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Body Condition Score: Recording and Biology

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Welfare indicator survey by the ICAR Functional Traits Working Group (FT-WG)

Survey by ICAR Functional Traits Working Group (FT-WG)

Welfare Indicators Surveys

- ‘Pre-survey’ to find key contact persons
- Three surveys created:
  1. Disease traits
  2. Body condition score, injuries and cleanliness
  3. Temperament, behavior and other traits
- Name and role of respondent (could remain anonymous)
- Section on purpose of scheme, training of assessors, size of scheme etc
- List of traits and scales used

- Organized in 2019
- In total 48 respondents
- BCS on the list of potential indicators
- Results presented at ICAR 2019 in Prague:
  - https://www.icar.org/Documents/Prague-2019/Presentations/02%20-%20Marie%20Haskell.pdf

Welfare Indicator	No. scoring
Body condition score	28
Lameness in loose-housed cows	24
Diarrhoea	18
Temperament	16
Skin alterations, swellings or injuries	16
Lameness in tie-stalls	16
Existing records	16
Cleanliness	15
Claw trimmer data	13
Hampered respiration	11
Vulval discharge	9
Cow comfort indices	8
Approach distance	8
Quality of movement from lying to standing	7
Time to lie down	6
Ocular discharge	6
Nasal discharge	6
Hair condition	6
Coughing	6
Polledness	5
Ectoparasites	4
Agonistic/aggressive	4
Qualitative Behavioural Analysis	3

- BCS was cited 28 times as welfare indicator
- 5 types of scales mentioned:

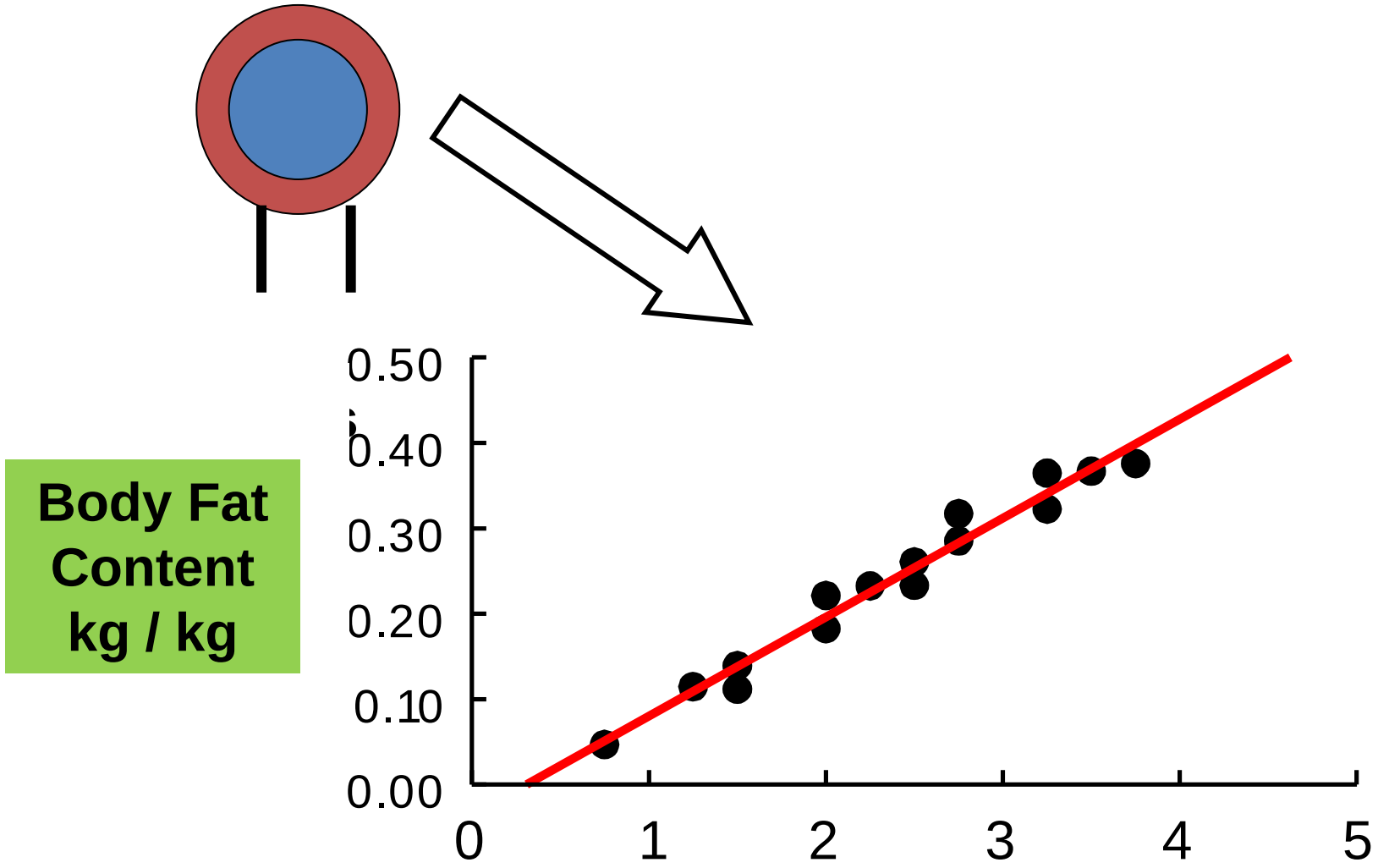
Response	No. respond.
8-point scale: **based on visual assessment of fat around tail, pins, spine**	4
5-point scale: **based on visual assessment of fat at tailhead, pins, etc.**	4
1-5 scale with quarter points: **based on visual assessment of pelvis, hooks, pins, ribs, spine**	1
1-5 scale with increments of 0.25: **based on visual assessment of hook-pin angle, tailhead etc.**	6
3 point scale (0-2): **based on visual assessment of fat around tailhead, pins, spine etc. (Welfare Quality Scheme)**	7

Origin of the Body Condition Score (BCS) concept and the biology behind it

What is Body Condition Scoring?

- Evaluating (scoring) body fat content ➔ visual (and tactile)
  - Indication of energy balance and underlying biology
- History
  - Complicated story with many (even conflicting) details in these two papers
  - Important points in time:
    - Initially for ewes (Jefferies, 1961):
      - palpating the backbone and lumbar processes
      - feeling for the sharpness and covering of the bones
    - Extended to/from beef cattle (Lowman et al., 1976)
      - used palpation of the backbone and lumbar processes
      - included palpation of the tailhead region
    - Mulvany (1981) modified the system for dairy cattle
      - Introduced adjustment factors if the scores in the tailhead and loin areas differed

BCS as estimator of body fatness



(Data from Wright and Russel, 1984)

Energy Balance (EBal)

- Traditionally EBal measured as = “Accounting” method
  - Difference between Eintake – Eoutput
  - Only research farms measure individual intake
- EBal = Body E change = Animals biology
  - Negative EBal ➔ body reserve mobilization
  - Positive EBal ➔ body reserve accretion
- Therefore
  - EBal can be measured from body reserves

EBal from lipid and protein reserves

- Some formulas:

$$EBal = ec_l(dL/dt) + ec_p(dP/dt)$$

with:

