Data Collection Ratings and Best Prediction of Lactation Yields

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Best Prediction

- Selection Index
  - Use measured yields to predict missing yields
  - Condense test days into lactation yield and persistency
  - Only phenotypic covariances are needed; herd means and variances assumed known
- Reverse prediction
  - Daily yield predicted from lactation yield and persistency
- Single or multiple trait prediction

History

- Calculation of lactation records for milk (M), fat (F), and protein (P) yields and somatic cell score (SCS) using best prediction (BP) began in November 1999
- Replaced the test interval method and projection factors at AIPL
- Used for cows calving on January 1, 1997 and later

Advantages

- Small for most 305 d lactations but larger for lactations with infrequent testing or missing components
- More precise estimation of records for SCS because test days are adjusted for stage of lactation
- Yields have slightly lower SD because BP regresses estimates toward the herd average

Users

- **AIPL:** Calculation of lactation yields and data collection ratings (DCR)
- **Breed Associations:** Publish DCR on pedigrees
- **DRPCs:** Interested in replacing test interval estimates with BP
  - Can also calculate persistency
  - May have management applications

How does BP work?

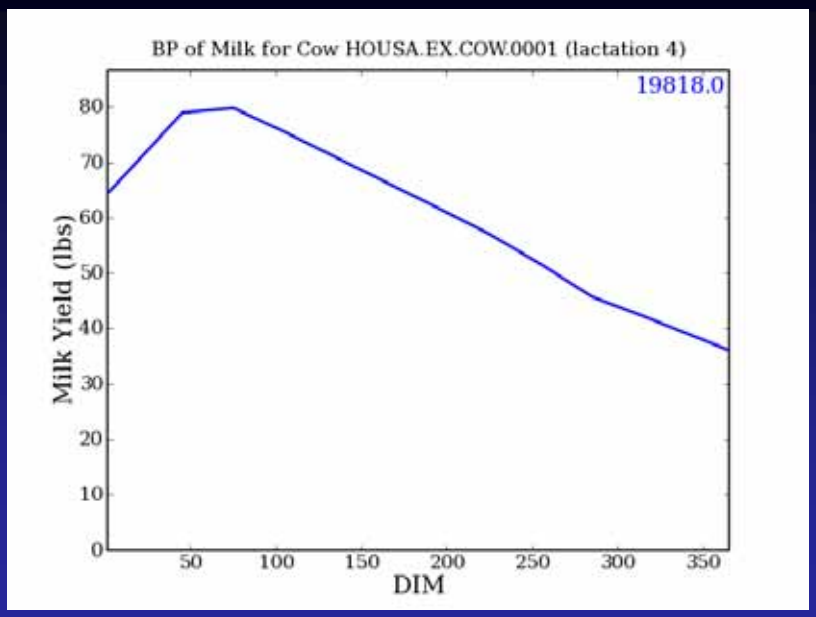
- **Inputs:** TD and herd averages
- **Computations:**
  - Standard curve calculated for each herd-breed-parity group
  - Cow's lactation curve based on her TD deviations from standard curve
- **Outputs:** Actual and ME yields, persistency, daily yields, DCR, REL

