Genetics of body condition score and its association with feed efficiency, fertility and health

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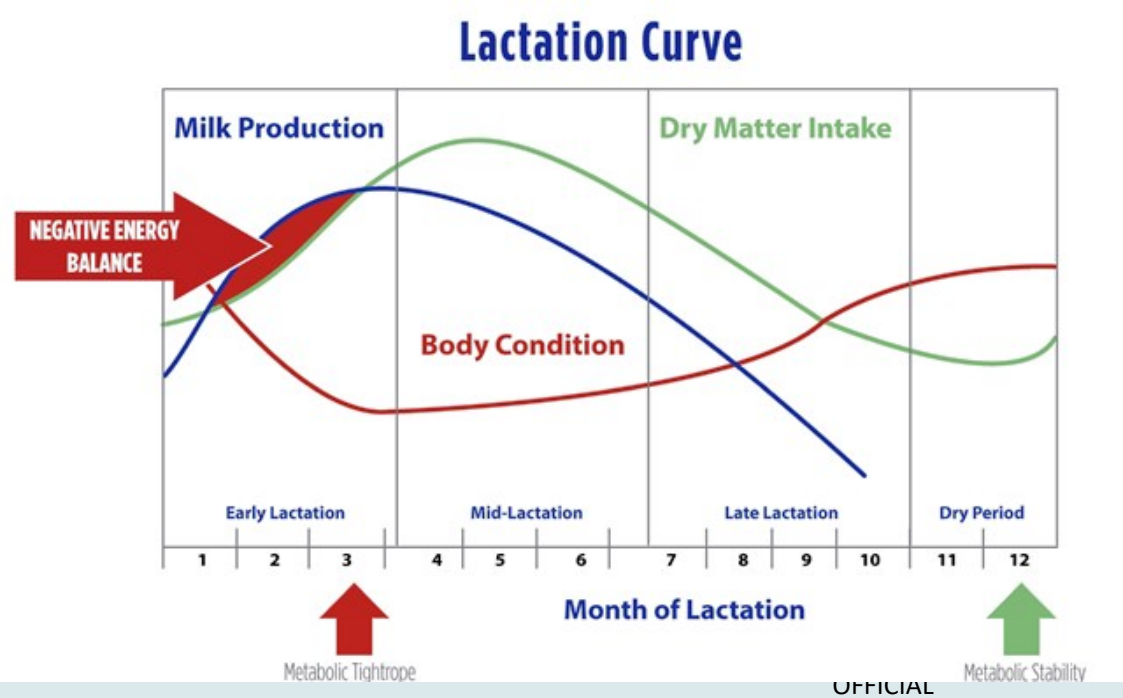
Background

- Body condition scoring has been widely accepted as the most practical method for assessing body fat mobilization and changes in energy reserves in dairy cattle (Bewley et al., 2008)



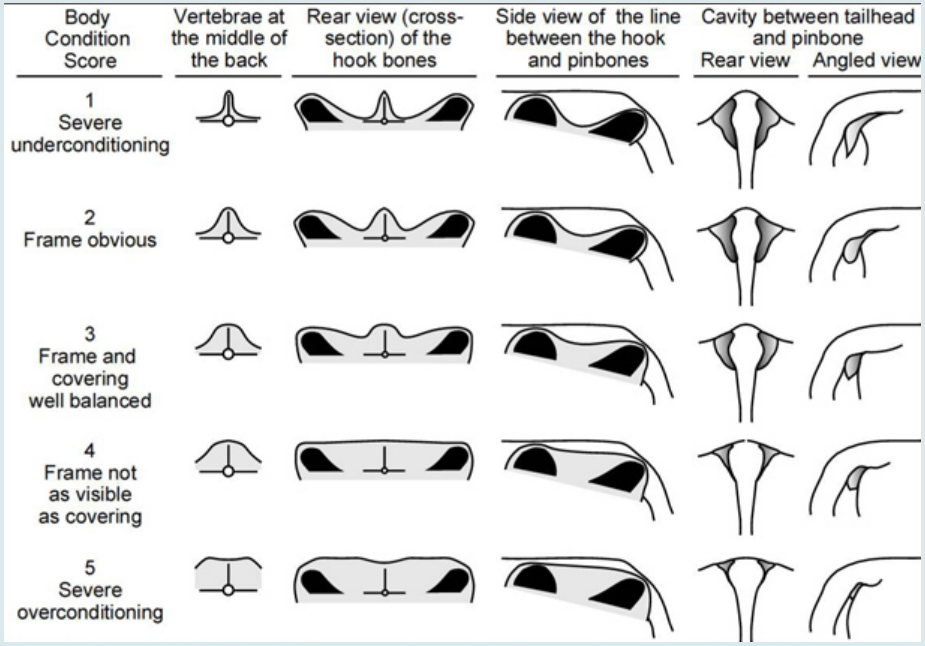
BODY CONDITION

Indicator or predictor of:

- Production
- Reproduction
- Health
- Animal Welfare

Body Condition Score (BCS)