$$P = k(LFEB)$$

$$LFEB = EBW - L$$

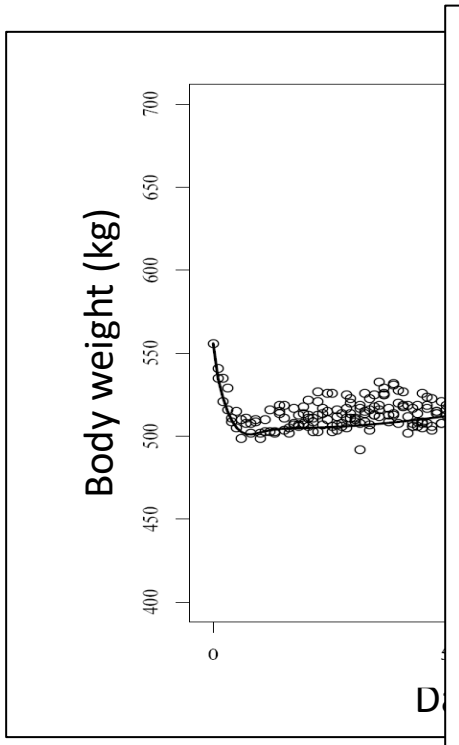
$$L = BFatContent \times EBW$$

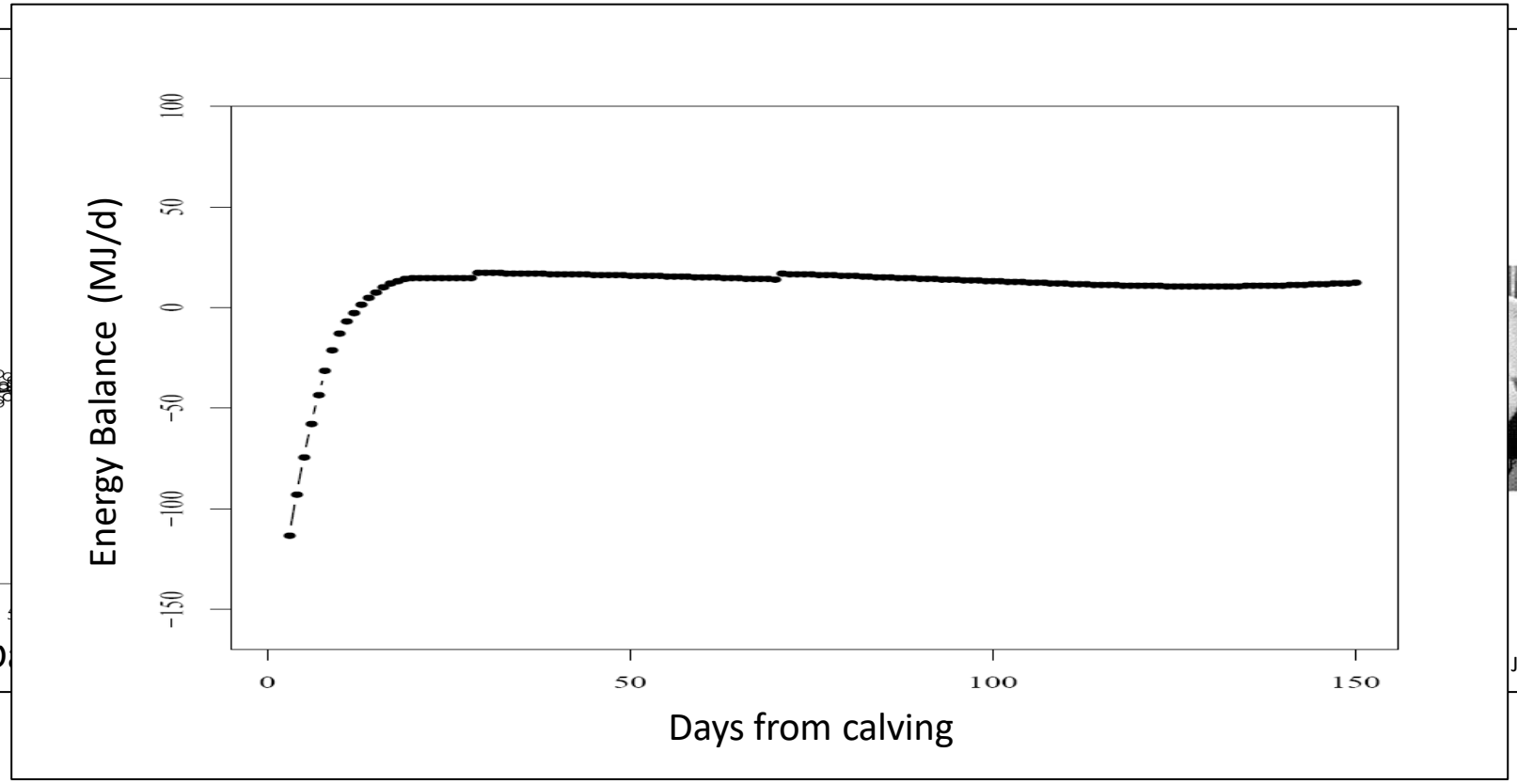
$$= (a + b \times BCS) \times EBW$$

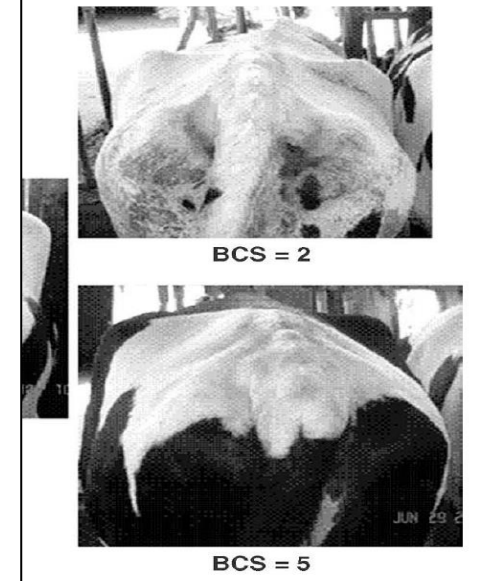
$$EBW = BW - Gutfill$$

- And where :
  - ec = energy content of L or P
  - L = lipid (fat)
  - P = protein
  - LFEB = lipid free empty body weight
  - BW = body weight
  - EBW = empty body weight

Consequence: BW and BCS ➔ Energy Balance







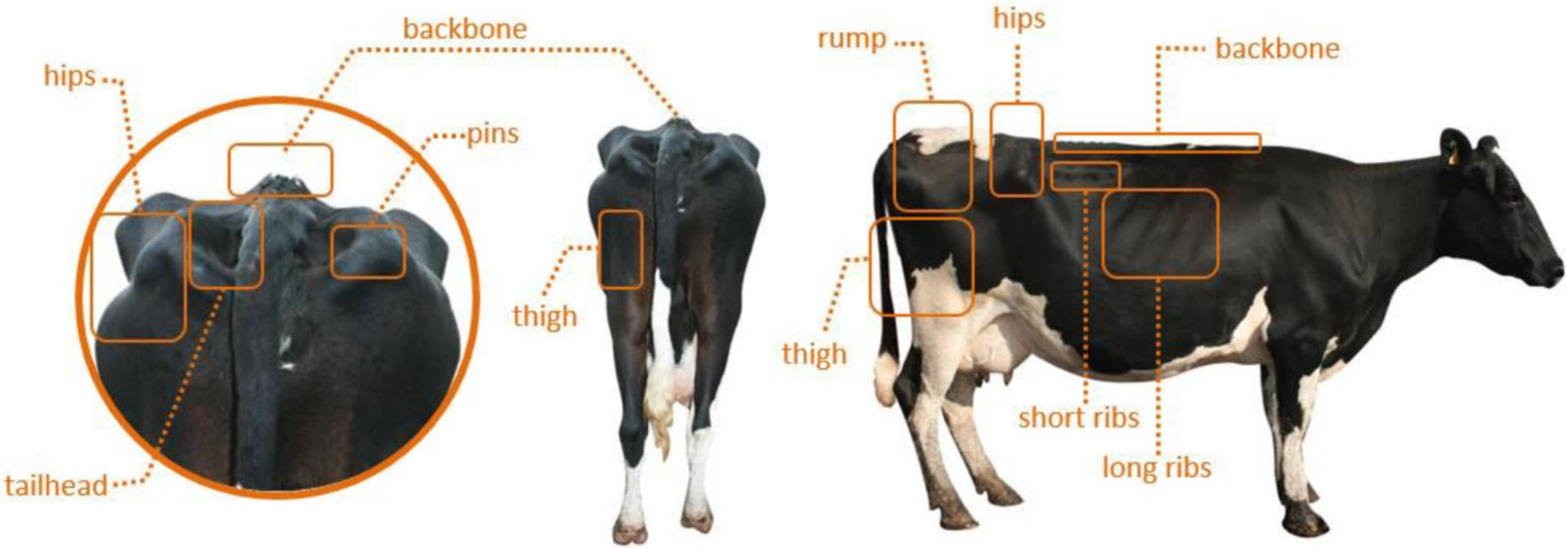
Provided frequent measures are available!

No need for intake. EBal available on real farms for the 1st time

Thorup et al. 2012, J. Dairy Sci.
Thorup et al. 2013, Animal

From biology to visual (and tactile) “human” scales…

Reminder of anatomy…..



Huang et al. (2019)

Large diversity of scales (and underlying biology)

- FT-WG survey at least 5 different scales
- Great diversity in literature, not only on used scales but also between 5 and 8 different evaluated body locations
- Basic systems
  - 3-point scale WQ scheme
  - 5-point scale system by Wildman et. al. (1982)
  - 8-point scale system by Earle (1976)
  - 9-point
  - 10-point….
- + many, many variants (cf survey)

8-point scale:
based on visual assessment of fat around tail, pins, spine

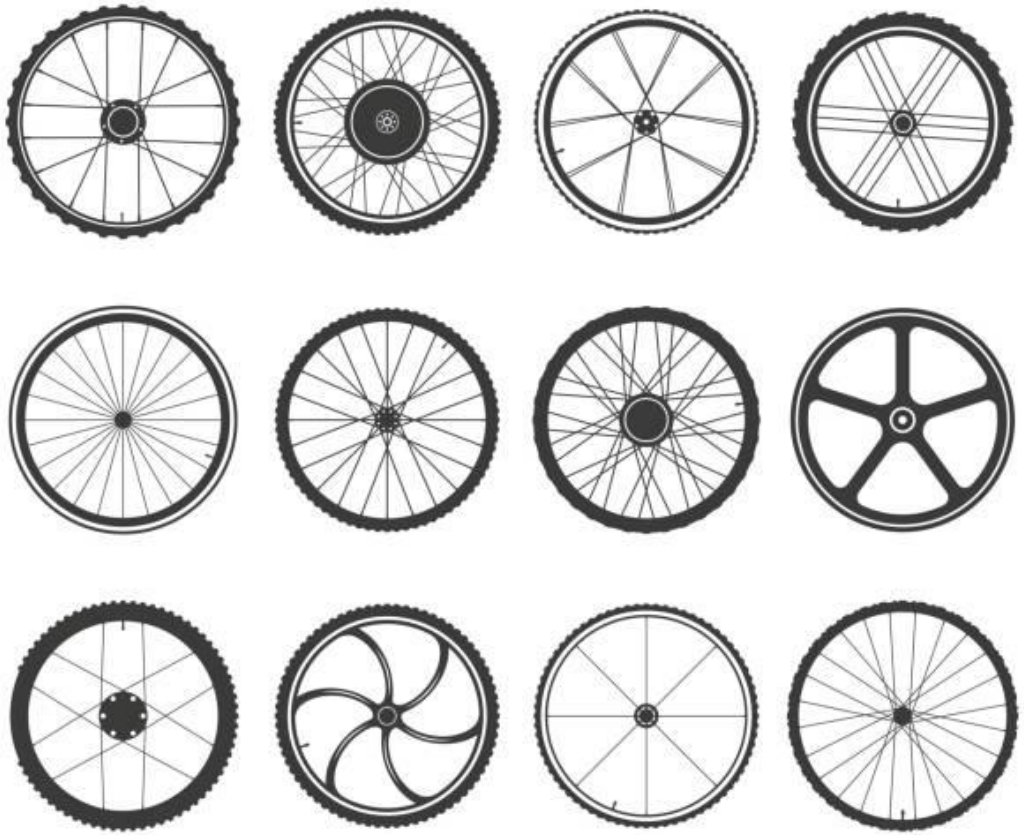
5-point scale:
based on visual assessment of fat at tailhead, pins, etc.

1-5 scale with quarter points:
based on visual assessment of pelvis, hooks, pins, ribs, spine

1-5 scale with increments of 0.25:
based on visual assessment of hook-pin angle, tailhead etc.

3 point scale (0-2):
based on visual assessment of fat around tailhead, pins, spine etc. (Welfare Quality Scheme)

Our preliminary conclusion….



It looks as if BCS scales were “reinvented” many times…
and some doing this several times…. !

