - +/+ ⇒ milk
  - mh/+ ⇒ intermediate

Three DP-BBB Types: mh/mh

Three DP-BBB Types: +/+

Three DP-BBB Types: mh/+

Mother of Clovis: Galbee

Galbee also produces milk!!!

Records in 305 days (kg)

1st lact.	6142	3.83%	3.44%
HL (3L)	7821	3.66%	3.34%
ØL (5L)	7191	3.75%	3.41%

Nicer pictures of similar cows

Nicer pictures of similar cows

DP-BBB: Similarities to (DP Milking) Shorthorns

- Also different lines
  - Some transfer lines DP-BBB ⇒ M-BBB
- Interesting fat / protein ratio
  - Less selected for fat content
- Good fertility
  - DP-BBB much faster in calf again
- Cattle used in low(er)-input systems
  - Most DP-BBB farmers limit their inputs, some run organic farms

50k Genotypes

- **Currently available**
  - 196 sires with on average 63 daughters
- **Under genotyping**
  - 49 other sires
- **Projected**
  - All future AI sires
  - All future natural mating bulls

⇒ **Already plugs in routine mh tests done**

Sequencing, HD and LD chips

- **Sequencing of reference animals**
  - To study selection sweeps to M-BBB but also Holstein (Friesians)
  - DP-BBB linked to both populations
- **Some HD genotyping**
  - Done inside a French project
- **LD (low-cost) chip**
  - To recover relationships between cows of interest with limited pedigree records and breeding population

Adapting Genomic Prediction Methods

- **Multi-step Genomic Prediction**
  - Does not look as best option
  - No meaningful reference population
- **Single-step Genomic Prediction**
  - Most benefits from high proportion of genotyped sires and additional cows
  - More complex models allowed, therefore

→ **Genomic prediction using single-step potentially best option**

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- **Single-step Genomic Prediction**
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  - More complex models allowed
  - Also links to other populations
    ⇒ **multibreed genomic evaluations**

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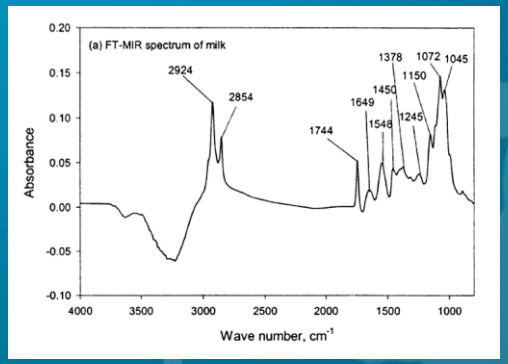
  - No meaningful reference population
- **Single-step Genomic Prediction**
  - Most benefits from high proportion of genotyped sires and additional cows
  - More complex models allowed
  - Potential for multibreed models
  - Also for **novel traits as milk fatty acids**

Getting Common Milk Components

Collection of milk samples

(Foss, 2008)

MIR spectrometer



Raw data = Spectra

Calibration equations

Predictions:

- Fat content
- Protein content
- Urea
- Lactose
- Casein
- Free fatty acids

Novel Traits (e.g., Fatty Acids)

Collection of milk samples

(Foss, 2008)

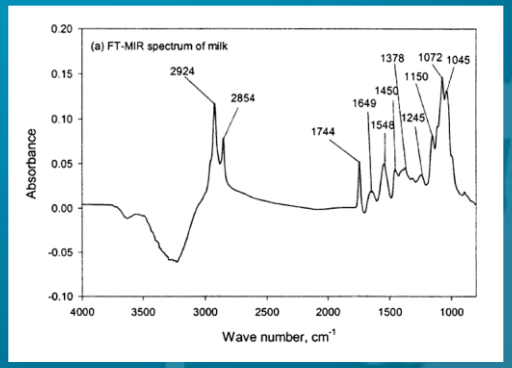
MIR spectrometer

Development of new equations

Calibration equations

New Predictions:

- Fatty acids
- Lactoferrin
- …



Raw data = Spectra

Genetic Evaluation for Milkcomposition

- **Since 2007 > 1 million spectral data records**
  - Southern Belgium (and Luxembourg)
- **Currently**
  - Development for fatty acids in progress
  - Will allow genetic evaluation for Holsteins and DP-BBB for these traits
    - Extension to DP-BBB in Northern France possible
- **For this talk**
  - Small study derived to obtain breed difference

Breed Differences

- First indication DP-BBB > Holstein
  - Based on first results
    Soyeurt et al., 2006 (J. Dairy Sci. 89:4858-4865)
- New study
  - First lactation only, simple ST-RR-TDM
  - 20 traits and trait groups
  - Between 328 330 and 321 764 records
  - 67 328 cows (required to have known sire)
    - Average breed composition: 4% DP-BBB, 89% Holstein and 7% other breeds

Breed Differences - Results

- Expressed in % of average, DP-BBB relative to Holstein
- Traditional traits:
  - Milk yield -27%
  - Fat yield -30% Fat content -4%
  - Protein yield -26% Protein content +2%
- Fatty acids (FA) content by groups
  - Saturated -5%
  - Unsaturated -3%
    - Mono -3%
    - Poly -2%

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Influence of 'mh' Mutation on FA

- **Evidence from beef**
  - E.g., Raes et al., 2001 (Anim. Sci. 73:253–260)
- **Buske et al., 2011**
  - J. Dairy Sci. 94:3687-3692
  - Study based on one herd to avoid confounding effects herd ⇔ genotypes
  - Therefore still preliminary

Influence of 'mh' Mutation on FA

- Expressed in % of average, relative to +/+
- Traditional traits:
  - Milk -3%
  - Fat yield -5% Fat content -2%
  - Protein yield -3% Protein content 0%
- FA content by groups
  - Saturated -2%
  - Monounsat +1%

Conclusions

- **Questions remain difficult to answer!!**
  - **Is there space for genomic selection in small populations?**
  - **Is there value in maintaining small populations?**

Maintaining small populations?

- Interest not only from a conservational background
  - Example of DP-BBB shows potential interest of currently minor breed
  - Gene pool for M-BBB, other breeds
- However requires specific economic situation
  - Including economic potential for new and currently unexploited genetic variability
  - Potentially linked to novel traits (e.g., FA)
- And the role of "genomics" ???

Genomic selection in small populations?

- **Example of DP-BBB shows interest at different levels**
  - To assess existing genetic variability
    - Necessary to link this to phenotypic variability
  - To recover relationships
    - Cows of interest with limited pedigree records
  - To evaluate (novel) traits of interest
    - Requires adapted methods
- **Also there is no easy answer!**

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