- Body condition can be scored by dairy farmers, veterinarians, field staff, or classifiers
- It can be recorded once or several times over the lactation



BCS CAMERA SYSTEM

DeLaval Body Condition Scoring, BCS DeLaval International AB, Tumba, Sweden

- Cows are scored 2 - 10 times per day
- System provides daily 7-days rolling average scores
- Currently there are algorithms available for scoring Holsteins including similar breeds, Simmental and Norwegian Red

BCS CAMERA SYSTEM

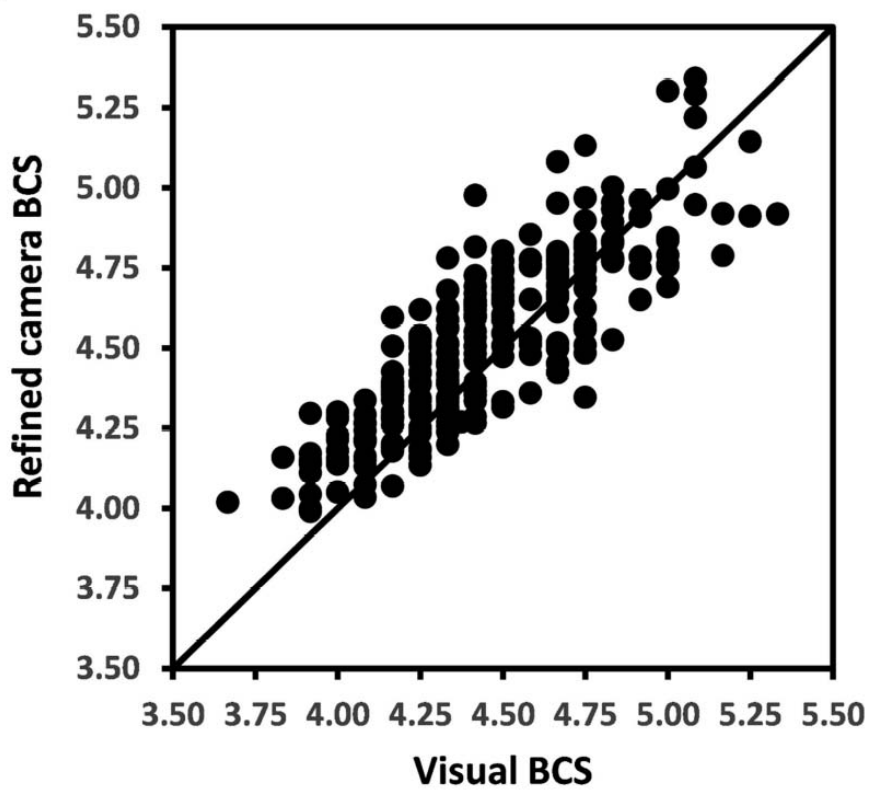


Figure 3. Scatter plot with each solid dot representing a weekly mean body condition score (BCS) for a cow by refined camera method versus visual measurement method. The solid line represents the line of agreement.

animals

MDPI

Article

An Improved Approach to Automated Measurement of Body Condition Score in Dairy Cows Using a Three-Dimensional Camera System

