Analysis of Longitudinal Data for Selection and Management

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Objectives of this Talk

- **Analysis of longitudinal data**
  - special respect to dairy test day model
  - development of models
- **More than only “genetic” results**
  - use of test day model results for herd management purposes
  - development of management tools
- **Evolution of genetic evaluation systems**
  - towards integrated systems for management and selection of animals

Analysis of Longitudinal Data

- **Dynamic biological processes**
  - provide longitudinal data (e.g. depending on time)
  - until recently “static” models
  - eliminating influence continuos variable
- **Examples**
  - test day yields $\Rightarrow$ lactation yields
  - individual weights $\Rightarrow$ standardized weights, ADG
- **Selection vs management**
  - two clearly different objectives !

Current Use for Management

- Simple management “traits”
  - dynamic aspect nuisance
- Often eliminated using trivial methods
  - computation of a weighted average or sum
  - standardization by using adjustments
- Strictly on a phenotypic level
  - no consideration of genetic differences
- Raw values reported to farmers

Example: Lactation Yields

- Aggregating daily yields over 305 days
- Computed by mostly simple methods
  - test interval (TIM)
  - centering date methods (CDM)
- Recently more advance methods
  - Bayesian (MTP) or Regression (BP)
- Extension of lactation problem
  - strictly on a phenotypic level
  - RIP dip and “Sunny Boy” effect

Use for Selection (until recently)

- **Genetic evaluations**
  - use of mixed linear models
  - based on aggregated “traits”
  - clearly distinguished from management
  - different organizations ?
- **Environmental effects ⇔ nuisance**
  - generally not used or even reported to farmers
  - lost of potentially interesting information !
- **Only EBVs reported to farmers**

Example: milk yield (until recently)

- **Genetic evaluations**
  - based on 305 day yield
- **Effects typically included:** (reported)
  - contemporary groups (no)
  - age effects (no)
  - permanent environment (nearly never)
  - genetic (yes)
- **Few exceptions**

Analyses of Longitudinal Data

- Recent advances
- Two central issues
  - describing E(y) and Var(y)
- Description of the mean
  - evolution E(y) over time
- Description of the (co)variances
  - evolution of Var(y) over time

Modeling E(y) over Time

- Often considered secondary
- Objective:
  - allowing correct comparisons among animals
- Central issue for selection
  - unbiasedness of genetic solutions
- Central issues for management
  - not the same

Modeling Var(y) over Time

- Central issue for genetic evaluations
- Repeatability models
  - $\Rightarrow$ Random coefficient (regression) models
- Multiple trait models
  - $\Rightarrow$ (Co)variance functions
- Equivalent

Example: Test Day Models (TDM)

- Direct use of daily milk results
- Most recent TDM directly model
  - variation E(y) over time
  - variation Var(y) over time
- Numerous advantages
- Feasible due to ⇑ computing power
- Results reported (currently)
  - report of performed yield and EBV

Test Day Models (TDM)

- **Interesting for management use**
  - strongest argument for TDM?
- **Fixed effects**
  - herd level, herd lactation curves
  - standard lactation curves
- **Random effects**
  - individual lactation curves
  - producing abilities persistency, maturity rate
- **Prediction**

Test Day Models (TDM)

- **Current TDM implementations**
  - focus on genetic effects
- **Some issues partly addressed**
  - standard lactation curves (reported?)
  - persistency (definitions? use ?)
  - maturity (definitions? use?)
- **Several unsolved issues**
  - herd/cow specific lactation curves
  - producing abilities
  - “prediction” (herd and individual level)

Cow Specific Lactation Curves

- PE and genetic random regressions
- PE + genetic solutions
  - mostly only EBV considered
- Producing abilities
  - management potential
- Prediction
  - herd specific lactation curves
  - however always only deviations

Herd Specific Lactation Curves

- Herd environmental random regressions
- Large herds
  - herd specific curves
- Small herds
  - regressed towards over population curves
- Now considered in several TDM
- Prediction
  - herd specific lactation curves
  - also deviations

Prediction

- Very important issue for management
  - not only deviations, but also overall level
- Next test and overall production
  - herd level
  - individual level
- Compared with real value measured
  - out of the prediction interval

➔ Management decisions !