Converting between BCS scales?

"The commonality of the body parts assessed and the direction of BCS with increasing adiposity allows for mathematical interconversion between many of these scales."

J. Dairy Sci. 92:5769–5801
doi:10.3168/jds.2009-2431

Invited review: Body condition score and its association with dairy cow productivity, health, and welfare

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But is this correct? – At least two issues

1. Have we the same trait (independently from the scale)?

2. Even if we have same trait, are the scales used the same way?

Not only about scales but about “Systems”

➔ Scale x Implementation

If same trait ➔ converting to a BCS 5 scale (using Maths…)

$$\text{1–4 scale: } 4/3 \times \text{BCS} - 1/3$$

$$\text{0–5 scale: } 4/5 \times \text{BCS} + 1$$

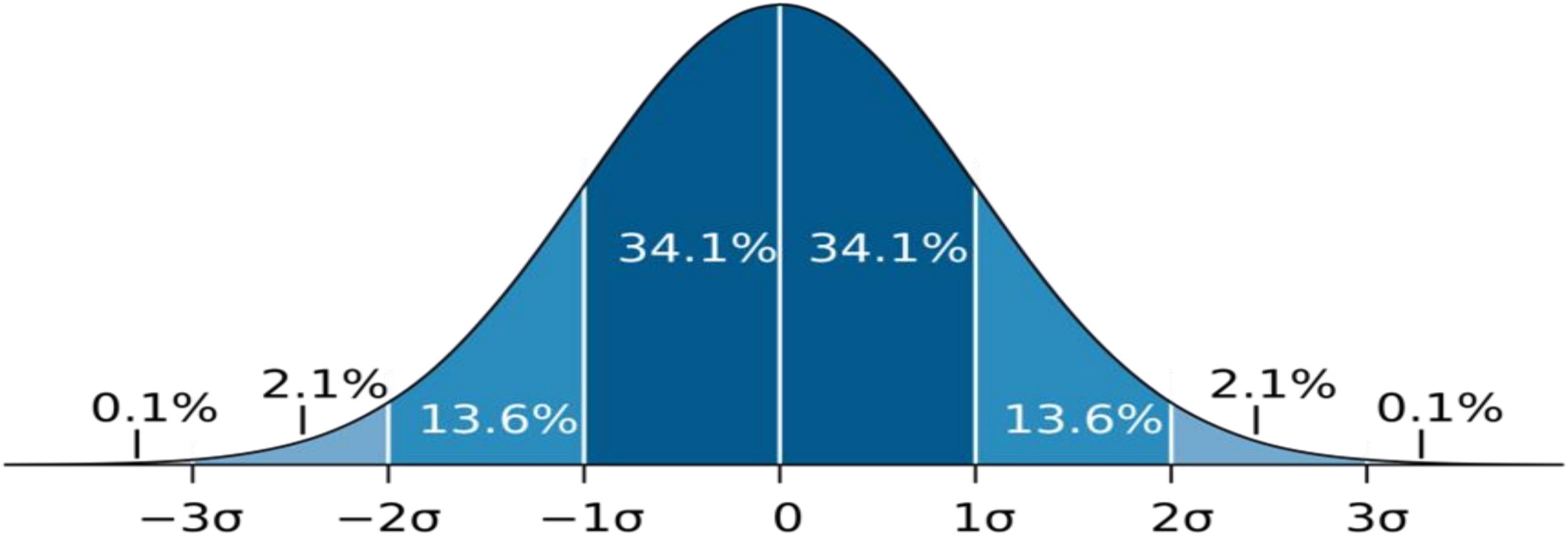
$$\text{1–8 scale: } 4/7 \times \text{BCS} + 3/7$$

$$\text{1–9 scale: } 1/2 \times \text{BCS} + 1/2$$

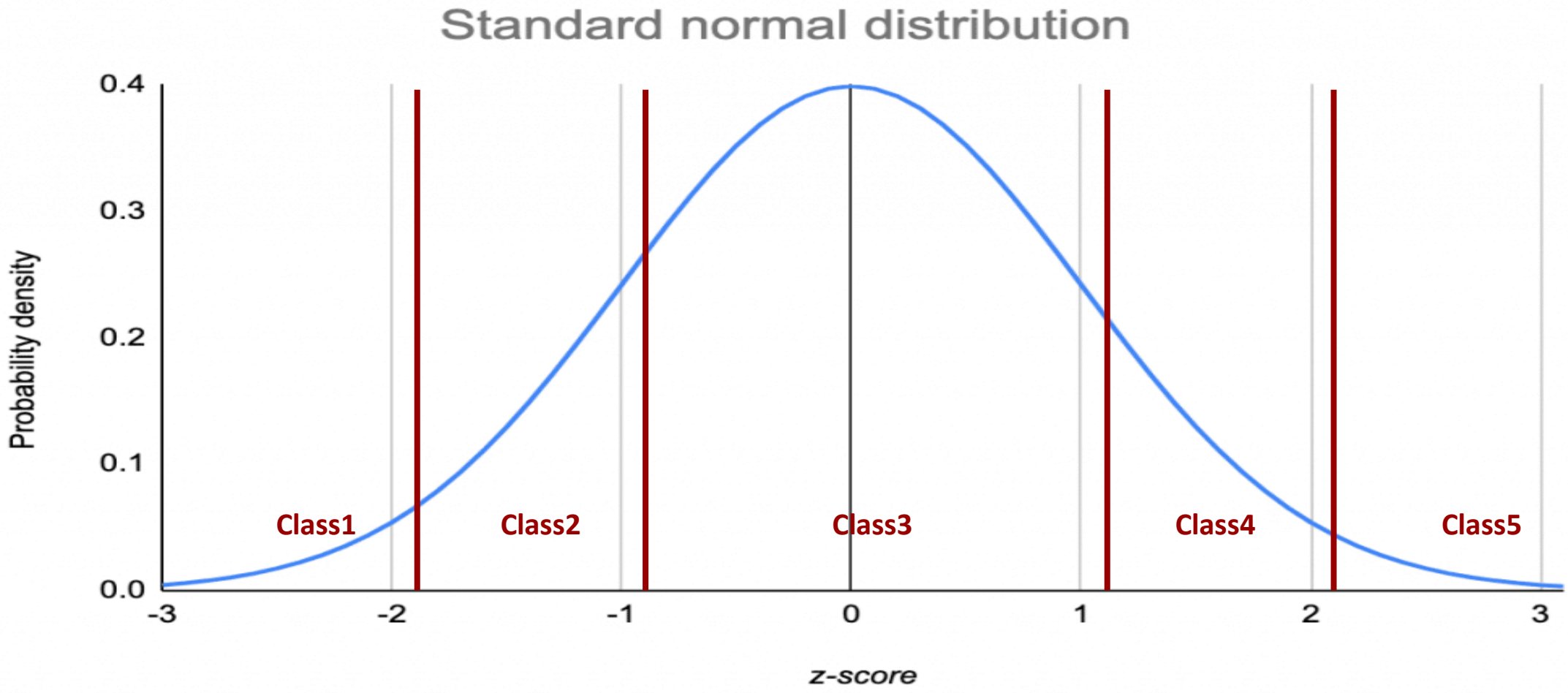
$$\text{1–10 scale: } 4/9 \times \text{BCS} + 5/9$$

Garnsworthy, P. C. 2006. Body condition score in dairy cows: Targets for production and fertility. Pages 61–86 in Recent Advances in Animal Nutrition. P. C. Garnsworthy and J. Wiseman, ed. Nottingham University Press, Nottingham, UK.

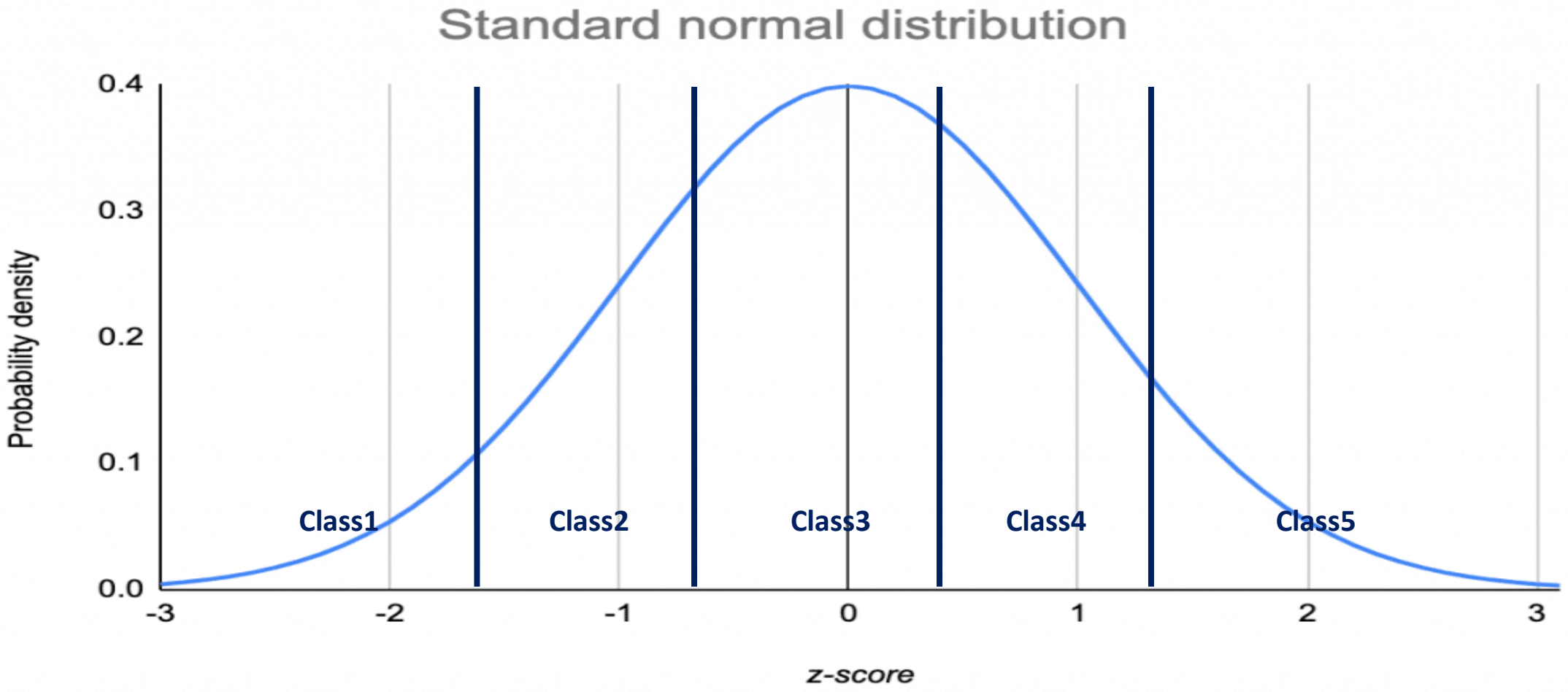
Underlying distribution of body condition ➔ “Liability”