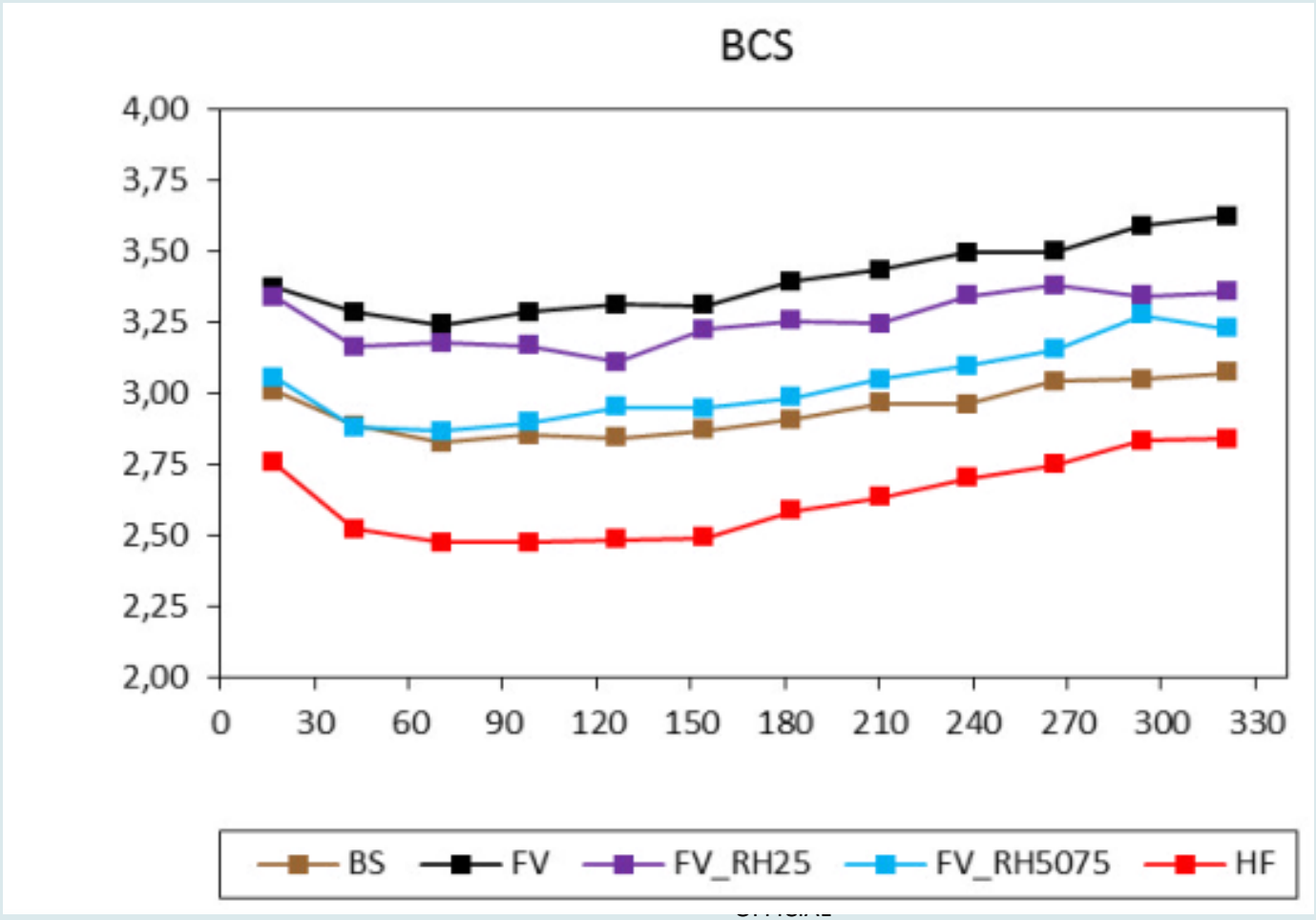
Rodrigo I. Albornoz [1,*], Khageswor Giri [2], Murray C. Hannah [1] and William J. Wales [1,3]

BCS – Intermediate optimum trait

- BCS is considered to be an intermediate optimum trait
- Health and reproductive disorders arise from having cows that are either too thin (in early lactation) or too fat (before calving)
- The ideal BCS is the level of body fat that allows the cow to optimize milk production while simultaneously minimizing metabolic and reproductive disorders (Bewley et al., 2008).
- The ideal BCS is highly dependent on lactation stage and on the production system in which cows are managed.

Mean BCS by breed (Ledinek et al. 2019)

Project Efficient Cow (Egger-Danner et al. 2016)
2016-11-29-Titel-Projektbericht.indd (dafne.at)



Heritability of BCS

- Estimates of heritability ranged from 0.05 to 0.79 but most of the studies reported heritabilities ranging from 0.20 to 0.50 (Bastin and Gengler, 2012)

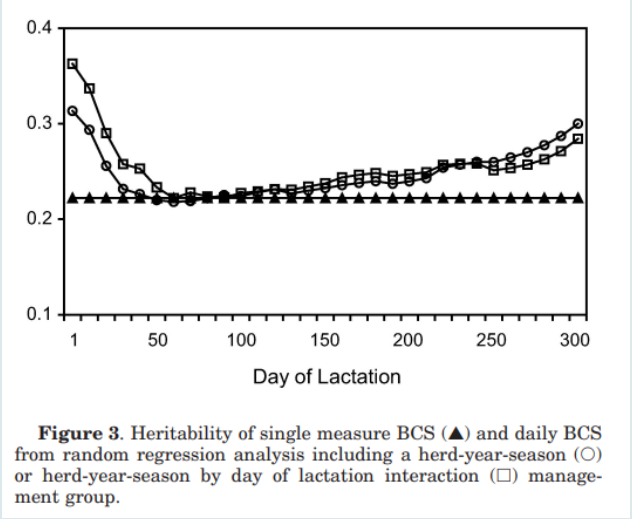


Figure 3. Heritability of single measure BCS (▲) and daily BCS from random regression analysis including a herd-year-season (○) or herd-year-season by day of lactation interaction (□) management group.