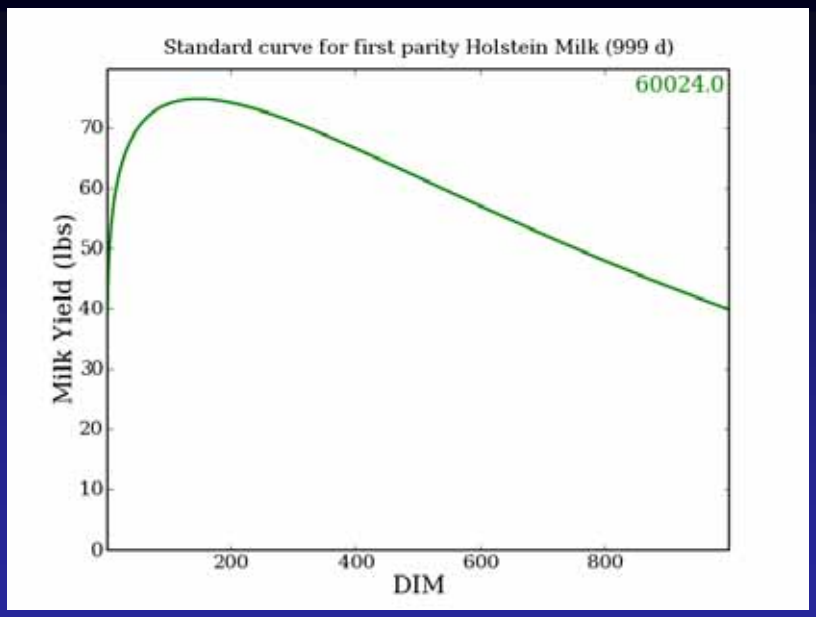
Specific curves

- **Breeds:** AY, BS, GU, HO, JE, MS
- **Traits:** M, F, P, SCS
- **Parity:** 1st versus later

Modeling long lactations

- Dematawewa et al. (2007) recommend simple models for long lactations
- Curves developed for M, F, and P yield, but not SCS
  - Little previous work on lactation curves for SCS (Rodriguez-Zas et al., 2000)
- BP also requires curves for the standard deviation (SD) of yields


BP of Milk for Cow HOUSA.EX.COW.0001 (lactation 4)
19818.0
Milk Yield (lbs)
DIM
0
10
20
30
40
50
60
70
80
50
100
150
200
250
300
350

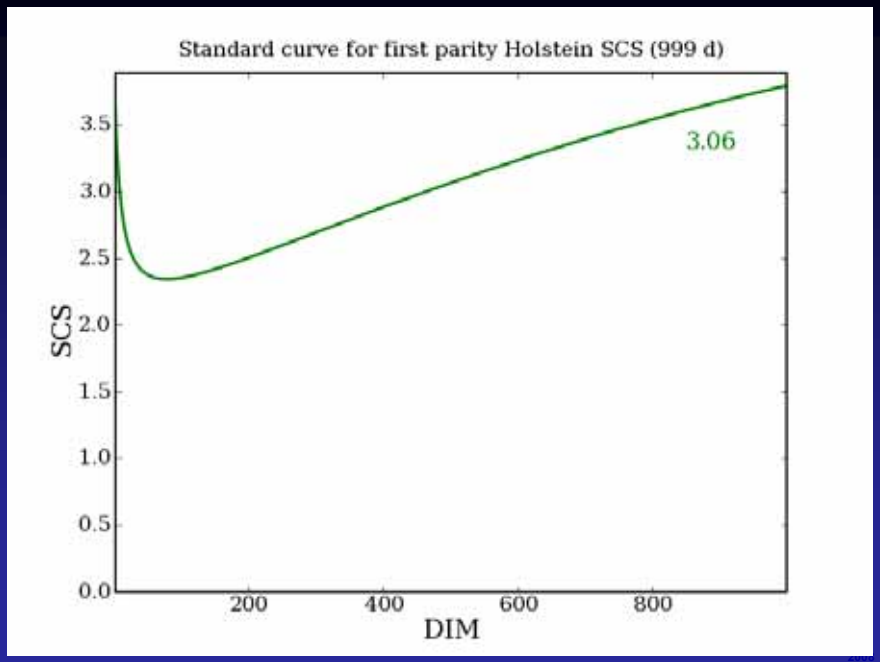

Standard curve for first parity Holstein Milk (999 d)
60024.0
Milk Yield (lbs)
DIM
0
10
20
30
40
50
60
70
200
400
600
800

