XXII Novos Enfoques na Produção e Reprodução de Bovinos
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Advancements in Nutritional Requirements of Beef Cattle: *Steer*

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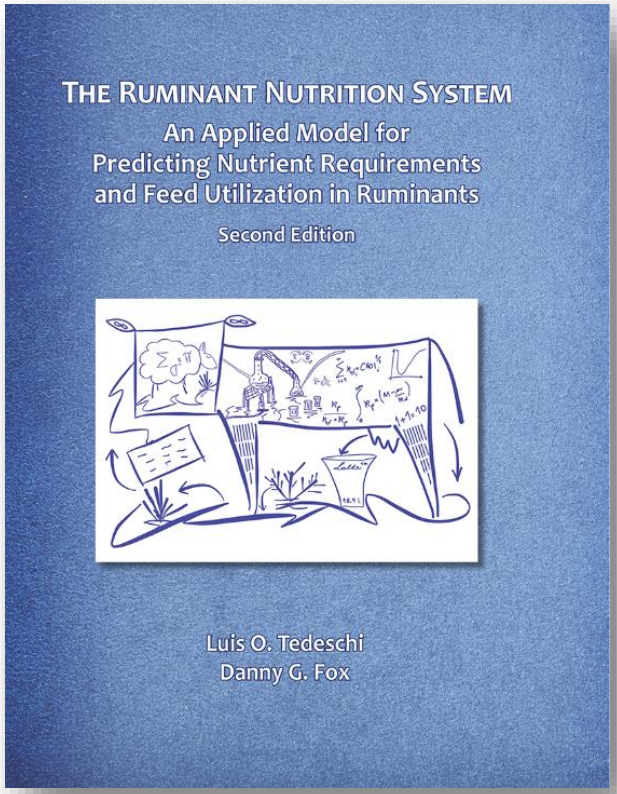
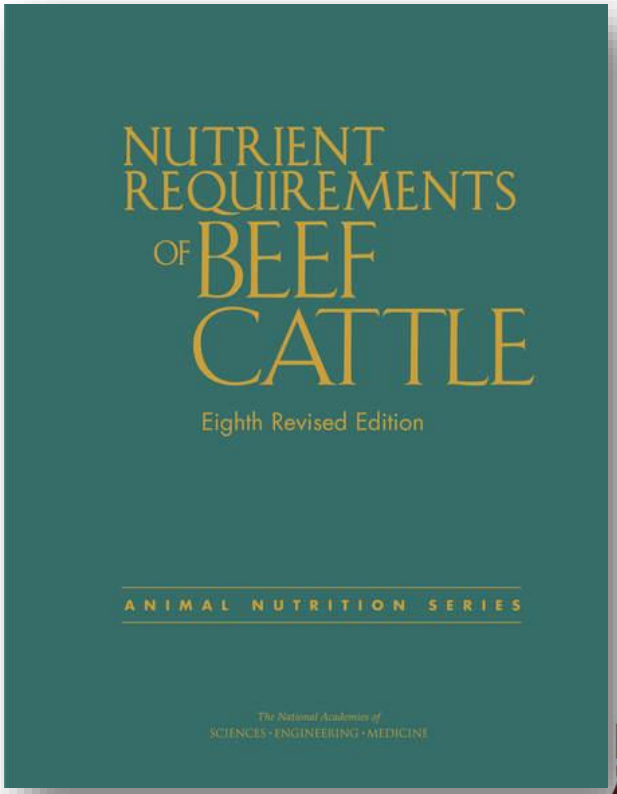
Where to Learn More?

Ruminant Nutrition System



"NRC" (2016)



Recent Changes in the NASEM (2016)

- Maintenance:
  - NEm = $0.077 \times SBW^{0.75}$
  - NRC (2000) assumed that *B. indicus* breeds had 10% less maintenance energy requirements than *B. taurus*

- Recent studies suggested that NEm for Nellore cattle was similar to $0.077 \times SBW^{0.75}$ (Tedeschi et al., 2002a; Marcondes et al., 2013; Chizzotti et al., 2008)

Maintenance Energy Requirement: <u>Heifer x Steer x Bull</u>

- A meta-analyzes showed that the NEm requirements for Nellore steers, bulls, and heifers were the same **0.077 Mcal/kg$^{0.75}$** (Chizzotti et al., 2008)

- The NEm requirements for Nellore steers and heifer were similar, but bulls had 5.4% higher MEm requirement (Tedeschi et al., 2002)

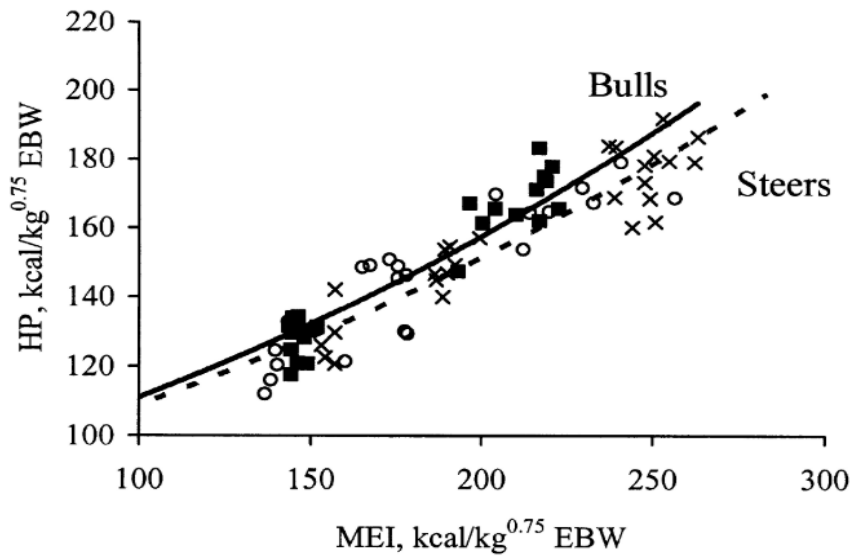


Figure 3. Exponential relationship between heat production (HP) and ME intake (MEI) for bulls (HP = 78.2 × $e^{(0.0035 \times MEI)}$, solid line) and steers (HP = 78.2 × $e^{(0.0033 \times MEI)}$, dashed line). Symbols are data from bulls (■) and from steers (Trial 2, ○; and Trial 3, ×).