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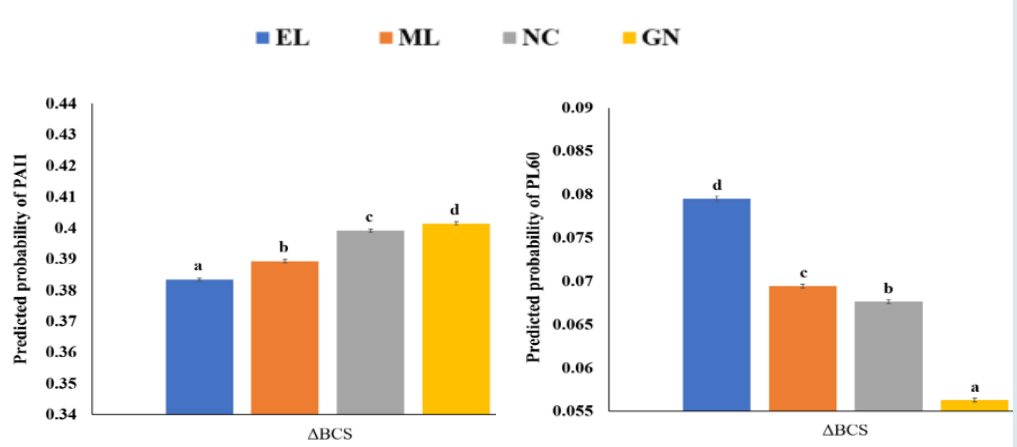
Evaluation of Body Condition Score Measured Throughout Lactation as an Indicator of Fertility in Dairy Cattle

G. Banos,[1] S. Brotherstone,[2,3] and M. P. Coffey[2]

- Heritability estimates for BCS change are lower and vary from 0.01 to 0.10 (Pryce et al., 2001; Berry et al., 2002; Dechow et al., 2002; Fürst-Walt and Egger-Danner, 2017)

BCS and Fertility

- Review by Roche et al. (2009): Most of the reports suggest a positive association between an earlier achievement of pregnancy and increased BCS and reduced BCS loss during early lactation.
- Severe BCS loss have been associated with reduced likelihood of pregnancy at first insemination and higher pregnancy loss at 60 d of gestation (Manriquez et al., 2021).



EL = excessive loss of BCS
ML = moderate loss of BCS
NC = no change of BCS
GN = gained BCS

Genetic correlations – BCS and fertility

Fertility	Average genetic correlation with BCS[1]	Range	References[2]
Days to first heat	- 0.41	-	5
Days to commencement of luteal activity	- 0.84	-	9
Days to first service	- 0.48	- 0.63 to - 0.35	3, 5, 6, 10, 14, 18, 20, 22
Days to last service	- 0.44	-	6
Days to conception, days open	- 0.38	- 0.46 to - 0.30	17, 22
Days from first service to conception	0.01	-	10
Days from first to last service	- 0.46	- 0.62 to - 0.30	20, 22
Calving interval	- 0.39	- 0.53 to - 0.14	2, 5, 6, 8, 14, 20
Number of services	- 0.22	- 0.37 to - 0.06	3, 6, 10, 20
Conception at first service	0.22	0.16 to 0.28	6, 10
Conception rate at first service	0.60	-	20
Pregnant 63d after the start of the breeding season	0.37	-	10
Presented for mating within 21d from the planned start of mating	0.49	-	19
Calving rate within 42d from the planned start of calving	0.43	-	19

[1] Correlations have been averaged first within studies and second among studies — *les corrélations ont été moyennées d'abord pour chaque étude, ensuite à travers toutes les études*; [2] 1: Veerkamp et al., 1997; 2: Pryce et al., 2000; 3: Dechow et al., 2001; 4: Gallo et al., 2001; 5: Pryce et al., 2001; 6: Veerkamp et al., 2001; 7: Berry et al., 2002; 8: Pryce et al., 2002; 9: Royal et al., 2002; 10: Berry et al., 2003a; 11: Dechow et al., 2003; 12: Kadarmideen et al., 2003; 13: Lassen et al., 2003; 14: Wall et al., 2003; 15: Dechow et al., 2004a; 16: Dechow et al., 2004b; 17: Dechow et al., 2004c; 18: Kadarmideen, 2004; 19: Pryce et al., 2006; 20: DeHaas et al., 2007; 21: Toshniwal et al., 2008; 22: Zink et al., 2011; 23: Koeck et al., 2012; 24: Loker et al., 2012; 25: Spurlock et al., 2012.

B A S E *Biotechnol. Agron. Soc. Environ.* 2013 **17**(1), 64-75

Focus on:

Genetics of body condition score as an indicator of dairy cattle fertility. A review

Catherine Bastin, Nicolas Gengler

BCS and Health

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-
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BCS and Subclinical ketosis

Cows that lost body condition in the 15 d before calving had (Sheehy et al., 2017):