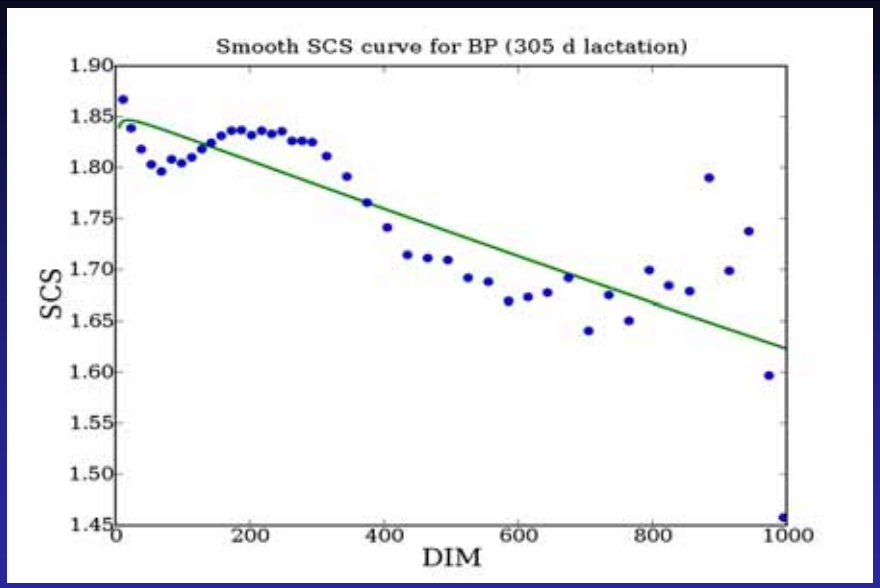
Data and edits

- Holstein TD data from the NDDB
- Edits of Dematawewa et al. (2007)
  - 1st through 5th parities
  - Lactations were ≤500 d for M, F, and P and ≤800 d for SCS
  - Records were made in a single herd
  - At least five tests reported
  - Only twice-daily milking reported

Modeling SCS and SD

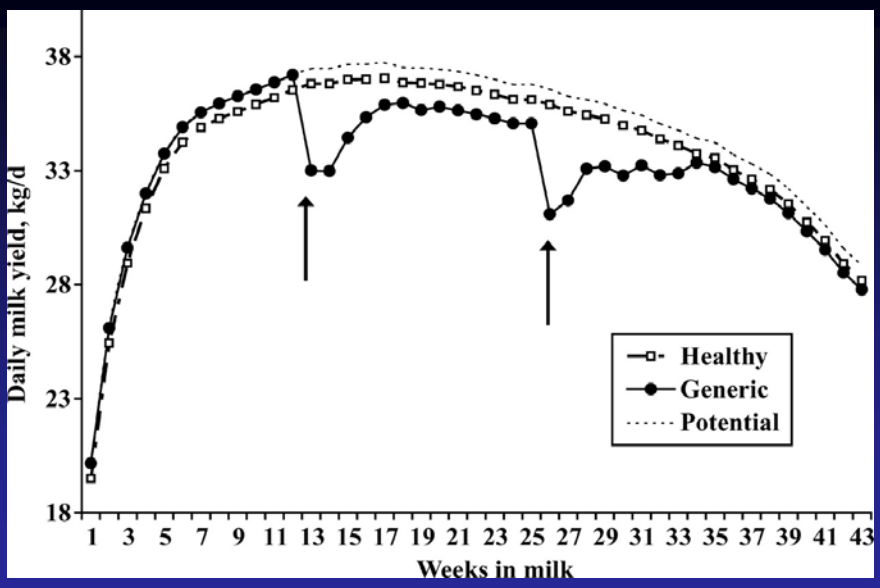
- TD yields were assigned to 30- or 15-d intervals, and means and SD were calculated for each interval
- Curves were fit to the resulting means (SCS) and SD (all traits)
  - M, F, and P modeled with Woods curves
  - SCS modeled using curve C4 from Morant and Gnanasakthy (1989)


Standard curve for first parity Holstein SCS (999 d)
3.06
SCS
DIM
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
200
400
600
800