THE NASEM (2016) REMOVED THE NELLORE BREED FROM THE 10% LESS GROUP…

… but kept other breeds based on MARC data

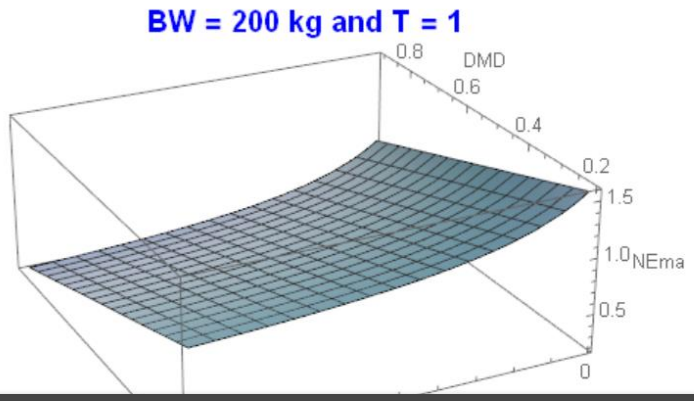
For Grazing Activities…

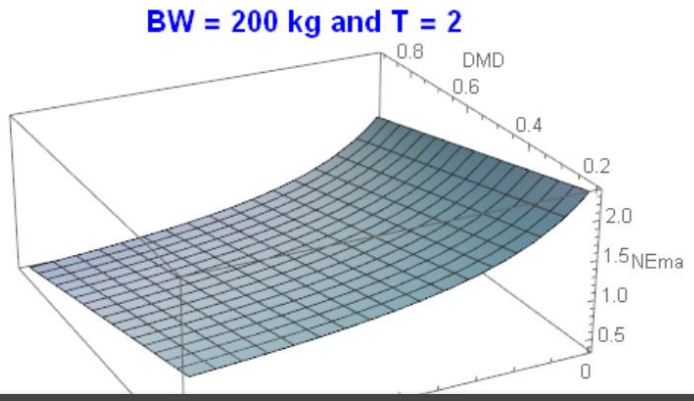
- The Australian Feeding Standards (CSIRO, 1990) estimated that grazing animals have 10 to 20% higher energy requirements when compared to penned cattle
- The NRC (1996, 2000) used the CSIRO (1990) approach to estimate the NE required for activity

$$NEm_{pa} = [0.006\ DMI \times (0.9 - D) + 0.05T/(GF + 3)] \times BW/4.184, \quad \text{(Eq. 11-14)}$$

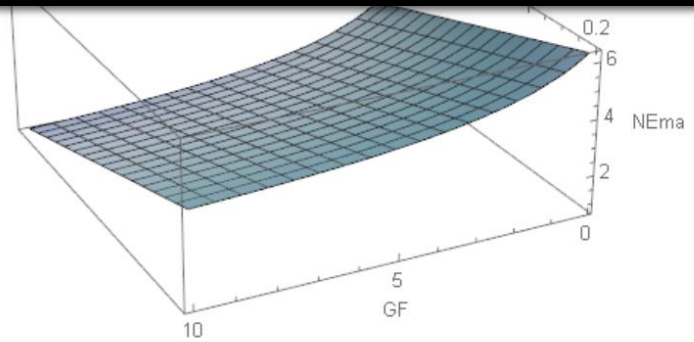
where

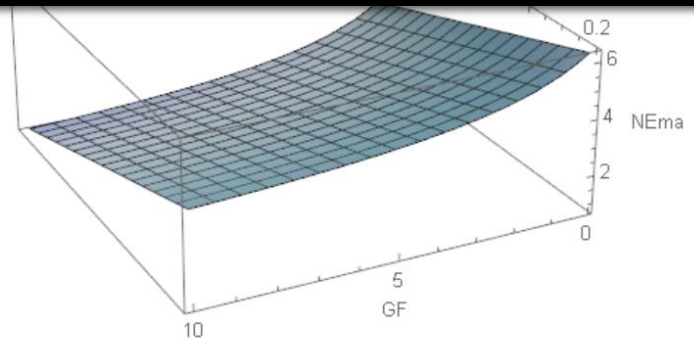
DMI is dry matter intake from pasture (kg/d);
D is digestibility of dry matter (as a decimal);
T is terrain (level, 1.0; undulating, 1.5; or hilly, 2.0);
BW is body weight (kg); and
GF is green forage availability (1,000 kg/ha).





The NASEM (2016) committee, however, chose not to include this adjustment to the maintenance requirements for activity until more data is available and more accurate prediction equations can be used

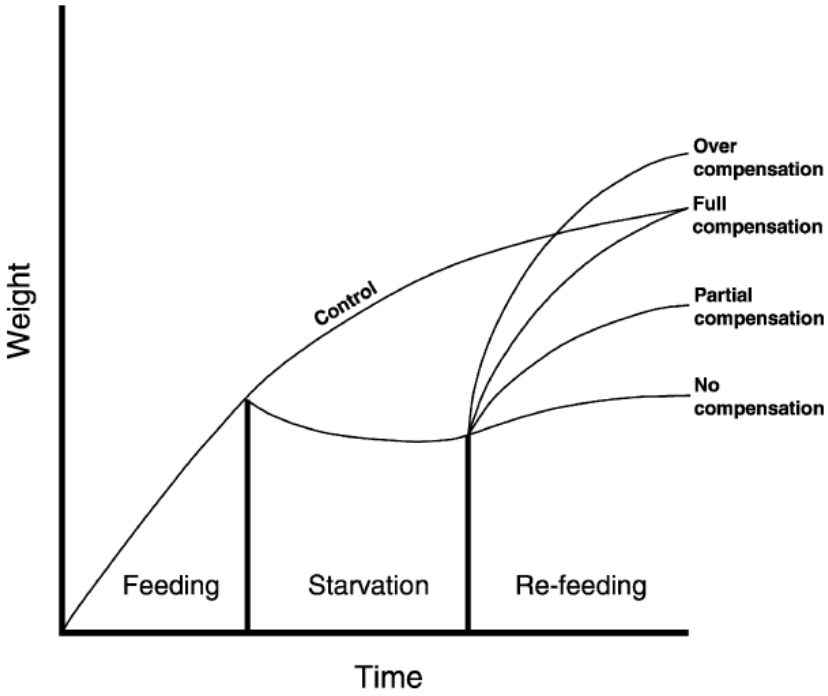




Compensatory Growth

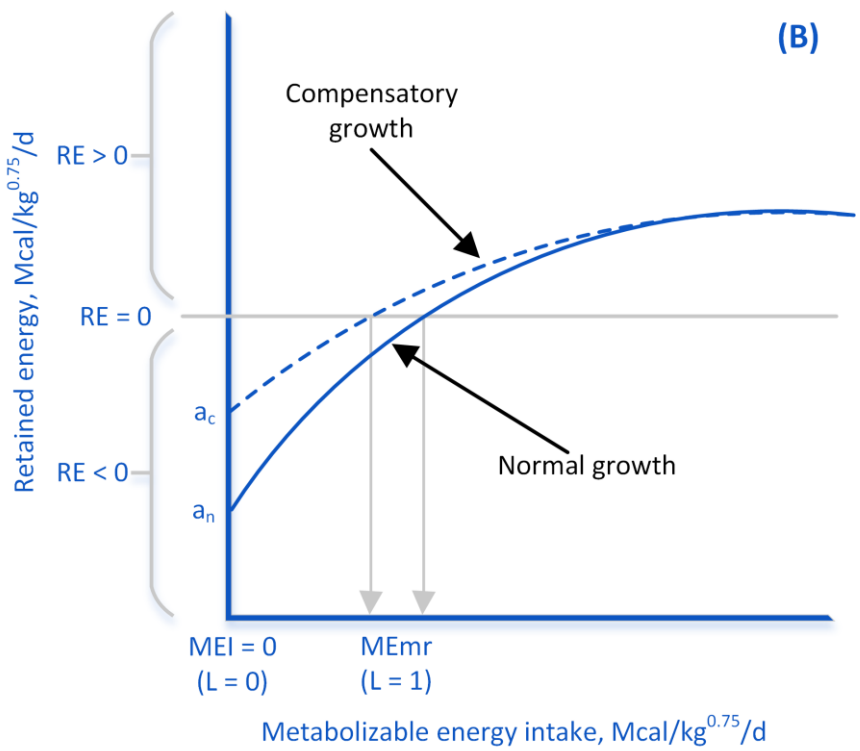
- The results on the extent of the decrease in NEm have been variable, and range from about 10% to more than 50%