- ↑
- ↓
- ↑
- ↑
- ↓
-

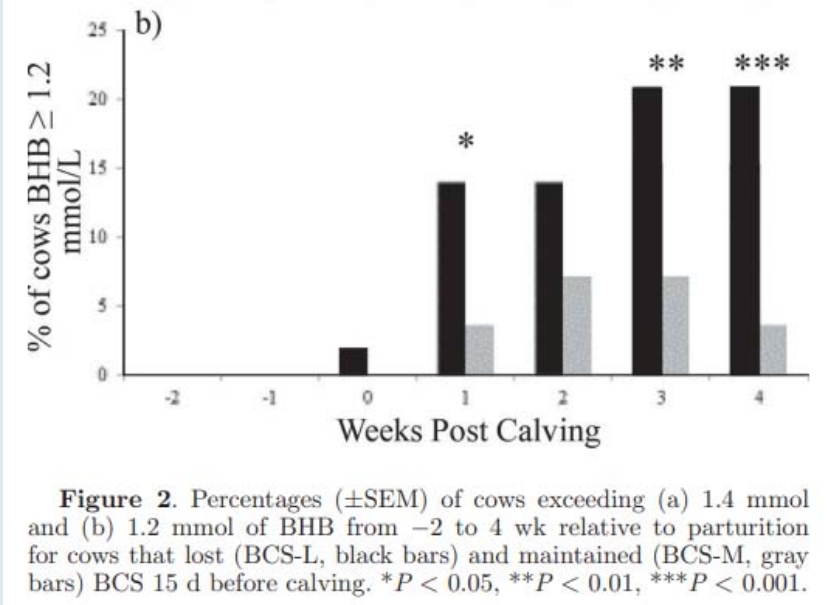
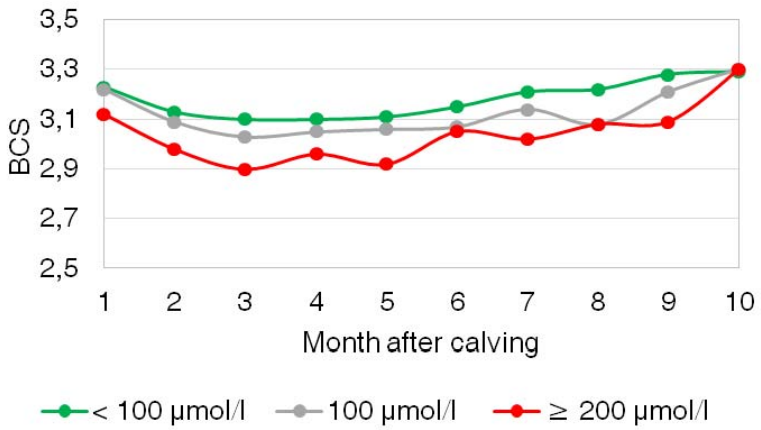
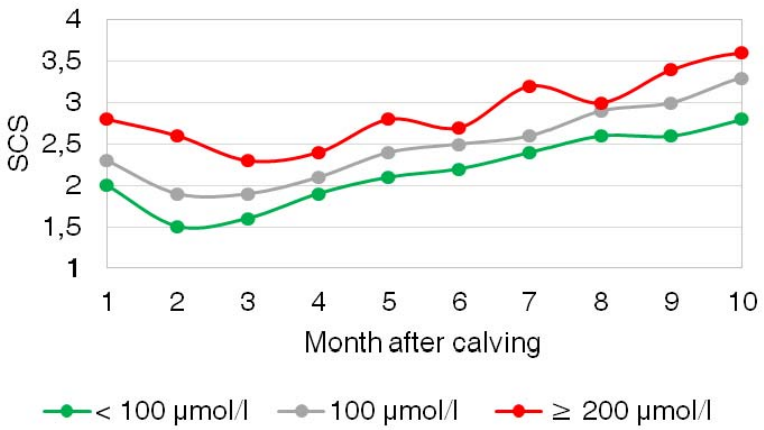


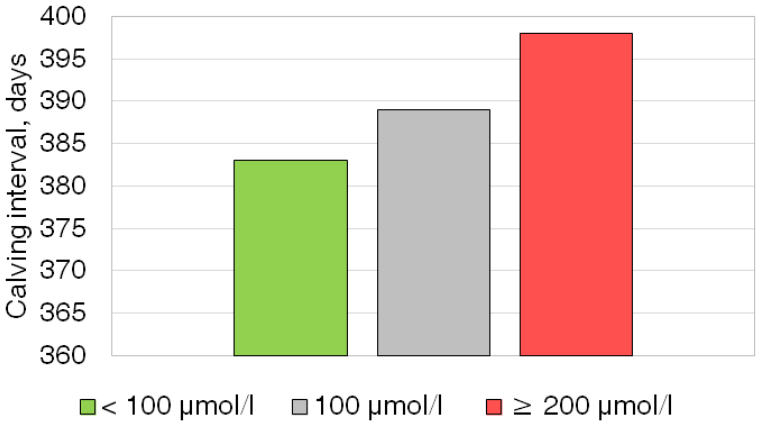
Figure 2. Percentages (±SEM) of cows exceeding (a) 1.4 mmol and (b) 1.2 mmol of BHB from −2 to 4 wk relative to parturition for cows that lost (BCS-L, black bars) and maintained (BCS-M, gray bars) BCS 15 d before calving. $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