Prediction with TDM

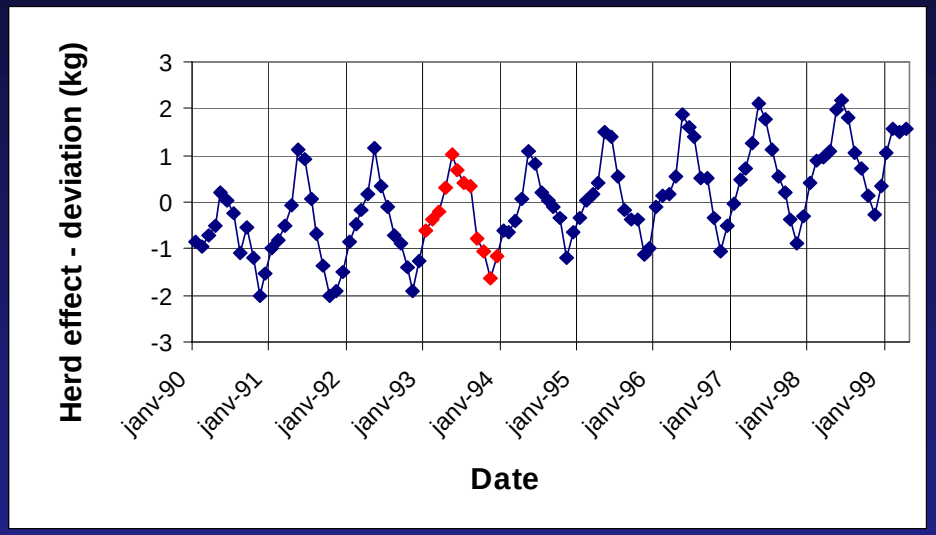
- Opposition to classical methods
  - TIM, CDM
  - MTP, BP
- They model directly the mean
- Prediction from TDM
  - could be directly obtained from solutions
  - by summing the effects of the model
- Problem: herd test day effect

Herd Test Day (HTD) Fixed Effect

- Results from Mayeres et al. (2002)
  - http://www-interbull.slu.se/bulletins/bulletin29/Mayeres.pdf
  - acknowledge Luxembourgish Herdbook, VIT
- HTD not predictable
  - effect does not model any trend
- Objective:
  - new modeling proposition
- Example how slight changes
  - improve usability of TDM

Study of HTD Fixed Effect

- HTD month's mean for each year across herds for the 3 traits
- For milk
- Two trends:
  - General upward trend through years
  - Yearly trend with maximum near the pastern release

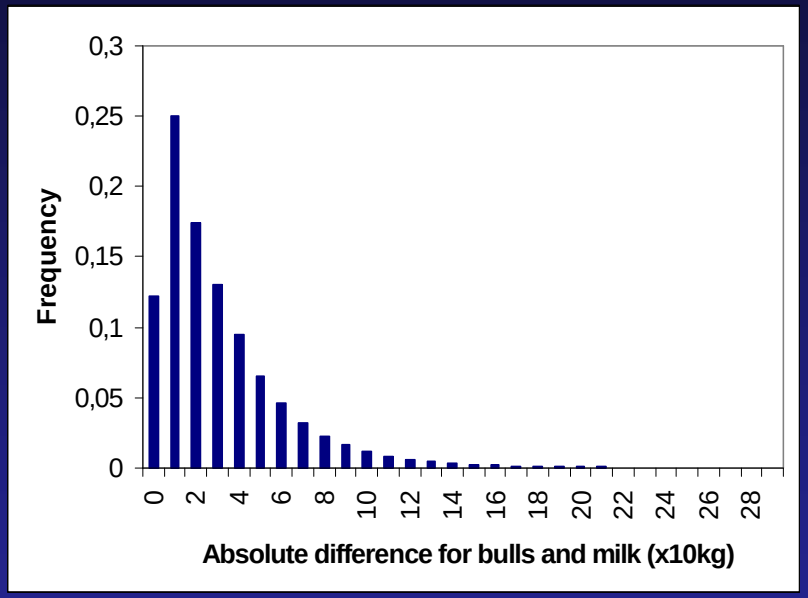


New Model

- Replacement of HTD fixed effect
- Herd test month fixed effect
  - period of 4 years (5 for newer years)
- Herd test year fixed effect
  - 2 years for current test years
- Herd test day random effect

Comparison of EBV

- **Few changes in ranking**
  - **rank correlation of cows and sires > 0.99 for each trait**
  - **absolute difference between EBV of cows and sires are low for each trait**