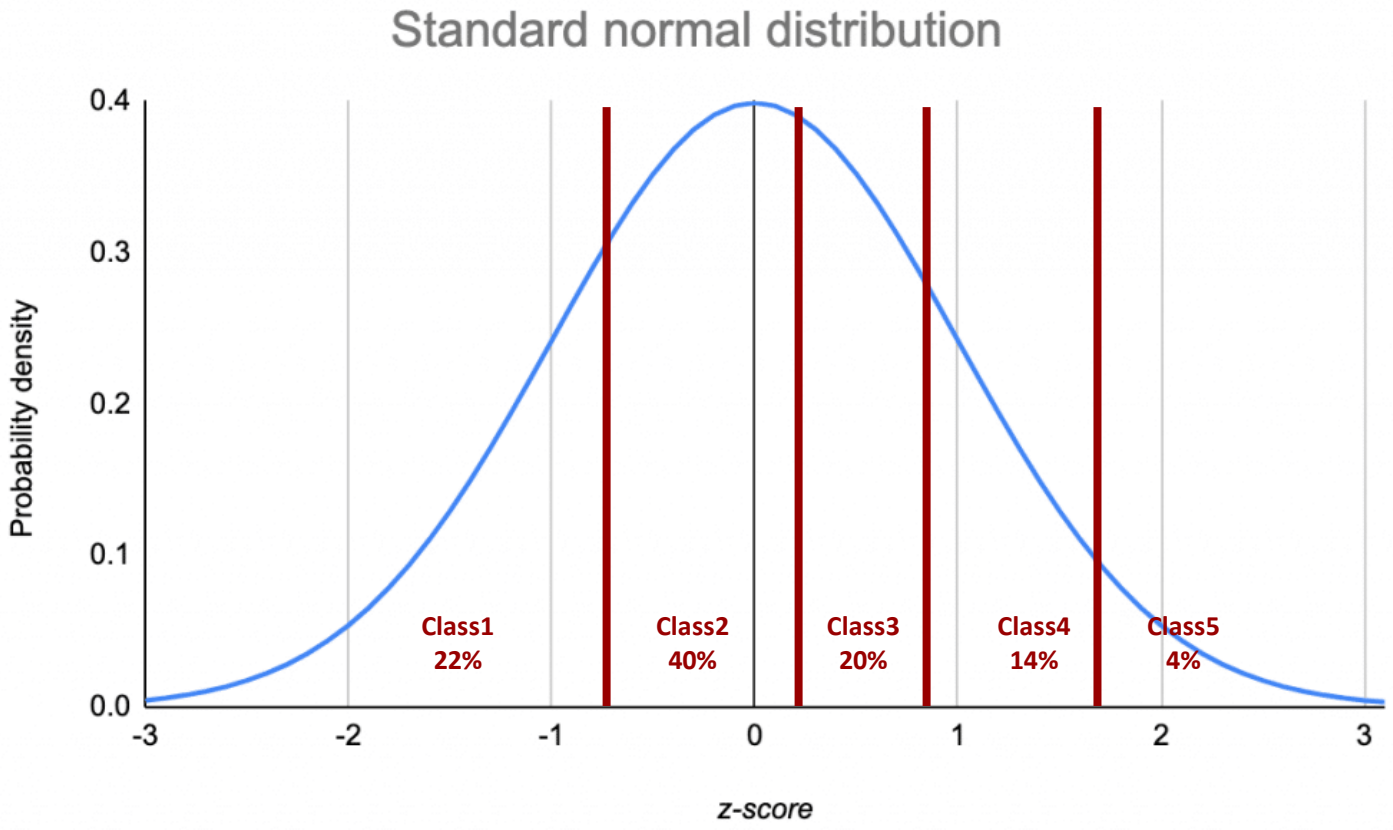
5-point scales ➔ 1st scale



5-point scales ➔ 2nd scale

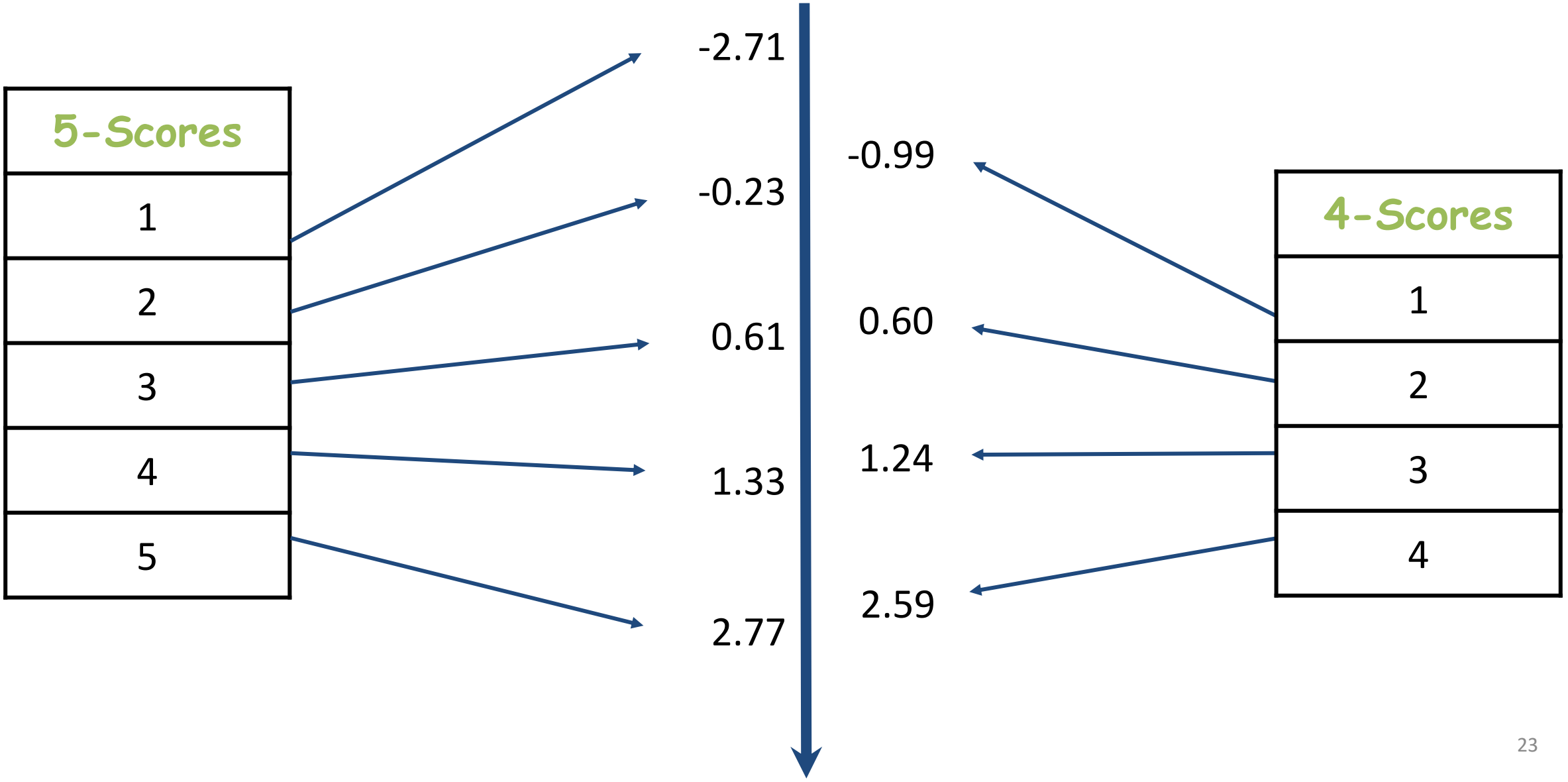


Original score ➔ distribution ➔ Snell Scores ➔ new value



Scale	Distribution	Snell Score
1	0.22	-2.71
2	0.40	-0.23
3	0.20	0.61
4	0.14	1.33
5	0.04	2.77

Mapping with Snell Scores



Same underlying trait?