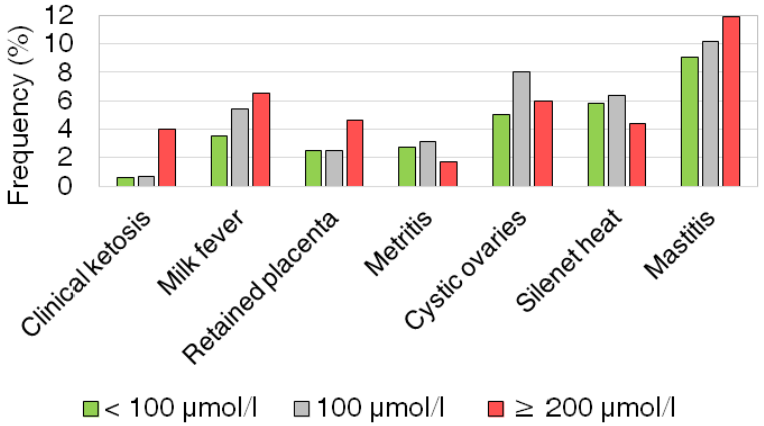
Cows with a dry BCS ≥4.0, or that lost 1 or more BCS unit across the transition to lactation period, had greater BHBmax than cows with lower BCS (Rathbun et al., 2017)

Subclinical ketosis (milk ketotest)