- There is a gap of information regarding the duration of the decreased maintenance



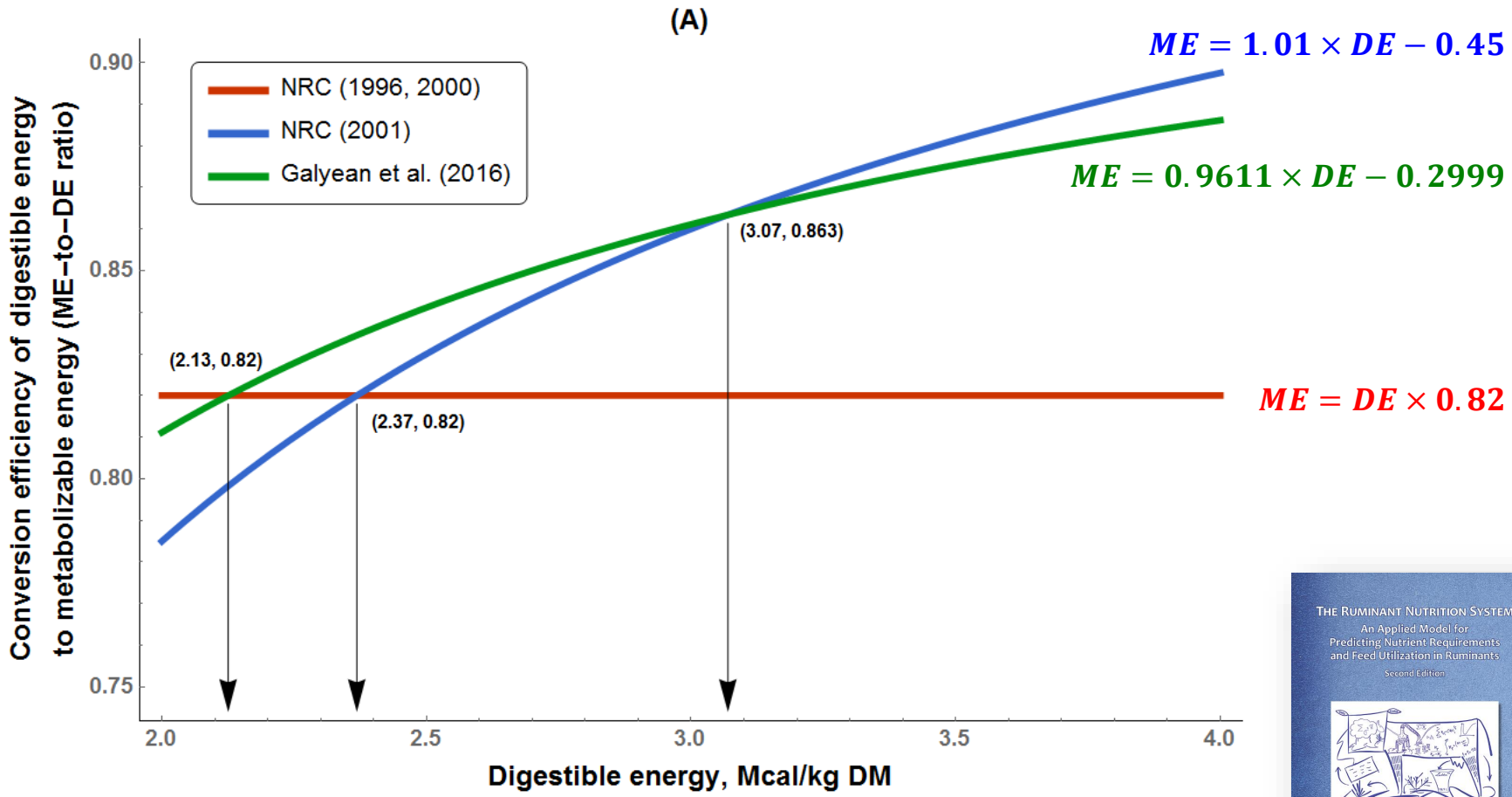
Energetics of Compensatory Growth

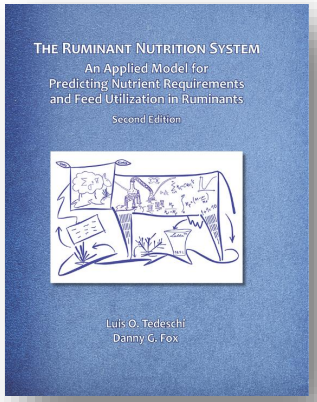
A 20% decrease in maintenance for a compensating animal seems reasonable, the duration of 60 to 90 d of compensation can be expected based on literature information



Tedeschi and Fox (2018)