J. Dairy Sci. 87:3076–3079

Relationships Among International Body Condition Scoring Systems

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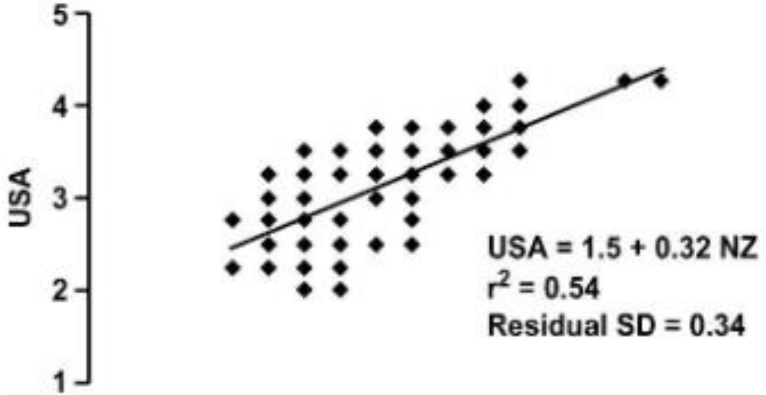
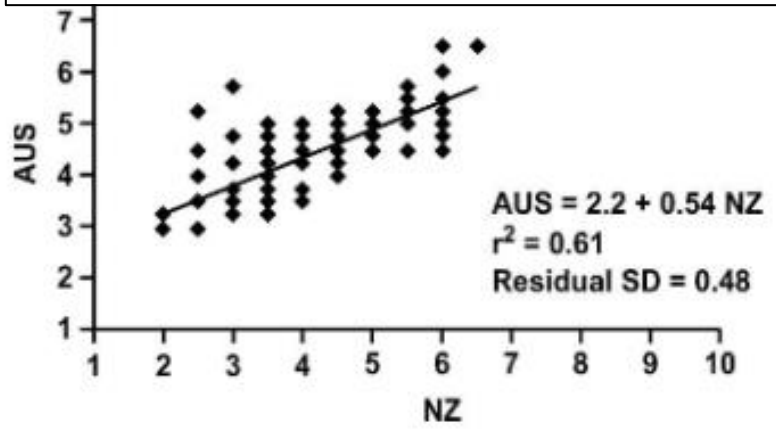


$$\text{USA} = 1.5 + 0.32\ \text{NZ}$$

$$\text{IRE} = 0.81 + 0.4\ \text{NZ}$$

$$\text{AUS} = 2.2 + 0.54\ \text{NZ}$$

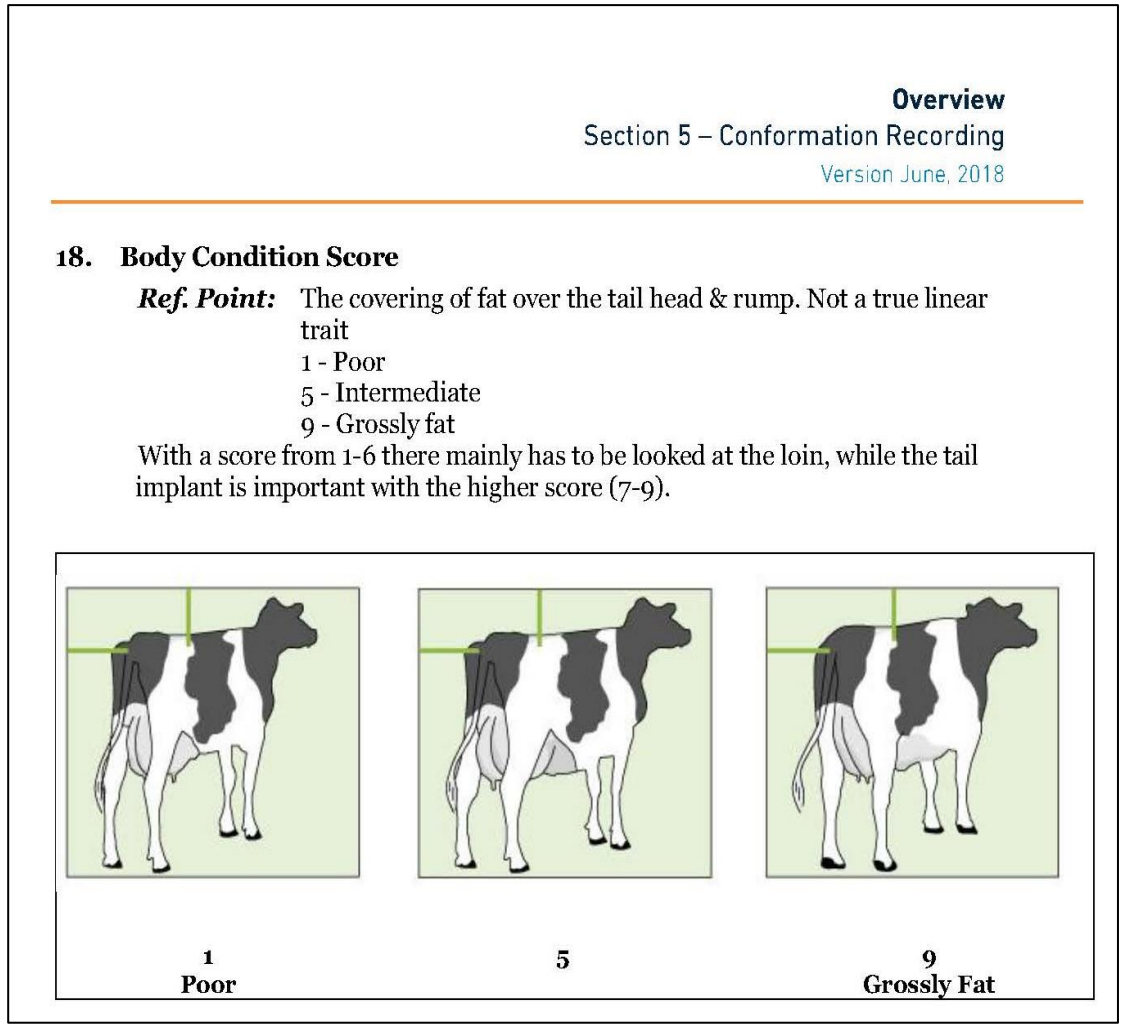


Alternative ways (or contexts) to BCS …

- Conformation
- Sensors
- Proxies

BCS inside the Conformation Recording Schemes

- BCS was introduced into conformation even if “not a true linear trait”
- Important
- Pros…
  - Taken on a (very) large number of cows
  - In a fairly uniform manner
  - ….
- Cons…
  - Mostly only 1x in 1st lactation
- More
  - M. van Pelt’s presentation (9:20 – 9:40): *BCS and conformation: from recording to data quality assurance*



Overview
Section 5 – Conformation Recording
Version June, 2018

18. Body Condition Score

Ref. Point: The covering of fat over the tail head & rump. Not a true linear trait
1 - Poor
5 - Intermediate
9 - Grossly fat

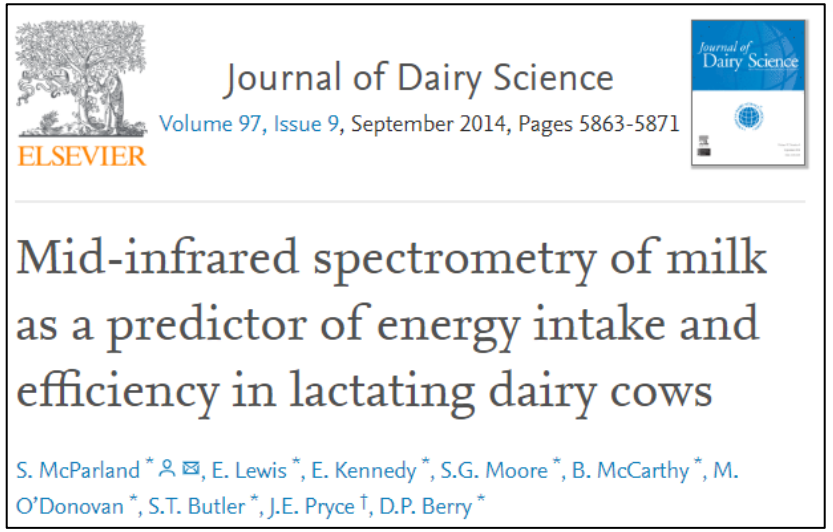
With a score from 1-6 there mainly has to be looked at the loin, while the tail implant is important with the higher score (7-9).

Automated technologies ➔ basic issues to solve

- (In)consistency of human recording
- Frequency of recording
- Automatization of recording
- More
  - Presentation by S. Sievert and R. Fourdraine (9:40 – 10:00): *Automatic technology and BCS recording: possibilities, reliability and requirements for data exchange*

Milk based proxies

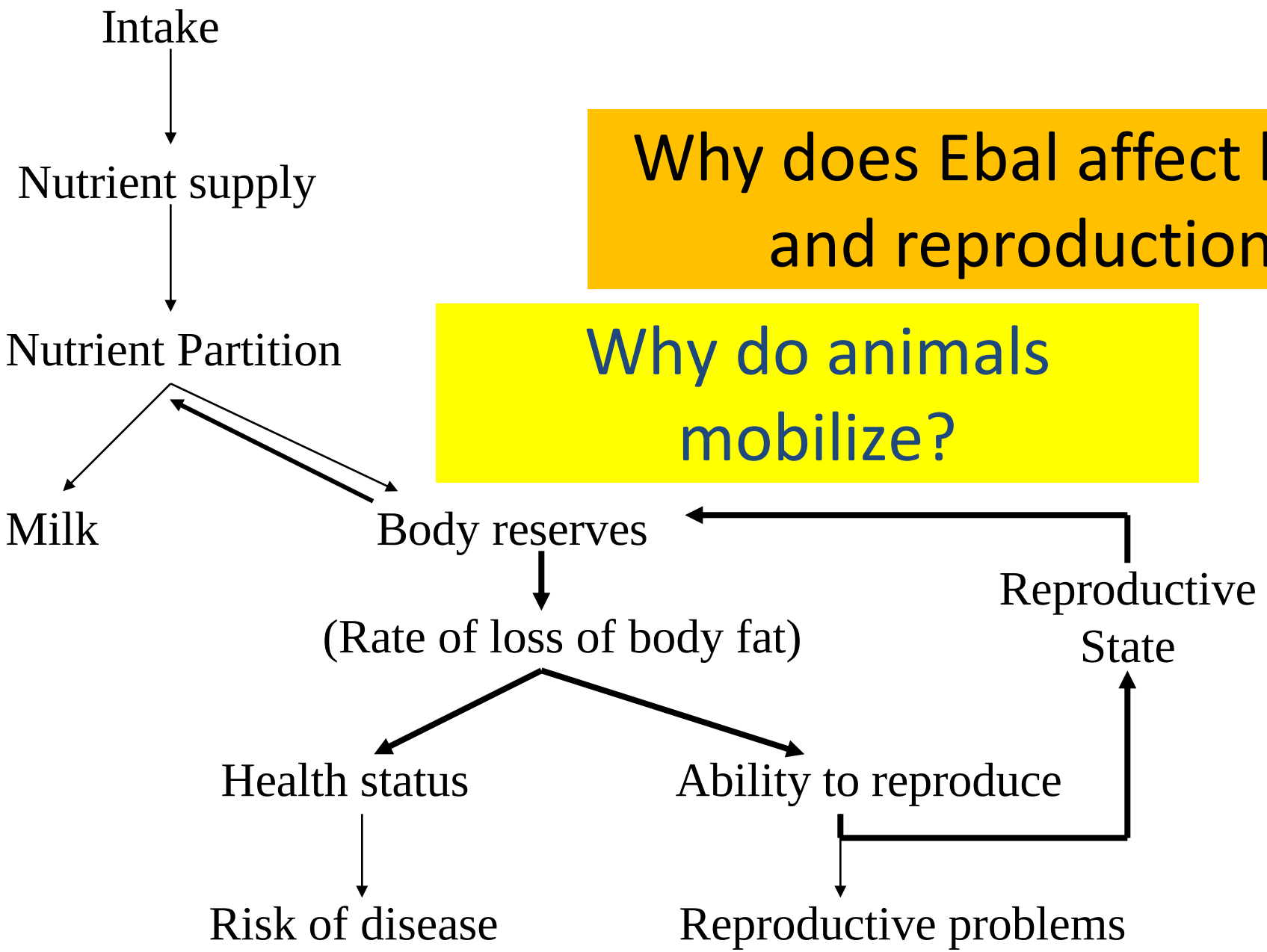
- Prediction accuracy using milk mild-infrared (MIR) data for ΔBCS > Ebal (= Eintake – Eoutput)
- Potentially due to link between certain good predictable FA (C18:0 and C18:1-cis9) and body energy changes
- More research needed, also good reference data, potentially from automation