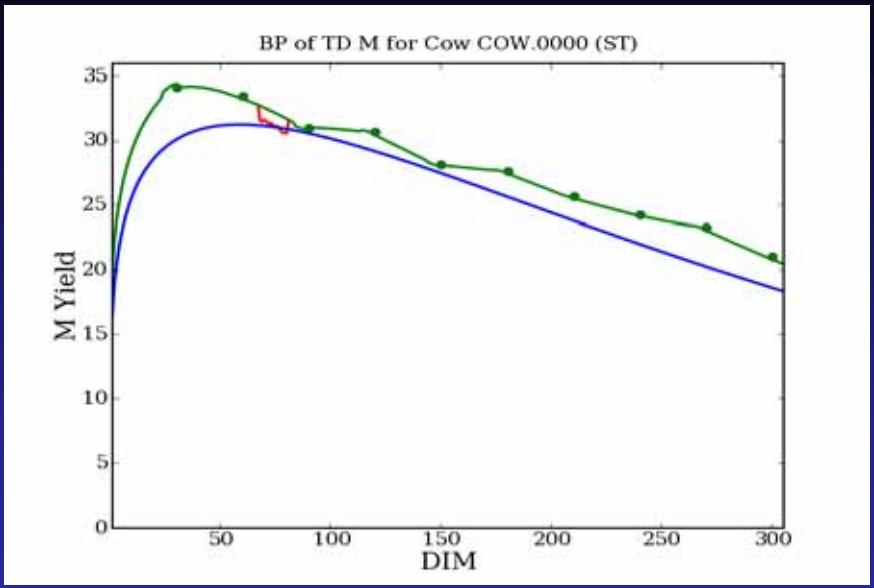

Smooth SCS curve for BP (305 d lactation)
SCS
DIM
1.45
1.50
1.55
1.60
1.65
1.70
1.75
1.80
1.85
1.90
0
200
400
600
800
1000

Uses of daily estimates

- Daily yields can be adjusted for known sources of variation
  - **Example:** Losses from clinical mastitis
- Animal-specific rather than group-specific adjustments
- Optimal management strategies
- Management support in software



Bar et al. JDS 90:4643-4653 (2007)



Validation: old versus new

Trait	Parity	Correlation
Milk	1	0.999
	2+	0.999
Fat	1	0.999
	2+	0.998
Protein	1	0.999
	2+	0.999
SCS	1	0.995
	2+	0.960

Validation: first 3 versus all 10 TD

Trait	Parity	Correlation
Milk	1	0.931
	2+	0.934
Fat	1	0.925
	2+	0.920
Protein	1	0.937
	2+	0.938
SCS	1	0.790
	2+	0.791

Validation: daily yields

- 7-d averages of daily M yield from on-farm systems in 4 university herds were compared to daily BP
- Correlations:
  - First parity: 0.927
  - Later parities: 0.956
- Quist et al. (2007) reported that actual yields are overestimated with the Canadian equivalent of BP

Data Collection Ratings

- Used to compare the accuracy of lactation records from test plans
- Squared correlation of estimated and true yields multiplied by 104
- Separate DCR are calculated for milk yield, components yield, and somatic cell score

Factors affecting DCR

- Averaging of several daily yields, as in labor efficient records (+)
- Collection of only a fraction of daily yields, as in AM-PM testing (-)
- Owner reporting rather than supervisor reporting of records (-)
- The number and pattern of tests within the lactation (±)

Use in the Animal Model

- The ratio of the error variance from daily testing to the error variance from less-complete testing is used to weight lactation records
  - Weights increase with sampling frequency
- The variance ratio does not include genetic and permanent environmental effects

High-frequency testing plans

Plan	Test Days	Weight (%)	DCR
Daily	305	100	104
10-d LER	100	99	104
5-d LER	50	98	103

Monthly testing plans

Plan	Test Days	Weight (%)	DCR
	Supervised		
All	10	95	100
2 of 3	10	92	97
1 of 2	10	89	95
1 of 3	10	83	90
	Owner-sampler		
All	10	66	75
2 of 3	10	64	73
1 of 2	10	63	72
1 of 3	10	60	69

Bi-monthly testing plans

Plan	Test Days	Weight (%)	DCR
	Supervised		
All	5	90	95
2 of 3	5	84	90
1 of 2	5	79	86
1 of 3	5	71	78
	Owner-sampler		
All	5	63	72
2 of 3	5	61	69
1 of 2	5	58	67
1 of 3	5	53	62

Implementation

- Mature equivalent yields in the AIPL test database have been updated
- Genetic evaluations have been calculated using the updated values
- Data will be submitted to the Interbull test run in August

Enhancements to BP software

- Can accommodate lactations of any reasonable length (tested to 999 d)
- Lactation-to-date and projected yields calculated
- BP of daily yields, test day yields, and standard curves now output
- Covariance modeling functions have simple biological interpretations

Best Prediction programs

- Source code in the public domain
  - May be freely downloaded, changed, and redistributed
- Written in Fortran 90 and C
  - Tested on Linux and Windows XP using free and commercial compilers
- Programs and documentation are available on the AIPL website
  - www.aipl.arsusda.gov/software/bestpred/

Conclusions

- BP is a flexible tool for accurately modeling M, F, and P yields and SCS in lactations of any reasonable length
- Almost all data from the field is used for genetic evaluation
- More frequent sampling with supervision results in higher DCR
- Daily BP of yields may be useful for on-farm management

Acknowledgments

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- **Testing:** Brad Heins at University of Minnesota