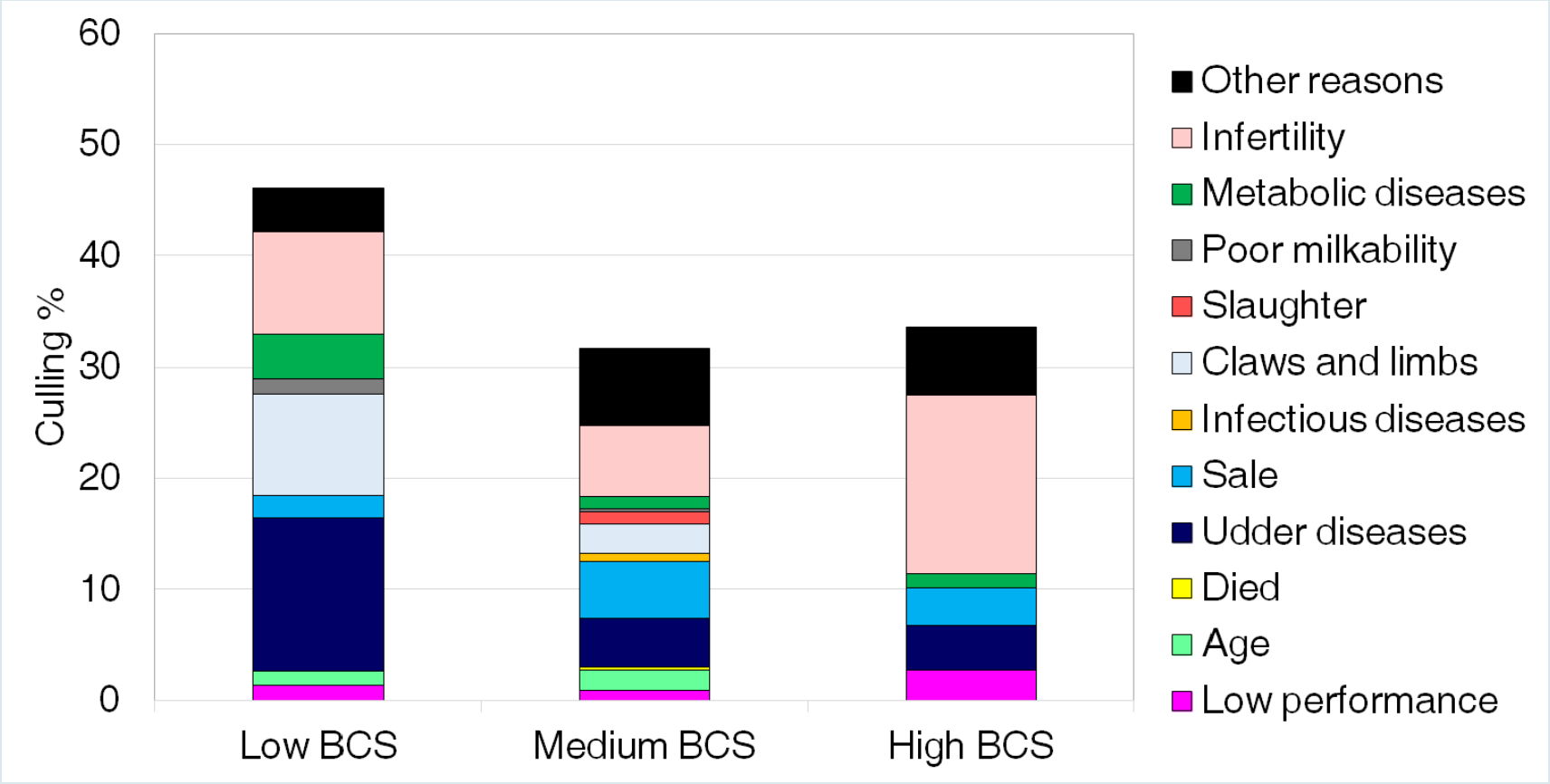


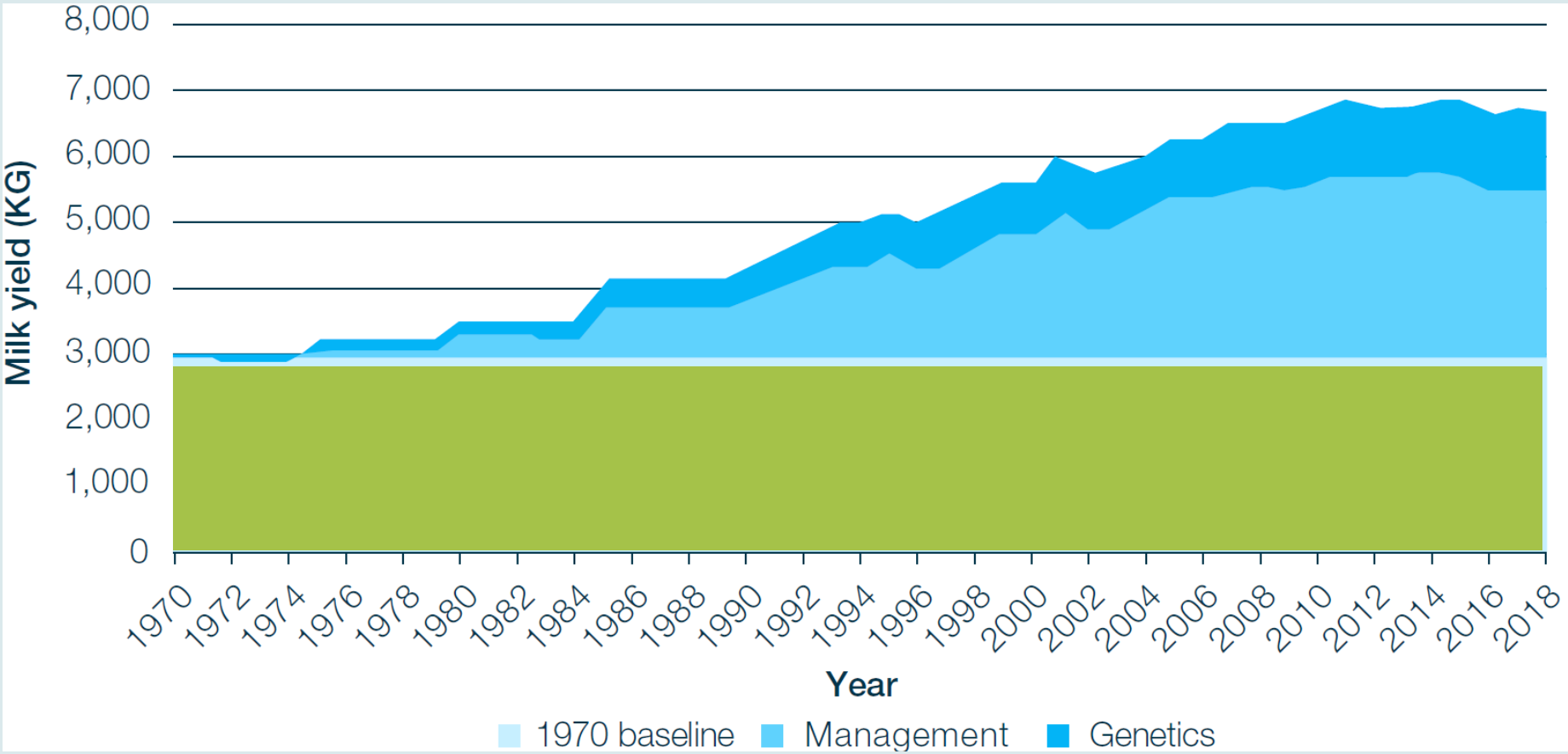
BCS ↓, SCS ↑, fertility ↓, other diseases ↑

Genetic correlations - BCS and disease resistance – Canadian Holsteins

(Koeck et al., 2012)

BCS and Culling reasons – Holstein




8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Milk yield (KG)
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
1970 baseline
Management
Genetics

BCS and Feed efficiency

- Feed efficiency is determined mostly by dry matter intake (DMI). Reducing DMI seems to increase efficiency if milk yield remains the same, but resulting negative energy balance (EB) may cause health problems, especially in early lactation (Becker et al., 2021).
- Results illustrate that cow effect correlations between DMI and disease categories are mostly negative, especially in early lactation.