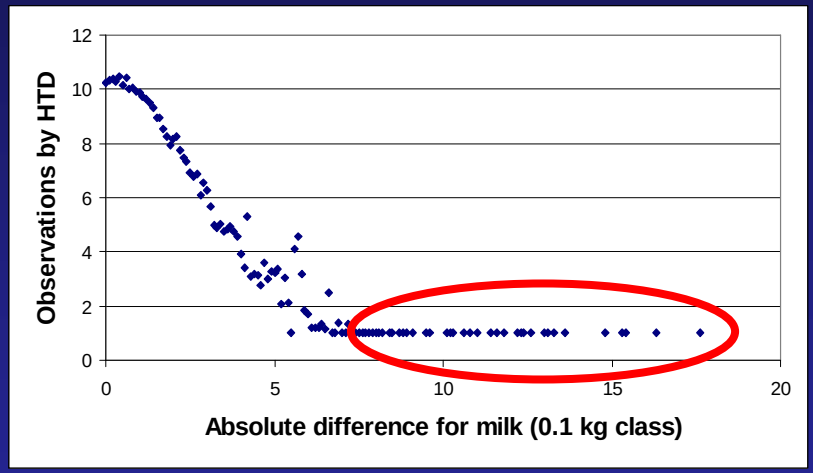


- **Only few rankings change significantly**

Comparison of Herd Effects

- **Model 2:**
  - Herd Effect = HTY+HTMp
- **Similar trend**
  - correlation is > 0.91 for each trait
  - absolute difference is very low for each trait

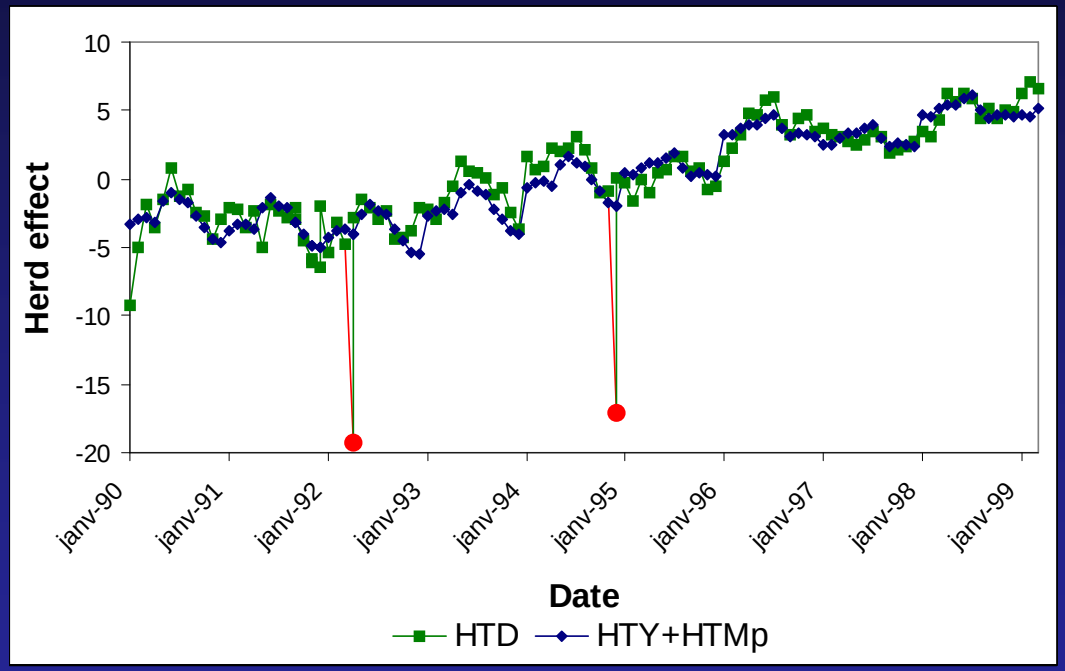
Trait	Correlation	Absolute difference		
		Mean	Std	Max
Milk	0.918	1.00	0.91	17.6
Fat	0.919	0.046	0.042	0.87
Protein	0.919	0.037	0.032	0.49



- **Biggest differences for HTD with few tests**

Comparison of Herd Effect

- **Particular herd**



- **Two special tests (•)**
  - **01/12/1994 and 06/04/1992 : one animal tested**

Some Questions

- Why no provide more results?
  - we compute them anyway!
- Why no adapt our models ?
  - we could gain too!
- What is the real interest in EBVs?
  - genetic evaluations very much separated from performance recording
  - current interest by farmers is decreasing
- What is need for successful management?

Implications for the Future

- **Personal opinions**
  - analysis of longitudinal data
  - opportunity to develop advanced management tools
  - large influence evolution of genetic evaluation systems
  - interest in “genetics” only decreasing
  - opportunity to use “optimal” modeling
  - higher integration of selection and management leading eventually to

  ⇒ **Integrated systems!**

Integrated Systems for Management and Selection

- Provide optimal useful results for
  - management
  - selection
- Optimal use of computing power
- “Re-conciliate” farmers with EBVs
  - showing link phenotype to genetic values
  - avoiding “black box” syndrome
- Could avoid that genetic evaluations are sidelined