DE-to-ME Efficiency

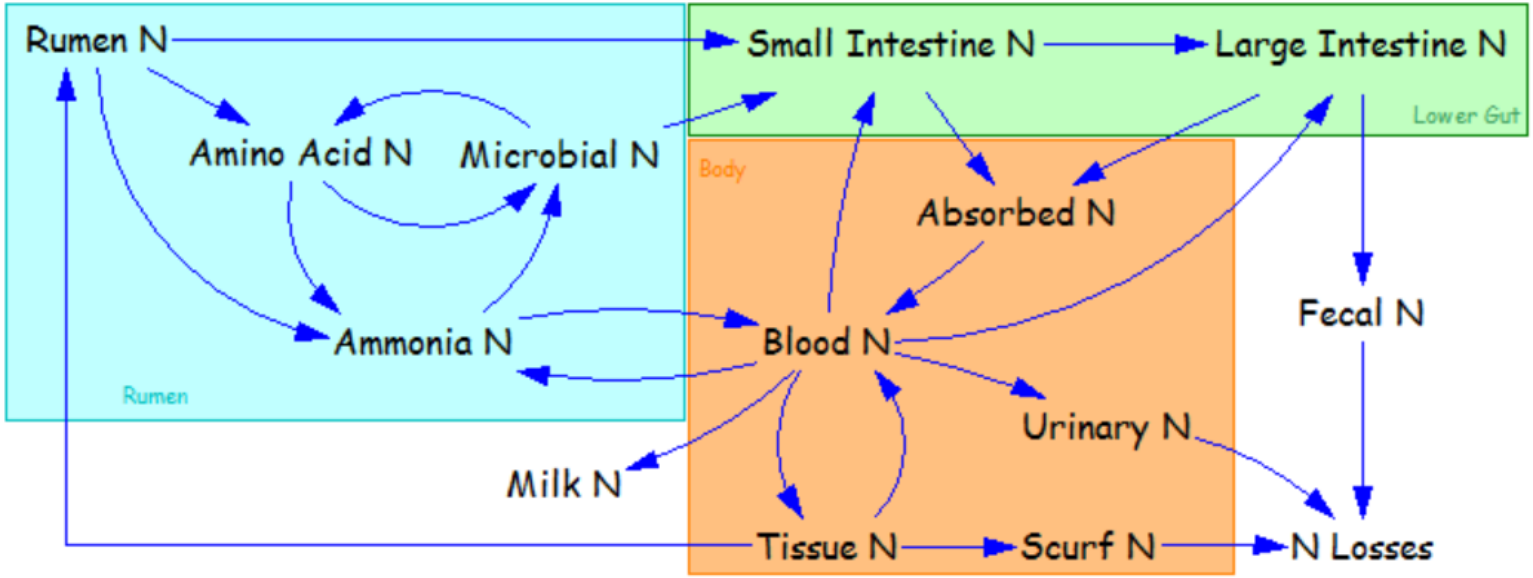




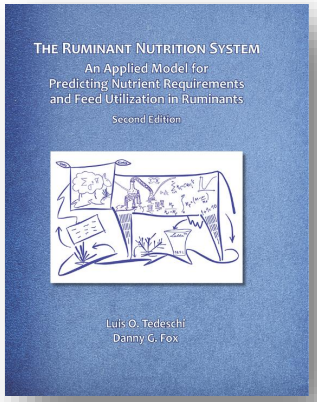
Protein Requirements for Maintenance

- Supply of metabolizable protein (MP) is the sum of digested ruminally undegraded feed protein (RUP) and digested microbial crude protein (MCP)
  - $MP_{Feed} = RUP \times 0.80 \; or \; RUP \times 0.60$
  - $MP_{MCP} = MCP \times 0.80 \times 0.80$
- MP requirements
  - $MPm = 3.8 \times SBW^{0.75}$ g/d

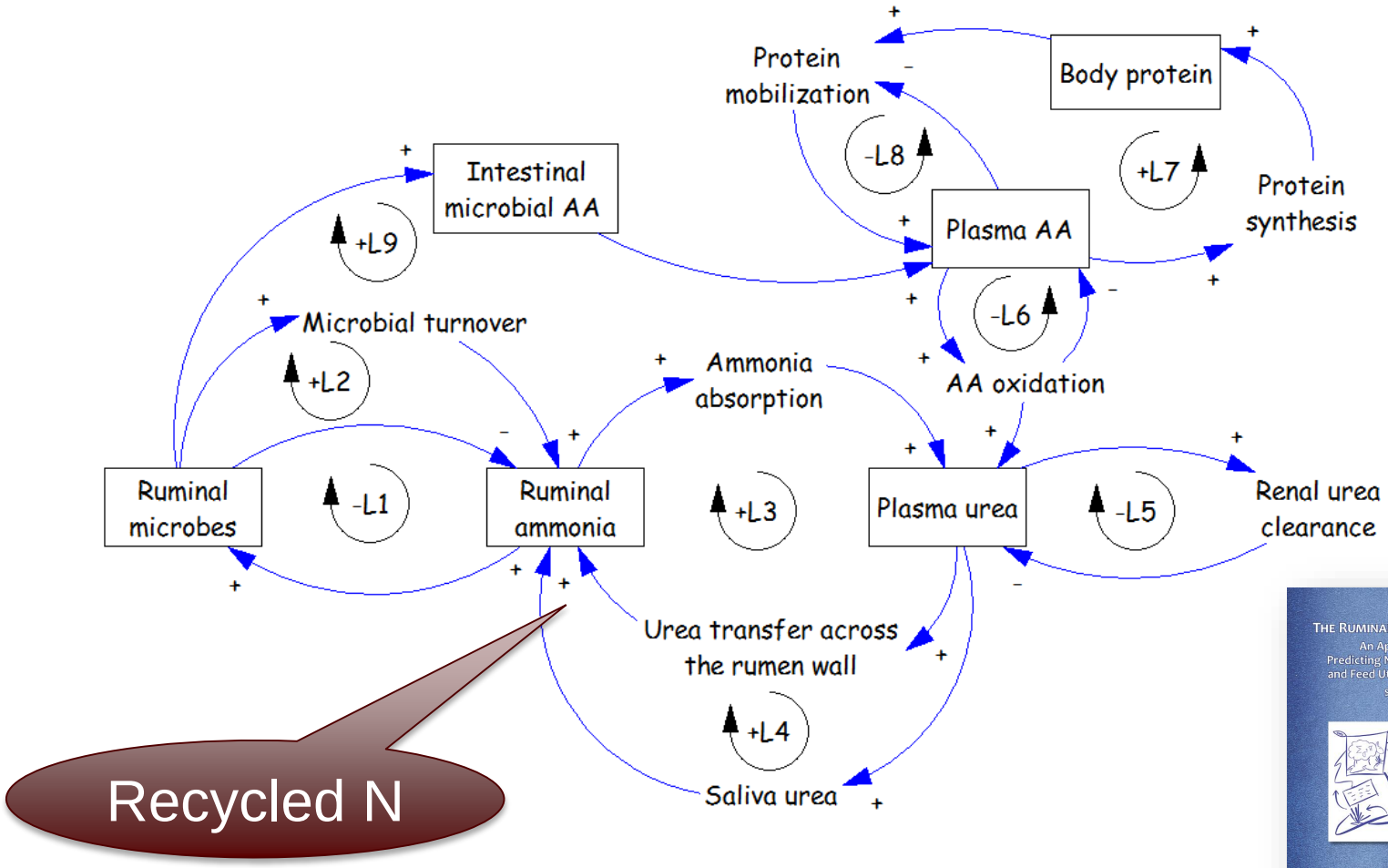
Nitrogen Transactions

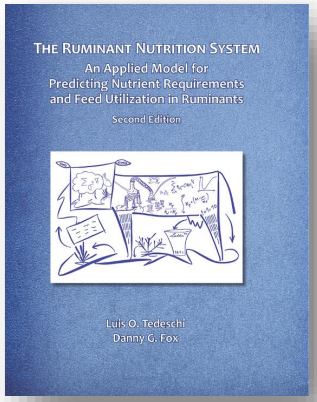


- Microbial crude protein
- Ruminally undegraded protein
- Recycled N
- Excreted N (milk + feces + urine + scurf)