BCS and the biology of efficiency, health, fertility….

Why does Ebal affect health and reproduction?

Why do animals mobilize?



Body reserves ➔ used in 2 ways

1. to buffer shortfalls in energy supply, a homeostatic role,

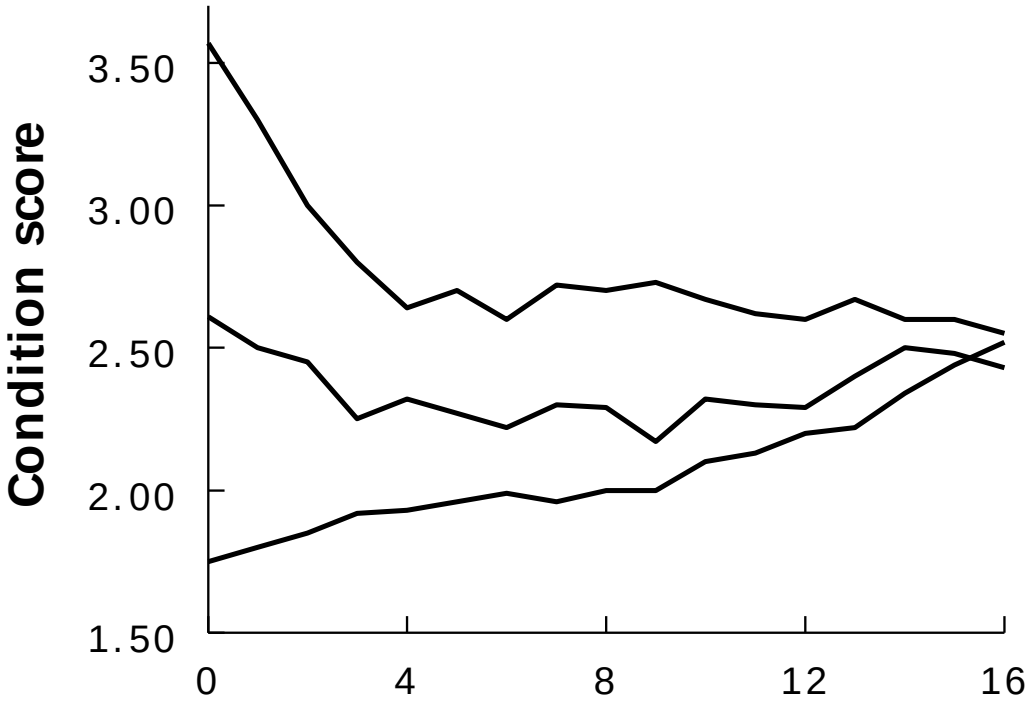
2. to safeguard reproduction in an "anticipatory" or homeorhetic role

- Cows genetically driven
  - to gain body reserves during pregnancy
  - to lose them in early lactation

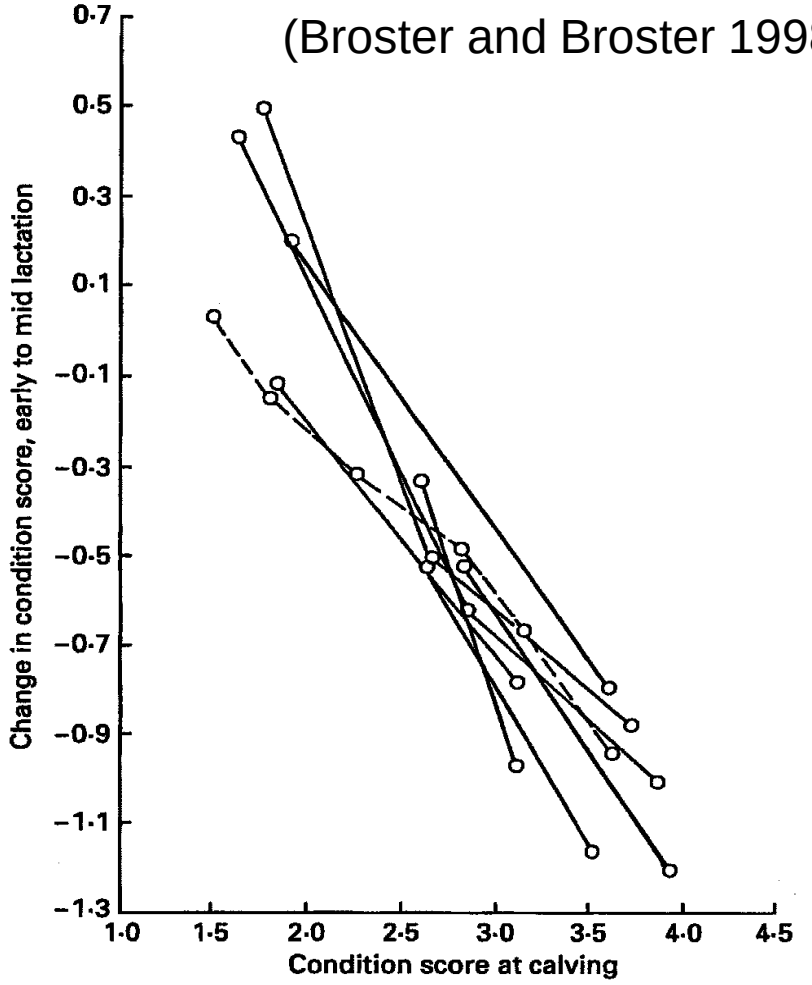
- Cows may show
  - Rebound trajectories = homeostasis ➔ reaction to environment potentially damaging
  - Naturally fatter or thinner at calving no rebound trajectories

Example: body reserve usage – classic view

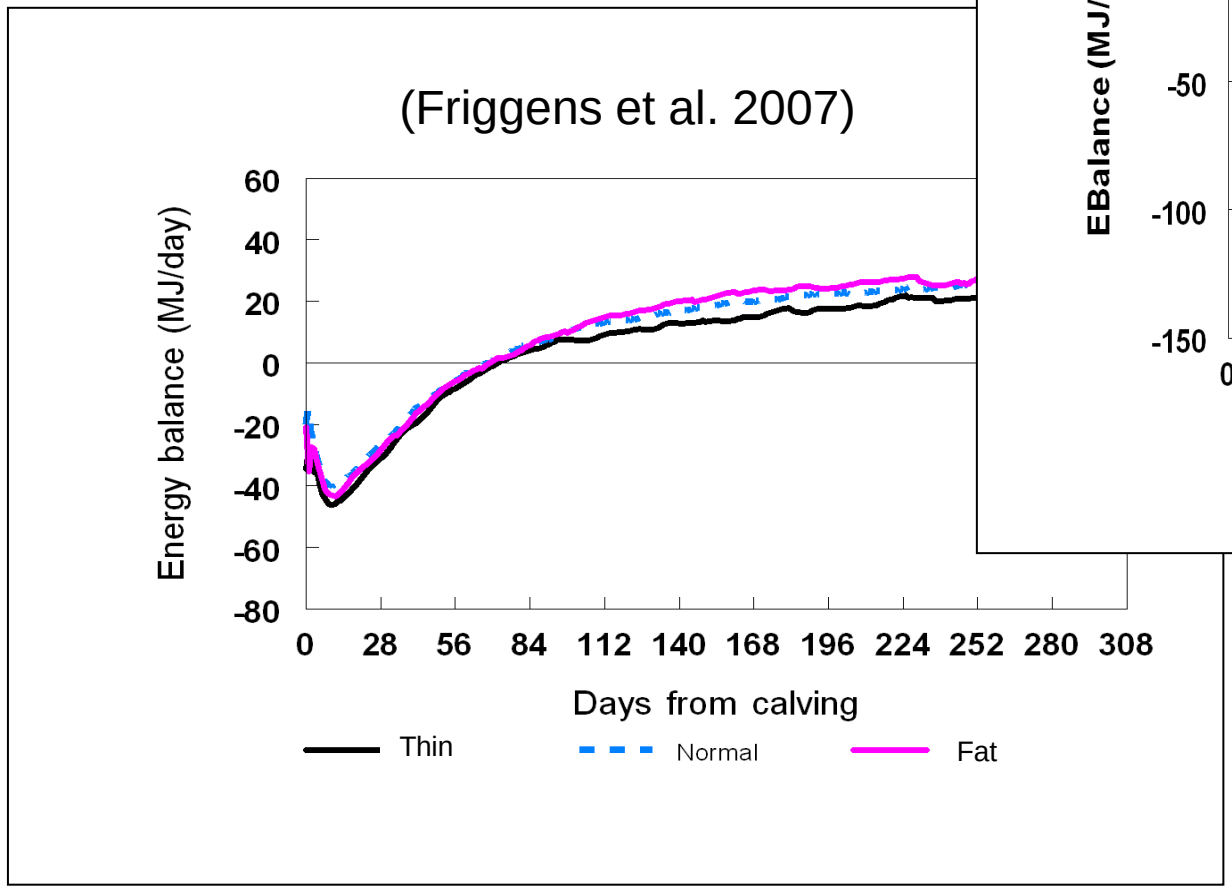
(Garnsworthy and Topps 1982)