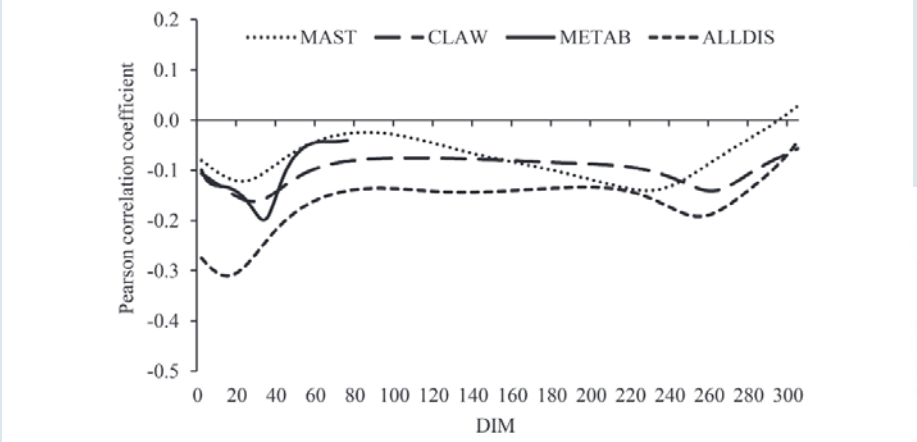


Figure 5. Correlation between cow effects for DMI and 4 disease categories (MAST = mastitis, CLAW = claw and leg diseases, METAB = metabolic diseases, ALLDIS = all diseases) plotted against DIM in German Holstein dairy cows (DIM 2–305: n = 1,312; DIM 2–76: n = 1,144; SE: MAST 0.027–0.028, CLAW 0.027–0.028, METAB 0.028–0.030, ALLDIS 0.025–0.028).

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Liability to diseases and their relation to dry matter intake and energy balance in German Holstein and Fleckvieh dairy cows

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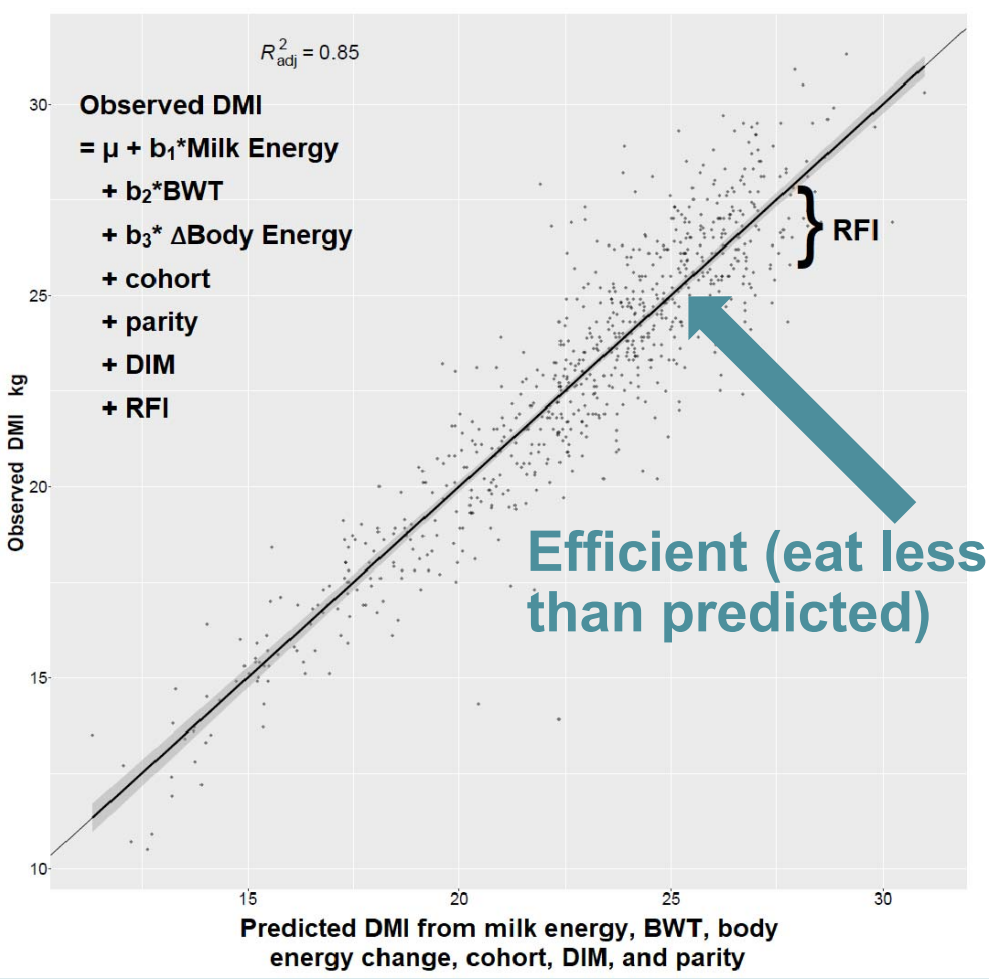
[2]TiDa Tier und Daten GmbH, 24259 Westensee/Brux, Germany

Residual feed intake



Accounting for BCS (or body energy) essential to calculate residual feed intake (RFI)

RFI is mathematically equivalent to energy balance without BCS

Conclusions

- BCS (+change) is indicative of energy balance and therefore genetically correlated to health and fertility traits
- BCS is moderately heritable (0.2-0.5), while BCS change is low heritability (<0.1)
- BCS is commonly measured through manual scoring, but automated processes show promise
- BCS is an intermediate optimum trait

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