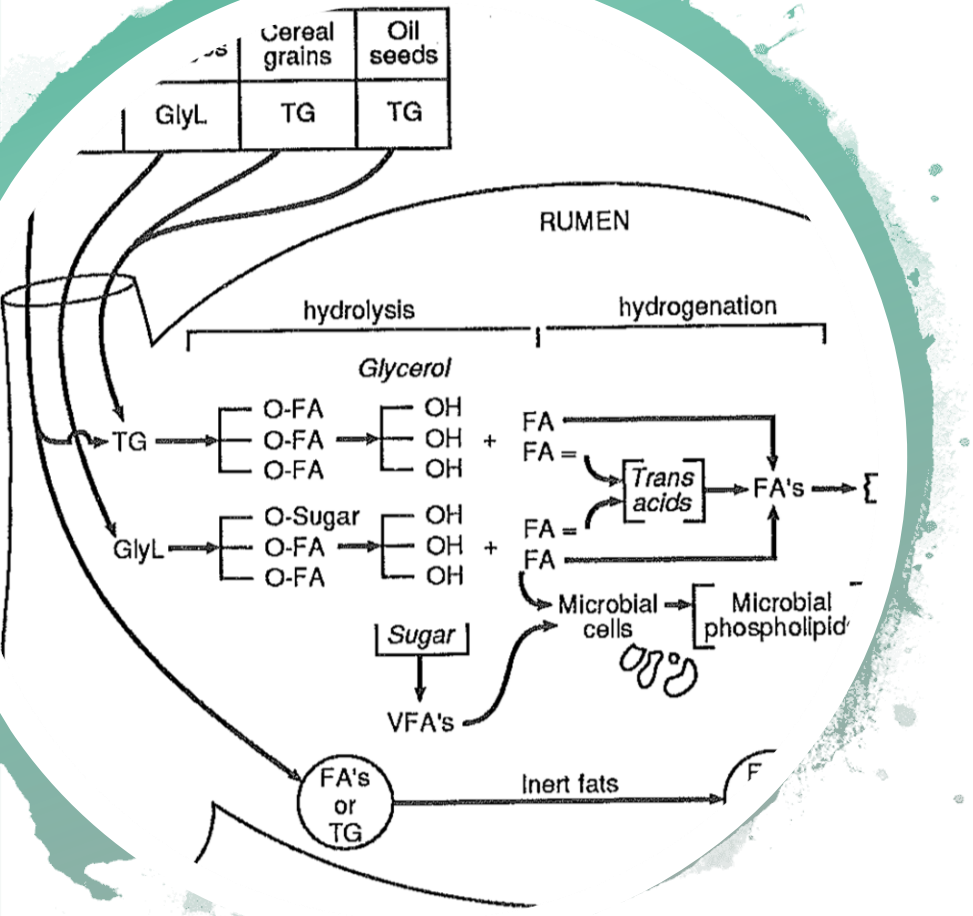


Recycled Nitrogen



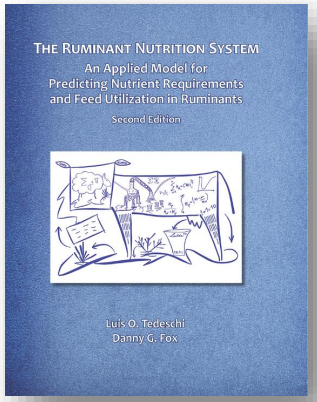


Lipid Metabolism



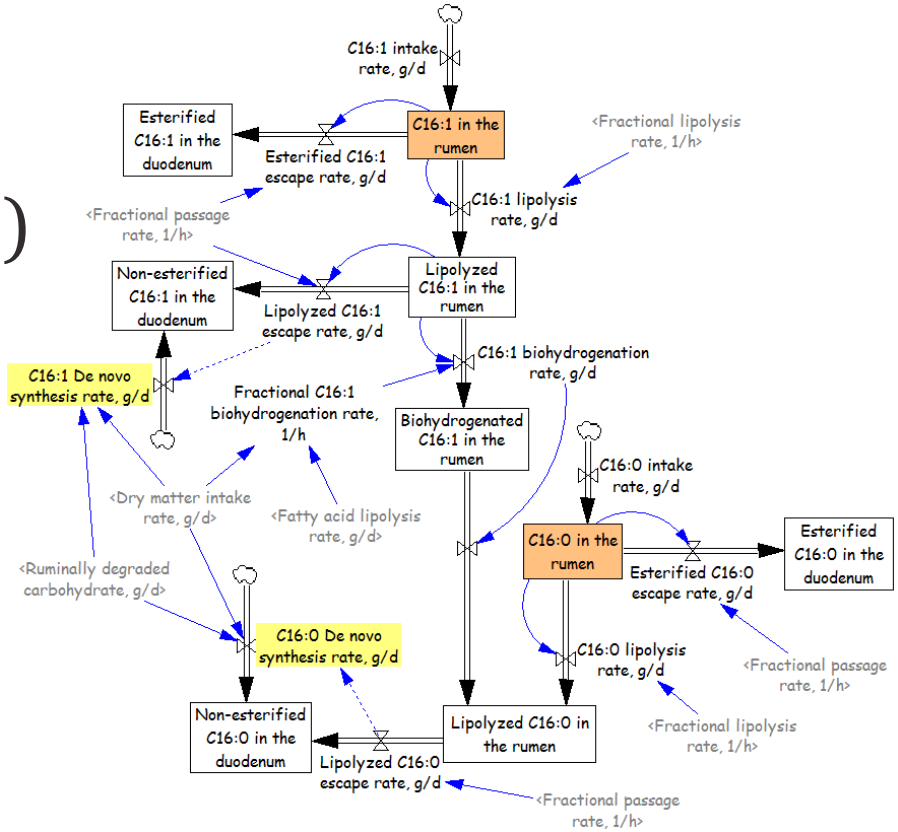
- ❑Digestibility of FA in the small intestine range from 55 to 92%
  - Chain length: decreases in chain above C18
  - Double bonds
  - Intake/BW (1g/kg BW or 7% DM)
- ❑GE of FA is 9.3 Mcal/kg (Hall and Eastridge, 2014)
- ❑Digestibility is 75% ➔ DE = 7 Mcal/kg
  - Assuming that there are no urinary or gaseous energy losses
- ❑ME = DE
- ❑NEg = 3.85 Mcal/kg

Long-Chain Fatty Acids (Lipids)



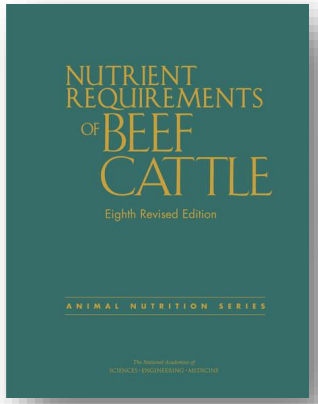
- NRC (1996, 2000) and NASEM (2016) do not account for long-chain fatty acids

- Tedeschi and Fox (2018)
  - Lipolysis
  - Biohydrogenation
  - *De novo* synthesis
  - Isomerization