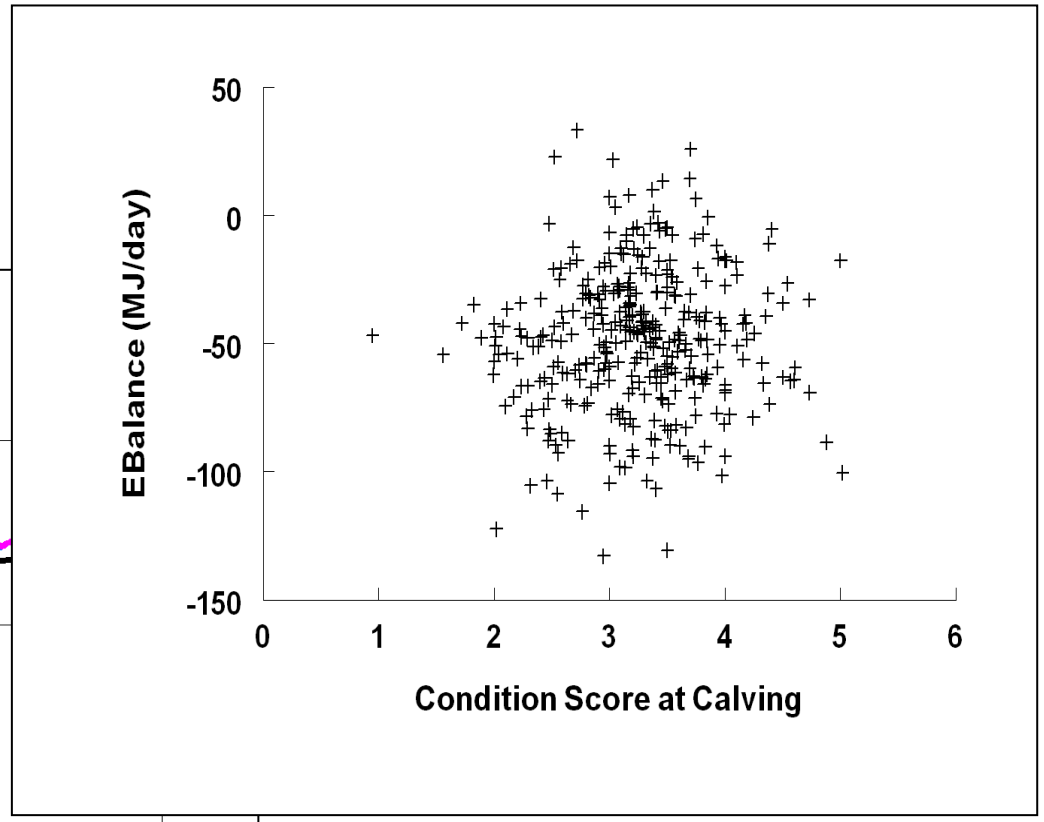


(Broster and Broster 1998)

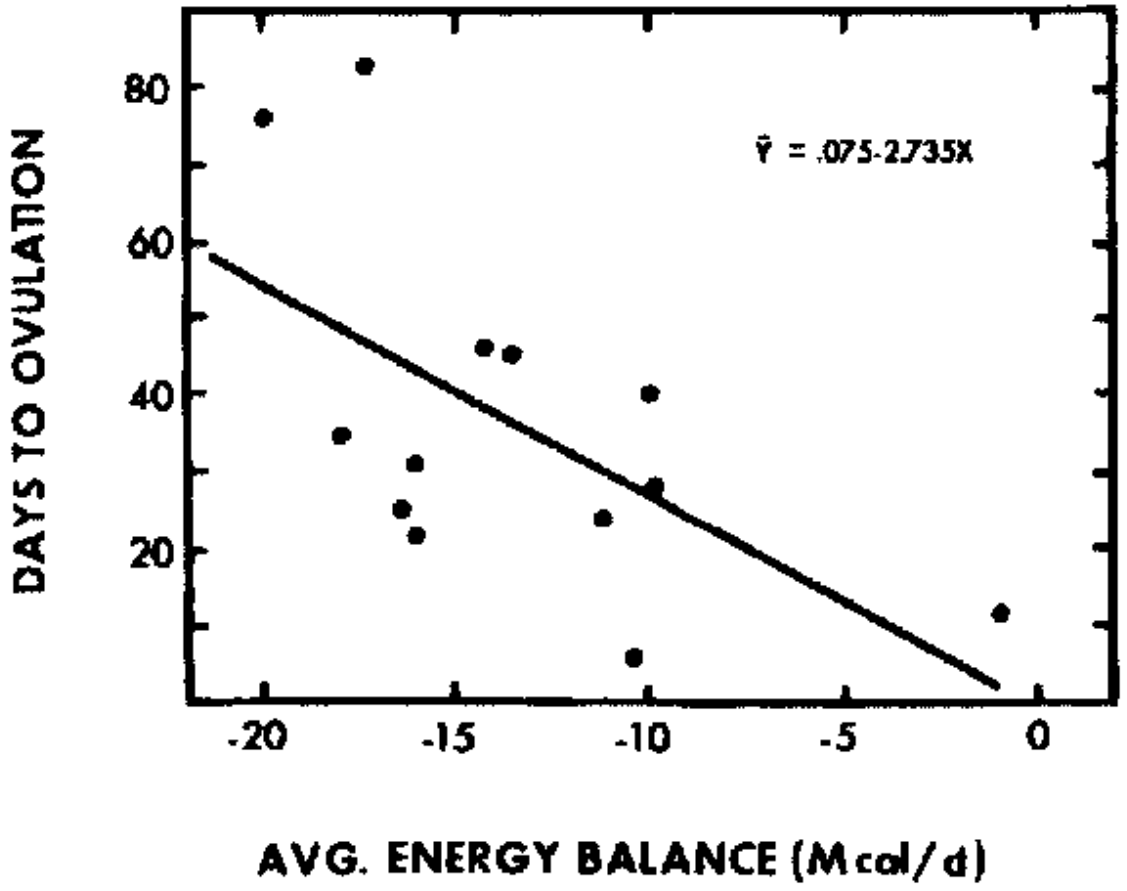


Body reserve usage – other results





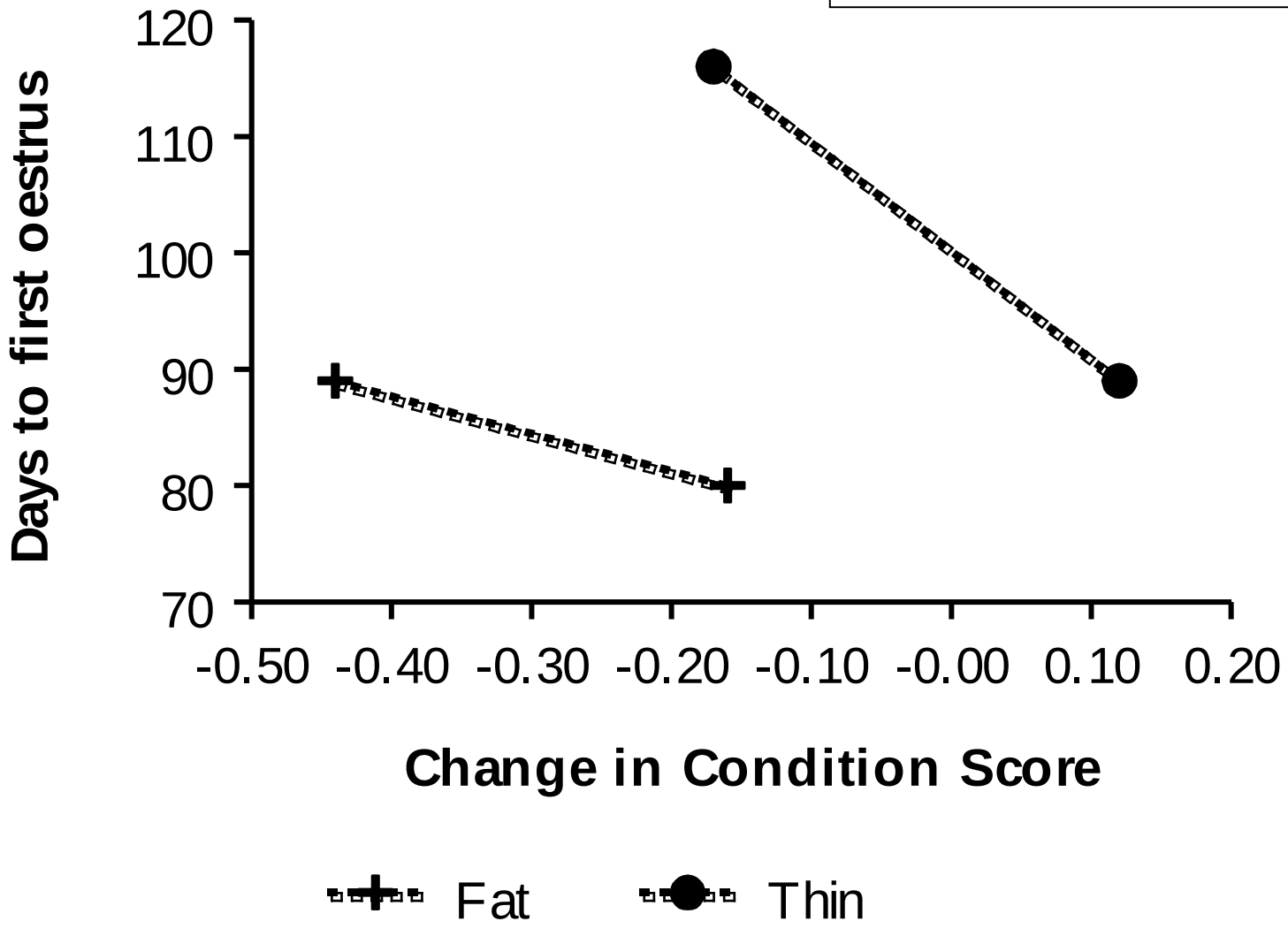
Mobilisation depresses reproduction in dairy cows



Butler et al. 1981

Mobilization depresses reproduction in beef cattle

(data of Wright et al. 1992)



Possible mechanisms

- “The energy required to develop, mature and ovulate a follicle, to form a corpus luteum, and to maintain early pregnancy is negligible” Leroy et al. (2008)

- Not a direct energy trade-off

- “Signal” mediated by:
  - Elevated NEFA, beta-hydroxybutyrate and urea decrease oocyte competence (Leroy et al., 2008)
  - Also lowered glucose concentration in follicular fluid

Use for feeding, breeding and consequences of these uses...