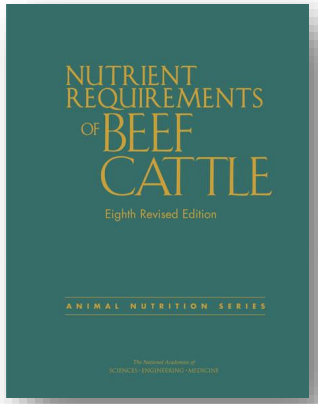
Protein Requirement for Growth

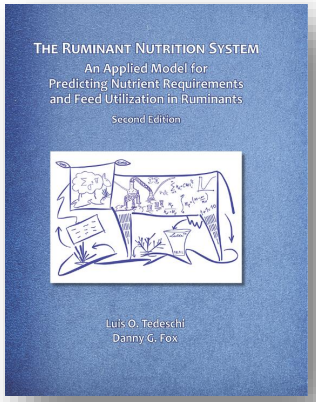
- $NPg = ADG \times (268 - 29.4 \times RE/ADG)$
- $MPg = NPg/k_{NP/MP}$
- $k_{NP/MP} = 0.492$ **<u>if EqSBW > 300 kg</u>**
- $k_{NP/MP} = 0.834 - 0.00114 \times EqSBW$ **<u>if EqSBW ≤ 300 kg</u>**



Energy Requirement for Growth

- EqSBW = SBW × SRW/FSBW
- EqEBW = 0.891 × EqSBW
- $RE = 0.0635 \times EqEBW^{0.75} \times (0.956 \times ADG)^{1.097}$

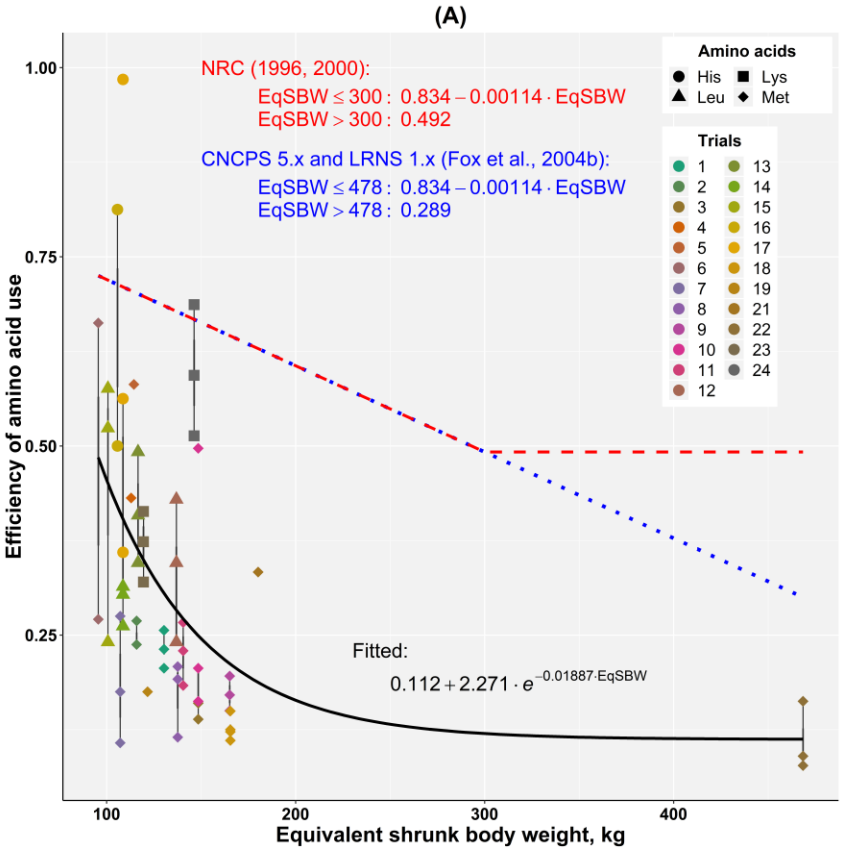




Efficiency of AA Use

- Efficiency of AA use do not support current MP/NP efficiency (Tedeschi and Fox, 2018)

- If the average EAAU is about 30%, how can MP efficiency of use be greater than 40%?

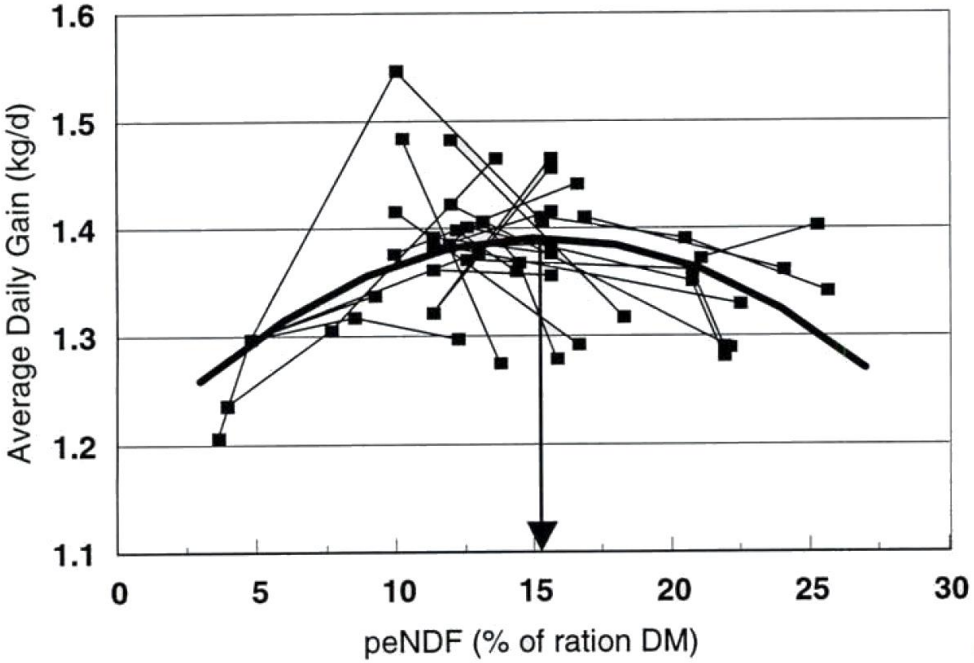


Requirement of Fiber

(Tedeschi and Fox, 2018)

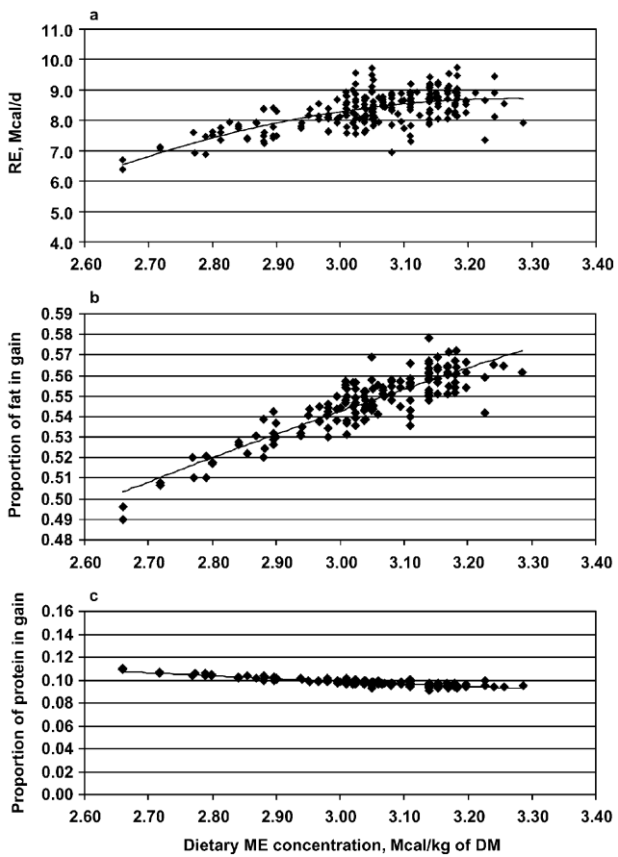
- Ruminal pH and motility $pH = 5.46 + 0.038 \times peNDF$
- peNDF

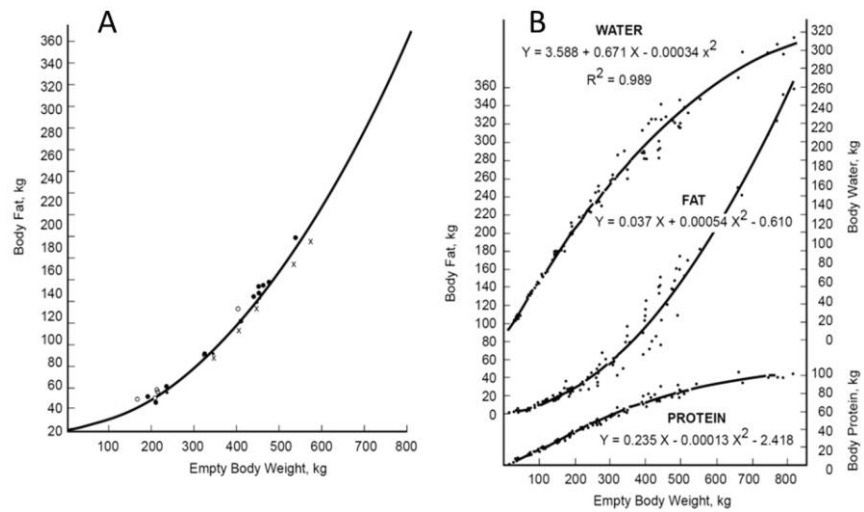
$$peNDFI = \begin{cases} 0.23 \times DMI & \text{Dairy cows} \\ 0.1 \times DMI & \text{Feedlot cattle, minimize acidosis} \\ 0.15 \times DMI & \text{Feedlot cattle, mazimize ADG} \end{cases}$$



Composition of Gain

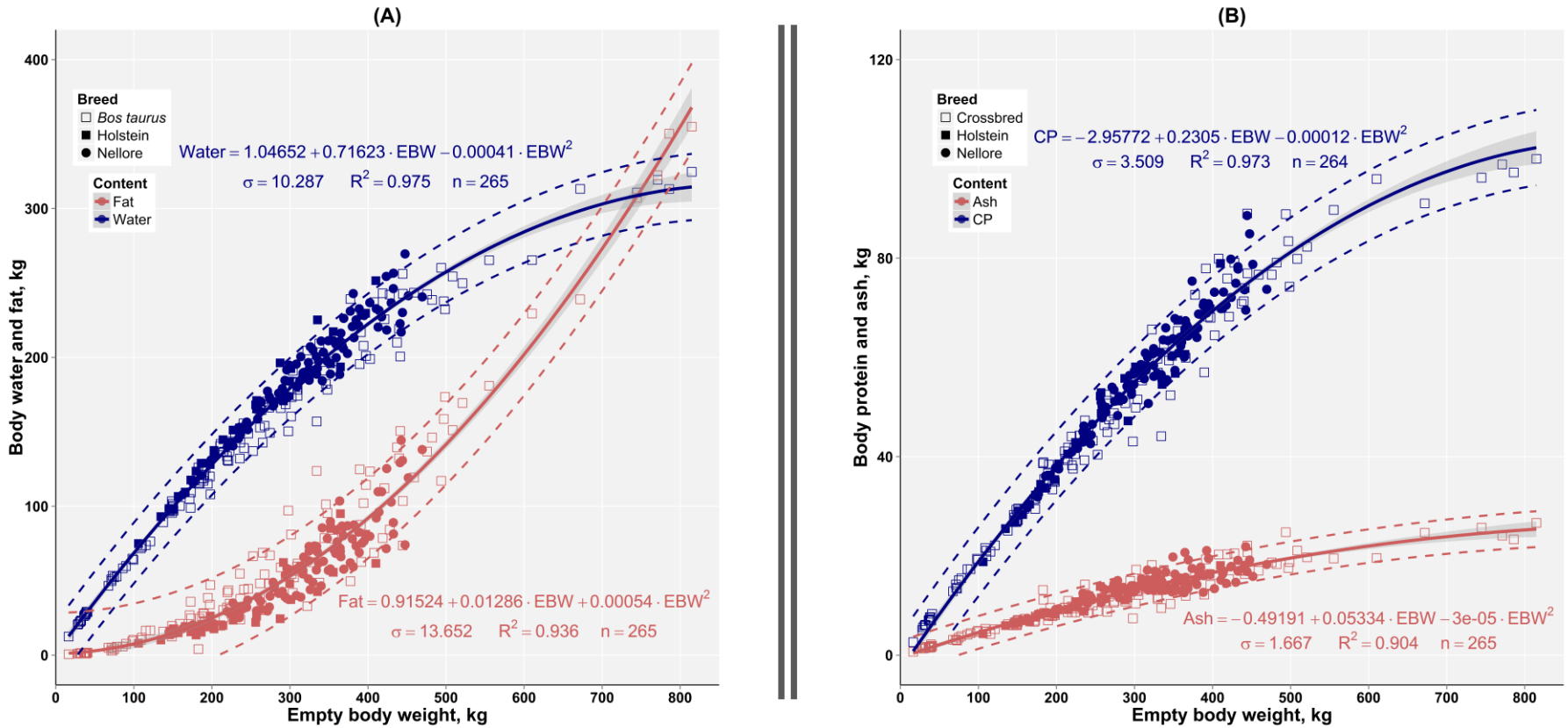
Composition of gain





Krehbiel et al. (2006)

NASEM (2016)



Revised Body Composition

Tedeschi and Fox (2018)