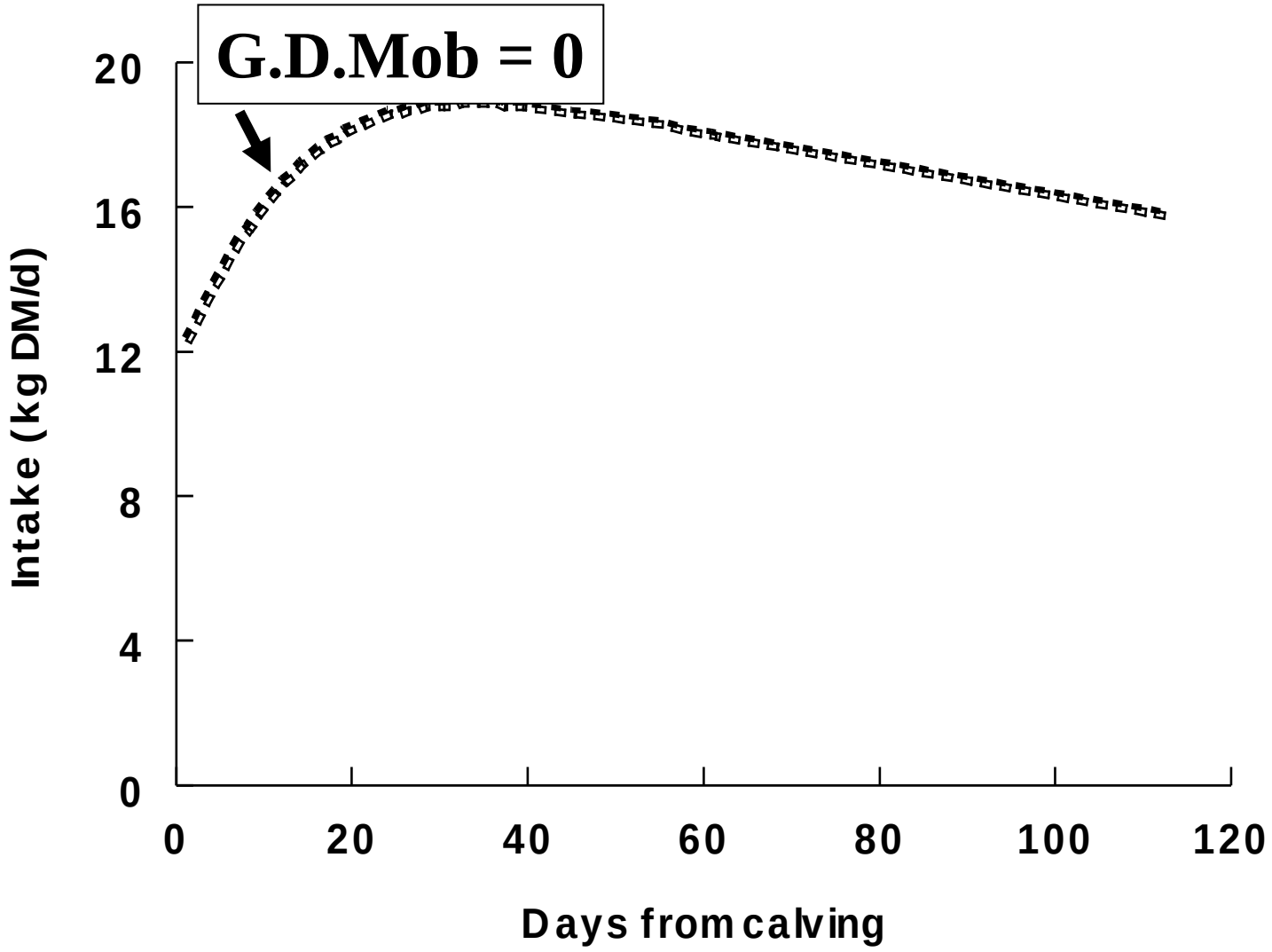
Practical implications for cow management

- Accepting genetically driven mobilization (GDM) implies:
  - Cows must mobilize body fat reserves in early lactation

➔ Feed intake will be reduced.

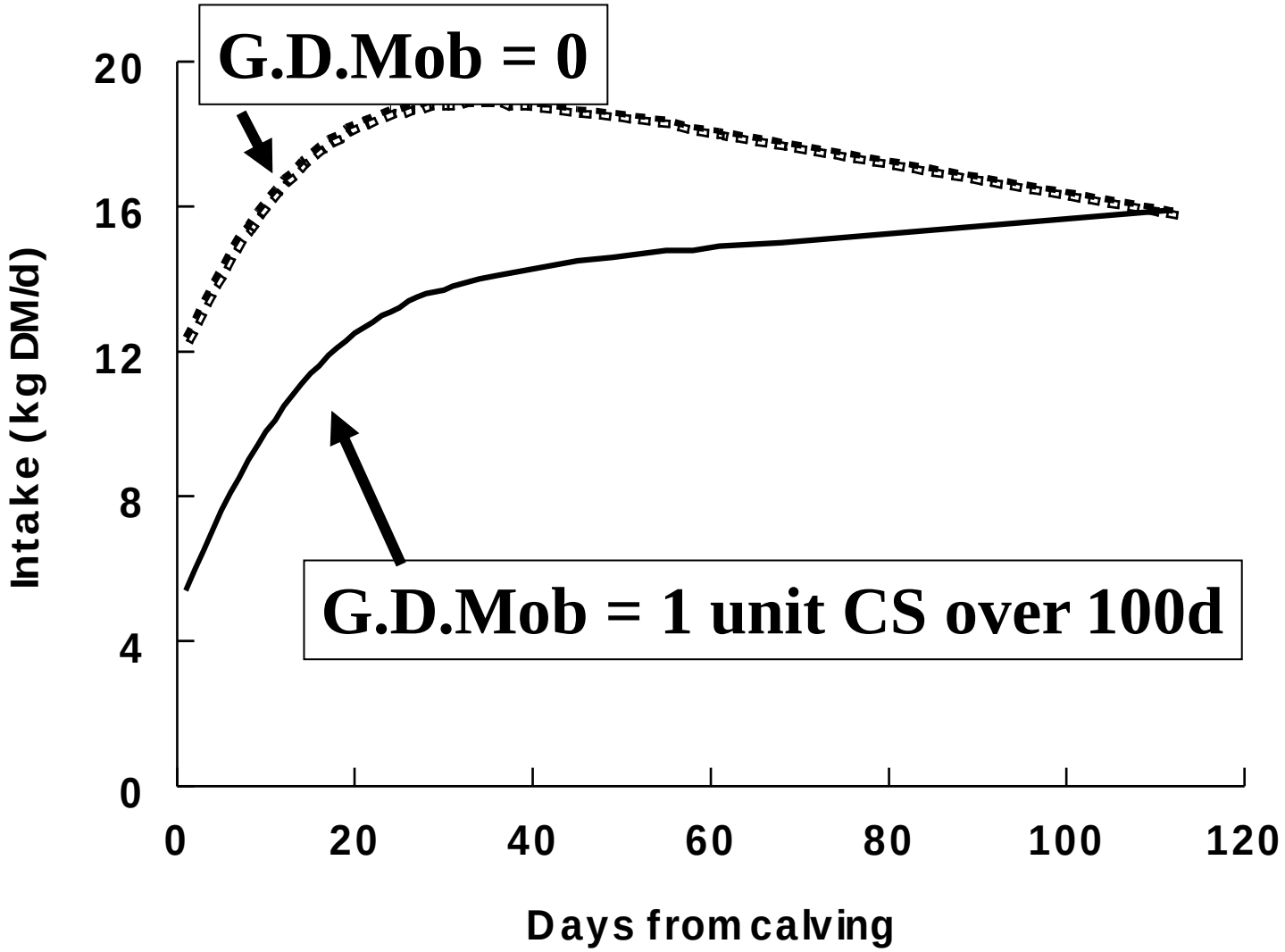
- This has consequences
  - For feeding and ration formulation…
  - But also for breeding...

Consequences on Intake Prediction



(A 615 kg cow producing 6500 kg milk from a 12.4 MJ ME TMR)

Consequences on Intake Prediction



(A 615 kg cow producing 6500 kg milk from a 12.4 MJ ME TMR)

Priming for body mobilization

- Instead of working against the cow, prepare her
  - Implies that the cow is NOT a machine
  - There is a natural, genetically driven, mobilization ➔ breeding
- Provoke an early start to fat mobilisation in the dry period by:
  - Use of fibre rich ration
  - Use a fat supplement in the feed
- Training of the liver

More about feeding and breeding in talks after the break

- A. Köck and J. Pryce (10:50 – 11:10):
  - *Genetics of body condition score and its association with feed efficiency, fertility and health*
- D. Santschi (11:10 – 11:30):
  - *BCS and Its Use for Optimization of Feeding / Herd Management*

Also, later, about economics…

- H. Hogeveen (10:30 – 10:50):
  - *Economics of early detection of diseases by using BCS*

And, now, obviously, cow well-being..

- M. Haskell (9:00 – 9:20):
  - *The relationship between body condition score and cow well-being*