Composition of gain

USDA Grade	Marbling Score	Marbling Code	N	Carcass Fat, %	Empty body Fat, %
Standard	Traces/Practically devoid	3 to 4	45	23.55	21.13
Select	Slight	4 to 5	470	28.98	26.15
Choice –	Small	5 to 6	461	31.64	28.61
Choice	Modest	6 to 7	206	33.02	29.88
Choice +	Moderate	7 to 8	90	34.23	31.00
Prime –	Slightly abundant	8 to 9	51	35.24	31.94
Prime	Moderately abundant	9 to 10	32	35.80	32.45

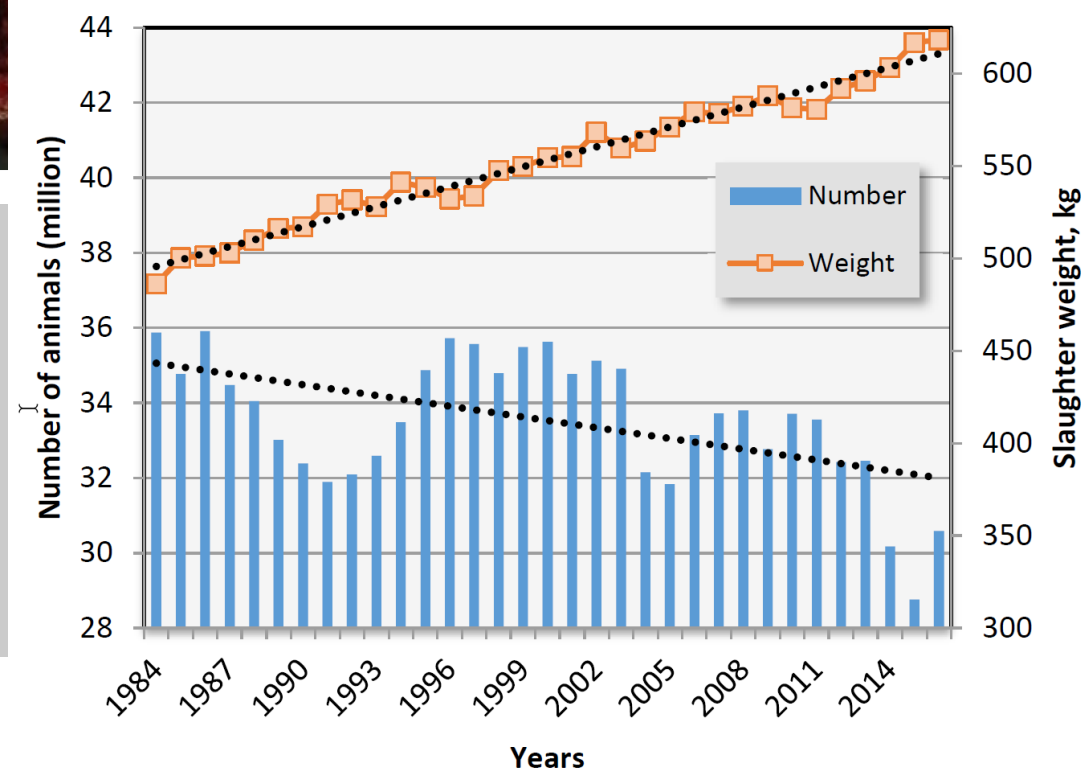
Items	Average USDA marbling scores			
	Devoid	Traces	Slight	Small
Body fat [1], %	22	25.2 ± 2.9	26.8 ± 3.0	27.8 ± 3.4
Standard reference weight [2], kg	400	435	462	478

In 2017 in the United States:

- Steers averaged 640 kg
- Heifers averaged 579 kg
- BW increases 3.6 kg/yr

In 2017 in the United States:

- 6% USDA Prime
- 72% Choice
- 18% Select



Tedeschi and Fox (2018)

Case Study

(Protein Requirement)

Case Study

- Assume a 350-kg animal, target gain of 0.8 kg/d with FSBW of 550 @ 25% empty body weight consuming 2.2%BW

EBF, %	SRW, kg
25.2	435
26.8	462
27.8	478

Required Metabolizable Protein?

- Based on this equations:
  - $MP_m = 298.2$ g/d (assuming 4% shrink of 350 kg BW)

  - $EqSBW = 265.75$ kg (assuming FSBW of 550 kg @ 25% EBF)
  - $EqEBW = 236.78$ kg
  - $RE = 2.86$ Mcal/d (assuming ADG of 0.8 kg/d)
  - $NP_g = 130.43$ g/d
  - $MP_g = 265.10$ g/d (assuming MP-to-NP efficiency of 49.2%)

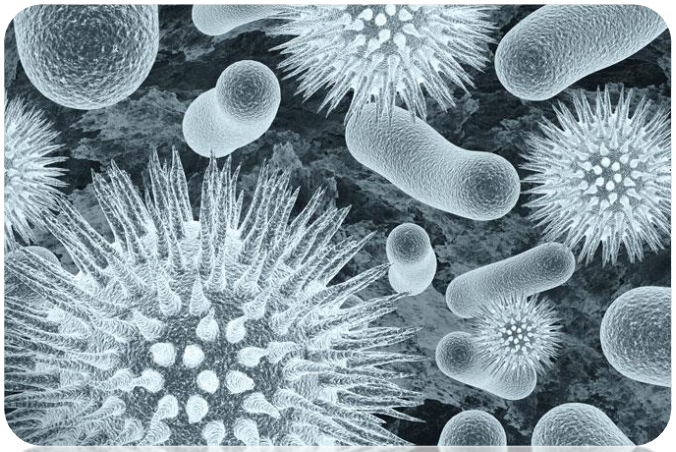
- $MP\ required = 298.2 + 265.10 = 563.32$ g/d

Energy and Protein Supply

- *Brachiaria brizantha*

  51.2% TDN, 7.06%CP, 39% RUP, 61% RDP
- 2.2 % DMI = 7.7 kg/d

Microbial Crude Protein



- NRC (1996, 2000)
  - $MCP = 0.13 \times TDN \times peNDF_{Factor}$
  - $peNDF_{Factor} = 1$ (if peNDF > 20% DM)
  - $peNDF_{Factor} = 1 - (20 - peNDF) \times 0.025$ (if peNDF ≤ 20% DM)

- NASEM (2016)
  - does not adjust MCP to peNDF
  - uses Galyean and Tedeschi (2016) equation to predict MCP

$$MCP_j = \begin{cases} (42.73 + 0.87 \times TDN_j \times DMI_j)/1{,}000, & EE < 3.9\% \\ (53.33 + 0.96 \times FFTDN_j \times DMI_j)/1{,}000, & EE \geq 3.9\% \end{cases}$$

Metabolizable Protein Supply

- Based on the Galyean and Tedeschi (2006) equations:
  - MCP = 385.7 g/d
  - MP_{MCP} = 385.7×0.8×0.8 = 246.86 g/d
  - MP_{RUP} = 212.9×0.6 = 127.7 g/d

- MP Balance = (246.86 + 127.7) – 563.32 = -188.76

Animals require protein supplementation; otherwise, they will not gain the 0.8 kg/d

Acknowledgements

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"Justin"

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